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Political parties

by Michael J. Malbin
799

Politicians and analysts who make it their business to check the temperature of the American voter are in fairly general agreement that the party alignments most of us have known for at least the past generation are not offering the voter what he wants. There is as much disagreement over what ought to be done about it as what this unhappiness will bring about. Next year's presidential election could result in a major political shift, or it could at least provide some guidelines as to the direction in which the American political system will move. NJR's exploration of the problem includes the texts of a series of interviews with political analysts.

Coal conversion

by James G. Phillips
816

An unusual de facto alliance of utilities and environmentalists wants to slow or stop President's Ford's plan to convert oil fired electric utility plants to coal and thus help in reducing U.S. dependence on foreign petroleum. While the whole program is facing some unexpected obstacles, the source of most of them is that the 1974 law authorizing the conversions was not meant to support the massive switch to coal being pushed by Ford. Included with the story is a list of the 80 oil and gas fired plants being considered for conversion to coal.

Romania trade

by Richard S. Frank
823

The Ford Administration has agreed to provide Congress with evidence that approval of a trade agreement between the United States and Romania is likely to bring changes in the emigration practices of that country. The precise form of the evidence is still to be determined, but the way the problem is resolved could point the way toward resolving similar problems with the Soviet Union and other Communist nations that are anxious for increased trade with the U.S.

Political

by Robert Walters
815

The failure of so many federal programs to end the problems they were designed to solve is creating a sense of frustration and disillusionment among many of the self-identified liberals who cherished the programs and fought for their enactment. A growing number of these people are beginning to suggest that a number of major federal departments may be serving little or no useful function beyond providing employment for thousands of civil servants.

Regulatory

by Louis M. Kohlmeier
826

With all the talk of reducing the regulation of the airline, trucking and railroad industries, there's been little discussion of reforming the regulation of the American merchant marine. The cost of merchant marine regulation has grown much more rapidly, and has become much more costly, in terms of direct federal expenditures, than railroad, trucking or airline regulation.

Presidential

by Dom Bonafede
827

In recent months, President Ford has increased markedly the pace of his appointments to federal jobs, most of them to middle-level executive positions. The step-up in the number of people holding federal jobs as a result of his having named them will make the Administration more responsive to Ford while also strengthening his political base.

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Political Report/Party system approaching crossroads in 1976 election

by Michael J. Malbin

There is a growing opinion among social scientists and politicians, including White House aides, that the American two party system is approaching a decisive crossroads in 1976. But there is substantial disagreement over where the system will go.

Perhaps the most widely publicized view is held by those who think that a majority of the American people are ready to join a conservative political party that would bring together the Republican followers of former California Gov. (1967-75) Ronald Reagan with the Democratic and Independent followers of Alabama Gov. George C. Wallace.

These people—including Sen. Jesse A. Helms, R-N.C., chairman of the Committee on Conservative Alternatives; M. Stanton Evans, chairman of the American Conservative Union; author Kevin P. Phillips; William A. Rusher, publisher of the *National Review*; and Howard J. Phillips, director of the Conservative Caucus—believe that the alignment of voting blocs that has dominated politics since the election of Franklin D. Roosevelt in 1932 finally is coming to an end.



Speculation about a ticket of George Wallace (left) and Ronald Reagan (right) typifies the uncertainties surrounding the American party system's future

its Watergate tainted name, and strike out with a fresh label.

The debate broadens considerably as soon as one moves away from the conservative movement. Some non-conservatives such as Walter Dean Burnham, a Massachusetts Institute of

ment and the growing willingness of party activists to work outside the two parties.

Still another view is that the turmoil that has characterized the political process in the past decade has had its effect and the parties can bounce back without either realigning or disintegrating. Among those who hold this view are authors Richard M. Scammon and Ben J. Wattenberg, Brookings Institution senior fellow James L. Sundquist and the top officials of both the Democratic and Republican National Committees. White House aide Calkins, while concerned about disintegration, also predicts the resurgence of the Republican Party, and with it, the two party system.

Party identification

Much of the recent theorizing is based on party identification trends in the past decade. A number of polling organizations have been looking at party identification. But no one organization's results can be compared directly to any other's because different organizations may use different sampling techniques, train their inter-

As the United States commemorates its struggle for independence next year, it also will be participating in a new struggle for the presidency that may culminate in a major revamping of its political party system. The signs of dissatisfaction with politics as they exist now are clear, and that dissatisfaction could result in a change in the system, in the parties or simply in the politicians. The texts of a series of interviews with political analysts are included with this article.

They believe that conditions are ripe for a political party realignment that will replace Roosevelt's depression-born configuration with a new type of "liberal-conservative" division in which the "conservative" party will be the new majority party.

They agree with Reagan that "conciliation and compromise" in "pale pastel" imitation of the Democrats cannot rally this new majority, but all say that a majority can be brought together with an uncompromising appeal to conservative principles.

The key point on which they disagree is whether the Republican Party offers a vehicle for them which can be remade in their image, or whether they should abandon the party, with

Technology political scientist, also think the United States is or will be in the throes of political realignment. But many, including White House political aide John T. Calkins, Democratic pollster Patrick H. Caddell and Republican pollster V. Lance Tarance, are concerned about something more far reaching—the possibility of a fundamental breakdown in the traditional two party system.

They point to the decline in voter identification with either major political party, the growth in self-identified Independents, the increase in ticket splitting, the growing independence of personal political organizations from political party organizations, the cynicism of voters about their govern-

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Party Identification 1952-1974: Michigan Survey

The University of Michigan's Center for Political Studies has been asking people their party identification every two years since 1952. A person's own party identification may not be the same as party registration or the way a person votes. Self-identified Republicans may well register as Democrats in some areas to

vote in primaries, and they may split their tickets in the voting booth. After the self-identification question, surveyors asked a second question designed to determine the strength of the identification or, in the case of Independents, the party toward which an Independent leaned. (Figures are in percentages).

	1952	1954	1956	1958	1960	1962	1964	1966	1968	1970	1972	1974
DEMOCRATIC												
Strong	22	22	21	23	21	23	26	18	20	20	15	18
Weak	25	25	23	24	25	23	25	27	25	23	25	21
Subtotal	47	47	44	47	46	46	51	45	45	43	40	39
INDEPENDENT												
Lean Democratic	10	9	7	7	8	8	9	9	10	10	11	13
Independent	5	7	9	8	8	8	8	12	11	13	13	16
Lean Republican	7	6	8	4	7	6	6	7	9	8	11	8
Subtotal	22	22	24	19	25	22	23	28	30	31	35	37
REPUBLICAN												
Weak	14	14	14	16	13	16	13	15	14	15	13	14
Strong	13	13	15	13	14	12	11	10	10	10	10	8
Subtotal	27	27	29	29	27	28	24	25	24	25	23	22
Apolitical, don't know	4	4	3	5	4	4	2	2	1	1	2	2

viewers in different ways or do any of a number of things differently. It is not even always possible to compare the results of two similar but differently phrased questions asked by the same company.

Every two years since 1952, the University of Michigan's Center for Political Studies has been asking a weighted sample of eligible voters whether they usually consider themselves Democratic, Republican or Independent. This is not the same thing as asking for party registration—a useless piece of information in many states—nor is it the same as asking how a person votes.

If the person being questioned says he considers himself a partisan, he is asked whether he considers himself a weak or strong identifier. If the respondent considers himself an Independent, he is asked whether he thinks of himself as leaning more toward the Democrats or the Republicans. Most of the leaners, the center has found, vote almost as if they were weak partisans.

Louis Harris and Associates Inc. and the Gallup Organization Inc. ask similar questions on party identification, but the Harris surveys date only from the early 1960s, while Gallup has not always asked the follow-up question that distinguishes Independent-leaners from Independent-Independents.

Michigan: According to the Michigan

data (see box, this page), both parties have been losing supporters to the Independents. Democratic identification remained fairly steady from 1952 to 1968, with a slight peak at the time of President Johnson's 1964 landslide defeat of Sen. Barry Goldwater, R-Ariz. Democrats have been losing support since 1968, with the sharpest drop at the time of the 1972 landslide defeat of Sen. George McGovern, D-S.D., by Richard M. Nixon.

Republicans, however, never quite recovered support after the Goldwater defeat, according to the Michigan data. The Democratic losses have not been matched by Republican gains, but by an increase in the percentage of Independents. The Republicans lost two more points between 1968 and 1970 but, surprisingly, there was no measurable decline directly attributable to Watergate in the 1974 post-election poll.

Arthur H. Miller, research director for the center, told *NJR* that Republicans may have contributed to the overwhelming Democratic victories of 1974 by refusing to vote, but they apparently remained Republicans once the air had cleared.

The group that has grown most spectacularly in the past decade has been the self-identified Independents. Roughly steady from 1952 to 1964, this group began to grow in 1966 and has not stopped since then. Independents numbered 23 per cent of the po-

tential electorate in 1964 and 37 per cent 10 years later. This is considerably higher than the 22 per cent who consider themselves Republican, and only slightly below the 39 per cent figure for the Democrats.

Gallup: The Gallup Organization's figures are similar to Michigan's, but there are enough differences to encourage caution about reading too much into specific historical events.

For example, while the Republicans never recovered from the Goldwater defeat in the Michigan data, they did in Gallup's. Gallup also shows a Democratic gain from Watergate, and some ups and downs in the percentage of Independents, rather than steady growth. According to Gallup, Independents are now at 32 per cent, well above the Republicans, who are at an all-time low of 22 per cent. The Independent figure is two points below the all-time Independent high, and well below the Democrats, whom Gallup has at a resurgent 46 per cent. (See box, p. 801.)

Harris: The Harris survey results show many more short term fluctuations over the past 10 years than do either the Michigan or the Gallup polls. For the first half of 1974, Harris had Republicans at 25 per cent, Democrats at 42 per cent and Independents at 33 per cent. For the second half of 1974, Harris showed Republicans at 21 per cent, Democrats at 47 per cent and Independents at 32 per cent.

Teeter: One other survey widely referred to is the December 1974 poll commissioned by the Republican National Committee and done by Robert M. Teeter of Market Opinion Research Corp. of Detroit.

Teeter decided to ask the University of Michigan's questions to a nationally weighted sample of eligible voters. He used the Michigan questions specifically to compare his results with the Michigan results from earlier years. (Michigan's 1974 survey results were not available until some time after Teeter presented his data to Republican state chairmen in January.)

Teeter's findings were worse from a Republican perspective than those of any other polling organization. He put Republican identification at 18 per cent, Democratic at 42 per cent and Independent at 40 per cent.

The figures jolted most Republicans who heard them, particularly since Teeter also found marked increases in voter cynicism toward government. One immediate result of his survey was a scaling down of the Republican plan to "sell" its party image in a media advertising campaign. (*For more on Teeter's poll and its effects, see Vol. 7, No. 9, p. 324.*)

What made Teeter's results look particularly bad for Republicans was his comparison of them with previous results from the Michigan center.

On virtually every question, Michigan showed voters moving in the same direction as Teeter did, but not as far. Miller said that he thinks, given the consistency of this pattern, that Teeter probably used a higher percentage of young people in his sample than Michigan did. Young people tend to be more distrustful, more cynical, more Independent and less Republican than older people do.

Age: Age probably is the single most important variable in surveys dealing with party identification, political participation and political cynicism. According to Miller, "About 80 per cent of the increase in Independents can be accounted for by young people." Miller said that while 51 per cent of people under 30 considered themselves Independents in 1974, only 25 per cent did in 1964.

The voting age people who were under 30 in 1964 are now between 30 and 40. Some of these voters have become Independents over the past 10 years, but the percentage of Independents in this group still does not approach the 51 per cent for those be-

Party Identification: Gallup Poll

The Gallup Organization Inc.'s survey question on party identification is not very different from the University of Michigan's. The major difference is that Gallup does not ask a follow-up question that would break Republicans, Democrats and Independents into sub-categories. Gallup shows a decline in Republican strength and a rise in Independents, as do the Michigan results. Unlike Michigan, Gallup shows Democratic strength growing in the past year, and less Independent strength than Michigan does.

	Republican % (18 and older)	Democratic %	Independent%
April 1975	22%	46%	32%
November 1974	23	47	30
July 1974	23	44	33
November 1972-February 1973	27	42	31
January-March 1971	26	45	29
	(21 and older)		
September-October 1970	29	45	26
January-June 1968	27	46	27
November-December 1966	27	48	25
March-May 1965	27	50	23
January-February 1964	25	53	22
August-November 1960	30	47	23
August-October 1950	33	45	22
January 1940	38	42	20

tween age 18 and 30 today, let alone the almost phenomenal 57 per cent for those between 18 and 24. (*See box, p. 802.*)

There always has been a correlation between youth and independence, but the correlation never has been this strong. Those whose political memories date back only as far as President Kennedy's assassination in 1963, the war in Vietnam and urban riots do not seem to be identifying strongly with either of the two major political parties. Two conclusions generally accepted among political scientists indicate what this may portend:

- Despite the growth of ticket splitting, a person's party identification still is a better predictor of his vote than any other single factor.

- In past political party realignments, major changes in the percentage of people identifying with one political party or the other came not from voters switching from one party to the other, but from new voters taking on an identification for the first time. (*See interview with Miller, p. 803.*)

Thus the political party that can capture the young voter's allegiance could dominate politics for the next generation. Miller said that more young people are Democratic than are Republican, but most are neither. This means that even though the Democrats clearly have the edge, the situation is far from settled.

Ticket splitters: The picture begins to look chaotic once one looks beyond self-identification to the way people actually vote. Lance Tarrance of Decision Making Information—co-author with Walter DeVries of *The Ticket Splitter* (Eerdmans, 1972)—reported in a March 1975 poll commissioned by the Republican National Committee that 23 per cent of those surveyed say they vote more for Republicans than for Democrats, 43 per cent say they vote more for Democrats, and 34 per cent say they vote for candidates from the two major parties about equally.

Since the actual voting electorate is made up disproportionately of people who identify with one or the other party—Miller told *NJR* that only 15 per cent of the people with no partisan leanings voted in 1974—Tarrance's figures suggest that a significant number of people who say they identify with a party split their tickets in the voting booth.

The number of ticket splitters appears to have grown almost as dramatically as the number of self-identified Independents. While there is no direct survey information on ticket splitters that is more than a few years old, there is substantial indirect evidence of its growth. To give just one example, the number of congressional districts in which the voters gave a plurality to congressional and presi-

1974 Party Identification by Age

The University of Michigan's Center for Political Studies breaks down its information about the party identification of Americans in different ways. Perhaps the most interesting breakdown for understanding the growth in Independents is the age breakdown. The following table, taken from the center's 1974 post-election survey, shows that the percentage of self-identified Independents is highest among young voters, and drops for each successive age group.

	18-24	25-29	All Under 30	30-59	60 and over	All Over 30
DEMOCRATIC						
Strong	11	16	14	18	24	20
Weak	22	23	22	23	17	21
Subtotal	33	39	36	41	41	41
INDEPENDENT						
Lean Democratic	22	16	19	12	9	11
Independent	27	21	24	14	10	12
Lean Republican	8	8	8	10	7	9
Subtotal	57	45	51	36	26	32
REPUBLICAN						
Weak	8	11	10	16	18	17
Strong	1	5	3	7	17	10
Subtotal	9	16	13	23	35	27

dential candidates of different parties increased from 3 per cent in 1900 to 44 per cent in 1972. (See box, p. 804.)

If the party identifiers who split their tickets about equally were added to the group of people who call themselves Independents (which is admittedly like adding apples and oranges), the two groups together might well comprise more than half of the total electorate. Moreover, trends suggest that both groups can be expected to grow. There can be no question, therefore, that these groups represent a substantial element of instability in electoral politics. What remains unclear is how this instability will work itself out.

Realignment

A number of conservatives are convinced that the electoral instability of the past decade is a signal for a major realignment in the political party identifications of the electorate.

Issues: Political scientists generally agree on five such realignments in American history associated with the elections of 1800, 1828, 1860, 1896 and 1932. Each of them dominated politics for at least a generation.

When used in this context, "realignment" refers to a durable change in political behavior, not to transient changes based on short term issues that sometimes lead life-long party identifiers to vote for the opposition party. Realignments generally have

occurred when some issue of lasting importance, not previously central to the division between the existing political parties, became so important and so divisive that voters became willing to form long term coalitions on opposite sides of the issue. The issue in 1800 was the power of the national government, in 1828 it was the democratic impulse of Jacksonianism, in 1860 it was slavery, in 1896 it was monetary policy and capitalism, and in 1932 it was the depression.

In each case, the parties reacted differently to the overriding political issue of the day, and voters for a generation based their partisan identifications largely on where the parties stood on that issue.

Impact: The long range impact of this stems from the importance of party identification in voting. Once a person identifies with either political party, that person tends to read current issues and candidates in light of that long standing identification. Perceptions of the facts are colored by partisan affiliation and, even if events lead him to vote for an opposition candidate, a party identifier will give his own party the benefit of the doubt and return to the fold in succeeding elections.

Party loyalties, a University of Michigan research team wrote in *The American Voter* (Wiley, 1960) "establish a basic division of electoral strength within which the competition of particular campaigns takes place."

Kevin Phillips: Conservative commentator and theoretician Kevin Phillips reads the current fluidity of electoral politics as the signal of a coming realignment. He first predicted realignment in *The Emerging Republican Majority* (Arlington House, 1969). The performance of the Nixon Administration since has made Phillips skeptical that the new majority ever will emerge under the Republican banner, but he thinks the potential for realignment is still there.

Phillips' new book, *Mediocracy* (Doubleday, 1975), presents his latest reading of how realignment is likely to occur. Although it was published on April 18, Phillips has been presenting its central theses for months in his *American Political Report*, a newsletter widely read among conservative activists. The book already has been warmly reviewed in *Human Events* and *National Review*. It appears well on its way toward becoming the standard theoretical reference work for third party conservatives.

Phillips argues that "the revolutionary social and economic changes of the 1960s also have revolutionized the underpinnings of U.S. politics." He says that "we are experiencing a degree of change like that of the mid-19th century," which saw the emergence in the United States of both the Republican Party and the Industrial Revolution.

He maintains that we have entered a new economic age in which the categories of the Industrial Revolution no longer are relevant, and says that "the present imprecision and obsolescence of party lines can be expected to yield new alignments based on the new socio-economic criteria."

Phillips' "new economic era" is one in which bureaucracies, "knowledge" and technology-related industries are increasingly important. The elites of these industries, unlike those of previous industries, are liberal allies of the client poor, with whom they have a symbiotic economic relationship, Phillips says.

Phillips says the Democratic Party irreversibly is dominated by the client poor and their upper middle class bureaucratic benefactors. The economic alliance of these groups against the taxpaying middle class, he says, has led to a neo-populist taxpayer's revolt that can be the basis of a new majority coalition.

The "total opportunity in American politics today," Phillips told the Con-

Arthur Miller: Chaos Without Realignment

Arthur H. Miller is the study director of the University of Michigan's Center for Political Studies. The center has conducted surveys of voter attitudes every two years since 1952. In this edited interview, Miller interprets the center's recent findings.

Q. How do you interpret the rise in the percentage of independent voters over the past 10 years?

A. It does mean a weakening of party ties, that's very clear. It means not only people are not tending to identify with one of the parties, but younger people, as they move through the life cycle, take on an identification at a much later age. It also means people are more likely to defect and vote for the opposition party.

Q. Are the new independents different from the ones you found in the 1950s? *The American Voter* reported that Independents were more ignorant politically than people who considered themselves Democrats or Republicans. Is that still true?

A. That's still true. You have to be careful of the interpretation here. Part of the interpretation should not be that they are more stupid. For a large segment of the Independents, the opposite is true. The implication is that a lot of people don't want to pay attention to politics any more, and that's particularly true among Independents and people who are apolitical. They are far more cynical about politics than the identifiers are, so they will tell you things like "it doesn't make any difference," or "why bother, you don't have any influence." So there are a couple of things happening. You have the normal being uninterested in politics that comes with being younger, and you have the other phenomenon, an increase in withdrawal and apathy.

Q. How much do Independents affect elections?

A. Not as much as identifiers do, simply because the Independents do not turn out. For instance, in 1974, the turnout among Independents was exceedingly low. When you look at turnout among Independents under the age of 30, only 15 per cent of them voted in 1974.

Q. What do you think is causing this? You suggested one possibility earlier, the growth in cynicism about government. I have heard several other possibilities mentioned: the cross-cutting issues of the 1960s, the weakening of faith in institutions, a more educated electorate and so on. Would you comment on these, indicating what factors you consider most important?

A. Let me pick the last first. It's true that what has been happening is that the voting public has become better educated. The reason is that the decline in turnout over the past six to 10 years has come primarily from among the less well educated. What happens then is that with a better informed public voting, they are better able to react in terms of the issues, so the issue cleavages that exist tend to have a greater importance. Now, the cleavages are strikingly there.

Within the Democratic Party, in particular, there is deep polarization between the conservatives and liberals, and that polarization tends to account for a fairly large percentage of the vote defections at the presidential level. If the party nominates someone who is not appealing to both wings, what happens is that one or the other wing gets basically alienated from the

party and that has a tendency not only to force them to vote for the other candidate, as the conservatives did in 1972, but also leads them to questioning what the party stands for.

Q. What does this mean for the parties over the long term? Let me again present two different interpretations heard frequently. One is that the parties are disintegrating, personal and factional candidacies are becoming more and more important, and party labels mean less and less. The other interpretation is that we are going through a time of classic party realignment, and that what is likely to emerge is a new alignment of voters along liberal-conservative lines.

A. Just because there is an extended period of chaos and a loosening of ties within the parties does not necessarily mean that there is going to be a realignment, particularly since a lot of the information on earlier realignments shows that what was most important was not people switching from one party to the other—that happened with relative infrequency. What was more important were the incoming voters and the identifications they took on. When you look at young people who are identifying, you find that they are favoring the Democratic Party over the Republican. Looking at it that way does not suggest a realignment. What is happening is that the bulk of the young people who are becoming voters are putting off taking an identification.

If you go through a period of instability, that means it is easier for one or the other party to capture the White House or any given seats. It reduces the stability of incumbents, particularly at the very high level. But later on, when the young people get around to identifying, you may find that in the aggregate, what you've got in identifications is exactly like those of the prior period. So you cannot necessarily jump from a loosening of party ties to a realignment situation, particularly given the present problems with the economy.

Q. What do you think of the thesis developed by Walter Dean Burnham and picked up by Kevin Phillips and others that what we are going through, with the development of a technological economy, is a new social and economic basis for the parties, and that the new parties will have to re-form around new issues so that, even if the numbers stay the same, it will be a different Democratic and a different Republican Party?

A. Well, so far the social characteristics do not seem to be doing a good job of identifying who the conservatives and liberals are. I have the feeling that they are so loosely tied to demographic factors, that it is more likely the new issues will disappear than that people will realign. Of course, if the Republicans can, over a long period of time, capture the loyalties of incoming voters, through this new issue cleavage, that would be one way to change the substantive focus of their party. But that means the new issues have to stay around for a long time.

Q. What about the other part of Burnham's thesis, the view of the progressive disintegration of the two party system?

A. Hardly any of the data would suggest that that is about to occur.

servative Political Action Conference Feb. 15, lies with a new political party that could capture these people. The Republicans are "the new Whigs," slated for extinction, not only because of Watergate, but because its big business ties are held in too much suspicion by the Wallace voters whom Phillips expects to be the backbone of the new majority.

Rusher: William Rusher's *The Making of the New Majority Party* (Sheed and Ward, Green Hill, 1975) is to Phillips' *Mediocracy* what Marx's *Communist Manifesto* is to *Das Kapital*. Where Phillips' book is an analysis of the current state of the party system, laced with a few predictions about the new majority, Rusher has written a practical handbook that is short on theory and long on practical advice for third party activists.

Rusher's theory essentially imposes Ayn Rand's categorization of the nation as "producers" and "non-producers" on top of Phillips' model of the new economy. (Rand's continuing influence among third party conservatives also can be seen in Howard Phillips' view that "self-determination" is the unifying theme binding together the concerns of neopopulists and old line conservatives. See box, p. 805.)

In Rusher's view, "circumstances have brought economic and social conservatives far closer together, in the past quarter century, than they ever were before. Prior to that time, most of the great social values on which they agree—unapologetic patriotism, anti-communism, a strong defense, respect for law, distrust for big government, and allegiance to the traditional mores—were common ground among all but a handful of Americans.

"The way was thus open for robust and even bitter disagreements over such issues as the respective rights of employers and employees, of debtors and creditors, of rich and poor. But only a grotesquely strained reading of recent American history will support the conclusion that these are the key issues in the mind of most Americans today.

"Instead, most of the values on which social and economic conservatives agree have come under sustained attack from the liberal, verbalist elite, supported politically and psychologically by its own proudest creation: an entire new economic and political constituency geared to the welfare ethic.

Split District

One set of statistics illustrating the decline of party identification is the growth in the number of "split results" at the congressional district level. A district is said to have a split result if it is carried by candidates from different parties for the presidency and the House. Almost nonexistent at the beginning of the century, more than two out of every five congressional districts were split in 1972.

Year	Number of districts	Percentage of split results
1900	295	3.4
1904	310	1.6
1908	314	6.8
1912	333	25.2
1916	333	10.5
1920	344	3.2
1924	356	11.8
1928	359	18.9
1932	355	14.1
1936	361	14.1
1940	362	14.6
1944	367	11.2
1948	422	22.5
1952	435	19.3
1956	435	29.9
1960	437	26.1
1964	435	33.3
1968	435	31.7
1972	435	43.7

SOURCE: Walter Dean Burnham, *Critical Elections and the Mainsprings of American Politics* (Norton, 1970).

That assault defines the truly key issue of our time."

Rusher maintains that only a new political party can counter this "assault." He is opposed to working within the Republican Party, he says, for three reasons. First, the liberal wing of the Republican Party has too much power, making it impossible for the party to pursue the policies that would attract working class social conservatives who support George Wallace. Second, even if conservatives can take over the Republican Party, "what will they have gained? The stain of Watergate, the onus of recession, and precious little else." Finally, "the Great Coalition must be in a position to make a clean break with the Ford Administration."

Statistics: Rusher, and most conservatives who agree with him, maintain that a conservative majority already exists that is open to the appeals of a new political party. Rusher writes that

"59 per cent of Americans with an opinion describe themselves as conservatives."

The figure Rusher is using comes from an April 1974 Gallup poll in which the Gallup Organization asked whether those surveyed would prefer a conservative or liberal party, if two new parties did replace the Republican and Democratic parties. Thirty-eight per cent said they would prefer a conservative party, 26 per cent said liberal and 36 per cent said they were undecided. When the undecideds were allocated on a proportional basis, Gallup said that 59 per cent considered themselves conservative and 41 per cent liberal.

A similar poll taken immediately after the 1974 elections showed 40 per cent conservative, 30 per cent liberal and 30 per cent undecided, or a 57-43 edge for the conservatives when the undecideds were allocated. Comparable figures in 1962 gave a 51 to 49 lead to the conservatives. In 1936 the conservative figure was precisely where it was a year ago, at 59 per cent.

Gallup's procedure of allocating the people who expressed no opinion raises some questions of method. One interpretation of the "undecideds" is not that they haven't made up their minds, but that they actively are rejecting the alternatives being offered.

When Louis Harris asks a similar question, for example, he gives people the options of choosing "middle of the road" and "radical" as well as conservative, liberal and not sure. Given this broader range of choice, conservatives fell in the Harris Survey from 37 to 30 per cent between 1968 and 1974, liberals fell from 17 to 15 per cent, radicals went from 2 to 3 per cent and middle of the roaders jumped from 31 to 43 per cent.

When broken down by the party of those responding, Democrats and Independents overwhelmingly described themselves as middle of the road, while Republicans gave conservatives only a slight edge over the middle (46 to 42 per cent). Conservatives are off slightly among Republicans since 1968 (from 47 to 46 per cent) while the middle is up from 31 to 42 per cent.

Harris' results are consistent with the interpretation Teeter has given his data. Teeter says that the terms "liberal" and "conservative," "left" and "right" are "simply not relevant" to most voters. Tarrance and Caddell both have agreed with this.

This is not to deny that people take

Howard Phillips: 'The Republican Party Is Going to Die'

Howard J. Phillips, 34, is national director of the new Conservative Caucus. One of the founders of Young Americans for Freedom in 1960, he was acting director of the Office of Economic Opportunity from Jan. 31 to June 30, 1973. In this edited interview, Phillips discusses the caucus, the future of the Republican Party, and the prospects for a new Conservative Party.

Q. Tell me a little bit about the Conservative Caucus.

A. We are targeting at that 44 per cent of the American people which is above the 18 per cent that identifies as Republican and below the 62 per cent that voted against McGovern in 1972.

Our plan is to find a state coordinator in each of the 50 states and a director in each congressional district. The congressional district director will work with the state coordinator in building a district steering committee . . . which reflects in microcosm the middle class majority in that district. We hope to have 435 caucuses with a minimum of 100 people each.

Q. Do you see a role for the caucus in the 1976 presidential election?

A. In this sense only: it's part of many things that need to be done. But electing a conservative President is not enough. Without the support of the grass roots and the Congress, the presidency would be of less value than it should be. I think the appropriate strategy for conservatives in 1976 is an Independent presidential candidacy. I believe that a Reagan-Wallace ticket would win. I am not thinking about a new political party in 1976 because frankly I think a new political party would have less chance. With an Independent presidential candidacy, guys like Phil Crane (Rep. Philip M. Crane, R-Ill.) or Jack Kemp (Rep. Jack F. Kemp, R-N.Y.) would not have to give up their Republican nominations but could support a Reagan running as an Independent.

We are having a national platform convention some time during the first nine months of 1976, in all likelihood subsequent to the Republican and Democratic National Conventions. The delegates to the platform convention, who will be chosen within each of the 435 district caucuses, could well decide to convert that convention into one that endorsed a nationwide presidential ticket.

Q. Wouldn't an Independent ticket just help elect a Democrat?

A. I am past the point of being able to perceive any value from retaining in office the Ford Administration. Frankly, if George McGovern had been elected in 1972, at least one political party would be opposing the things that have happened in the last several years.

Q. Do you expect a Conservative Party to replace the Republican Party, or do you expect conservatives to take over the Republican Party?

A. I think the Republican Party is going to die. I think it will linger through 1976. If an Independent presidential ticket, either Reagan or Wallace, does well, and by "does well" I mean 20 per cent or better, then I believe many of the people in the Republican Party who have clung to it with the feeling that it is their only hope, will desert it and the party will wither. If

there is 20 per cent support for a conservative ticket in 1976, I think there will be a new party in '78 which will run candidates from dog catcher to President and which, I think, will do very well.

The role of the Conservative Caucus, as I see it, is to serve as a halfway house. Even though the polls show that people are ready to accept the idea, there is no way the idea can emerge without somebody shooting it down.

Q. You say that because more people call themselves conservative than liberal, there is a conservative majority waiting to be mobilized into a new party. But when other people survey voters on specific issues, it turns out that they want to conserve the New Deal liberal approach to solving economic problems. How can you build a Conservative Party on this?

A. There is no question that there are issues on which a majority of the American people take a liberal position, whether with respect to energy, health insurance, or whatever. I don't expect people to agree with me on everything. When I say there is a conservative majority, I mean there is a majority that shares my basic premises and values. If they haven't reached the same conclusions I have, it's because their perspective on events has been different from mine. The next question is, are there sufficiently overriding issues to keep this group together? I think there are.

Q. What are they? What could give your group something you say political parties must have—coherent philosophy?

A. If I could sum it up in one word I'd say it was self-determination. People want to preserve the family, they want to determine their own lives, they're upset about 44 per cent of their income going for taxes and everybody telling them what to do, where their kids can go to school, how their kids can be educated, how to run their businesses, how institutions shall be run with respect to quotas, and sexual equality, and so forth.

This desire for self-determination is the one theme that goes through all of it, whether its taxes, or busing, or what have you. The one thing that doesn't tie in directly is the right to life theme, but the fetus is entitled to the protection of the law.

Q. Many voters in 1964 were concerned that this might mean an end to social security. Is this what you mean? And if not, how do you say "this far but no further" in a "coherent philosophy." Will voters buy this?

A. That really depends on the degree of economic crisis. In '64 they had more social security to lose than they do in '75. Conservatives aren't going to win in '76 calling for a repeal of social security and unemployment compensation. You can cut government spending without cutting those programs. There are other things that relate to national security and so forth that can carry a campaign. But the guy who belongs to the United Auto Workers or the AFL-CIO has his eyes more open now than he did in '64, and those programs are not sacred cows. Too much of what Barry Goldwater has predicted already has come true.

Alienation, Cynicism and Efficacy

In addition to its questions about party identification, the University of Michigan Center for Political Studies' surveys include several questions asking people whether they trust their government, and whether they feel they can influence the course of policy. Following are the questions and responses, expressed in percentages:

Trust: How much of the time do you think you can trust the government in Washington to do what is right—just about always, most of the time, or only some of the time?

	1964	1968	1972	1974
Always	14	8	7	3
Most of the time	62	53	45	33
Only some of the time	22	37	45	61
Don't know/Not ascertained	2	2	3	3

Big interests: Would you say the government is pretty much run by a few big interests looking out for themselves or that it is run for the benefit of all the people?

	1964	1968	1972	1974
For benefit of all	64	52	43	25
Few big interests	29	39	48	65
Other/Depends/Both	4	5	3	3
Don't know/Not ascertained	3	4	6	8

Honesty: Do you think that quite a few of the people running the government are a little crooked, not very many people are or hardly any of them are crooked at all?

	1964	1968	1972	1974
Hardly any	18	18	16	10
Not many	48	49	46	41
Quite a few	28	25	34	45
Don't know/Not ascertained	5	8	4	4

Efficacy: People like me don't have any say about what the government does.

	1964	1968	1972	1974
Agree	29	41	36	40
Disagree	69	58	64	57
Don't know/Not ascertained	2	1	1	3

positions on political issues that politicians might classify as liberal or conservative. Teeter says that people take centrist positions on New Deal economic issues, but conservative ones on "social control" issues.

Gallup, in a 1974 pre-election survey, found people taking "liberal" positions on domestic spending for social programs, women's rights, wage and price controls, campaign financing and relations with Cuba. They took "conservative" positions on school busing, the death penalty, unconditional draft amnesty and the legalization of marijuana. People were about evenly divided on cutting defense spending, ending legalized abortions through the first three months of pregnancy, federal aid to parochial schools and a 5 per cent income tax surtax. Gallup did not ask any energy-environment questions. The results

obtained by William Watts and Lloyd Free in *State of the Nation, 1974* (Harper, 1974) were similarly mixed, perhaps somewhat more "liberal."

Reagan and Wallace: The weakness of the data used by conservatives to prove the existence of a conservative majority does not undercut the support in the electorate for both Wallace and Reagan. In early April 1975, Louis Harris asked voters how they would vote if they had to choose between President Ford and Sen. Edmund S. Muskie, D-Maine. The two ran exactly even—45 per cent each. Ten per cent were undecided.

Harris then asked how they would vote in a race among Ford, Muskie and Reagan. Thirty-nine per cent said they would support Muskie, 29 per cent picked Ford, 21 per cent chose Reagan, and 11 per cent said they were not sure.

In a similar survey in early May, Harris asked people to choose among a Democratic ticket that included Sen. Edward M. Kennedy, D-Mass., and Sen. John Glenn, D-Ohio, a Republican ticket of Ford and Nelson A. Rockefeller, and a "Conservative-Independent" Reagan-Wallace ticket. Kennedy-Glenn drew 38 per cent to 30 per cent for Ford-Rockefeller and 23 per cent for Reagan-Wallace. Harris said this was the highest third party preference he ever has recorded.

Democratic pollster Caddell partly confirms this. He said he has never seen as high a level of support for Wallace as he has in some of his own recent polls.

The support for Reagan and Wallace clearly is significant. They have not yet shown the strength to win, but they may have the power to deny a victory to Ford.

If Reagan stays within the Republican Party, a third party ticket might be headed by Wallace. Reagan draws from Ford, but Wallace may draw support from both parties about equally. Perhaps more important, the widespread support for Wallace is not necessarily the same thing as support for a new political party.

While it is too early to know the intentions of either Wallace or Reagan, the likelihood of a third party race by Reagan is considered less than an Independent race by Wallace, assuming he is not on the Democratic ticket.

Reagan—Reagan aide Peter Hannaford said in an interview that Reagan believes the two party system has served us well, and third parties only elect the person its adherents are trying to defeat.

When asked whether he thought Reagan meant that one of the two major parties should be the Republican Party, Hannaford said that Reagan has specifically said that in some of his speeches. While Hannaford would not rule out a third party race or a Reagan-Wallace ticket, he emphasized the Republican Party. Nor would Hannaford or anyone else close to Reagan say whether he thought Reagan would challenge Ford for the Republican nomination.

But the conservative Republican political consultant, F. Clifton White, who is close to Reagan, said that he thinks "probably a majority" of the third party talk by Republican conservatives would be stilled if Reagan did make a run for the GOP nomina-

Eugene McCarthy: 'The Parties Work Very Badly'

Former Sen. (1959-71) Eugene J. McCarthy, D-Minn., is running for the presidency for the third time. But while the 1968 and the brief 1972 campaigns were attempts to gain the Democratic Party's nomination, this year McCarthy is running as an Independent, directly challenging the two party system. McCarthy discusses his views of the party system in this edited interview.

Q. Why have you decided to run as an Independent?

A. It would be hopeless for me to do anything in the Democratic Party because of some of the things that are left over from '68—the regular party people, the Kennedy people, and so on. Even if there were no dispute on issues or procedure, there is just too much resentment left over. But the other consideration is that I just don't think much is going to come out of the party process.

Q. What do you think is the problem with the party process?

A. We raised that issue in the party in '68, saying the process was unrepresentative and had to be opened up. Now we raise it in the broader scheme, saying actually the two party system is a restrictive system. What we really need is to open up the whole procedure by which Presidents are chosen, and this involves a challenge to the parties, to both of them, and to their methodology. What you get now is a brokered convention in which each party brokers a candidate. People say you can't have a brokered electoral college. Why not? Why should we be dependent on what happens in the two parties as a preliminary to a national choice?

Q. Why would that be any better than a brokered convention?

A. I don't say it would be any better, but you know where it's happening, you know everybody who's there and they're out in the open. Who knows who brokers the conventions?

Q. Do you see yourself as a kind of lightning rod for dissatisfaction with the party system?

A. Well, I would be just as happy if (former Oregon Gov., 1967-75) Tom McCall would run in a couple of states and I could run in another and let's put something together and have an electoral college meeting that means something.

Q. But the point is, are you trying to have an effect on the over-all party system?

A. On the over-all political system, and since that includes control by the parties you have to do something about the parties. It isn't just a question of trying to reform the parties. As far as presidential politics, we'd really be better off if we didn't have winner take all.

Everybody talks about instability, but what you have now are three bad ideas running the act. One is the idea of party loyalty as an excuse. So you have Democrats supporting the war in Vietnam because you had a Democratic President, turning against it when there was a Republican President. Then you had Republicans supporting Nixon after it had become obvious that he should be impeached. Party loyalty got in the way of judgment in both cases.

Second, you have the idea of a loyal opposition,

which has no place in a congressional system. You see it in the way Congress is reacting to Ford. And the third is this thing about two parties being less sensitive to make the country work right. You have roughly 435 parties in the House of Representatives as it is. If you picked the President in the electoral college it would be much more representative than what you have now.

Q. But why would it be more representative? It sounds like just another smoke filled room.

A. They (the electors) have been chosen by people who know them. It's always true that you work through representatives, unless you have a popular election. This is more representative because you have fewer places where the minority decision would be eliminated. You'd keep it until the last decision.

Q. What is your response to the argument made in favor of the party system, that parties are the one mechanism we have for getting the different branches and levels of government to work together?

A. We've had a non-partisan legislature in Minnesota for 25 years and a partisan election for the Governorship and it works. People say it, but there's no evidence, that it wouldn't work. Matter of fact, there's evidence that partisanship makes for bad government when you have a President of one party and a Congress of the other. So it works both ways. If you had a brokered President out of the electoral college, he could then turn to the Congress and say, "Look, I'm not the President of the Democratic Party, I was picked through this process and here I am." The psychological commitment, it seems to me, would be much stronger.

Q. Why do you think you will have better government with weaker parties?

A. I don't know if you would have better government. You would have more representative government, and that's one of the things we're committed to.

Q. Do you think we should expect to see a multiplication of Independent presidential candidacies, or do you think we are more likely to get a reshuffling of the two major parties, leaving the Democrats more liberal and the Republicans more conservative?

A. It depends on what we do about structure. If you are going to pass laws that favor the two parties, maybe you can adjust within the two parties, maybe you get to the point where neither party means anything and you just sort of trade offices. Or you get a polarization like in England where you can't have government.

Q. Are you finding support among people you would expect to be your natural allies?

A. The press ought to be with us, the ADA (Americans for Democratic Action) ought to be with us, the liberals ought to be with us. But they're still playing the old game. They want to capture the flag.

Q. Why shouldn't they be satisfied if they can capture it, as they did in '72? Aren't they more likely to get the policies they want by playing that old game?

A. I don't think they are. First of all, I don't think they'll capture it. And even if they do, they're going to get what they got with McGovern when they got beat.

Q. Wouldn't McGovern have been beaten your way?

A. He wouldn't have gotten beaten that badly.

tion. He said he has a "hunch" Reagan will challenge Ford for the Republican nomination.

Wallace—Wallace, on the other hand, actively is considering a third party race. His campaign manager, Charles S. Snider, said in an interview that "if the Democrats want to turn a deaf ear to the majority of the people in this country, then they will do so at their own peril. I feel very strongly that Gov. Wallace will give the people of this country the opportunity to express their opinion."

While Snider, as Hannaford, refused to rule out a Reagan-Wallace ticket, he made it clear that Wallace is proceeding on his own to make sure he has the option to run as an Independent if he wants to. "We are encouraging people who are working toward getting ballot lines in the 50 states," he said.

If Wallace runs as an Independent, his ability to deny an electoral college victory to either candidate probably will depend on whom the Democrats nominate. A nominee such as Sen. Henry M. Jackson, D-Wash., who would have labor union support and would be for a strong defense budget, could weaken the Wallace candidacy, but strengthen a liberal Independent candidacy such as that of former Sen. (1959-71) Eugene J. McCarthy, D-Minn. (For an interview with McCarthy, see box, p. 807.)

But if the Democrats move in the opposite direction, choosing someone who is not popular with labor's hierarchy and wants to cut the defense budget significantly, it is not at all clear whether the net effect would help Wallace or Ford.

Party revival

Despite the growth in ticket splitting and Independent identification, the two party system is in no immediate danger, say such people as Ben Wattenberg.

Wattenberg said the theory that there will be a major party realignment with a new Conservative Party replacing the Republicans assumes that both Democrats and Republicans will "keep behaving like jerks."

If there are enough votes to be gained by standing for law and order and opposing busing, Wattenberg said, somebody in the two major parties will be smart enough to figure it out and steal the issue. (For an interview with Wattenberg and Richard Scammon, see box, p. 811.)



John T. Calkins

The University of Michigan's Miller does not predict a two party recovery as strongly as do Scammon and Wattenberg, but he said that he thinks there is no data to support predictions of either a major party realignment or a disintegration of the two party system. (See box, p. 803, for an interview with Miller.)

James Sundquist said he thinks there conceivably could be a realignment of the sort predicted by Phillips and Rusher, but only if the conservatives are able to make voters feel more concerned about "social issues" than about economic issues.

Sundquist rejected the idea that the new economics had created a "producing" class that could be bound together against a "non-producing" class on economic issues. Far more significant economically, he said, is the division between the less-well-off and the more-well-off.

If the Democrats stress this division, he said, and if they stress other issues that raise the classic Democratic-Republican differences over the proper extent of governmental intervention to solve problems, the likely result will be a strengthening of both political parties. (For an interview with Sundquist, see box, p. 809.)

White House political aide John Calkins essentially agrees with Sundquist that the social and economic class structure in the United States does not follow the model created by Phillips and Rusher. Calkins' prescription for Republican recovery calls for the party to spread a broad umbrella that would include Americans who are in the middle class as well as those who aspire to become middle class.

(For an interview with Calkins, see box, p. 812.)

Calkins' way of looking at things is the partisan obverse of the analysis offered by Sundquist. Where Sundquist talks about the less-well-off and more-well-off without saying where the national average is, Calkins plays down the need for a drastic policy of economic redistribution by calling the United States a middle class nation.

This disagreement is the classic stuff from which the 1932 alignment was made. If both parties continue to draw the issues this way, Sundquist's predictions could receive a direct test. The problem with this, as Sundquist observed, is that politicians may not be able to control the issues this precisely.

Disintegration

The insistent data about Independents and about ticket splitters leads some analysts to doubt both the return of the old pattern and the likelihood of a classic realignment.

"I am convinced we are in a political decomposition period," Lance Tarrance said in an interview. "People have been grasping for something that is not in the two party system."

Others, such as Robert Teeter, associate this "decomposition" with the "tremendous" increases in the levels of cynicism in and alienation with the whole political system." (See box, p. 806.)

Others, such as Clifton White, see it as part of a "breakdown or readjustment in all of our fundamental institutions"—church and family as well as political parties.

Patrick Caddell said he thinks the most likely result will be an increase in multi-candidate and multi-party races.

Caddell's multi-party prediction is lent support by some of the results of the 1974 elections:

- An Independent was elected Governor of Maine.
- The American Party candidate for the Senate from Florida received 15 per cent of the vote.
- The Conservative Party's Senate candidate in New York received 16 per cent. (The party elected a Senator in 1970.)
- The American Party's Senate candidate in Utah received 6 per cent.
- La Raza Unida's gubernatorial candidate in Texas received 6 per cent. (For more on voter independence in the 1974 elections, see Vol. 6, No. 46, p. 1716.)

James Sundquist: The New Deal Issues Still Exist

James L. Sundquist, a senior fellow of The Brookings Institution, wrote Dynamics of the Party System: Alignment and Realignment of Political Parties in the United States (Brookings, 1973). In this edited interview, he discusses possible realignment.

Q. Do you think the 1974 elections signaled the impending death of the Republican Party?

A. I think that's overreacting. Parties have their ups and downs, and you would expect the Republican Party, with what it went through with Watergate, to take quite a shellacking. I would think that when it gets firmly established under new leadership, it can rebound most, if not all, of the way back to where it was. However, where it was, even before Watergate, wasn't any too high. Both parties have been slipping.

My interpretation of the 1974 elections was that it acted to reaffirm and reinstate party allegiances. The thesis of *The Dynamics of the Party System* was that the rise in Independents was because of the cross-cutting issues that dominated the last half of the 1960s. But I predicted there that if the political contests focused on domestic issues, the kind that formed the rationale of the present party system—that is, economic issues and class issues—that should operate to strengthen the bond between people and their parties.

In order for voters to attach themselves to parties, they have to see that the parties have a real difference on issues that matter to them. They did not have a real difference on all the cross-cutting issues. But when you get back to the old taxing, spending, government intervention, government regulation complex of issues, then the parties will tend to come out on opposite sides.

Q. Some analysts have suggested that the growth of the middle class has made it difficult for parties to dramatize the economic and class issues.

A. There are two bases to the New Deal party alignment. The basic one, it seems to me, is the issue of activism in governmental intervention, and the other is the class division. The reason they coincided so well in those days was that the intervention tended to be redistributive, on the side of those who were doing less well. But it never coincided perfectly with class. You had rich interventionists in the New Deal days.

Q. But if there are substantially fewer people who are poor. . . .

A. But there are not substantially fewer people who are less well off than other people. The distribution of incomes has not changed a bit. The majority of the people still make less than the average income, and they want government to act on their behalf.

But they also want government to act for other reasons. They want something done about the environment, consumer protection, equal rights and so on. A lot of these things are not directly related to a person's class status.

Q. You suggested earlier that one way to reduce the percentage of Independents would be for the parties to come out dramatically and decisively on different sides of the same issue. . . .

A. That can be done either on the old alignment or the

new one. What Reagan and company are trying to do is in effect bring about a realignment. If they can get the parties on opposite sides of what are now cross-cutting issues, they can realign the electorate the way it has been done at intervals in the past, and they think they will come out with a majority. But if the issues on which the parties take opposite sides are along the lines of the current cleavage, it will strengthen the current cleavage and the percentage of Independents will go down just as if a realignment had occurred.

Q. If you were in President Ford's position, with the Republican Party where it is, what would you do? Would you try to compromise with the Democrats on economic issues, or would you try to polarize and risk the kind of defeat Goldwater took?

A. Goldwater didn't do exactly what Reagan is trying. Goldwater tried to be ultra-conservative on the existing set of issues. He didn't do much in '64 with the cross-cutting issues. He talked about law and order and he voted against the civil rights bill, but the big things in people's minds in that campaign were that he was against social security, for selling the TVA (Tennessee Valley Authority) and that kind of stuff. He thought he could get a lot of hidden and inactive conservatives to come out.

If Reagan is going down the economic conservative course, that's the way to disaster. If he is trying to flush out these social conservatives who are economic liberals, and get them to vote conservative because he so dramatizes the social issues that they become predominant, then it's a gamble he could win if he can bring those issues to that kind of prominence.

But I doubt if any candidate could do that. I don't think the candidate makes the issues. The issues make themselves and then the candidates respond to them. At the moment, the social issues just are not in people's minds, with the exception of busing in a few localized spots. If the economy is in lousy shape, that's what people will be concerned about, not pornography.

I think probably what the Republicans ought to do is what they did in 1938 and 1940—take a good conservative stand on the old issues.

Q. But how can a Republican do this without becoming another Goldwater?

A. They have to make the transition that they made between Hoover and Willkie. Goldwater went back for the first time since Alf Landon and really challenged the fundamentals of the New Deal. The course that has been successful for the Republicans ever since they started their comeback in 1938 has been not to challenge fundamentally the system of intervention that has been built up, but to indicate that they are going to do it cheaper, with more businesslike management.

Q. And what about the Democrats?

A. I think the Democrats ought to be pushing the frontiers of social intervention further, forcing the President's veto, and campaigning against the veto. They can do that in a number of fields: health insurance, the environment, consumer affairs. If they do that, both parties will get back some Independents.



Arthur H. Miller

The 1976 presidential election virtually is certain to have at least one Independent candidate whose name will be well known to the voters (McCarthy) and may have others in Wallace and Reagan.

Control—This increase in Independent candidates is an extension of something that has been going on within the parties since the turn of the century. As Richard Scammon said in an interview, the parties have been losing control over who runs under their label ever since the nominating process was opened up through the enactment of primary laws.

As traditional party machines have become less able to control the nominating process, personal political machines have replaced them. Many of the recent increases in congressional staff allotments—including the growth in recent years of clubhouse style congressional offices in the district—can be read as signs of the institutionalization of personal political organizations independent of the local parties.

Several people have argued that the replacement of party organizations with personal ones has brought about a situation in which many candidates may be only a step or two away from disregarding party labels entirely to run as Independents. This step will be made even easier, they say, if the parties continue to diminish in importance as guides to voting.

On the other side of the issue, Watenberg is one of those who maintains that office holders require political parties for too many things, such as their legislative committee assignments, to make it easy for them to work outside the party structure.



Kevin Phillips

Finance: H. Edward Mahe Jr., Republican National Committee executive director, said that the new campaign finance law gives the two party system a strong institutional boost. He said the law's spending limits will make candidates more dependent on the parties for technical services.

But the campaign finance law may not be able to carry a burden as heavy as the preservation of the two party system, even if it does survive constitutional scrutiny in the courts. Wallace has shown that a candidate can get by without using public funds. In addition, according to Marc F. Plattner writing in the Fall 1974 issue of *Public Interest*, the provision in the law that was intended to give equal protection to minor parties "might help to protect them beyond their natural life." Plattner said that if the law had been in effect in 1968, Wallace would have received no federal money for his third party campaign. But in 1972, American Independent Party candidate John G. Schmitz would have received a multi-million dollar federal contribution that would have been based on Wallace's share of the 1968 vote.

The new law also has a disruptive effect within the parties. Richard A. Viguerie, the direct mail specialist who is raising money this year for Wallace and the Conservative Caucus, said in an interview that the law, by favoring direct mail, gives a distinct advantage to ideological candidates over centrists.

To the extent that this is true, it means that the law favors precisely the type of candidates who, if they win the nomination, will stimulate opponents

to run against them as Independents. **Philosophy:** None of this would be particularly significant if voters were more attached to the parties than they are. The great unanswered question for party leaders is how to generate this attachment.

One theory, the "responsible party government doctrine," says that the way for a party to gain new adherents is to impose some view of what it stands for on its candidates. Republican conservatives and some "reform" Democrats share this view.

If this theory is correct, it would mean that parties never will be able to recapture people from the growing pool of Independents unless they somehow can gain greater control over the nominating process, perhaps even reversing the trend toward primaries and more open caucuses. But, since no one thinks such a step away from procedural democracy is likely, some adherents of this theory conclude that a further weakening of the two party system is bound to occur.

Both parties have rejected this theory. Virtually every speaker at the Republican Party's Leadership Conference held in March, from President Ford on down, spoke of the need for an "open" and "broad based" party.

The Democratic Party's Charter Commission rejected proposals that would have required formal party membership and would have empowered the party to take Democratic positions on the issues. In one move the "responsible party" theorists liked, Democrats adopted a set of presidential delegate selection rules that may result in a multi-balloted convention. But these rules were written out of a desire for democratic procedure rather than party responsibility. (*See Vol. 6, No. 38, p. 1407.*)

Openness—Top officials in both parties maintain that "openness" rather than "responsibility" is the key to reversing the decline in party identification.

Republican National Committee Chairman Mary Louise Smith said in an interview that the best way to gain new party adherents is to attract people to individual candidates.

Democratic National Committee Chairman Robert S. Strauss said that as both parties begin implementing affirmative action programs under which local party organizations inform people how to participate in party affairs, this will increase party identity

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Scammon and Wattenberg: Conservatives Will Fail

Richard M. Scammon and Ben J. Wattenberg in 1970 wrote The Real Majority (Coward-McCann, 1970), a book that was intended both as a lesson for Democrats who feared the "law and order" issue, and a reply to Kevin Phillips' The Emerging Republican Majority (Arlington House, 1969). Scammon, director of the Elections Research Center in Washington and former director (1961-65) of the U.S. Bureau of the Census, currently is preparing a book on voter registration laws abroad for the American Enterprise Institute for Public Policy Research. Wattenberg, an aide in the 1972 presidential nomination campaign of Sen. Henry M. Jackson, D-Wash., wrote The Real America (Doubleday, 1974). In these separate edited interviews, Scammon and Wattenberg assess the state of the party system.

Scammon

Q. Do you think we are about to have a major political party realignment?

A. The only thing you can really talk about are presidential candidates, because when you talk about parties in any other sense, the fact is that every other nomination is controlled by the local electors in primaries. If you were talking about 1976, my guess would be that the so-called conservative effort would either fail or elect a Democrat.

Q. What about the argument made by some conservatives that the Republican Party is on its last legs?

A. The Republican Party has been dying for 120 years. This is what they said after Landon went down. These two parties are institutionalized in many states. The idea that you are going to set up some new party, call it Conservative, and put up candidates for Congress, Senate, county auditor, state legislature, and so on, I don't believe it.

Q. Primarily for institutional and legal reasons?

A. Partly because of institutional and legal reasons, partly because of inherited loyalties, partly because of the mathematics of the situation. If you really ran conservative candidates against Republicans for Congress everywhere in the U.S., you could easily reduce the number of Republicans in Congress to under 100 if the conservative candidates were anywhere successful. Now, it's a little different in New York because in New York both the Liberal and Conservative Parties live because they can be endorsing lines. But if you required a candidate to run only under his own party label, none of the big party candidates would run with conservative or liberal endorsement. Those two parties would wither in one election. If the conservatives are strong enough to set up a third party, they are strong enough to take over the Republican Party, if the Republican Party is as weak as they say it is.

Wattenberg

Q. Some conservatives seem to think a Wallace or a Reagan-Wallace campaign could be their engine for destroying the Republican Party and creating a new Conservative Party...

A. That's the politics of suicide for conservatives—to elect Ted Kennedy or Mo Udall or Ed Muskie, so in 1984 they can put something together. The world is going to turn around many times before then.

It seems to me the beauty of our two party system is that the two parties are not rigid or doctrinaire or terribly ideological. They are pretty much empty vessels, and because of the unique nature of our primary system, these non-Europeanized empty vessels can accept any color liquid you choose to put in them, if you have the delegate votes.

There's a vehicle in place for these guys to go to, and that's the Republican Party. All they have to do is to win the primaries. I am just wondering what the conservatives gain by scrambling all the eggs to set up a new party. By the time all the foot shuffling got done, you would screw away one election, two elections and what do you have—you have another empty vessel party with a new name on it.

Q. Some people think that instead of a new two party system, we will have a disintegration of the parties with many more third and fourth party candidates bolting the two parties than there have been in the past.

A. We have had third, fourth and fifth parties in most races, and they don't draw flies. The reason is that there is a dynamic working against them. First of all, candidates will be lured into running within their own party. If they win, they win. If they lose and bolt, they're considered sore losers. After the two parties pick the major candidates and then some rump convention picks a Reagan or whatever, unless the polls show them way up high right away, they have to face the whole he-can't-win syndrome.

The thing that usually prevents bolts is that all the bolters want to take over the parties. Once you bolt, it's hard to come back. Moreover, you just about rule out, because of the seniority structure, any possibility of getting support from well known politicians. So there are a lot of strikes against them.

These grand theories are always being dreamed up, and the fact that they so rarely come about tells you something. There is something in the mechanism that tends to respond. Our political mechanism is cooptive and responsive.

If these ideas have crept up on us so silently, and there is something called conservatism that's so hot that it's got this majority, I will guarantee you that every liberal Democrat will be swiping some of that conservative rhetoric, just the way Nixon made some overtures to pick up the New Left rhetoric in 1968.

This is always going on, and it's the flaw in all of the mechanistic theories about politics, because they never understand how responsive and malleable and flexible the system is. As soon as they can put together a definable group of votes, somebody is going to steal them for the existing parties. These parties don't have written constitutions or written ideologies. They're a bunch of people who want to win elections. The mechanical view says that Ford is going to continue to play dumb, the Democrats are going to play dumb, everybody's going to play dumb.

Jack Calkins: 1976 Election Will Determine . . .

John T. (Jack) Calkins is deputy to Robert T. Hartmann, President Ford's chief political adviser. Calkins was the staff director of the Republican Congressional Campaign Committee for four years before that. In this edited interview, he discusses the future of the Republican Party and the two party system.

Q. A number of conservatives are saying that the Republican Party is going through its death throes. What do you think?

A. I believe I am a political realist, and I have been saying since a couple of days after the 1974 elections that I thought there was a real danger that our traditional two party system might be going down the drain. Now obviously, the key word here is traditional, because traditionally—at least for the past 100 and some odd years—we have had Democrats and Republicans as the two major parties with occasional third parties that never last very long on a nationwide basis. I don't think anyone will argue seriously with the thesis that a two party system appears to have served our political system and its people pretty well. The fact that we have not proliferated into numerous parties with narrow constituencies has lent a considerable amount of political stability to the country.

A facet of that is that we can still have a two party system, but one of them will not be called Republican, it will be called Conservative or something like that. That is a possibility. I think any realist would be foolish to claim otherwise. There is a real danger that the Republican Party might dissolve or come apart over the next few years.

I do not think it is an imminent danger in the sense of something before 1976, let's say. I think it is reasonably clear that despite these rumblings, there will be a Republican Party and a Republican candidate in 1976 and probably for several elections thereafter. The question, I believe, is whether the Republican candidate for the presidency either wins or comes very close to winning and concurrently, whether the party's strength is increased in the House and Senate and state legislatures—or at the very least, not worsened from what it is now.

Now, let's assume the best. Assume the presidential candidate will win—and I believe the presidential candidate will be President Ford and I believe he will win. Assume we increase the numbers in the House and Senate, gaining back many of those we lost in 1974, particularly in the House. And assume we win state and local offices around the country in fairly solid numbers. I don't mean a landslide in any of these, but that we win. That's going to show that the Republican Party, while it suffered a severe setback in 1974, is a long way from being dead.

So, you've got a couple of separate questions, it seems to me. Does one believe in the two party system? And, secondly, does one believe that those parties will be Democratic and Republican? The President very obviously believes in the traditional two party system, and avowedly believes that one party should be Democratic and the other should be Republican, with I

think, inferentially a certain amount of flexibility and modernization to cope with the particular problems of the times.

The people like (Howard J.) Phillips, (William A.) Rusher, Stan (M. Stanton) Evans and others of that nature see an opportunity in the long run to preserve the two party system by trying to generate enough support among conservative Democrats, Republicans and Independents to put together another party. They justify this by saying that if it is a third party, it will be number three for a relatively short time, because they honestly believe the Republican Party is dying, and they have to replace it with something else—otherwise the Democratic Party goes way to the left and there is no viable alternative. That is a logical approach to the subject. I would give them the benefit of the doubt and say they are not trying to scuttle the Republican Party. They just honestly believe it is going to fall apart from the inside.

I think we are in a short-term era right now when the truth or falsity of their thesis can be proven relatively quickly, probably as soon as the 1976 election. If the party goes down from the present low position in legislatures, Governorships, and representation at the federal level, then they will be able to make their case all the stronger, and perhaps attract conservatives of the three different groups to put together a third party. But, as I said earlier, if the Republicans gain and if they hold the presidency, I think their thesis will be unable to be put into effect.

I think we are in kind of a make or break point for somewhere between the next year and a half and 1980. I do not think there will be a third party formed between now and 1976. I feel that the dissatisfaction of Republican conservatives, at least with some of the actions of this President, will tend to be somewhat mollified by presidential actions, by an improving economy, and other factors. I think this President is going to continue, slowly perhaps but very perceptibly, to increase his measure of public support. If that is also accompanied, as most observers expect, by an improvement in the economy, by a year from today we will have a much stronger Administration and a much stronger candidacy than can be seen now.

Q. Earlier you said that you are concerned not only about the Republican Party but about the continued existence of the two party system. Could you elaborate on that?

A. I think without any question, that along with the erosion of membership in a lot of institutions—religious, social, whatever—the major political parties have eroded in their strength as well. There isn't any question of that statistically. And although the Democrats outnumber the Republicans, they too have declined. We are in a situation, and have been for the past several years, that is beginning to reflect nationwide what we have in Massachusetts, where the Independents are more than the enrolled Democrats and Republicans combined.

When you get to that point on a nationwide basis,

... Whether the Republican Party Will Survive

and we are heading toward it, then it becomes a serious question whether these traditional, formal political parties really have enough broad appeal to justify their continued existence, or whether we ought to go into some sort of other nominating process. After all, it was not constitutionally ordained that we nominate our candidates the way we do.

Q. There have been two major views about how to go about rebuilding the Republican Party. One is the view implicit in the national committee's current registration program and made explicit in presidential and vice presidential speeches: the party should continue to be a broad umbrella party, working to "broaden its base" without reading any Republicans out of the party for ideological reasons. The other view, stated repeatedly by Ronald Reagan, is that a party cannot gain new adherents unless it stands uncompromisingly on a clear set of principles. The President appears to have rejected Reagan's approach. How, if it does not follow Reagan's suggestions, can the Republican Party generate the kind of enthusiasm needed to make Democrats and Independents become Republican Party loyalists?

A. There are several approaches that could be used. If you differentiate between the two parties, the Democratic Party is essentially a grouping of special interest groups coalesced into a national party name. They dicker with each other for their pieces of the action. The Democratic Party is not, as a party, terribly ideological itself, although it is perceived that way by a lot of people. It is not in its truest sense a party, but an amalgam of interest groups that tend to negotiate things out with each other.

The Republican Party, on the other hand, has thought of itself as a party with consistent ideologies and beliefs that might change from time to time, but were not constantly the subject of negotiation within the party. That is a very essential difference, and I think this has been part of the problem of Republican moderates and liberals—they are not looked at in the Republican Party in the way that people with similar views are looked at in the Democratic Party. They're tolerated within the Democratic Party, sometimes more than tolerated. They recognize that, well, there's a group, we can bring them in, we need their votes, we want their votes, so let's use them for their votes and let's negotiate with them.

Because of this, we have developed into this period of looking for the soul of the Republican Party. Are we going to be an open arms party, welcoming all kinds of ethnic groups and the disadvantaged, whose aspiration is to climb into the middle class, which is essentially what the Republican Party is? Or will we say that we've got to be an ideologically pure party, and we only want those people who are as conservative as we are? Well, clearly, that has not been solved by argument, and it may not be for a long time.

This is, I think, further complicated by some unfortunate Watergate factors. Your average Republican adherent in the past was always able to take confidence

and solace in the fact that when we were in power, we were the better managers and, secondly, there was always a smug feeling that we were just a little more honest than the other people were. Well, both of these things got pretty badly damaged in the Watergate fallout. I think if the economy continues to improve and President Ford continues to perform well, this confidence by Republicans will continue to reappear.

Q. I still am not sure how to understand the call for a broadened base. Will there be a new ideology, or does the President intend to transform the party into a new bargaining type of party? Did you mean to be suggesting one of these alternatives?

A. Not necessarily. I think that almost any political practitioner would agree with the basic thesis that if a political party is going to survive, it has got to be able to appeal to a majority of voters. That's what the game is all about. To consciously go into a program that would truncate one's numbers obviously is political suicide. But this seems to be the way it is sometimes written about—closed party as opposed to open party. The fact of the matter is, if you do not have something—whether it's ideology, or an appeal to the middle class that is not necessarily based on ideology—there isn't much sense in talking about broadening the base of the party as if there were millions of people out there who want to sign up.

No Republican I know wants to read conservatives out of the party and say, "go form a third party." If we are interested in the Republican Party, we know we had better keep every adherent we can. But I do think there has to be developed a new doctrine, let's say, for want of a better term, that spells out a bit more clearly just what it means to be a Republican.

The traditional, old line Republican has seen so many of his treasured precepts violated by Republican Presidents because of the pressing need to meet a severe national or international problem. If he is that conservative and cannot bend at all, obviously he is going to feel disaffected after all these years, what with deficit budgets, detente, establishing relations with China, and so forth, even though those acts were taken by a Republican President who was generally perceived to be a fairly conservative person.

But if they are that unadjustable, if they are that classically conservative in the American sense of that word, then they probably are just sitting ducks for this kind of a movement to a true Conservative Party. But those numbers aren't going to win any elections.

Q. Can we expect in the near future to see a statement explaining how Republicans still differ from Democrats, given the record of the last eight years?

A. I am not personally working on one, let's put it that way, so I cannot promise there will be one. I do see personally that it would be desirable. It's one of these situations where you do not have Moses coming down off the mountain. You are going to do it at the very least by a sizable committee. But it won't surprise me a bit to see something of that nature within the next year.

Caddell: 'Realignment Is Less Likely Than Disintegration'

Patrick H. Caddell, president of Cambridge Survey Research Inc., did surveys for Sen. George McGovern, D-S.D., throughout the 1972 presidential primary and election campaigns. In this edited interview, Caddell expresses his view of the future of the parties.

Q. Do you think recent survey information suggests that we have entered a period in which the parties and voters are likely to realign themselves?

A. I don't think we are witnessing realignment as much as the death of the two party system. Realignment is less likely than the disintegration of both parties. Among voters you have movements that are not so much ideological as they are toward new faces. But inside the parties, the problem is that they are being fractured ideologically. The result of this is that you have both parties weakening internally, and a public that's moving away from both. I think we are going to see a lot of Independents running in a serious way in '76. If the Republicans are coming apart, the Democrats certainly are not very far behind. I'm not sure we'll ever see a reconstruction of the parties on the old style.

Q. What about the efforts of some conservatives to form a new party that would join conservative Republicans with Wallace Democrats?

A. The potential is there, but a new party would be structurally very difficult to sustain. We are more likely to see loose coalitions around causes than new parties. The situation is very uncertain and cloudy. You have the public situation there for a new party, but you don't really have it in terms of the structure. Therefore, what happens internally in the parties will be critical.

Q. Given their goal, are the conservatives on the right track?

A. If they want to blow up the parties, they're going about it the right way. But the problem is they seem to be making a fight to preserve something (conservative



Patrick H. Caddell

ideology) that has no credibility with the public.

Q. How will the campaign finance law affect all this?

A. If you have serious third and fourth candidates, they will be encouraged by the potential support.

Q. Why can't the parties just keep on as old style umbrella parties?

A. The umbrella doesn't have anything to offer if it can't hold anything. After future ideological battles within the party, people will be less likely to accept the party's decisions if it is against them. The increased willingness of party activists to move outside the party is very important. And the Republicans are in much worse shape than the Democrats.

Without third and fourth party alternatives, a lot of people are dropping out of the system. A minimum of seven million people who participated in 1970 did not in 1974. This might be different if they have alternative choices.

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tification and reduce the number of Independents.

People will begin to feel attached to parties, this view implies, when they feel they can participate in its affairs.

Smith and Strauss may be right. There is one political danger to this commitment to openness, however. The people who are likely to be willing to give up their free time for partisan activity easily could include a disproportionate number of the ideologues Caddell says would be most likely to support a third or fourth party.

Outlook

It seems fairly clear, even at this early stage, that conservative analysts are jumping well ahead of their data when they say they see a probable

realignment in the classic style. Such a realignment is possible, but to call it probable is going too far.

Nor does the data show the Republican Party on its death bed. The party has its problems, but the Republican conservatives are a part of this problem, not passive observers of it. The immediate danger will be considerably lessened if Reagan keeps his 1976 efforts within the party.

If the Republican Party does disappear, as some conservatives predict, it is not at all clear what would take its place. If the conservatives form a new party, and they stay only with the positions on issues that current conservative activists accept, there then would be every opportunity for a new political alignment with a vastly increased Democratic majority.

For this to occur, however, the

Democratic Party would have to take advantage of the opportunity by moving, in Scammon and Wattenberg's terms, to occupy the center.

The statistics on party identification and alienation and the decrease in voting percentages show, if nothing else, that both parties are failing to address the concerns of the electorate. If this continues, a growth in Independent candidacies could well result, as voters find the parties increasingly irrelevant.

Probably the most sober position to take at this time is the one suggested by White House aide Calkins. A wide range of things could happen between now and 1976, including the resurgence of the Republican Party. We may not know the long range future now, but we should know a great deal more within 18 months. □

Liberals Disillusioned with Government

"I find myself alienated from much of my own politics," says Washington lawyer Michael J. Horowitz. "I'd like to think I still embrace whatever values I've always held about social equality and opportunity... but so many of my friends support programs and candidates with which I don't agree any more."

The political metamorphosis that Horowitz is undergoing typifies the profound change under way among many self-identified liberals who have become frustrated because of the failure of so many of the government programs they once cherished. Many of the new federal laws, agencies and programs sought by the liberals in recent decades have come to pass—but the social problems that the programs were supposed to solve remain.

Horowitz' liberal credentials are impeccable. A native New Yorker, he spent two years in the Deep South during the mid-1960s, at the height of the civil rights struggle, on the faculty of the University of Mississippi Law School. He actively supported former New York Mayor (1965-72) John V. Lindsay and counts himself as both a personal friend and political ally of former Rep. (1969-71) Allard K. Lowenstein, one of the Democratic party's best known liberal organizers of the late 1960s.

But today, says Horowitz, "it's hard for me to persuade my wife and my best friends that I continue to maintain a strong commitment to social justice when I find myself so disaffected by the government programs which fly the banner of social justice."

He is not alone in his disillusionment with government. Edward C. Maeder, a fellow Washington lawyer, talks in virtually identical terms about a "counter-reformation" that he believes is rapidly carrying the nation "to the point where people are beginning to understand that big government is not necessarily your friend."

Although the rhetoric sounds conservative, it comes from a man who ran the campaign of the first black to be elected to the Virginia legislature since Reconstruction, was the campaign manager for former Sen. (1967-73) William B. Spong Jr., D-Va., and worked in the 1972 presidential campaign of Sen. Edmund S. Muskie, D-Maine.

For Maeder, the experience of President Franklin D. Roosevelt's New Deal and President Lyndon B. Johnson's extension of that philosophy, in the Great Society programs, has produced questions such as these: "How do you involve the government so that you don't have the deadening hand of the bureaucracy—the proliferation of controls and regulations—ruining programs supposedly designed to help people? Is opposition to social change coming only from the 'mossbacks,' or does it also come from the bureaucrats at the Department of Housing and Urban Development who are presiding over programs which don't work?"

Consensus: There already exists in Washington a consensus, embracing such disparate political figures as President Ford and consumer advocate Ralph Nader, that a number of federal regulatory agencies ought to be either abolished or have their authority drastically reduced on the grounds that they now may be anachronisms that thwart competition and the consumer

more than they encourage either.

But the two Washington lawyers quoted above and a growing number of others who share their views have gone well beyond that point to suggest that a number of the major federal departments, spending billions of dollars annually on domestic programs, also may be serving little or no useful social function beyond providing employment for thousands of civil servants.

For example, Maeder cites this quotation from Malcolm Muggeridge, the noted British critic and author: "The assumption is that as you spend more and more money on education you will produce more and more enlightened people. Actually, of course, exactly the opposite has happened. I like to think that when the politicians have spent the whole of the country's revenue on education, we should have become a nation of illiterates, except for a few old men mooning about in the London library."

Liberal acceptance: What is notable is the extent to which those who identify themselves as liberals are coming to accept that philosophy. Among the nation's elected officeholders, that trend is most noticeable in state government, with several liberal Democratic Governors publicly rejecting the concept that "big government" can resolve the problems of their constituents.

The most highly publicized example of recent months comes from California, where Gov. Edmund G. Brown Jr. has startled both friends and foes by proposing a state budget that calls for a 5.9 per cent increase in spending over the previous year, contrasted with an average annual increase of 12.2 per cent during the administration of former Gov. (1967-75) Ronald Reagan, a conservative Republican.

Also abandoning what a Brown aide describes as "the notion that problems can be solved by throwing money at them" are Massachusetts Gov. Michael S. Dukakis and Wisconsin Gov. Patrick J. Lucey. In addition, former Georgia Gov. (1970-75) Jimmy Carter is touring the country proclaiming the virtues of "zero-based budgeting" and "performance auditing" as part of his campaign for the 1976 Democratic presidential nomination.

Alabama Gov. George C. Wallace has inveighed for years against the real and imagined evils of the Washington bureaucracy, but he is addressing himself to a basically conservative audience in his bid for next year's Democratic presidential nomination.

Particularly striking is the fact that within the very sizable group of centrist-to-liberal contenders for that nomination there appears to be virtually no recognition of growing public sentiment on the subject. The much discussed inability of any of those candidates to capture the public's imagination well may be the product of what many voters perceive as the politicians' continued reliance upon outdated rhetoric and unworkable solutions.

It will be politically difficult, if not impossible, for conservatives—Republican or Democratic—to provide effective leadership in this field because they are too widely believed to be insensitive to the needs of the poor, minorities and others the federal programs were designed to help. If there is to be effective action, the leadership must come from the liberals. □

Energy Report/Unexpected obstacles hinder Ford plan for coal conversion

by James G. Phillips

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President Ford's plan to reduce American dependence on foreign oil by converting oil fired electric power plants to coal is running into trouble.

A rare alliance of environmental groups and electrical utilities—interests that traditionally oppose each other on energy and environmental issues—is out to slow or stop the conversions, and it may succeed unless Congress gives the conversion program a stronger legislative basis.

Although their motives are poles apart (and there is no actual lobbying coalition), environmentalists and utility executives agree that Ford's plan to rely on coal conversions to produce more than half of his targeted reduction of one million barrels a day of utility oil consumption by 1980 is far too ambitious.

Utilities, who argue that the costs of acquiring low sulfur coal (if it is even available) or installing pollution control devices outweigh the benefits of oil savings, have threatened to take the program to court. And environmental groups may do the same if any specific conversions ordered by the government pose significant air pollution problems.

The source of the trouble for the



President Ford hopes to conserve oil by converting power plants to coal

eral air quality standards. The law also was designed as a stop-gap measure to deal with foreign oil embargoes.

The bill directs the federal energy administrator to order conversion to coal of any oil or gas fired electric power plant or other major fuel burning installation provided the plant has the equipment to burn coal, access

that went on the Federal Energy Administration's (FEA) list for potential conversion after Ford ordered the oil savings program on Oct. 8, 1974.

"The bill was a copout," said John L. McCormick, vice president of the Environmental Policy Center, an environmental lobbying group in Washington, at the time of the measure's passage. "I doubt that there will be many conversions because no utility wants to spend \$20 million to gear up for coal amid the uncertainty that the act may be softened further and that the investment won't be necessary."

Hurdles

So far, the problems of implementing the act are legion. Already the FEA has scaled down the goal of the conversion program from oil savings of one million barrels a day in 1980 to about 826,000 barrels. Of the 826,000 barrels, 398,000 are attributed to conversions of existing plants, 144,000 to conversions of new plants, 57,700 from preventing coal burning plants to go through with plans to shift to oil, 83,000 from more efficient use of nuclear power plants, and 143,000 from accelerated licensing of nuclear plants.

Supply: Perhaps the biggest stumbling block for the program is assuring enough low sulfur coal at reasonable prices to bring converted plants into line with air quality standards. Not only does the act require that primary standards be met by all converted plants, but it also imposes a so-called regional limitation, whereby secondary standards must be met in air quality regions where the primary stand-

Federal air quality standards and a shortage of low sulfur coal are raising a substantial hurdle to President Ford's ambitious plan to convert oil burning electric power plants to coal and thus reduce the amount of imported petroleum needed to fuel the nation's energy requirements. Utility executives and environmentalists are in an informal marriage of convenience in seeking to slow Ford's plan—the utilities because they feel the financial costs would be too great, the environmentalists because they feel the environmental costs would be too great.

President's program is that the law authorizing the conversions—the 1974 Energy Supply and Environmental Coordination Act (88 Stat 246)—was not intended to support the massive switch to coal sought by the President. (For more on the coal conversion program, see Vol. 6, No. 50, p. 1867; No. 48, p. 1805.)

The law, passed June 12, 1974, was a compromise designed to postpone a showdown over pressures by the Nixon Administration and electric utilities to ease air quality standards until sulfur removal technology was perfected—a development that would stimulate the use of the nation's vast deposits of high sulfur coal, which cannot be burned under current fed-

to adequate coal supplies and can meet other qualifications, most of them aimed at protecting the environment.

All plants ordered to convert must be able to meet primary (health related) air quality standards at the time of conversion but could receive a variance from secondary (welfare related) air standards, provided that the Environmental Protection Agency (EPA) certified that the converting utility had a compliance plan that would enable the plant to meet all clean air requirements (by acquiring low sulfur coal or installing pollution control devices) by Jan. 1, 1979.

EPA figured that the rules in the bill would permit 23 plants to convert to coal—a fraction of the 80 plants

ard is violated at any point, though not by the converted plant itself. These requirements threaten to pinch an already tight supply of low sulfur coal, particularly on the Eastern Seaboard, where air quality standards are stiff and much low sulfur coal is committed to steel making. Of the 80 candidates for conversion, 45 are in the 13 state Eastern Seaboard region.

FEA has the authority under the act to allocate coal to support the conversions but does not want to use it. The alternative is to open new mines, but the coal industry is demanding that utilities put up massive advance investments for them, and, in some cases, contract for the mine's entire output. Utilities are balking at that prospect.

The stalemate on opening new mines could torpedo the conversion program. The 826,000 barrel oil reduction program envisioned by FEA would increase the nation's annual demand for coal by 41 million tons by 1980, a requirement that cannot be met alone by existing mines, according to FEA planners.

FEA figures that an 18 million ton increase in annual coal production needed for the conversions by 1978 could be met by the "surge" capacity of the existing mining system, that is, expanding production of existing mines by running them overtime and reopening small mines that have been closed because of the depressed price structure that prevailed in the industry until recent months.

Although there is wide disagreement over the extent of the coal industry's surge capacity, FEA planners agree that the 41 million ton requirement probably exceeds that capacity. Even if it does not, they say, the cost of deploying men and equipment overtime on such a large scale would make the program uneconomical.

FEA says the answer is to open new mines. And it says the commitments for those mines must be entered into soon because of the lead time involved in bringing new mines on line. Typically, it takes two to three years to get a large strip mine into full production. Deep underground mines take three to five years.

Pollution equipment: Another problem for FEA is determining the economic "practicability," as required by the act, of conversions requiring pollution control equipment where cleaner burning coal is not available. One EPA study estimated that 26 of

the plants labeled as conversion candidates by FEA would need stack gas "scrubbers"—devices for removing sulfur oxides from utility smokestacks—if EPA's estimates of low sulfur coal availability were accurate. Utilities have contended that the cost of installing scrubber systems in existing plants could run well in excess of \$100 a kilowatt—more than one-fourth the cost of building a typical coal fired plant.

Yet another headache for FEA is the uncertainty of what happens to converted plants if the act is allowed to expire on Jan. 1, 1979. Would utilities simply switch back to oil if the economics looked right? Or would states or cities order the converted plants back on oil once FEA's authority to require coal burning lapsed? Such uncertainty has given utility executives another inducement to avoid the long-term coal contracts sought by the coal industry as a condition for opening new mines.

Remedies

In a move to resolve the unanswered questions, both the Administration and congressional proponents of coal conversion have proposed new legislation to revamp the program.

The Administration wants only to amend the law to extend its deadlines and relax or remove some of its environmental restrictions such as the "regional limitation." But Senate supporters of a more viable coal industry think more radical surgery is needed. They want assurances for both the utilities and the coal industry that the plants will continue to use coal for the duration of their operating lives.

A bill embodying that principle (S 1777) was introduced in the Senate May 20 by the chairmen of three key Senate committees—Sens. Jennings Randolph, D-W. Va., of Public Works, Henry M. Jackson, D-Wash., of Interior and Insular Affairs, and Warren G. Magnuson, D-Wash., of Commerce. But despite the prestige of its sponsors, the coal buildup contemplated by the measure raises such controversial environmental problems—such as strip mining and renewal of federal coal leasing—that its future is uncertain at best.

Implementation: Bugged down by the shortcomings of the law, FEA has moved slowly and deliberately to launch the President's coal conversion program.

Despite an existing deadline of June 30 for filing all conversion orders, it was not until May 9 that FEA notified any utilities of the agency's intention to order them to convert. And the target of the first batch of orders was modest—nine Midwestern utilities that already burn coal part of the year and natural gas the rest of it.

"It would be ironic if there were an injunction filed with the next batch of orders, in effect killing the program on June 30," said the Environmental Policy Center's McCormick. "The net results would be conversion of nine utilities' plants with a net saving of not one drop of foreign oil."

To head off this prospect, the Administration has proposed a series of amendments, including a two year extension of FEA's authority to issue conversion orders (through June 30, 1977), a six year extension (to Jan. 1, 1985), of FEA's authority to enforce conversion orders, removal of the "regional limitation," and authority for converted plants to continue employing "intermittent control systems" (such as a shift to lower sulfur fuels at times of pollution buildup and use of tall stacks to disperse pollutants in the atmosphere) through 1985, where such controls may be used to attain and maintain primary standards. The existing law prohibits use of such methods for converted plants after Jan. 1, 1979.

If the amendments do not go through (and the only congressional action thus far is Senate approval of a mere six month extension of FEA's authority to issue conversion orders), the Energy Supply and Environmental Control Act may prove to be an exercise in futility. FEA administrator Frank G. Zarb informed Randolph on May 1 that no more than 30 prohibition orders would be issued by June 30. "These will be the easy ones," Judith M. Liersch, director of FEA's Office of Fuel Utilization, which runs the conversion program, told *NJR*. "We won't get into the hairy ones until later. The orders that we'll issue before June 30 won't involve plants that may need stack gas scrubbers."

But assuming that Congress extends the law, and FEA eventually orders conversion of all or most of the 80 plants targeted for conversion (plus numerous oil fired plants now in the planning stages), confrontations with both utilities and environmental groups will be inevitable.

Utilities

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Rumors have been floating around FEA for months that utilities will sue to overturn conversion orders that envisioned installation of scrubbers.

On May 13, George C. Freeman Jr., an attorney for the Virginia Electric and Power Co. (Veeco), which has four plants on FEA's list of conversion candidates, confirmed for *NJR* that his utility would sue to block any conversion order requiring installation of stack gas scrubbers.

In another interview, Harry H. Voigt, an attorney for the Edison Electric Institute (EEI), the trade association representing the nation's investor owned electric utilities, was more circumspect on the question of legal action while hinting at the same action.

"The decision to sue will fall to the individual companies," Voigt said. "If a company gets an order it can't live with, it would probably go to court. Maybe EEI would support such a suit, but I don't think the matter is under active consideration thus far."

Freeman said the gist of any suit filed by Veeco (and presumably by any other utility) would be that the installation of scrubbers would not be economically practical, in keeping with the bill's guidelines. In hearings before the FEA, utility attorneys have argued that coal prices—now about two-thirds the price of imported oil on a Btu basis—eventually will escalate to the level of oil prices, and the net result will be excessive costs to utilities at a time when they are experiencing a severe capital crunch.

FEA rebuttal: FEA, by contrast, contends that there will be considerable economic savings from the conversions in addition to the national security benefits to be gleaned from curbing oil imports. In a Jan. 31 report, it argued that savings associated with oil import reductions would be \$2.19 a barrel, assuming continuation of a \$12 a barrel oil price, a \$40 a ton price for coal on the spot market, a \$60 per kilowatt cost for scrubbers installed in new plants and an \$80 per kilowatt cost for modifications of existing plants to accommodate scrubbers.

Some FEA officials said privately that the reason for utility opposition to the program is that utilities can quickly recoup their increased costs for foreign oil through "fuel adjustment clauses" whereby increased fuel costs are passed through to consumers



Judith M. Liersch

each month as they are incurred. Recouping capital costs is a much more drawn out process, they said.

Environmentalists

Whether environmentalists join utilities in challenging the law in court appears to hinge on how tough a course EPA takes in discharging its responsibilities under the law.

Most environmental groups frown on conversions altogether—at least in the short term—until more low sulfur coal supplies are developed or stack gas scrubbers are perfected. Nonetheless, environmentalists generally concede that there is no recourse against conversions that meet primary air quality standards (and secondary standards in cases where the regional limitation applies).

Basis: But there is another provision that gives EPA considerable latitude over the rules governing conversions in one type of conversion situation that environmentalists deem critical, and it is this provision that could form the basis for an environmentalist suit.

The provision requires EPA to ensure that coal conversions do not create a "significant risk" to public health from concentrations of pollutants for which no ambient air quality standard has been established. The provision is directed primarily at the problem of acid "sulfates"—fine particles formed in the atmosphere by sulfur dioxide emissions. Sulfates are thought to remain a relatively long time in the atmosphere and to be capable of penetrating the respiratory tract.

The sulfates problem is under extensive study, both by EPA and out-

side scientific groups, but definitive findings are probably years away. In the meantime, EPA plans to issue guidelines for the coal conversions based on preliminary analyses of the problem by the National Academy of Sciences and EPA's internal studies, both of which indicate that sulfate concentrations should be curbed. (*For more on sulfates and other air pollution issues, see Vol. 6, No. 30, p. 1103.*)

If EPA follows through with its intentions, there probably will not be an environmentalist suit—at least one based on the significant risk provision. Although the agency does not now contemplate denying conversions in areas where sulfates may be a problem, according to private discussions with EPA officials, it is leaning toward requiring converted plants in such areas to meet secondary standards at the time of conversion instead of on Jan. 1, 1979, when variances from the secondary standards run out.

"If EPA follows through on that interpretation, we probably wouldn't sue," said Richard E. Ayres, an attorney for the Natural Resources Defense Council Inc. (NRDC), a public interest law firm that has been the primary legal arm of the environmental movement. "But if a substantial number of plants that we feel are sulfate problem plants get variances despite the significant risk and regional limitation provisions, we wouldn't want them to get away with that."

Other possibility: Ayres said another possibility for an environmentalist suit, albeit a much lesser one, might arise if FEA waits until the vicinity of the June 30 deadline to issue a large number of conversion orders that may not be backed up by substantial supporting data.

"Suppose FEA had developed hard data on about 10 conversion candidates but issued 80 conversion orders just before the bell," Ayres said. "That would look like a sham, and it could spell trouble for FEA in court. The judge would probably say, 'Look here fellows, that's not what Congress had in mind in authorizing this program.' It would look particularly bad if FEA wound up rescinding some of the orders at some point down the road after they developed better data."

Ayres also said environmentalists might become a party to suits filed by utilities to enjoin coal conversion orders. "Our motives for opposing the

conversions would be different, but our objective would be the same—to stop the conversions," Ayres said. "The net result in the court's mind would be that everybody is against the conversions."

Randolph bill

Convinced that a broader framework is needed to support the coal conversion program, Randolph, Jackson and Magnuson have devised an approach that moves back the timetable for conversions, but puts the electric utility industry on notice to gear up for long-term use of coal.

The bill, scheduled for joint hearings beginning June 5 before the three committees chaired by its sponsors—Public Works, Interior and Commerce—employs a two step process for converting both the utility industry and other major industrial users of oil and gas (such as chemical plants) to coal and keeping them there.

Provisions: The first step is to require that after Jan. 1, 1979, new electric power plants and major industrial plants that use oil or gas as a boiler fuel must install equipment for burning coal as their primary energy source. Existing oil and gas fired plants—if not scheduled for retirement by Jan. 1, 1985—would have to install coal burning equipment by Jan. 1, 1980.

The second step would be to require that by Jan. 1, 1985, "to the maximum extent practicable," such plants are burning coal as their primary boiler fuel in a manner consistent with applicable environmental requirements. There would be no variances of the kind in the 1974 law since the bill's sponsors assume that sufficient low sulfur coal deposits would be developed or scrubbers would be perfected by that time.

Plants ordered to coal under the program would have to remain on coal for the rest of their useful lives—a factor that would provide certainty for both the utilities and the coal industry. Extension of the 1985 deadline for coal use would be granted only if coal or coal transportation facilities were not available, despite "good faith efforts" on behalf of the affected plant owner to line them up.

According to Richard D. Grundy, executive secretary for the Senate's National Fuels and Energy Policy Study, who helped draft the measure, the 1985 targets for coal utilization are the critical ones and the dates for



Richard E. Ayres

equipment installation may be moved back if the hearings uncover potential bottlenecks in equipment availability.

But if the timetable stands, Grundy said, many converted plants probably will be burning coal well before 1985, because the mere installation of coal burning equipment probably would be sufficient incentive for coal use, provided coal was still cheaper than oil.

Reaction: The coal industry sees the Randolph bill as a big green light for expanded coal production—an implied commitment to remove environmental and other constraints that they fear could prevent the industry from meeting President Ford's goal of doubling coal production by 1985. Environmentalists, by contrast, oppose the bill because of its implications for environmental degradation. And utilities, are still convinced that the costs of the conversion program would outweigh its benefits.

Coal industry: "The bill explicitly provides there will be a long-term future for the coal industry," said Carl E. Bagge, president of the National Coal Association, the leading trade group for the nation's coal companies, in an interview. "If this goes through, much needed trade offs in the environmental area will be made. The bill carries an implied commitment to remove the constraints that are shackling coal production—such as air quality standards, the moratorium on coal leasing, etc. Maybe it takes a bill like this as a prerequisite to making decisions that aren't being made today because there's no national policy or directive requiring us to make them."

"I think all the pieces for orderly and rational development of the coal

industry will fall into place if this kind of policy is adopted," Bagge said. "Having approved such a policy, Congress can't very well turn its back and walk away from the problem."

Environmentalists—Both the NRDC's Ayres and the Environmental Policy Center's McCormick expressed reservations about the bill and predicted that environmental groups would seek to kill or at least reshape it.

"The new bill sounds like the existing conversion act without any environmental limitations," said Ayres. The NRDC lawyer was particularly concerned about the bill's requirement that converted plants conform with environmental laws to the "maximum extent practicable." He said this imposed a "whole different standard of requirement" from those of the air and water quality acts. "Those acts are explicit," he said. "You either meet the compliance dates or you shut down. There's nothing in those acts about meeting the requirements 'to the maximum extent practicable.'"

"What worries me about this bill is the possibility that utilities can get around the environmental requirements by simply saying, 'We've made the best try we could to meet the standards. But scrubbers aren't perfected yet, so you have to bend the requirement for us.'"

"I think the technology for solving the environmental problems associated with coal is in existence. But the question is whether the country will have the will to apply that technology. On balance, this bill gives an unequivocal commitment to coal production and an equivocal commitment to applying solutions to environmental problems."

Ayres also said it is "silly" to require every utility in the country to burn coal. "In many urban areas, oil is preferable both from an environmental and economic standpoint. In some urban areas, coal burning would not be environmentally acceptable even if you used scrubbers. And even if a utility could get low-sulfur coal, its sulfur content would never be as low as that of oil."

"What the country ought to do," Ayres said, "is sober up and talk about ways to cut gasoline consumption as a means of cutting oil imports. We're not going to get there by converting oil burning power plants to coal."

McCormick is more sanguine about

Federal Energy Administration's 80 Candidates . . .

The Federal Energy Administration lists 80 oil and gas fired electric power plants being considered for conversion to coal. They are divided into these five categories.

Category 1

Plants that have adequate stack gas precipitators (a mechanism for cleaning out coal ash) and can burn coal with sulfur content greater than 1 per cent by weight:

Company	Plant	Unit numbers	Capacity (in megawatts)
Alabama Electric Cooperative Inc.	McWilliams	3	25
City of Ames, Iowa	Ames	7	33
Iowa Power and Light Co.	Des Moines	10, 11	190
Iowa Public Service Co.	George Neal	1	139
Iowa Public Service Co.	Maynard Station	14	50
Board of Public Utilities, Kansas City, Kan.	Kaw River	3	65
Board of Public Utilities, Kansas City, Kan.	Quindaro	1, 2	240
Potomac Electric Power Co. (Md.)	Morgantown	1, 2	1,251
Kansas City Power and Light Co.	Hawthorne	3, 4, 5	769
Wisconsin Public Service Corp.	Weston	2	75

Subtotal: 10 plants, 15 units, 2,837 megawatts

Category II

Plants that require precipitator upgrading and can burn coal with sulfur content greater than 1 per cent:

Company	Plant	Unit numbers	Capacity
New England Power Co. (Mass.)	Brayton Point	1, 2, 3	1,162
Detroit Edison Co.	St. Clair	5	358
Nebraska Public Power District	Sheldon	1, 2	225
Central Hudson (N.Y.) Gas and Electric Corp.	Danskammer	1, 2	146
Virginia Electric and Power Co.	Chesterfield	3, 4, 5, 6	1,353
Virginia Electric and Power Co.	Yorktown	1, 2	375

Subtotal: 6 plants, 14 units, 3,619 megawatts

Category III

Plants that need new precipitators, are larger than 100 megawatts and can burn 1 per cent sulfur coal:

Company	Plant	Unit numbers	Capacity
Arkansas Power and Light Co.	Ritchie	1, 2	904
Delmarva Power and Light Co. (Del.)	Edge Moor	1, 2, 3, 4	390
Savannah Electric and Power Co. (Ga.)	Port Wentworth	1, 2, 3	207
Georgia Power Co.	McManus	1, 2	140
Commonwealth Edison Co. (Ill.)	Ridgeland	1, 2, 3, 4, 5, 6	690
Iowa Electric Light and Power Co.	Southerland	1, 2, 3	157
Board of Public Utilities, Kansas City, Kan.	Kaw River	1, 2	96
Kansas Power and Light Co.	Lawrence	3, 4, 5	583.3
Kansas Power and Light Co.	Tecumseh	9, 10	231
Baltimore Gas and Electric Co.	Crane	1, 2	400
Baltimore Gas and Electric Co.	Gould Street	3	104
Baltimore Gas and Electric Co.	Riverside	4, 5	154
Baltimore Gas and Electric Co.	Wagner	1, 2	269
Holyoke (Mass.) Water Power Co.	Mt. Tom	1	136
Montaup (Mass.) Electric Co.	Somerset	7, 8	194
Western Massachusetts Electric Co.	West Springfield	2, 3	164
Springfield (Mo.) City Utilities	James River	3, 4	104
Public Service Co. of N.H.	Schiller	4, 5	100
Atlantic City (N.J.) Electric Co.	England	1, 2	299
Niagara Mohawk Power Co. (N.Y.)	Albany	1, 2, 3, 4	400
Carolina Power and Light Co. (N.C.)	Sutton	1, 2, 3	672
Narragansett Electric Co. (R.I.)	South Street Station	121, 122	104
South Carolina Public Service Authority	Jefferies	1, 2	100
Virginia Electric and Power Co.	Portsmouth	1, 2, 3, 4	650

Subtotal: 25 plants, 64 units, 7,378.3 megawatts

... for Conversion from Oil Fired Plants to Coal

Category IV

Plants that need new precipitators, are smaller than 100 megawatts and can burn 1 per cent sulfur coal:

Company	Plant	Unit numbers	Capacity
Connecticut Light and Power Co.	Montville	5	75
Corn Belt Power Cooperative	Wisdom	1	38
Board of Public Utilities, Kansas City, Kan.	Quindaro	2, 22	35
Central Maine Power Co.	Mason	3, 4	69
Delmarva Power and Light Co. of Maryland	Vienna	7	38
Interstate Power Co. (Minn.)	Fox Lake	3	82
Independence Power and Light Co. (Mo.)	Blue Valley	3	58
St. Joseph (Mo.) Light and Power Co.	Lake Road	5, 6	85
Omaha Public Power District	Jones Street	27	40
Freemont (Neb.) Department of Utilities	L. D. Wright	2	25
City of Vineland (N.Y.)	Down	10	25
Oklahoma Gas and Electric Co.	Mustang	2	63
Potomac Edison Co.	Riverton	1	40
Public Service Co. of Colorado	Zuni	3	75

Subtotal: 14 plants, 16 units, 748 megawatts

Category V

Plants that must reduce emissions to the equivalent of coal with sulfur content less than 1 per cent by weight. (These plants, according to the Environmental Protection Agency, would require stack gas scrubbers—a device for removing sulfur oxides from utility smokestacks—if low sulfur coal were not available):

Company	Plant	Unit numbers	Capacity
Connecticut Light and Power Co.	Devon	3, 7, 8	273
Hartford Electric Light Co.	Middletown	1, 2, 3	422
Connecticut Light and Power Co.	Norwalk Harbor	1, 2	326
Florida Power Corp.	Crystal River	1, 2	847
New England Power Co. (Mass.)	Salem Harbor	1, 2, 3	275
Cambridge Electric Light Co.	Kendal Square	3	27
Public Service Electric and Gas Co. (N.J.)	Bergen	1, 2	650
Public Service Electric and Gas Co.	Burlington	7	227
Atlantic City Electric Co.	Deep Water	1, 8	155
Public Service Electric and Gas Co.	Hudson	1	455
Public Service Electric and Gas Co.	Kearney	7, 8	294
Jersey Central Power and Electric Co.	Sayreville	7, 8	248
Public Service Electric and Gas Co.	Sewaren	4	119
Jersey Central Power and Light Co.	Werner	4	60
Consolidated Edison Co. of New York Inc.	Arthur Kill	20, 30	826
Consolidated Edison Co.	Astoria	10, 20, 30, 40, 50	1,455
Long Island Lighting Co. (N.Y.)	Barrett	10	188
Long Island Lighting Co.	Far Rockaway	40	114
Orange and Rockland Utilities Inc. (N.Y.)	Lovett	3, 4, 5	449
Long Island Lighting Co.	Port Jefferson	30, 40	375
Consolidated Edison Co.	Ravenswood	30N, 30S	1,000
Philadelphia Electric Co.	Cromby	2	200
Philadelphia Electric Co.	Delaware	7, 8	250
Allegheny Power Service Corp.	Mitchell	33	294
Allegheny Power Service Corp.	Springdale	88	142
Virginia Electric and Power Co.	Possom Point	2, 3, 4	422

Subtotal: 26 plants, 50 units, 10,093 megawatts



Carl E. Bagge



Richard D. Grundy



John L. McCormick

the conversion program than is Ayres but he is equally concerned about the bill's environmental implications.

"Oil and gas are too precious for use as a boiler fuel," he said, in support of the general principle of conversion. "But conversions should be permitted only where they don't violate environmental standards. It doesn't make sense to convert every plant in the country, so exceptions ought to be written into the bill. And the states ought to have veto power over the conversions."

McCormick also said the bill should be modified to ensure that plants that would be phased out before 1990 would not have to convert. "In that sense, the requirement that the conversion be 'practicable' is a good thing," he said. "It would be an unfair economic burden to make those plants convert."

McCormick also said that the massive commitment to coal that the bill signifies should be backed up by an expanded program to make underground mining an attractive alternative to strip mining (which poses greater environmental problems).

Utilities—Utilities think the new bill would leave them in exactly the same position as the existing law does. They say low sulfur coal still would not be available by 1985, and thus they still would have to install scrubbers.

"This bill, like the present program, fails to take into account any economic factors," said David R. Toll, managing director of the National Association of Electric Companies, the lobbying arm of the investor owned utility industry. "It doesn't say anything about costs. The bill says

throughout that we simply have to comply with all environmental requirements, and that means scrubbers.

"The attitude of EPA and some of the states toward adoption of state implementation plans (plant-emission limits) that are much tougher than needed to meet primary standards are what's holding up coal conversion right now. If you relax those plans, coal conversions could go ahead very promptly. But as long as you've got overly tight environmental limitations, you've got to put on scrubbers if you can't get the low sulfur coal. We think that's largely a waste of money when you can get clean air by other measures" (such as intermittent controls).

"We're sympathetic to the goal of burning more coal," Toll said, "but we can't support the Randolph bill as written. The bill has to have two major amendments—some consideration of economics and some way to get environmental overkill out of the state implementation plans."

Outlook

Broad concessions will be necessary if proponents of coal conversion expect any more of a future for their program than the six month extension voted by the Senate (and expected to be approved by the House).

But those concessions must be delicately balanced to meet both the demands of utilities and environmental groups—either of whom can torpedo the program. Environmentalists can probably exert enough lobbying muscle to disrupt the program in Congress. And utilities, though they have less lobbying clout, could similarly

stymie the program by throwing it into the courts.

On the surface, there seems little ground for compromise because any softening of the requirement for scrubbers would entail more environmentalist opposition, and any tougher environmental standards would send utilities scurrying to court.

However, Randolph is considering a move that could pave the way for some horsetrading.

To get around the utilities' argument that conversion of existing plants is not feasible economically, Randolph is considering reshaping his bill to make it apply mostly to plants now in the planning process and new ones that have long useful lives. (Randolph's bill, rather than the Administration amendments, is likely to be the framework for discussion because Randolph's Public Works Committee has jurisdiction over both measures.)

Although it is too early to predict the outcome, environmentalists might go along with Randolph's compromise provided assurances are made that the new coal burning plants are kept out of heavily polluted areas.

Utilities, on the other hand, are likely to fight any legislation requiring them to install scrubbers—even if only on new plants. Their economic feasibility argument would be weakened, however, and perhaps their opposition to the bill diminished, as a result of the compromise approach.

While a court might buy their arguments that conversion of an old plant is uneconomic, the picture could be far different for plants with a life cycle of 20 to 30 years in which to recoup the investment in scrubbers. □

Trade Report/Emigration stalls Romania pact; settlement could serve as model

by Richard S. Frank

The Ford Administration has agreed to give Congress further evidence that the approval of a U.S.-Romanian trade agreement is likely to lead to immediate improvements in the emigration practices of that Eastern European Communist country.

The precise form of the additional evidence has not been determined, but it must be substantial enough to persuade Congress to approve the trade agreement but not so detailed as to lead the Romanians to repudiate the agreement as the Soviet Union did under similar circumstances five months ago.

How the Administration and Congress resolve this issue is being viewed as a key to prospects for expanded trade between the United States and the Communist countries of Eastern Europe, including the Soviet Union.

The Russians canceled a trade agreement with the United States in January because of provisions in the Trade Act of 1974 (88 Stat 1978) that tie tariff and credit terms to the emigration practices of Communist nations.



Arthur A. Hartman



John K. Tabor

Soviet agreement

The U.S.-Soviet trade agreement, signed Oct. 18, 1972, provides for each signatory to extend equal tariff treatment (most-favored-nation status) to the other and to make export credits available on the same basis as

A scarcely noted trade agreement between the United States and Romania could be the key that unlocks the door barring increased trade between the U.S. and the Communist countries, including the Soviet Union. A previous, much heralded pact between the U.S. and Russia fell apart over the issue of emigration by Jews from Russia. The same provision in U.S. law that affected the treaty with Russia applies to the Romanian agreement. The way it's handled now could establish a precedent for other nations, including the Soviet Union.

Most of the Eastern European countries, including several known to be quite anxious for increased trade with the United States, have followed the Russian lead and declined to negotiate trade agreements with this country; Romania, often a maverick on foreign policy issues, has been the single exception.

There has been little congressional opposition to the terms of the U.S.-Romanian trade pact or to the grant of nondiscriminatory tariff status for Romanian imports.

Nevertheless, there is little likelihood of congressional approval of the agreement and the equal tariff status until Congress is convinced that Romania is letting down the bars to its citizens who wish to emigrate, and particularly to Romanian Jews who want to move to Israel.

for other countries.

Simultaneously, President Nixon issued an executive order making the Russians eligible for credits from the Export-Import Bank of the United States (Eximbank) and pledged to ask Congress to authorize equal tariff status for Russian goods.

Restriction: The Trade Act, signed into law by President Ford on Jan. 4, 1975, includes that authority, but also includes a restriction that the Russians said violates the terms of the trade agreement and compelled their cancellation of that pact.

The restriction, sponsored by Sen. Henry M. Jackson, D-Wash., and Rep. Charles A. Vanik, D-Ohio, denies most-favored-nation status and Eximbank credits to any Communist country that limits its citizens' right of emigration.

Strongly supported by American Jewish groups, the Jackson-Vanik amendment to the trade bill was aimed directly at the Soviet Union and its restrictions on Jewish emigration to Israel. The Administration's refusal to accept the amendment, and congressional unwillingness to approve the trade bill without it, tied the legislation up for more than a year. (For details, see Vol. 6, No. 52, p. 1939 and p. 1948).

Waiver: The impasse finally was broken with the announcement on Oct. 18, 1974 by Jackson that the United States had received assurances from the Soviet Union that relatively unrestricted emigration would be permitted and that the State Department was prepared to assume that the rate of emigration would begin to climb almost immediately.

Jackson and his congressional colleagues said that based on this understanding, they were ready to sponsor an amendment to the trade bill that would permit the President to waive the ban on credits and nondiscriminatory tariffs for Communist countries if he has been given "assurances" that the emigration practices of those country would "lead substantially" to free emigration.

The President could issue the waiver at any time during the first 18 months after the Trade Act became law; after that, he would need congressional approval to issue a waiver.

After acting to waive the emigration provisions, the President then could submit trade agreements and most-favored-nation proclamations to Congress for formal approval by both chambers within 60 days (but in the

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Tariff Rate Comparison

If Congress approves the pending concurrent resolution (HConRes 252) implementing a trade agreement between the United States and Romania, the latter country will be eligible for substantial reductions in the tariffs placed on its imports into the United States.

The agreement calls for extension of most-favored-nation (MFN) status for Romania, which means its products will be subject to the same duties that apply to almost every other country that trades with the United States. Without MFN status, Romanian goods are subject to the generally higher rates that apply to most Communist countries.

Here are the rates on some products that Romania exports to the United States, based on 1972 tariff schedules:

Product	MFN rate	non-MFN rate
Wooden chairs	8.5 per cent	40 per cent
Cheese, sheeps milk	9 per cent	35 per cent
Feathers and down	15 per cent	20 per cent
Flat glass (40-60 in.)	\$0.009 lb.	\$0.019 lb.
Flat glass (60-100 in.)	\$0.011 lb.	\$0.029 lb.
Pork hams	\$0.03 lb.	\$0.03 lb.
Agricultural tractors	free	free

case of the already negotiated Russian agreement, it could go into effect automatically unless either chamber vetoed it within 90 days after the President notified Congress).

Ford had been prepared to waive the emigration requirements for the Soviet Union and to initiate the 90 day countdown on the trade pact and equal tariff status proclamation when the Russians denounced the Trade Act restrictions and said they were revoking the 1972 trade agreement.

Romanian agreement

The U.S.-Romanian trade agreement was signed April 2, 1975. On April 24, Ford sent Congress the text of the agreement and of his proclamation moving Romania into the category of most favored nation, making it eligible for the same import duties as almost all other U.S. trading partners—rates at least equal to and generally lower than those that apply to most other Communist countries.

Pursuant to the terms of the Trade Act, Congress must vote on the agreement and on the proclamation within 60 working days. There are special provisions that guarantee that the concurrent resolution (HConRes 252) on the subject comes up for a vote within that time, which will run out in the first few days of August, based on the current congressional work schedule, or some time in September, if it is caught up in the summer recess.

Ford April 24 also signed an executive order waiving the emigration provisions of the Trade Act for Romania,

and sent Congress the required report explaining why he had so acted.

Terms: The U.S.-Romanian trade agreement, in addition to including provisions for reciprocal most-favored-nation status, includes what the Administration describes as safeguard arrangements to protect U.S. workers and firms from a flood of Romanian imports.

The trade pact also provides for facilities in Romania for U.S. businessmen, protection for industrial property rights and copyrights and encourages arbitration of commercial disputes by third countries.

Waiver: In his report to Congress on his waiver of the emigration provisions of the Trade Act, Ford referred to a declaration signed in Washington, Dec. 5, 1973 by Nixon and Romanian President Nicolae Ceausescu and quoted one passage in which the two Presidents promised to "contribute to the solution of humanitarian problems on the basis of mutual confidence and good will."

Although neither that passage nor the entire section from which it was extracted makes any reference to emigration policy, Ford said in his waiver report:

"I have been assured that if and when such problems arise, they will be solved on a reciprocal basis, in the spirit of that declaration. Accordingly, I am convinced that the emigration practices of Romania will lead substantially to the achievement of the objectives" of the emigration provisions of the Trade Act.

Hearings

Although officially the only thing before Congress is the trade agreement, including the extension of equal tariff treatment, most of the Members' interest has centered on the emigration issue, even though the waiver legally is not subject to legislative review.

Economic issues: The Administration received strong support from business groups and faced strong opposition from organized labor on its economic justification for improving trade relations with Romania.

In testimony before the House Ways and Means Subcommittee on Trade May 7, Commerce Undersecretary John K. Tabor predicted that two way trade between the United States and Romania should rise steadily to about \$1 billion a year by 1980 if the trade agreement was implemented.

In 1974, trade between the two countries stood at \$407.6 million, with a U.S. trade advantage of more than 2-1.

Business spokesmen generally endorsed the trade agreement and the resumption of Eximbank credits to Romania that would accompany approval of the agreement (technically, Romania became eligible for credits when Ford issued the waiver April 24, but an Eximbank spokesman said no credits will be extended until Congress acts on the trade pact).

Labor, however, condemned the trade agreement as "a mockery of fair international trade," in the words of AFL-CIO legislative representative Ray Denison.

In testimony May 8 to the Ways and Means subcommittee, Denison said the agreement would make trade "a one way street into the U.S. at the expense of U.S. jobs, production and revenue, for the benefit of multinational firms (and) a Communist country with state controlled labor."

Emigration: Aides to the subcommittee said members had no insurmountable problems with the specifics of the trade agreement. They are, however, concerned about the emigration issue.

Subcommittee members closely questioned Arthur A. Hartman, assistant secretary of State for European affairs, on the "assurances" received from Romania on emigration practices in the future.

Hartman declined to reveal any specifics, warning that the U.S. discussions with Romania were sensitive and reminding the subcommittee

members that the Soviet trade agreement had foundered over Russian insistence that it would not tolerate interference in its internal affairs.

The Romanian agreement "could fall apart" if details were made public and subjected to public debate, he said.

Under the terms of the Trade Act, if Congress approves the trade agreement with Romania along with the grant of most-favored-nation status, it would have another chance one year later to review the status of Romanian emigration practices.

If it did not like what it found then, Hartman told the Ways and Means subcommittee, Congress could refuse to permit the President to extend the waiver.

The act provides that the emigration waiver must be renewed annually after the initial 18-month period ends (in July 1976), and that trade agreements must be renewed every three years.

Hartman, noting that the subcommittee had until roughly the middle of July to send the concurrent resolution to the House floor, suggested that it wait until near its deadline, in the meantime watching for new developments in Romanian emigration practices.

That approach was supported by two representatives of the American Jewish community—Rabbi Israel Miller, speaking for the Conference of Presidents of Major American Jewish Organizations, an umbrella group, and David M. Blumberg, president of B'nai B'rith International.

The two men said the rate of Jewish emigration from Romania to Israel had declined from some 3,500 a year to well under 1,000 in April 1975. They said the subcommittee should await the figures for May and for at least part of June before acting on the trade agreement legislation.

The Senate Finance Committee, which has scheduled its hearings on the resolution for June 5 and 6, also expects to examine the May and June emigration figures before deciding what to do about the trade agreement, a committee aide said.

"If Romania is acting in good faith," said a spokesman for a Jewish group who declined to be identified, "there should be a significant upturn in emigration in the next few months."

"There is no question there are Jews in Romania who want to get out if they can," he said. "As many as



Frederick B. Dent

30,000 to 40,000 are ready to leave."

Evidence: Ways and Means subcommittee members are not satisfied, an aide said, with the presidential report on the emigration waiver. They say it is too vague, and that it cites a document (the 1973 joint declaration) that has nothing to do with the emigration issue.

Hartman has been told that something more than the single paragraph of presidential explanation is required.

Secretary of State Henry A. Kissinger "is skittish about another exchange of letters," an Administration official said with reference to the exchange of letters between Kissinger and Jackson that nailed down the compromise on the Jackson amendment but ultimately led to the Russian repudiation of the bilateral trade agreement.

But the Administration is aware that some additional written statement is required, and it is now attempting to reach agreement with subcommittee members over language that would meet congressional wishes without antagonizing the Romanians.

"Nobody wants to get into the Russian situation again," said a Ways and Means Committee aide with reference to the public discussion and debate over Soviet emigration practices that contributed to the Russian repudiation of the 1972 trade agreement.

Similarly, one of the Jewish spokesmen said his organization plans no public outcry about the state of Jewish emigration from Romania.

"We want to avoid any excuse that Romania will back out of its trade agreement as the Soviet Union did in January," he said.



Ray Denison

"There is no disposition on the part of American Jews to hit Romania over the head," he said. "We only want the Jews who want to get out (of Romania) to get out."

Outlook

The Ways and Means Committee is considering the possibility of reopening its hearings just before its deadline for action to question Administration witnesses on the latest developments in Romanian emigration practices.

If the numbers are up significantly, the trade agreement resolution is likely to be enacted without too much difficulty. If there is little or no improvement, the legislation will be in serious trouble.

The outcome could determine whether other Eastern European countries seek similar trade arrangements with the United States and whether the Soviet Union seeks to implement its dormant U.S. trade agreement.

"If there is success next door, I think people tend to review the situation," testified Frederick B. Dent, the Special Representative for Trade Negotiations, at the Ways and Means hearings.

But representatives of Jewish organizations said they are determined not to let the desire for increased trade with the Communist bloc override the concern about emigration from those countries.

"If Romania gets it (the trade agreement) on the cheap," said a spokesman for one of those organizations, "Russia will expect the same." □

Shipping Subsidies Defy Trend

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The Ford Administration seems to have overlooked something. "To reverse this trend of costly . . . growing regulation," President Ford has said, he is sending to Congress proposals to reform railroad, trucking and airline regulation. But nobody in the Ford Administration has said anything about reforming regulation of the American merchant marine.

If one defines regulation broadly, as Ford does, then merchant marine regulation has grown much more rapidly and has become much costlier, in terms of direct federal expenditures, than railroad, trucking or airline regulation.

Background: Congress first provided merchant marine subsidies, in the form of ocean mail contracts, in 1847. The subsidies grew under legislation enacted in 1891 and 1916. The 1916 Shipping Act also granted anti-trust immunity to rates fixed by international steamship rate conferences.

But in 1934, a special Senate committee, headed by then Sen. Hugo L. Black of Alabama, concluded that "Our system of marine subsidy has not produced and will not, if continued in its present form, ever produce an adequate and efficient merchant marine." So Congress enacted the 1936 Merchant Marine Act, providing larger construction and operating subsidies.

Operating subsidies alone grew from \$454,000 in 1891 to \$24 million in 1936 to \$106 million in 1956. But in 1960 the National Academy of Sciences asserted that "the subsidy system as it now stands is actually hindering U.S. maritime progress."

The latest chapter in this sea saga began during the 1968 presidential campaign when Richard M. Nixon promised that, if elected, he would revitalize the merchant marine. Nixon proposed and Congress passed the 1970 Merchant Marine Act, providing a 10 year subsidy program of nearly \$5 billion. But, alas, the merchant marine today is flailing worse than ever.

Nixon certainly tried. He generated the biggest shipbuilding boom in peacetime history. Old shipyards were expanded and new yards opened, including the Seatrain Lines Inc. shipyard at Brooklyn, N.Y., that hired and trained 3,000 inner city blacks. When the 1972 campaign came, a National Maritime Committee to Re-Elect the President was headed by Paul Hall, president of the Seafarers International Union of North America.

Wrong ships: As it turns out, however, Nixon built the wrong kind of ships. The Nixon Administration spent the bulk of construction subsidies on oil tankers and supertankers. It happens that no U.S. port is deep enough for loaded supertankers, but Congress remedied that deficiency with the Deepwater Port Act of 1974, authorizing offshore superports to be built.

In 1973, after more than \$1 billion of tanker and supertanker construction subsidy contracts had been awarded, the energy crisis gathered. Then the Arabs quadrupled oil prices. World oil trade slumped. Now the bottom has fallen out of the world market for tankers.

More than 170 tankers and supertankers are laid up around the world, representing 20 million deadweight tons, and idle capacity may grow to 100 million tons. There are 31 idle U.S. tankers and supertankers, and they will grow to 40 soon.

The shipbuilding boom has become a bust. Construction of at least 10 American vessels, aggregating more than a million tons, has been cancelled or suspended. Tanker construction cancellations are expected to reach 100 million tons worldwide.

The bust does not appear to be temporary. The Arabs are talking about further increases in oil prices. Ford is insisting on further decreases in U.S. oil imports now and, within 10 years or so, making the U.S. independent of the need for imported oil.

In light of the history of the 1970 Merchant Marine Act, it might seem that the time has come "to reverse this trend of costly . . . growing regulation." Ford for a time seemed to feel that way. In January he vetoed a bill, strongly backed by maritime lobbyists, requiring a larger share of shrinking oil imports to be carried in U.S. tankers.

Ford now seems to feel, however, that the time has not come to reverse trends. The Ford Administration is increasing substantially the potential cost of the 1970 act by bailing out busted shipyards. The Commerce Department has guaranteed, for instance, a \$40 million loan to Seatrain Shipbuilding, so that Seatrain can complete construction of two more supertankers.

Buckley role: If, given Ford's regulatory reform plans, his bailout decision seems inconsistent, the role of Sen. James L. Buckley, Con-R-N.Y., seems stranger. Buckley is one of the Senate's most conservative members and strongest proponents of regulatory reform and of "our free enterprise philosophy." Yet, Buckley urged Ford to bail out Seatrain and flew to New York to announce the bailout.

Buckley, like Ford, is preparing for next year's election, but Buckley's aides deny that the Seatrain bailout is political. They say the government may as well bail out Seatrain because unemployment and welfare benefits for the laid off blacks would cost millions in state and local funds.

Buckley's new concern for blacks could be costly, however, if two more supertankers, already representing a subsidy investment of \$56 million, never sail. If the supertankers should sail, they might never serve U.S. commercial or defense needs because there now is uncertainty whether U.S. superports will be built.

If Ford and Buckley feel the time has not come to reverse trends, a substantial majority in Congress agrees. The Senate recently passed by voice vote, with no debate, the Maritime Appropriation Authorization Act of 1975 (S 1542), increasing annual subsidies to nearly \$600 million. When the House passed a companion bill (HR 3902), not a single member spoke in opposition.

Congress wisely decided to spend the new subsidies mostly on cargo ships instead of tankers, and the House Merchant Marine and Fisheries Committee has decided to conduct exhaustive oversight hearings on the 1970 Merchant Marine Act. But, as the committee chairman, Rep. Leonor K. Sullivan, D-Mo., said, "The funding in the present authorization bill, of course, does not relate to the problems . . . of the world tanker market."

The moral of the tale for reformers of "costly . . . growing regulation" is that regulatory reformers come and go but merchant marine subsidies go on forever. □

Ford Steps Up Appointments Pace

President Ford within the last few months has increased the pace of his appointments markedly.

Shortly after Ford assumed office last August, the vacancy rate among presidentially appointed positions was estimated at 15 per cent. Currently, it is less than 5 per cent.

From early March through the first three weeks of May, Ford has made more than 250 appointments, or an average slightly in excess of three a day. The nominations span the spectrum of government service, from Cabinet-level officers requiring Senate confirmation to members of part-time presidential commissions.

Among the "name" appointees selected for prestige posts were Rogers C. B. Morton, former Interior Secretary and close friend of Ford, to be Commerce Secretary; Harvard professor Daniel P. Moynihan, former White House aide and envoy to India, as U.S. ambassador to the United Nations; and former Wyoming Gov. Stanley K. Hathaway, R, to be Interior Secretary.

Second level spots: The bulk of the appointments, however, involved middle-level executive positions in the federal departments and agencies.

Among the Cabinet departments, Health, Education and Welfare (HEW) and Justice experienced a particularly rapid turnover in high ranking officials. New appointees at HEW include Theodore Cooper as assistant secretary and Donald S. Frederickson as director of the National Institutes of Health.

Recently named Justice officials include Harold R. Tyler as deputy attorney general, Michael M. Uhlmann as assistant attorney general (legislative affairs), Richard L. Thornburgh as assistant attorney general (Criminal Division) and Rex E. Lee as assistant attorney general (Civil Division).

Talent hunt: M. Alan Woods, deputy White House personnel director, said that Watergate no longer is a deterrent to recruiting talent. "It's always difficult to find qualified people," he said. "They just don't drop out of the sky, although in some instances they have. It's encouraging as to the number of people who have written in to tell us that they want to help the Administration."

Ford's interest: The step-up in presidential appointments obviously works to Ford's advantage. It makes the Administration more responsive to him; it gives the Administration an image of his own making, one which conforms to his style and philosophy; and it strengthens his political base.

As a veteran politician, Ford is aware of the blessings that accrue from politics and patronage. It is hardly coincidental that he named more than a dozen defeated Republican Members of Congress to government posts and appointed a black (Transportation Secretary William T. Coleman Jr.) and a woman (Housing and Urban Development Secretary Carla A. Hills) to his Cabinet. Even though these nominees may have been experienced and highly qualified, and deserving on merit alone, their appointments were viewed as something special by various political and special interest groups.

Public relations dividends also are realized from the large number of appointments to presidential commissions, whose membership often carries a status symbol. Prominent among these, for example, is the 35 mem-

ber National Commission on the Observance of International Women's Year. Among its members are Clare Boothe Luce, television personality Barbara Walters, actor Alan Alda, and actress Katharine Hepburn.

The agencies: Wholesale personnel changes were made in top positions at several agencies, notably ACTION and the Office of the Special Representative for Trade Negotiations.

At ACTION, which reportedly has been split by internal dissension, former Rep. John R. Dellenback, R-Ore., was appointed associate director in charge of the revised Peace Corps March 29. The same day, Ronald E. Gerevas, the agency's director of recruitment and communications, was named associate director in charge of the domestic and anti-poverty operations, and Willard H. Meinecke, formerly with the U.S. Agency for International Development, was chosen assistant director for administration and finance.

On April 15, William N. Walker, director of the presidential personnel office, and Clayton K. Yeutter, assistant secretary of Agriculture and former Nixon campaign official, were chosen deputy special trade representatives. Once confirmed, they will serve under Frederick B. Dent, former Commerce Secretary, who earlier this year became the President's Special Representative for Trade Negotiations.

New opportunities: The creation of new agencies gave President Ford an opportunity to make additional appointments. A chairman and three commissioners were nominated March 18 to the Commodity Futures Trading Commission, created in October 1974 to regulate trading in commodity futures. An administrator and deputy administrator were announced April 11 for the National Fire Prevention and Control Administration, also established in October 1974.

The most numerous group of appointees were named to the Federal Energy Administration (FEA) and the Energy Research and Development Administration (ERDA). Four high officials recently were named to ERDA and two officials, including deputy administrator John A. Hill, were appointed to the FEA.

Reason for turnover: An official at the White House personnel office contended that the middle-level executive turnover was "the result of changes at the top." He said, "At the end of the Nixon Administration, we were almost fully staffed. Most of the Cabinet officers had been on board at least a couple of years and had their own staff people. When Nixon left, they stayed on because they didn't want to leave under a cloud when things were tense. Now, they feel it is a good time to leave."

Of the recent wave of Ford appointees, two encountered confirmation troubles in the Senate—Hathaway, accused of siding with industrial interests on environmental issues while Governor of Wyoming from 1967-75, and Walker, whose qualifications in the area of international trade were questioned.

"The Senate is tougher than it used to be," said the personnel aide. "It's a hangover from Watergate and the previous Administration. Even guys you don't read about are having problems and are exposed to much closer scrutiny than they used to be."

Privately, White House aides express confidence that both Hathaway and Walker will be confirmed. □

Ford orders second oil import fee; April balance of trade shows surplus

President Ford announced in a televised address May 27 that a second \$1 a barrel fee on imported oil would be levied June 1. Ford also said he would submit to Congress, shortly after it resumes work June 2, his plan for decontrol of domestic oil prices.

The President said he was ordering these actions because Congress had failed to respond to his requests for energy legislation. "We are today worse off than we were in January," he said.

The first \$1 fee on imported crude oil was put into effect Feb. 1 as part of the Administration's program to discourage greater reliance on foreign energy. Imposition of a second and third \$1 fee was deferred while Congress considered alternate proposals. (See Vol. 7, No. 19, p. 704.)

The economy

Trade balance: The third consecutive monthly trade surplus was recorded by the United States in April, the Commerce Department announced May 27. For the year to date, the merchandise trade account is \$2.6 billion in the black.

The April surplus of \$556.8 million was, however, considerably lower than those recorded for February and March, with imports of expensive foreign oil rising by \$965 million to a total of \$2.34 billion.

The shrinking of the surplus from the March record monthly surplus of \$1.38 billion was the result of a \$146.3 million decline in U.S. exports and a \$677.2 million increase in imports.

Consumer prices: A turnaround in food prices sent the consumer price index up a seasonally adjusted 0.6 per cent in April, its largest rise since January.

The Bureau of Labor Statistics (BLS) said, however, that the April increase also was the result of an even sharper increase in the prices of non-food commodities.

During the past three months, the index has risen at a seasonally adjusted annual rate of 5.8 per cent. During the past 12 months, it has risen 10.2 per cent.

The 0.4 per cent increase in food prices came after two consecutive monthly declines. The BLS said the

rise was due mainly to higher beef and egg prices. The bureau noted, however, that the food price increase was significantly less than those in late 1974.

Non-food items rose 0.8 per cent, after a 0.5 per cent increase in March. That part of the index has been rising each month within a 0.5-0.8 per cent range. The April increase was due to higher prices for gasoline, coal and various items related to home buying and upkeep.

Real earnings: Real earnings continued to fall in April, but the drop this time was less than it has been in past months. The Bureau of Labor Statistics said May 21 that real spendable earnings fell 0.1 per cent in April. In the past 12 months they have fallen 4.1 per cent, with 3.4 per cent of that the result of shrinking paychecks and 0.8 per cent caused by higher taxes.

Consumer affairs

Advertising: The Federal Trade Commission (FTC) issued guidelines and proposed guidelines May 20 designed to make advertising endorsements more accurate.

One guide issued by the commission requires experts to have the expertise they are represented as possessing. Also, their expertise actually must be used in evaluating product features or characteristics. Another guide says that organizational endorsements must be decided "by a process that fairly reflects the collective judgment of the organization."

Three proposed guidelines would require that every endorsement reflect the honest views of the endorser; that the advertiser be prohibited from distorting the endorser's opinion or experience with the product; and that the endorser be a bona fide user of the product.

A guideline, which is less authoritative than a trade regulation rule, serves as a warning to businesses that those who violate its provisions might be sued by the FTC. The commission is receiving written comments on the three proposed guidelines for 60 days.

Justice

Criminal privacy regulations: The Justice Department May 19 announced new regulations governing the use of

criminal records maintained by the federal government or subsidized by federal funds. Because the Federal Bureau of Investigation keeps records from nearly all state and local police departments, the regulations will have a broad scope. The regulations were mandated by Congress in 1973, and the Justice Department and Law Enforcement Assistance Administration took more than a year to approve the final rules, which become effective June 19.

A principal purpose of the regulations is to prevent dissemination of an arrest record to a non-criminal justice agency if the record does not include the disposition of the case within 12 months after the arrest. Also, computerized criminal records must be under the control of a criminal justice agency. (For a report, see Vol. 6, No. 41, p. 1521.)

Newsman subpoenas: The Justice Department May 23 reported that the Attorney General has approved issuance of subpoenas to 54 newsmen during the past 26 months. An additional 22 subpoenas were issued by department employees, usually by a U.S. Attorney, without approval of the Attorney General. Former Attorney General (1969-72) John N. Mitchell issued guidelines in 1970 designed to reduce the number of subpoenas to newsmen and to assure the Attorney General's approval of each action.

The information was made available by Antonin Scalia, assistant attorney general in charge of the Office of Legal Counsel, in a letter to Rep. Robert W. Kastenmeier, D-Wis., chairman of the House Judiciary Subcommittee on Courts, Civil Liberties and Administration of Justice. The panel is considering legislation (HR 215) proposing that reporters be granted at least a partial privilege from testifying in court.

Scalia's letter said that 42 of the 54 subpoenas were issued after the reporter had agreed to testify. In three instances, the Attorney General rejected a staff request that a subpoena be issued.

Transportation

Amtrak: President Ford May 26 signed into law a bill (HR 4975) authorizing \$1.12 billion for the National Railroad Passenger Corp. (Amtrak) to cover operating deficits and new equipment purchases through Oct. 1, 1977. □

Congressional Actions

Conferees agree on mortgage aid bill; Senate panel recommends Hathaway

House and Senate conferees May 21 reached agreement on a limited version of a bill (HR 4485) designed to stimulate the housing industry and help prevent unemployed home owners from losing their homes through mortgage foreclosures.

The conference committee first reached agreement on May 13, but after House conferees said the bill faced rejection by the House, the new version was drafted. It retains only the "emergency" portions of the bill, dropping a section under which the federal government would subsidize mortgage rates for middle income home buyers, with the government providing loans at an 8 per cent rate and the home owner picking up the difference between that and the prevailing rate. The first conference report stated that it was the intent of Congress that the program would be triggered whenever housing starts fell below a seasonally adjusted annual rate of 1.6 million a month for three consecutive months.

Instead, the final conference report limited itself to assistance for unemployed home owners and temporary incentives to spur the housing market. Those include a 7 per cent loan for the life of the mortgage, a 6 per cent loan phased out over six years or a \$1,000 grant to help make a down payment on a newly purchased home.

The bill also provides loans of up to \$250 a month for up to two years for an estimated 100,000 home owners faced with the loss of income due to the recession. The House version had provided \$200 a month, the Senate version \$300.

Rep. Henry S. Reuss, D-Wis., chairman of the House Banking, Currency and Housing Committee, said a presidential veto of the legislation was unavoidable. "They're going to veto anything we send them," he said, "so there's no use trying to placate them."

Environment, resources

Hathaway: The Senate Interior and Insular Affairs Committee on May 21, by a vote of 10-4, ordered favorably reported the nomination of Stanley K. Hathaway to be Secretary of the Interior. The vote followed an open session during which the committee ques-

tioned Hathaway on his connections with the Citizens National Bank and Trust Co. of Torrington, Wyo., for which Hathaway served as a director and shareholder during his two terms as Governor of the state.

White House

Electoral College: The Senate Judiciary Subcommittee on Constitutional Amendments May 21 unanimously approved a proposed constitutional amendment to abolish the electoral college and provide for direct election of the President.

Under the bill (SJRes 1), sponsored by subcommittee chairman Birch Bayh, D-Ind., and 49 co-sponsors, the candidate with a plurality of popular votes would be elected President. If no candidate received 40 per cent of the votes, the selection would be made from the top two candidates by the 535 Members of the new Congress.

A similar bill was approved by the subcommittee in 1973 but not acted upon by the full committee. The House passed an electoral college reform bill in 1969, but the measure was killed by a Senate filibuster in 1970.

Budget

Supplemental appropriations: A \$15.7 billion supplemental appropriations bill (HR 5899) was delayed for at least the Memorial Day recess as the House and Senate could not reach agreement May 22 on the conference report.

The House approved the conference report, 317-34, but insisted on striking a Senate amendment to appropriate \$700 million for improvements to railroad facilities, which the House has not authorized yet and on which hearings will not be held until late June.

The Senate, however, which already has passed a bill (S 1730) authorizing the improvements, rejected, 16-46, a motion to recede from the amendment appropriating the railroad funds. The measure was sent back to the House, but not before many Members had left for recess, and a quorum could not be raised.

The bill would appropriate \$5 billion for unemployment compensation, \$885 million for the food stamp program, \$256 million for veterans' compensation and pensions, \$473 for hu-

man development programs, \$492 million for the Community Services Administration, \$1.75 billion for an additional \$50 for every social security recipient and \$2 billion for federal pay increases.

Employment and labor

Unemployment benefits: The House May 21 passed, 381-8, a \$6 billion bill (HR 6900) to extend and expand unemployment benefits through June 30, 1976. The Senate is expected to approve a similar measure in June.

Under the House bill, the current maximum of 65 weeks of benefits would continue to be available to workers covered under regular unemployment insurance programs for another year. The maximum is scheduled to revert to 26 weeks in another month.

The bill also would expand coverage for workers who have not been eligible for benefits until this year from 26 to 29 weeks until the end of June 1976.

The Ford Administration, which generally supports the legislation, had proposed to cut back on benefits in areas where unemployment is declining, but the House did not adopt the suggestion.

Securities reform: Congress passed and sent to the President a bill (S 249) that gives the Securities and Exchange Commission enhanced authority to restructure the nation's securities markets. The House vote on the conference report on the bill came May 22.

Prompted by the paperwork crisis in brokerage houses in the late 1960s, the bill has been in the works for several years. Among its features, the measure ratifies the end of fixed commission rates and prepares the way for the eventual creation of a single nationwide stock exchange.

Agriculture

Supplemental food: The House May 21 and the Senate May 22 passed a bill (HR 7136) to extend the special supplemental food program for women, infants and children through Sept. 30.

The program is designed to meet the nutritional needs of young children from low income families and provide additional protein-rich food to their mothers during pregnancy and while nursing.

The program was due to expire on June 30. The bill authorizes the expansion of the program while Congress prepares legislation to extend the program permanently. □

House votes 185, 187, 188, 189, 190, 191, 192, 193

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185—Printing resolution (SConRes 23):
May 7, 1975. The House adopted, 262-138 (D 259-9; R 3-129), a concurrent resolution, sponsored by Sen. Mike Mansfield, D-Mont., to authorize the printing of 20,000 additional copies of *The Congressional Program of Economic Recovery and Energy Efficiency*, a report prepared by the Joint Economic Committee.

187—Strip mining, conference report (HR 25): **May 7, 1975.** The House agreed 293-115 (D 216-57; R 77-58), to the conference report on a bill, sponsored by Rep. Morris K. Udall, D-Ariz., to provide for a federal-state program to regulate the strip mining of coal.

188—National Health Service Corps, consideration (HR 4114): **May 7, 1975.** The House adopted, 401-0 (D 272-0; R 129-0), a resolution (HRes 417), sponsored by Rep. Claude Pepper, D-Fla., to provide for the consideration of a bill to extend the National Health Service Corps program through fiscal 1975 and to authorize \$16 million in fiscal 1975 and \$30 million in fiscal 1976 for the program.

189—National Health Service Corps (HR 4114): **May 7, 1975.** The House passed, 399-4 (D 270-2; R 129-2), a bill, sponsored by Rep. Paul G. Rogers, D-Fla., to extend the National Health Service Corps program through fiscal 1975 and to authorize \$46 million for fiscal 1975-76. The bill authorizes \$1,000 a month bonuses for corps members and authorizes medical support grants of up to \$25,000 for communities that are medically underserved.

190—Nurse Training Act (HR 4115): **May 7, 1975.** The House passed, 384-17 (D 269-1; R 115-16), a bill, sponsored by Rep. Paul G. Rogers, D-Fla., to extend the nurse training program through fiscal 1975 and to authorize \$558 million in fiscal 1976-78 for it. The bill provides loans and scholarships for nurse trainees and financial assistance to nursing schools.

191—Variable interest rate mortgages, consideration (HR 6209): **May 8, 1975.** The House adopted, 392-0 (D 263-0; R 129-0), a resolution (HRes 446), sponsored by Rep. Andrew Young, D-Ga., to provide for the consideration of a bill to prohibit the Federal Home Loan Bank Board from permitting federally chartered savings and loan associations to offer variable interest rates on home mortgages.

192—Variable interest rate mortgages, Rees substitute (HR 6209): **May 8, 1975.** The House rejected, 167-232 (D 53-216; R 114-16), an amendment in the nature of a substitute bill by Rep. Thomas M. Rees, D-Calif., to allow federally-chartered banks in states where variable rates are already permissible to offer the rates for four years.

193—Variable interest rate mortgages, expiration date (HR 6209): **May 8, 1975.** The House rejected, 164-231 (D 48-219; R 116-12), an amendment by Rep. J. William Stanton, R-Ohio, to provide that the prohibition on variable interest rate mortgages would expire on June 30, 1977.

Key

Y = Voted "yea" **N** = Voted "nay"
+ = Announced or paired "yea"
- = Announced or paired "nay"
***** = Not voting, unannounced

Source: *Congressional Record*, Daily Edition. Quorum calls not included.
 Democrats—289, Republicans—144

ALABAMA

Bevill 4
Buchanan 6
Dickinson 2
Edwards 1
Flowers 7
Jones 5
Nichols 3
Young AL

ALASKA

ARIZONA

Conlan 4
Rhodes 1
Steiger 3
Udall 2

ARKANSAS

Alexander 1
Hammerschmidt 3
Mills 2
Thornton 4

CALIFORNIA

Anderson 32
Bell 27
Brown 36
Burgener 43
Burke 28
Burton J 5
Burton P 6
Clausen 2
Clawson 33
Corman 21
Danielson 30
DeLums 8
Edwards 10
Goldwater 20
Hannaford 34
Hawkins 29
Hinshaw 40
Johnson 1
Ketchum 18
Krebs 17
Lagomarsino 19
Leggett 4
Lloyd 35
McCloskey 12
McFall 14
Miller 7
Mineta 13
Moorhead 22
Moss 3
Patterson 38
Pettis 37
Rees 23
Rousselot 26
Roybal 25
Ryan 11
Sisk 15
Stark 9
Talcott 16
Van Deerlin 42
Waxman 24
Wiggins 39
Wilson C 31
Wilson B 41

COLORADO

Armstrong 5
Evans 3
Johnson 4
Schroeder 1
Wirth 2

CONNECTICUT

Cotter 1
Dodd 2
Giaino 3
McKinney 4
Moffatt 6
Sarasin 5

DELAWARE

FLORIDA

DuPont AL
Batalis 10
Bennett 3
Burke 12
Chappell 4
Fascell 15

	185	187	188	189	190	191	192	193
Alabama	Y	N	Y	Y	Y	Y	N	N
Alaska	N	N	*	Y	Y	Y	Y	Y
Arizona	*	N	Y	Y	N	Y	Y	Y
Arkansas	Y	N	Y	Y	Y	Y	Y	Y
California	Y	Y	Y	Y	Y	Y	N	N
Colorado	N	Y	Y	Y	Y	Y	Y	Y
Connecticut	Y	Y	Y	Y	Y	Y	N	N
Delaware	N	Y	Y	Y	Y	Y	Y	Y
Florida	N	Y	Y	Y	Y	Y	Y	Y
Georgia	Y	Y	Y	Y	Y	Y	Y	Y
Idaho	N	N	Y	Y	N	Y	Y	Y
Illinois	N	*	*	*	*	*	*	*
Indiana	Y	Y	Y	Y	Y	Y	Y	Y
Iowa	N	Y	Y	Y	Y	Y	Y	Y
Kansas	N	Y	Y	Y	Y	Y	Y	N
Kentucky	Y	Y	Y	Y	Y	Y	Y	Y
Louisiana	Y	Y	Y	Y	Y	Y	Y	N
Maine	N	Y	Y	Y	Y	Y	Y	Y
Maryland	N	N	Y	Y	N	Y	Y	Y
Massachusetts	Y	Y	Y	Y	Y	Y	Y	Y
Michigan	Y	Y	Y	Y	Y	Y	Y	Y
Minnesota	Y	Y	Y	Y	Y	Y	Y	Y
Mississippi	Y	Y	Y	Y	Y	Y	Y	Y
Missouri	Y	Y	Y	Y	Y	Y	Y	Y
Montana	Y	Y	Y	Y	Y	Y	Y	Y
Nebraska	Y	Y	Y	Y	Y	Y	Y	Y
Nevada	Y	Y	Y	Y	Y	Y	Y	Y
New Hampshire	Y	Y	Y	Y	Y	Y	Y	Y
New Jersey	Y	Y	Y	Y	Y	Y	Y	Y
New Mexico	Y	Y	Y	Y	Y	Y	Y	Y
New York	Y	Y	Y	Y	Y	Y	Y	Y
North Carolina	Y	Y	Y	Y	Y	Y	Y	Y
North Dakota	Y	Y	Y	Y	Y	Y	Y	Y
Ohio	N	Y	Y	Y	Y	Y	Y	Y
Oklahoma	Y	Y	Y	Y	Y	Y	Y	Y
Oregon	Y	Y	Y	Y	Y	Y	Y	Y
Pennsylvania	Y	Y	Y	Y	Y	Y	Y	Y
Rhode Island	Y	Y	Y	Y	Y	Y	Y	Y
South Carolina	Y	Y	Y	Y	Y	Y	Y	Y
South Dakota	Y	Y	Y	Y	Y	Y	Y	Y
Tennessee	Y	Y	Y	Y	Y	Y	Y	Y
Texas	Y	Y	Y	Y	Y	Y	Y	Y
Utah	Y	Y	Y	Y	Y	Y	Y	Y
Vermont	Y	Y	Y	Y	Y	Y	Y	Y
Virginia	Y	Y	Y	Y	Y	Y	Y	Y
Washington	Y	Y	Y	Y	Y	Y	Y	Y
West Virginia	Y	Y	Y	Y	Y	Y	Y	Y
Wisconsin	Y	Y	Y	Y	Y	Y	Y	Y
Wyoming	Y	Y	Y	Y	Y	Y	Y	Y

	185	187	188	189	190	191	192	193
Frey 9	N	Y	Y	Y	Y	Y	Y	Y
Fuqua 2	Y	Y	Y	Y	Y	Y	Y	N
Gibbons 7	Y	Y	Y	Y	Y	*	*	*
Haley 8	Y	Y	Y	Y	Y	Y	Y	Y
Kelly 5	N	Y	Y	Y	N	Y	Y	Y
Lehman 13	Y	Y	Y	Y	Y	Y	N	N
Pepper 14	Y	Y	Y	Y	Y	Y	*	*
Rogers 11	Y	Y	Y	Y	Y	Y	N	N
Sikes 1	Y	Y	*	*	Y	*	*	*
Young 6	N	Y	Y	Y	Y	Y	Y	Y
Georgia	Y	Y	Y	Y	Y	Y	N	N
Brinkley 3	Y	N	Y	Y	Y	Y	Y	Y
Flynt 6	Y	N	Y	Y	Y	Y	Y	Y
Ginn 1	*	*	*	*	*	*	*	*
Landrum 9	Y	Y	Y	Y	Y	Y	Y	Y
Levitas 4	Y	Y	Y	Y	Y	Y	Y	Y
Mathias 2	N	N	Y	Y	Y	Y	Y	Y
McDonald 7	N	N	Y	N	N	Y	Y	Y
Stephens 10	Y	N	Y	Y	Y	Y	Y	Y
Stuckey 8	*	Y	Y	Y	Y	Y	Y	N
Young 5	Y	Y	Y	Y	Y	Y	N	N
Hawaii	Y	Y	Y	Y	Y	Y	N	N
Matsunaga 1	Y	Y	Y	Y	Y	Y	N	N
Mink 2	*	*	*	*	*	*	*	*
Idaho	N	N	Y	Y	N	Y	Y	Y
Hansen 2	N	N	Y	N	N	Y	Y	Y
Symms 1	N	N	Y	N	N	Y	Y	Y
Illinois	N	*	*	*	*	*	*	*
Anderson 16	Y	Y	Y	Y	Y	Y	N	N
Annunzio 11	Y	Y	Y	Y	Y	Y	N	N
Collins 7	Y	Y	Y	Y	Y	Y	N	N
Crane 12	N	N	*	*	Y	Y	Y	Y
Derwinski 4	Y	N	Y	Y	Y	Y	N	Y
Erlenborn 14	N	N	Y	Y	Y	*	Y	Y
Findley 20	N	Y	Y	Y	Y	Y	Y	Y
Hall 15	Y	Y	Y	Y	Y	Y	N	N
Hyde 6	N	Y	Y	Y	Y	Y	Y	Y
Madigan 21	N	Y	Y	Y	Y	Y	Y	*
McClary 13	N	Y	Y	Y	Y	Y	Y	Y
Metcalfe 1	Y	Y	Y	Y	Y	Y	N	N
Michel 18	N	N	Y	Y	Y	Y	N	N
Mikva 10	Y	Y	Y	Y	Y	Y	N	N
Murphy 2	Y	Y	Y	Y	Y	Y	N	N
O'Brien 17	N	N	Y	Y	Y	*	*	*
Price 23	Y	Y	Y	Y	Y	Y	N	N
Railsback 19	N	Y	*	Y	Y	Y	N	Y
Rostenkowski 8	Y	Y	Y	Y	Y	Y	N	N
Russo 3	Y	Y	Y	Y	Y	*	*	*
Shipley 22	Y	Y	Y	Y	Y	*	*	*
Simon 24	Y	Y	Y	Y	Y	Y	N	Y
Yates 9	Y	Y	Y	Y	Y	Y	N	N
Vacant 5	Y	Y	Y	Y	Y	Y	Y	Y
Indiana	Y	Y	Y	Y	Y	Y	N	N
Brademas 3	Y	Y	Y	Y	Y	Y	N	N
Evans 6	N	Y	Y	Y	Y	Y	N	Y
Fithian 2	Y	*	Y	Y	Y	Y	N	Y
Hamilton 9	Y	Y	Y	Y	Y	Y	N	Y
Hayes 8	Y	Y	Y	Y	Y	Y	N	N
Hillis 5	N	Y	Y	Y	Y	Y	Y	Y
Jacobs 11	N	Y	Y	Y	Y	Y	N	N
Madden 1	Y	Y	Y	Y	Y	Y	N	N
Myers 7	N	Y	Y	Y	Y	Y	Y	Y
Roush 4	N	Y	Y	Y	Y	Y	N	Y
Sharp 10	Y	Y	Y	Y	Y	Y	N	Y
Iowa	N	Y	Y	Y	Y	Y	*	*
Bedell 6	Y	Y	Y	Y	Y	Y	N	N
Blouin 2	Y	Y	Y	Y	Y	Y	N	N
Grassley 3	N	Y	Y	Y	Y	Y	Y	Y
Harkin 5	*	Y	Y	Y	Y	Y	N	N
Mezvinsky 1	Y	Y	Y	Y	Y	Y	N	N
Smith 4	Y	Y	Y	Y	Y	Y	Y	Y
Kansas	N	Y	Y	Y	Y	Y	N	N
Keys 2	N	Y	Y	Y	Y	Y	Y	Y
Sebelius 7	*	*	*	*	*	*	Y	Y
Shriver 4	N	Y	Y	Y	Y	Y	N	Y
Skubitz 5	N	Y	Y	Y	Y	Y	N	Y
Winn 3	N	Y	Y	Y	Y	Y	*	*
Kentucky	Y	Y	Y	Y	Y	Y	Y	Y
Breckinridge 6	Y	Y	Y	Y	Y	Y	Y	Y
Carter 5	N	N	Y	Y	Y	Y	N	Y
Hubbard 1	Y	N	Y	Y	*	Y	N	N
Mazzoli 3	Y	Y	Y	Y	Y	Y	N	N
Natcher 2	Y	Y	Y	Y	Y	Y	N	N
Perkins 7	Y	Y	Y	Y	Y	Y	N	N
Snyder 4	N	N	Y	Y	Y	Y	N	Y
Louisiana	Y	Y	Y	Y	Y	Y	N	N
Boggs 2	Y	N	Y	Y	Y	Y	N	N
Breaux 7	Y	N	Y	Y	Y	Y	N	N
Hebert 1	Y	N	*	Y	*	Y	N	Y
Long 8	Y	Y	Y	Y	Y	Y	N	N
Moore 6	N	N	Y	Y	Y	Y	Y	Y
Passman 5	Y	N	Y	Y	Y	Y	Y	Y
Treen 3	N	N	Y	Y	Y	Y	Y	Y
Waggonner 4	Y	N	Y	Y	Y	Y	Y	N
Maine	N	Y	Y	Y	Y	Y	Y	Y
Cohen 2	N	Y	Y	Y	Y	Y	Y	Y
Emery 1	N	Y	Y	Y	Y	Y	Y	Y
Maryland	N	N	Y	Y	N	Y	Y	Y
Bauman 1	Y	N	Y	Y	Y	Y	Y	Y
Byron 6	N	N	Y	Y	Y	Y	Y	N

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182—Consumer advocacy agency, counsel (S 200): May 15, 1975. The Senate rejected, 24-67 (D 5-49; R 19-18), an amendment by Sen. William Lloyd Scott, R-Va., to provide that the Attorney General handle all lawsuits brought by the consumer agency. Under the bill, the agency's administrator would appoint a counsel to handle such proceedings.

183—Consumer advocacy agency, cost-benefit assessments (S 200): May 15, 1975. The Senate rejected, 24-66 (D 8-46; R 16-20), an amendment by Sen. Robert P. Griffin, R-Mich., to strike all sections of the bill except those that require federal agencies to make cost-benefit assessments before issuing new regulations.

184—Consumer advocacy agency (S 200): May 15, 1975. The Senate passed, 61-28 (D 42-11; R 19-17), a bill, sponsored by Sen. Abraham Ribicoff, D-Conn., to establish an Agency for Consumer Advocacy in the executive branch for three years to represent consumer interests in judicial proceedings and before other executive agencies and departments.

185—Refugee aid authorization, substitute (HR 6755): May 16, 1975. The Senate rejected, 6-74 (D 0-47; R 6-27), an amendment by Sen. Jesse A. Helms, R-N.C., in the nature of a substitute bill, to appropriate no funds for the resettlement of refugees, instead relying on donations to religious and charitable organizations, and to require all Members of the House and Senate to donate at least \$1,000 to the effort.

186—Refugee aid authorization (HR 6755): May 16, 1975. The Senate passed, 77-2 (D 47-0; R 30-2), a bill, sponsored by Rep. Thomas E. Morgan, D-Pa., after substituting the Senate version (S 1661) for all but the enacting clause. The Senate-passed bill authorizes \$405 million to assist refugees from South Vietnam and Cambodia. Under the Senate version, funds would be provided to refugees who want to return to their homeland.

187—Refugee aid appropriations (HR 6894): May 16, 1975. The Senate passed, 79-2 (D 48-0; R 31-2), a bill, sponsored by Rep. George H. Mahon, D-Texas, to appropriate \$405 million to assist refugees from South Vietnam and Cambodia.

188—Emergency rail improvements, fund transferral (S 1730): May 16, 1975. The Senate rejected, 24-52 (D 4-41; R 20-11), an amendment by Sen. James L. Buckley, Con-R-N.Y., to reduce the authorization of the Comprehensive Employment and Training Act of 1973 from \$2.5 million to \$1.9 million, using that \$600 million for emergency rail roadbed and facility improvements.

189—Emergency rail improvements (S 1730): May 16, 1975. The Senate passed, 67-10 (D 42-3; R 25-7), a bill, sponsored by Sen. Vance Hartke, D-Ind., to authorize \$600 million to repair rail roadbeds and facilities, thereby creating emergency public service jobs.

Key
Y = Voted "yea" N = Voted "nay"
+ = Announced or paired "yea"
- = Announced or paired "nay"
* = Not voting, unannounced
Source: *Congressional Record*, Daily Edition. Quorum calls not included.
Democrats—61 Republicans—38

	182	183	184	185	186	187	188	189
ALABAMA								
Allen	Y	Y	N	N	Y	Y	Y	N
Sparkman	N	Y	N	N	Y	Y	N	Y
ALASKA								
Gravel	*	*	*	*	+	+	*	*
Stevens	Y	N	Y	N	Y	Y	Y	Y
ARIZONA								
Fannin	Y	Y	N	N	Y	Y	Y	N
Goldwater	Y	Y	N	Y	Y	Y	Y	N
ARKANSAS								
Bumpers	N	N	Y	N	Y	Y	N	Y
McClellan	Y	Y	N	N	Y	Y	N	Y
CALIFORNIA								
Cranston	N	N	Y	N	Y	Y	N	Y
Tunney	*	*	+	*	*	*	*	*
COLORADO								
Hart	N	N	Y	N	Y	Y	N	Y
Haskell	N	N	Y	N	Y	Y	N	Y
CONNECTICUT								
Ribicoff	N	N	Y	N	Y	Y	N	Y
Weicker	N	N	Y	N	Y	Y	Y	Y
DELAWARE								
Biden	N	N	Y	*	*	*	*	*
Roth	N	N	Y	N	Y	Y	Y	Y
FLORIDA								
Chiles	N	N	Y	N	Y	Y	N	Y
Stone	N	N	Y	N	Y	Y	N	Y
GEORGIA								
Nunn	N	Y	N	*	+	+	*	*
Talmadge	Y	Y	N	*	*	*	*	*
HAWAII								
Fong	Y	N	Y	N	Y	Y	N	N
Inouye	N	N	Y	N	Y	Y	*	*
IDAHO								
Church	N	N	Y	N	Y	Y	N	Y
McClure	Y	Y	N	Y	Y	Y	Y	Y
ILLINOIS								
Percy	N	N	Y	N	Y	Y	N	Y
Stevenson	-	-	+	-	+	+	-	+
INDIANA								
Bayh	*	*	*	-	+	+	-	+
Hartke	N	N	Y	N	Y	Y	N	Y
IOWA								
Clark	N	N	Y	N	Y	Y	-	+
Culver	N	N	Y	N	Y	Y	N	Y
KANSAS								
Dole	N	N	Y	N	Y	Y	Y	Y
Pearson	N	N	Y	N	Y	Y	Y	Y
KENTUCKY								
Ford	N	N	Y	N	Y	Y	N	Y
Huddleston	N	N	Y	N	Y	Y	N	Y
LOUISIANA								
Johnston	*	*	-	*	*	*	*	*
Long	N	N	N	N	Y	Y	N	Y
MAINE								
Hathaway	N	N	Y	N	Y	Y	N	Y
Muskie	N	N	Y	*	*	*	*	*
MARYLAND								
Beall	N	N	Y	N	Y	Y	N	Y
Mathias	N	N	Y	N	Y	Y	N	Y
MASSACHUSETTS								
Brooke	N	N	Y	N	Y	Y	N	Y
Kennedy	N	N	Y	N	Y	Y	N	Y
MICHIGAN								
Griffin	Y	Y	N	N	Y	Y	*	*
Hart	N	N	Y	N	Y	Y	N	Y

MINNESOTA								
Humphrey	N	N	Y	N	Y	Y	N	Y
Mondale	N	N	Y	N	Y	Y	N	Y
MISSISSIPPI								
Eastland	Y	Y	N	*	*	*	*	*
Stennis	N	Y	N	N	Y	Y	N	Y
MISSOURI								
Eagleton	N	N	Y	N	Y	Y	N	Y
Symington	N	N	N	N	Y	Y	N	Y
MONTANA								
Mansfield	N	N	+	N	Y	Y	N	Y
Metcalf	*	*	*	N	Y	Y	N	Y
NEBRASKA								
Curtis	Y	Y	N	Y	Y	Y	Y	N
Hruska	Y	Y	N	*	+	+	*	*
NEVADA								
Cannon	N	N	Y	N	Y	Y	N	Y
Laxalt	Y	Y	N	N	Y	Y	Y	Y
NEW HAMPSHIRE								
McIntyre	N	N	Y	N	Y	Y	N	Y
Undecided								
NEW JERSEY								
Case	N	N	Y	N	Y	Y	N	Y
Williams	N	N	Y	N	Y	Y	*	Y
NEW MEXICO								
Domenici	N	N	Y	N	Y	Y	N	Y
Montoya	N	N	Y	*	*	*	*	*
NEW YORK								
Buckley	Y	Y	N	*	*	Y	Y	Y
Javits	N	N	Y	N	Y	Y	N	Y
NORTH CAROLINA								
Helms	Y	Y	N	Y	N	N	Y	N
Morgan	N	N	Y	-	+	Y	*	*
NORTH DAKOTA								
Burdick	N	N	Y	N	Y	Y	N	Y
Young	Y	Y	N	N	Y	Y	N	Y
OHIO								
Glenn	N	N	Y	N	Y	Y	N	Y
Taft	Y	N	N	*	+	+	*	+
OKLAHOMA								
Bartlett	Y	Y	N	N	*	*	*	*
Bellmon	N	Y	N	*	*	*	*	*
OREGON								
Hatfield	N	N	Y	Y	Y	Y	Y	Y
Packwood	Y	N	Y	N	Y	Y	Y	Y
PENNSYLVANIA								
Schweiker	N	N	Y	N	Y	Y	N	Y
Scott	N	N	Y	N	Y	Y	N	Y
RHODE ISLAND								
Pastore	N	N	Y	N	Y	Y	N	Y
Pell	N	N	Y	N	Y	Y	N	Y
SOUTH CAROLINA								
Hollings	N	N	Y	N	Y	Y	Y	Y
Thurmond	+	+	-	Y	Y	Y	Y	N
SOUTH DAKOTA								
Abourezk	N	N	Y	N	Y	Y	N	Y
McGovern	N	N	Y	N	Y	Y	N	Y
TENNESSEE								
Baker	N	*	+	*	*	*	*	*
Brock	N	N	Y	N	Y	Y	Y	Y
TEXAS								
Bentsen	N	N	Y	N	Y	Y	N	Y
Tower	Y	Y	N	N	Y	Y	Y	Y
UTAH								
Garn	Y	Y	N	N	Y	Y	Y	Y
Moss	N	N	Y	*	+	+	*	*
VERMONT								
Leahy	N	N	Y	N	Y	Y	N	Y
Stafford	N	N	Y	N	Y	Y	N	Y
VIRGINIA								
Byrd	Y	Y	N	N	Y	Y	Y	N
Scott	Y	Y	N	N	N	N	Y	N
WASHINGTON								
Jackson	N	N	Y	N	Y	Y	N	Y
Magnuson	N	N	Y	N	Y	Y	N	Y
WEST VIRGINIA								
Byrd	N	N	N	N	Y	Y	N	Y
Randolph	N	N	Y	N	Y	Y	N	Y
WISCONSIN								
Nelson	N	N	Y	N	Y	Y	N	Y
Proxmire	N	N	Y	N	Y	Y	Y	N
WYOMING								
Hansen	Y	Y	N	N	Y	Y	Y	Y
McGee	*	*	*	*	+	+	*	+

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OCE REPORT

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FEDERAL COMMUNICATIONS COMMISSION

Technological Boundaries of Television

VOLUME **3** APPENDICES
TO VOLUME 1



TECHNOLOGICAL BOUNDARIES
OF TELEVISION

PREPARED FOR
THE FEDERAL COMMUNICATIONS COMMISSION

By Raymond M. Wilmotte
Consultant

November 1974

A STUDY OF THE NATIONAL OUTLOOK FOR THE

QUALITY OF TELEVISION DISPLAYS

APPENDICES TO VOLUME I

APPENDIX A

THE EYE-BRAIN COMPLEX

- A1 THE VISUAL PARAMETERS
- A2 SHARPNESS
- A3 CONTRAST
- A4 COLOR
- A5 ILLUSION OF SIZE
- A6 BEST VIEWING DISTANCE
- A7 IMPLICATIONS TO TELEVISION

APPENDIX ATHE EYE-BRAIN COMPLEXA.1 THE VISUAL PARAMETERS*

A curious feature of human response to television is that if it represents accurately the physical characteristics of the original scene it depicts as to color, contrast and sharpness, it is generally not pleasing. A reproduction that is physically exact in these respects appears under-saturated, much too low in contrast (as though veiled in a fog), and slightly lacking in sharpness. The reason for this remarkable result was established only by means of a long series of psychophysical studies carried out by Eastman Kodak. The finding is of great importance in connection with standards and operational practices of television. This aspect is discussed in Section A.3 on contrast.

The human response to visual scenes and pictures is a combination of the characteristics of the eye as a detector of light and of the brain as the coordinator of the enormous amount of complex information developed by the eyes. The eye-brain complex can detect an extraordinary range of visual characteristics. It can handle a dynamic range of a billion to one. At its maximum sensitivity it has an angular resolution of one

*Much of the information in this section was obtained from the Research Division of Eastman Kodak through the cooperation of Mr. Clarence N. Nelson.

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minute of arc. It has the capability to detect differences in brightness of seven parts in a thousand across a sharp edge separating two large areas. It can distinguish between some two million different colors under best conditions, but only eight or ten reliably from memory. These human sensitivities are not linear. They interact with one another and are affected by the light in the surrounding area. These non-linearities and interactions all seem to have very practical reasons for being there. They are, in all their complexity, essential elements of the television system.

There is a great deal of information on the psychophysics of vision. Much information has been collected on the quality parameters of photographic films during the last decade and the field is currently very active. Little has yet been collected, however, on television displays.

The subjective components or dimensions on the basis of which picture quality is judged are not directly related to measurable physical parameters. A problem is to find out what they are and establish their relation to subjective picture quality. That relationship is being sought for films, and at this time is partially formulated.

The following table lists judgments of picture characteristics and the physical parameters with which they are connected:

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Table 1

<u>Subjective Components</u>	<u>Objective Components</u>
Color**	
Brightness* (Munsell value)	Luminance, Reflectance, Transmittance
Hue	Dominant Wavelength } Chromaticity (for Physicist)
Saturation	
Chromatiness	
Contrast	Tone reproduction curve (Y)
Sharpness of picture*	A function of Modulation Transfer contrast and noise
Sharpness of edge*	Acutance
Snow in TV	Noise
Granularity, graininess in film	

*Good texts are by Higgins (61) and Nelson (62).

**A good text is by McAdam (63, 64)

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A.2 SHARPNESS

An important physical parameter of a picture, the principal one for resolution or sharpness, is the Modulation Transfer Function (MTF), often expressed as $H(w)$, introduced into the science of vision by Crane in 1964. ⁽⁶⁵⁾ It is a function of frequency; it is the plot of the ratio of the output modulation, the spatial modulation of the picture, against the frequency of the sinusoidal input. Each component of an optical system has its MTF; that includes the eye, the display, the lenses, the film or TV camera, etc. The MTF of the system is the product of the MTF's of its components including the eye.

The MTF for the eye is given by the top set of curves (a) of Fig. A1. The curves vary with the viewing distance, the ordinate being inversely proportional to that distance. It is seen that the curves reach a peak at a relatively low frequency. The set of curves (b) compare the MTF of film of a quality commonly used for television, and of the plumbicon camera for the same size of picture. The one-inch plumbicon is commonly used in television studios. A curve is also shown for a two-inch plumbicon ⁽³³⁾ recently developed and still in the laboratory. without taking into account the degradation of the system due to other components, it is seen that the one-inch plumbicon is close to the Super 8 film in modulation transfer quality, and the two-inch plumbicon close to the 35 mm film. With all parts of the system included these comparisons would be somewhat different.

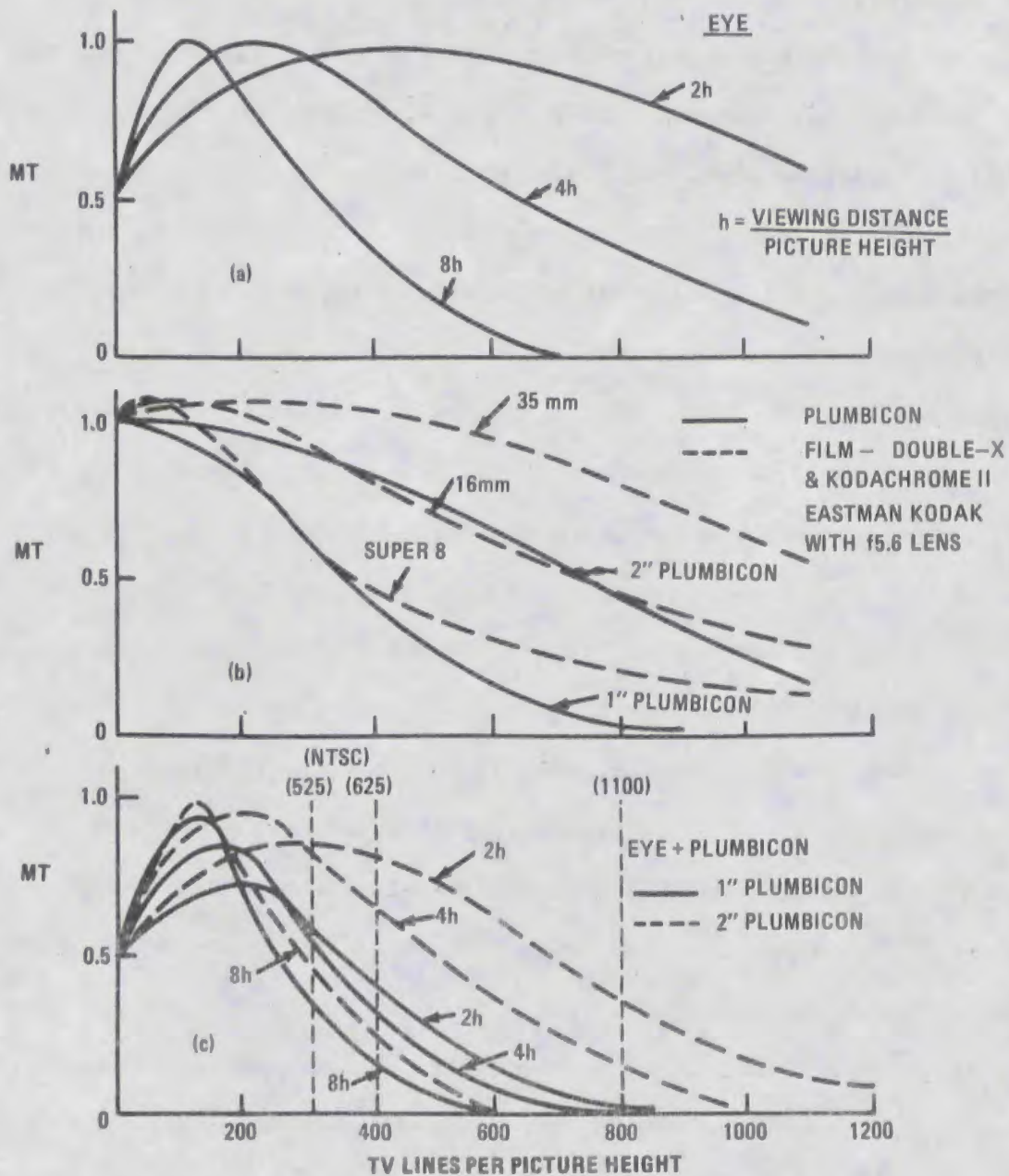


Fig. A1 COMPARISON OF MODULATION TRANSFER FOR FILM & PLUMBICON
 (Source: for Plumbicon Amperex Corporation(33) for film Eastman Kodak)

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Closer to practical comparisons is the lower set of curves (c). These combine the modulation transfer of the eye with that of the plumbicons, but still excludes the other components of a complete system. It is seen that for large distances, eight times the picture height or more, the MT of the eye dominates, so that there is little difference between the one-inch and the two-inch plumbicons. The difference becomes very noticeable at closer distances -- double and four times the picture height. The vertical dashed lines show the effective number of lines (taking into account the Kell factor 0.7) for 525 (NTSC), 625 (European) and 1100 lines. It is seen that at short distances there is a significant improvement to be expected with the two-inch plumbicon by increasing the number of scan lines to 1100 and even more, but little at the longest distance of eight times the picture height. There also seems to be significant improvement with the one-inch plumbicon in increasing from 525 lines to 625 lines at all the distances for which the curves were drawn. Improvement seems particularly sensitive in this range of the number of lines.

A.3 CONTRAST

As already mentioned, if the reproduction is identical in the visual parameters of color, contrast and sharpness with the scene it represents, the viewer will not like it. The effect is related to the fact that the image being viewed has an average luminance which is usually much lower

than that of the original scene. The maximum luminance of a motion picture or TV image is about 5 to 20 Ft Lamberts, whereas that of a sunlit scene is about 5000 Ft Lamberts. If it were not for visual adaptation (the increase in the sensitivity of the eye at low levels of light) we would scarcely be able to see the motion picture or TV images. The adaptation is incomplete however. The residual gap between the actual and the ideal adaptation causes images having exact physical contrast to be unsatisfactory from a subjective point of view. Fortunately, a simple remedy exists. It involves deliberately making the contrast of the picture different from the original.

Fig. A2 shows tone reproduction curves. The gradient of the straight portion is referred to as gamma (γ). The early workers in motion pictures discovered by trial that the gap between the actual and ideal adaptations to a dimly lighted or dark room could be closed almost exactly by raising the physical contrast (gamma) of the image. It was necessary also to allow the color saturations and image sharpness to rise in the manner they automatically do in a color-photographic system when the gamma is increased. Research workers eventually discovered that the gamma of the eye when viewing motion pictures is about 1/1.6 times the gamma of the eye when viewing the brightly lighted original scenes. Furthermore, the dark surround was found to give a big increase in the subjective brightness. Thus one can understand, partly at least, why it is that the use of a dark or dim surround and a relatively high physical gamma makes it possible to obtain motion picture and TV images that provide greatly improved subjective

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reproductions of brightness, saturation and sharpness, for these conditions accurately compensate for the change in the γ of the eye caused by the change in brightness. We still, for other reasons, usually fall short of the goal of ideal sharpness, but we do often obtain excellent reproduction of brightness and saturation.

Fig. A2 shows the contrast characteristics of reproduction of a scene in relation to those of the original for three values of γ . Viewers are more sensitive to changes in the value of γ in its higher ranges, around 1.5, than in the lower, around 1.0. For motion pictures and transparencies in a dark surround γ should lie between 1.4 and 1.6. It is usually 1.6. For paper photographs, which are viewed by the light reflected from the paper, the borders should be white and the γ in a normally lighted room should be between 1.0 and 1.1. Also important to the viewer is the shape of the curve at both its ends. For television, the effect of the reflection of the ambient light on the glass surface must be taken into account; it reduces the γ ; a γ of 1.6 is reduced to appear as 1.4. In the average light ambience for viewing television the effective γ is not exactly known; it is probably about 1.3 or 1.4. The original film or tape should therefore have a γ of 1.5 or 1.6. (66)

Certain operational problems occur in broadcasting which tend to degrade the contrast. The value of γ is often too high; at the same time

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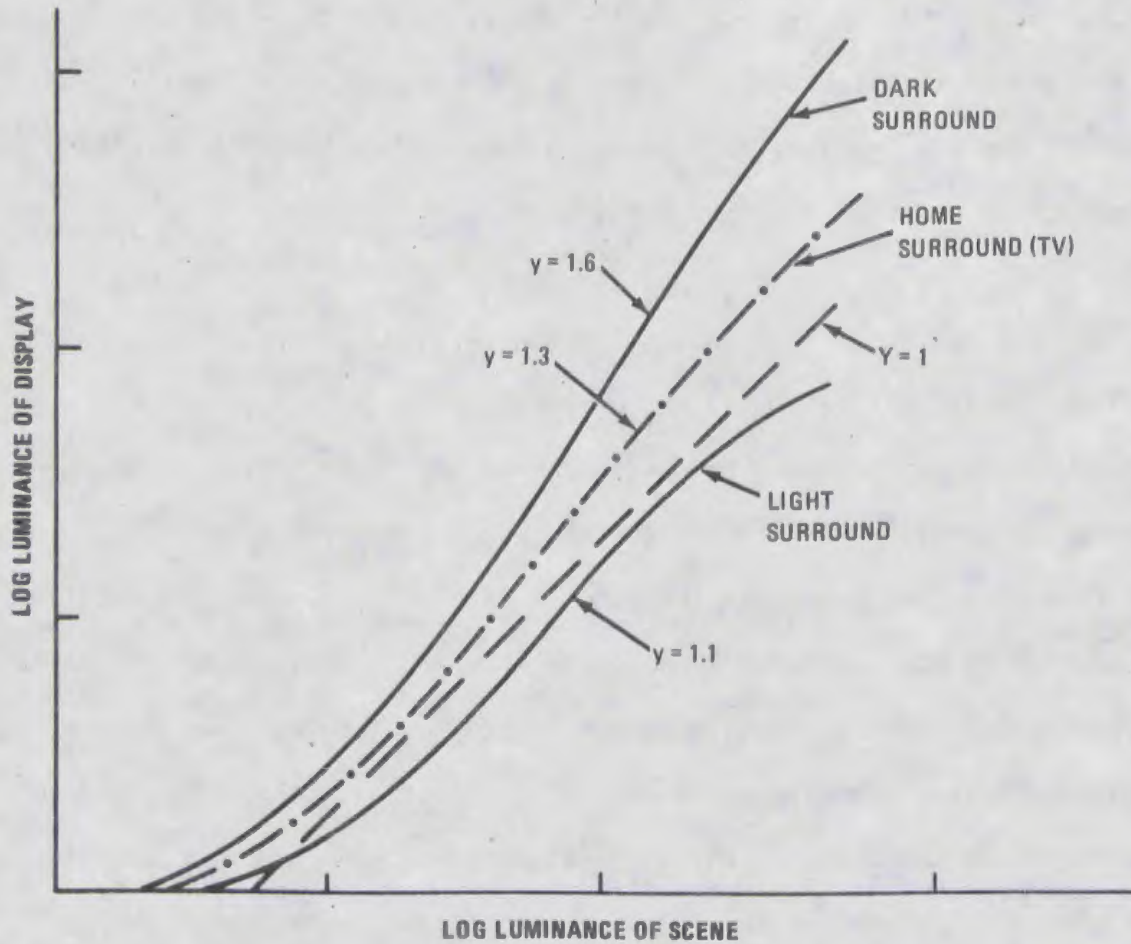


Fig. A2 PREFERRED PICTURE CHARACTERISTICS OF TONE REPRODUCTION IN RELATION TO THOSE OF THE ORIGINAL SCENE (Source: C. N. Nelson of Eastman Kodak)

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shadows are not reproduced and the contrasts in the shadows are decreased, sometimes nearly eliminated. The problem arises in part because of color quality as explained in the next Section A.4 and in part because of the effort to maintain "full amplitude all the time" induces the operator to maintain the darkest part of the picture full black, corresponding to maximum amplitude, for all programs and throughout each program. The process is referred to as "pulling the blacks." One reason, probably the strongest reason for this tendency, is the concern for serving distant areas with as strong a signal as possible. DeMarsh has analyzed and described some of these effects for telecine operation, the process of producing a television picture signal from a movie-projector. Fig. A3 showing the effect of pulling the blacks is derived from one of his papers. (67)

This defect in the reproduction of contrast could be avoided by adopting a technique similar to Lincompex. This technique has been recommended by the CCIR⁽⁶⁸⁾ for long distance telephone transmission at frequencies below 30 MHz. The technique involves compressing the dynamic range of the voice at the transmitting end and providing a control signal the frequency of which defines the amount of compression and excites circuits at the receiver end, expanding the dynamic range back to that in the original input with appropriate circuitry. In the case of television, the darkest grey in the picture would be made to correspond close to 100%

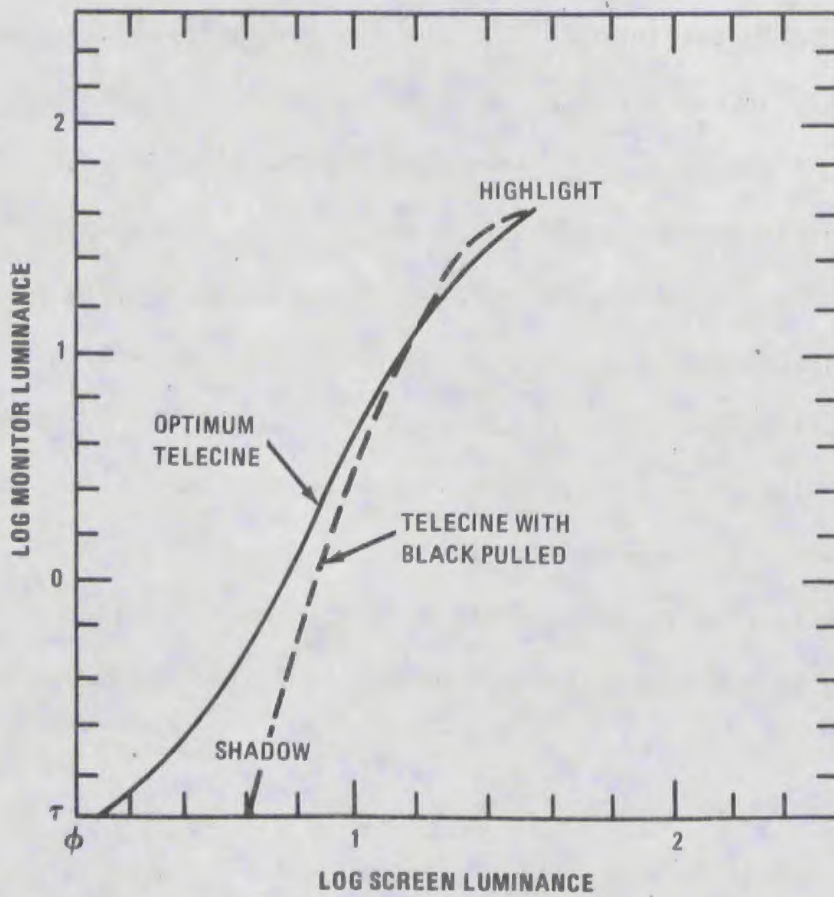


Fig. A3 SYSTEM TRANSFER CURVES

(Source: L. E. DeMarsh (67))

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modulation and a control signal would activate special circuits modifying contrast characteristics so that the correct grey tones would appear on the screen. Receivers which did not have such corrective circuit would receive a quality of contrast similar to that they had been receiving with the blacks being pulled; the receivers with these circuits would show desirable contrast characteristics and the signal-to-noise ratio of the output pictures would consistently be the highest that the station could provide.

A.4 COLOR

Accurate description of color has been given a great deal of attention over the years. A complete description requires three quantities -- brightness, saturation and hue. Hue itself can be expressed in a single quantity, but as explained in Appendix B its subjective recognition in cartesian coordinates is two-dimensional.

It is common to view color in a three-dimensional space. Fig. A4 shows a chromaticity diagram, a two-dimensional section of this space for a constant luminance. It is known as the unit plane. The hue is represented by the scale of wavelength around the horseshoe curve. All colors fall within the boundaries of that curve according to their hue and saturation. The point A corresponding to white, has zero colorimetric

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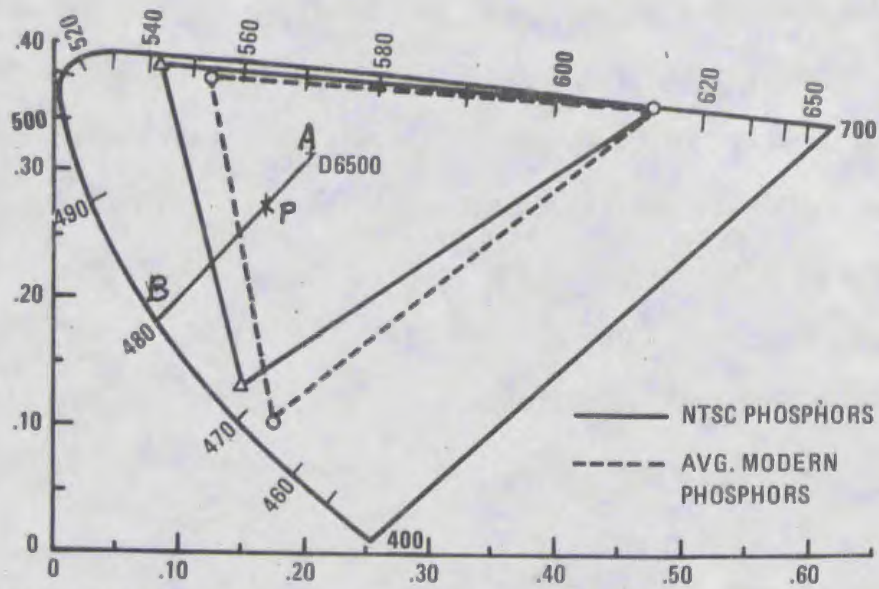


Fig. A4 COMPARISON OF NTSC AND MODERN PHOSPHOR CHROMATICITIES.

(Source: L. E. DeMarsh and J. E. Pinney (69))

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purity.* The point P has a colorimetric purity equal to AP/AB . Any point such as P represents a color that matches a combination of a certain amount (BP/AB) of white and a certain amount (AP/AB) of a pure color ($\lambda = 480$ nanometers). The same color can also be produced by a combination of at least three colors.

A three-dimensional presentation of color is shown in Fig. A5. The length of the vector from the origin (black) represents the luminance.

The phosphors available for the television screen do not permit the development of all colors. The boundaries of the solid triangle of Fig. A4 show the gamut of colors that were obtainable from the phosphors used in 1953 when the NTSC standards were approved. This triangle was obtained from the spectrum of the three phosphors of Fig. A6.* (69)

Since then other phosphors have been developed with strong emphasis on increasing the brightness of the picture. The brightness has been increased, but the gamut of available colors has been reduced as indicated by the dashed triangle of Fig. A4. This triangle was obtained

* The symbol D6500 is the white that has been adopted as the standard white. It corresponds to daylight and is color of a 6500° K blackbody.

**The negative parts of the curves represent hues that lie outside the triangles of Fig. A4 and cannot be reproduced.

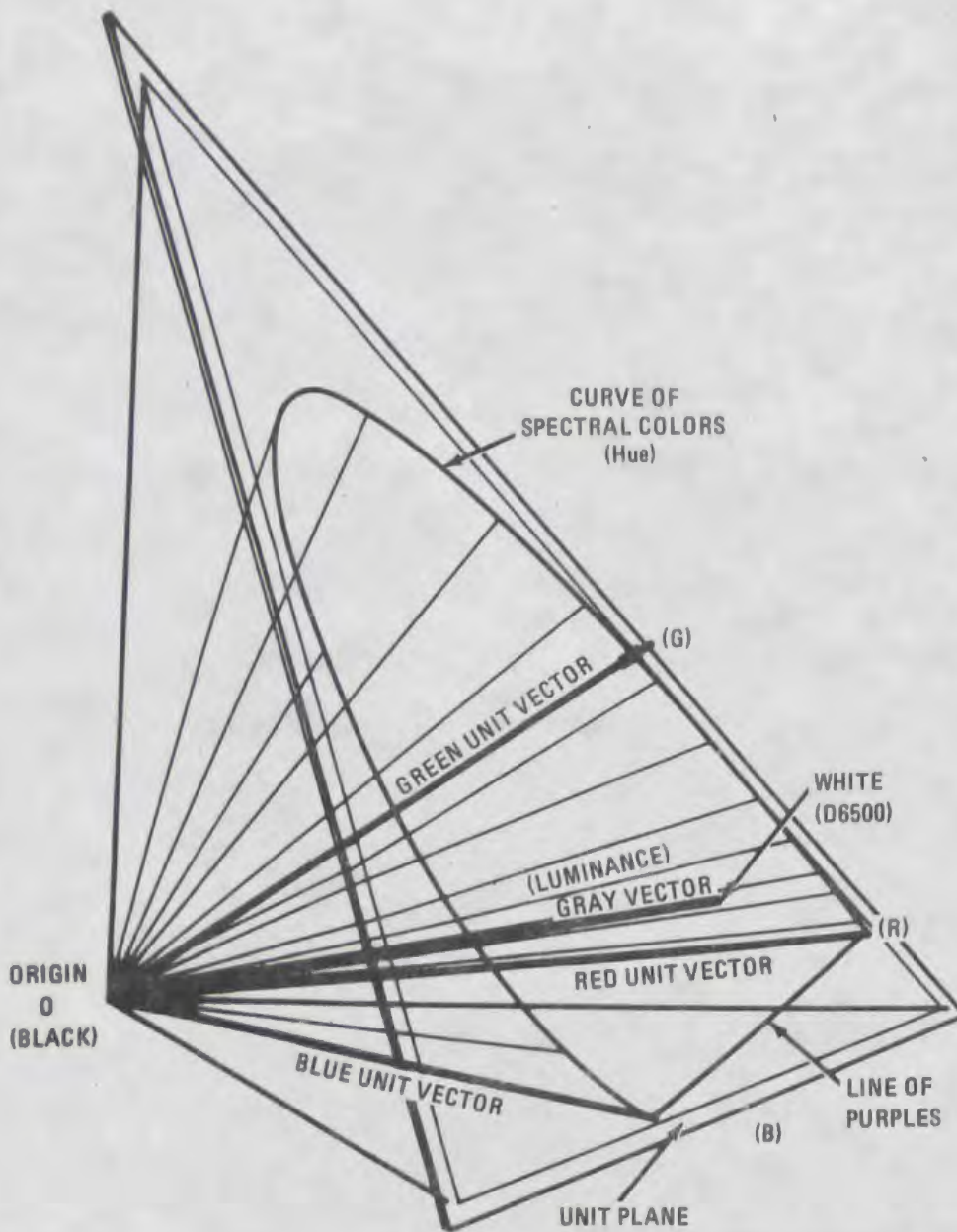


Fig. A5 COLOR SPACE MODEL

(Source: Hazeltine Corporation Report #7127 "Color Space & Color Triangles" May 14, 1952) (70)

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from the spectrum of the phosphors of Fig. A7. The most noticeable change occurred in the green part of the spectrum.

The development of new phosphors creates an operational problem. Should the monitors which broadcast stations use for adjusting the transmitted chrominance signal be set for best color quality with NTSC phosphors or with the new phosphors? The exact situation between old and new phosphors the operation of color cameras and the setting of monitors can be confusing. One of the effects could be a tendency to "pull the blacks" (see Section A.3) in an effort to improve color quality as seen on the monitor by increasing color saturation.

In order to maintain the color quality of the old sets, some effort is being made to standardize on the NTSC colors. If the standard were recognized, the electronic network, the matrix that analyzes the input chrominance signal to excite the phosphors in the desired ratio for color quality, would be set for the NTSC standard at the station monitor. All set manufacturers would then design their set matrices for the best color quality which the phosphors adopted would provide with transmitted signals meeting the NTSC standards.*

When film is the picture input to a television system, it would be desirable to have some means of assessing the quality of this input. The assessment could be carried out in several ways. The simplest would be

*There is brewing a potential conflict between U.S. and European experts as to whether to retain NTSC color standards or modify them to conform to the new phosphors (see subscript in Section 5.2.1).

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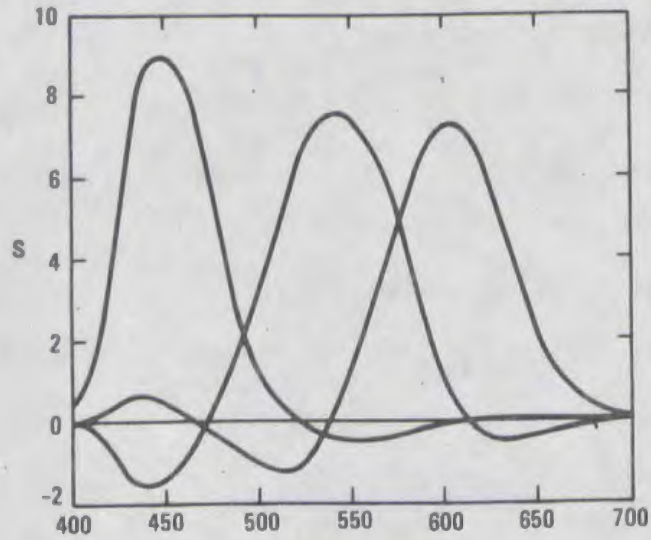


Fig. A6 NTSC PHOSPHORS COLOR MIXTURE CURVES
(Source: L. E. DeMarsh and J. E. Pinney (69))

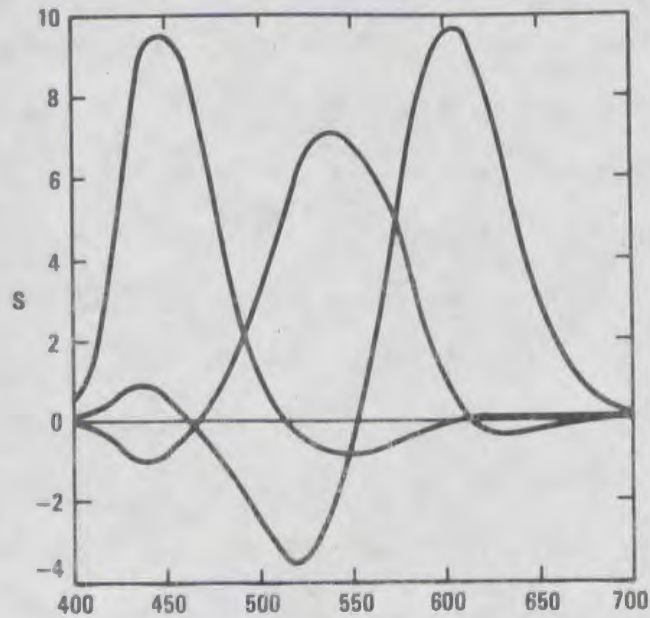


Fig. A7 MODERN PHOSPHOR COLOR MIXTURE CURVES.
(Source: L. E. DeMarsh and J. E. Pinney (69))

to photograph a test pattern and judge the quality of the output by visual examination, adjusting the correcting electronic circuits accordingly. The British Broadcasting Company makes use of such a scheme. A more automatic approach would be to put a small pattern on the edge of the film to be analyzed electronically and made to control automatically corrective circuits.

A.5 ILLUSION OF SIZE

As with many other physical characteristics of the eye-brain complex, perception of size of an objective is dependent on the surround. The eye, as the sensor of human vision perceives the size of an object as directly proportional to the visual angle; nearly always engineers calculate perceived size on that basis. But, as Herold points out, the brain interprets it differently. ⁽⁷¹⁾ Designers of television systems must design as the brain perceives it, not as the eye senses it.

This interpretation by the brain of what the eye senses can be proven by anyone. Put a 10" and a 23" television set at distances from a chair so that the angles the screens subtend at the eye are equal, and ask anyone to sit in the chair (not an engineer, for he has been educated out of normal perceptive responses), and ask him which is the bigger screen. He will point at the 23" screen, (unless he is angry, as has happened, that you should ask him such a silly question). Of greater

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importance is the set he will be inclined to watch, when the programs are the same and the images of similar quality. Nearly always he will watch the 23" set. Why? Presumably because he prefers a large screen!

Holway and Borning⁽⁷²⁾ have studied the psychophysics of the illusion of size. They give references to the recognition of the phenomenon dating as far back as 1860.⁽⁷³⁾ They made tests with an observer looking down two long, darkened corridors at two uniformly illuminated circular images. While distance of one image was 10 feet the other was varied from 10 to 120 feet, the size over the whole range of distance was correctly judged to be very nearly the physical size of the images regardless of distance. Substantially, the same result was obtained when viewed with one eye closed. The effect of distance on the observed size became apparent with one eye only when the tunnels were so dark that the sides could not be seen. The sense of distance had been provided by the impression of perspective provided by the sides.

A.6 BEST VIEWING DISTANCE

The Motion Picture and Television Test Center of the Association of Picture and Television Producers carried out the only tests that appear to have been made, or at least published, on the distance at which people prefer to view motion pictures in terms of the width of the screen. In the tests conducted by Petros Vlahos,⁽⁷⁴⁾ the same quality of film was used --

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35 and 70 mm wide. The width of the screen ranged from 11½ feet to 35 feet. Four short subjects were presented to twelve observers covering a wide range of ages from college past middle age, none of whom were in the picture business. The observers were told that four systems were being tested to find the best seating positions for each one. They were instructed to change their seats each time the house lights were raised, so that by the fourth time each would have found the best seat. The results are listed in Table 2.

TABLE 2

Range of Preferred Shortest Viewing Distance

Test No.	Film Width mm	Screen Width Ft.	Magnification	Shortest Viewing Distance		(Magnification) Max	(Viewing Distance) Min
				Max	Min		
1	35	11.7	102	82	47	1.2	2.2
2	70	3.5	152	>105*	70	1.4	2.2
3	35	14.6	127	92	58	1.4	2.2
4	35	2.9	252	>105*	>105*	2.5	2.5

*The depth of the 1000 seat theater was 105 feet.

One might expect that the minimum "best" distance would be where the graininess and other defects would not be disturbing. If that is so, one would expect the ratio of the viewing distance to be constant for

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the same quality of film. Indeed, this was the finding as indicated by the constancy of the figures of the last column. One exception was test 2, but the reason for that result was, that according to the formula, the minimum distance was greater than the 105 feet depth of the theater; nine out of 12 observers were still going back at the end of the test.

The maximum "best" distance might be the distance beyond which significant details begin to be lost or, in technical terms, the resolution or MTF has been reduced as much as seemed desirable. The data, however, showed no correlation between the maximum best distance and the magnification. It is probable that this maximum distance depends on the scene being shown.

The results confirm these preliminary thoughts. The constancy of the figures in the last column of Table 2 must be at least partly coincidence, for it is far better than could reasonably be expected from this type of measurement. The correct psycho-physical correlation is undoubtedly much more complex. It can be expected to include the MTF of the picture and of the eye (and the MTF of the eye is a function of the viewing distance), the luminance of the screen and the illumination of the theater.

Of special interest to the present study there is in the paper describing these tests the statement " . . . not one of the 12 chose a

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quality poorer than television." From these few tests, the association of Motion Picture and Television Producers raised the warning that poor quality film and wide screen might have the effect of pushing back the best viewing area of a theater and might extend much of this best area beyond the back wall! In Table 2 it is to be noted, the last two columns show some of the experiments pushed the preferred boundaries beyond the throw of 105 feet of the 1000 seat theater.

A brief survey of the literature uncovered little recent work on television in this area. Biberman⁽⁷⁵⁾ quotes F. T. Thomson⁽⁷⁶⁾ reporting on personal preferences in viewing television imagery that "experiments indicate that television viewers tend to select a viewing angle (the vertical angle subtended at the eye by the screen) at which line structure just begins to disappear." His experiments indicate that the viewers who chose to view the picture at a distance corresponding to viewing angle of 8° preferred a closer distance ranging from an angle of 10° to 16° , when the line structure was not visible. It is to be noted that at a distance corresponding to 8° subtended angle, the eye is just barely able to see the line structure of 480 active lines.

Thomson also investigated the possibility of reducing the visibility of raster lines by a sinusoidal oscillation of the scanning beam

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(wobbling) and found for a television scan about 15" x 20" (25" diagonal) that viewers preferred viewing distances at which the raster just disappeared -- an average of 10.6 feet for conventional raster and 6.1 feet for wobbled raster. A practical problem of applying the wobbled raster is the maintenance of a very accurate interlace.

No information was found on the longest acceptable viewing distance for television. Presumably, it is the distance at which important details, such as facial expressions, begin to be lost. There is much information available in the literature on the picture characteristics to recognize objects in the presence of noise; recognition of tanks, trucks, camouflaged stores, geometrical figures and the like have been studied in depth. Rosell gives a summary of the state of the art of scanning requirements for the recognition of such objects⁽⁷⁷⁾ in which he includes the broad estimates made by Johnson⁽⁷⁸⁾ on the number of scan lines required for several degrees of recognition. The resolution requirements given in Table 3 may be taken as a rule of thumb. Rosell has broadened the application of these figures by taking into account the effect of the signal-to-noise ratio and contrast of display.

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Table 3

<u>Discrimination Level</u>	<u>Resolution for the minimum dimension of an object</u>
Detection	+1.0
	2 -0.5
Orientation	+0.8
	2.8 -0.4
Recognition	+1.6
	8.0 -0.4
Identification	+3.2
	12.8 -2.8

No information has been uncovered on the requirements for the recognition of individuals or of facial expressions. It seems that it would be useful to the planning of a program for the director to know how much of the details of his production the viewers can be expected to perceive.

A.7 IMPLICATIONS TO TELEVISION

The implication of these findings to television is the need to develop this type of information for designing the overall system for the

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home, with its restricted viewing area, and also for the larger areas of the theaters.

The best viewing areas should be known and the operation designed to fit the available space. The limits of recognition of details important to the scene being presented should be worked out by better communication between the producer and the system engineer at the highest level of competence, and the information distributed throughout the industry.

APPENDIX BMULTIDIMENSIONAL SCALING (MDS)*B.1 INTRODUCTION

Multidimensional scaling (MDS) refers to a family of techniques for determining the subjective factors or "dimensions" involved in perceptual judgments, their relative influence on the judgments and their relation to known physical and behavioral parameters. By presenting to a subject a number of stimuli and obtaining an expression of his perception of similarity of the stimuli, MDS is able to provide this information in quantitative terms. With this knowledge an engineer is able to optimize the design of a system to psychological requirements.

MDS bridges the gap between human needs and aspirations on the one hand and technology on the other, between the soft data used by the one and the hard data required by the other, thus opening the way to rational economic planning and implementation. For this reason, it is convenient to use different terms to clearly identify which side of the

*This brief description of multidimensional scaling and its application was developed with the help of discussions with Dr. Douglas Carroll who heads a group devoting its attention to this technique at the Murray Hill Laboratory of the Bell Telephone Laboratories and with C. N. Nelson of Eastman Kodak.

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gap is being referred to; it is convenient therefore to use the term "dimension" when dealing with variables derived from judgments and "parameter" when dealing with recognizable physical or behavioral characteristics. The description of MDS that follows will be easier to understand if the difference between these two terms is kept in mind. The difference is important, for an ultimate purpose is to find a correlation between parameters and the dimensions deduced from the judgment data.

By being able to establish the dimensions of an individual's perception, MDS makes it possible to define groups of people in accordance with the similarity of their perceptual structures.

MDS can be expected to be a big step in understanding many man-machine relationships, and also some man-to-man or social relationships, quantifying them and developing into an important tool of policy and decision-making and engineering.

Two important advances were made the last fifteen years in the field of quantitative psychological measurements (or psychometrics). One originated by Torgerson,⁽⁷⁹⁾ Tucker and Abelson⁽⁸⁰⁾ and others in the early fifties, made it possible to identify the psychological dimensions of a subject's judgment directly from the subject himself. Torgerson showed that the identification of these dimensions as well as their relative

magnitude could be deduced from his comparative perception of the stimuli without the dimensions being predetermined by the experimenter or known to the subject. There was then little question that the dimensions so identified were the true, natural dimensions of the subject's perception. Previously, in psychological measurements, the dimensions were predetermined. In most cases only one dimension was treated in a test and multidimensional representations developed from dimensions studied one at a time. Although multidimensional scaling dates back to a paper by Richardson in 1938, (81) the term "classical" multidimensional scaling, usually shortened as it is in this report to multidimensional scaling (or MDS), is applied today to the process where the dimensions are initially undetermined.

The other important advance came in the early sixties from the work of Shepard, (82) Kruskal, (83) and others, when nonmetric MDS came into being. Metric scaling requires quantitative judgments, nonmetric requires only a rank ordering of judgments. There are therefore two broad categories of MDS for the scaling of undetermined dimensions -- metric and nonmetric. The many dimensions of perception can also be analyzed when the dimensions are predetermined by various forms of multiple regression analysis. This process is generally simpler than MDS.

A sequence of examples starting with a simple one and moving toward the more complex will exemplify the main categories of processes

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relating psychological dimensions to physical or behavioral parameters. In the first example the question is asked of the subjects on their perception of the psychological attribute of "heaviness" and the stimuli are rings of identical size, shape and appearance, but different in the physical parameter of weight. In this example judgments are based on only one dimension. The judgment is to be expressed either by a number, the estimate of heaviness, or by simple rank ordering of heaviness with the heaviest stimulus at one end and the lightest at the other. When expressed by a number, the measurement is "metric" -- "This stimulus is four tenths as heavy as that one;" when expressed by rank ordering it is "non-metric" -- "This stimulus is heavier than that one."

In the second example, the stimuli are changed to a set of different weights and of different size, but still of the same ring shape, so that to carry these and feel their heaviness muscles are exercised differently. The relationship of heaviness to weight will probably be different, for it will be influenced by the size. There are now two dimensions to the judgments and these will correlate with the two parameters -- weight and size -- for the particular shape used. We know this, for both dimensions were predetermined; we know that in this case heaviness is a function of weight and size. We can establish the relationship of heaviness to weight and also to size over the range covered by the stimuli

and how they interact. Thus, heaviness can be expressed mathematically as a function of weight and size. This can be done for three or more predetermined dimensions by the mathematics of multiple regression.

When Torgerson and others appeared on the scene more complex situations could be handled. In the third example the stimuli differ in a wide range of characteristics including those mentioned plus shape, surface roughness, materials (some of lead, some of feathers, some ...) possibly also the test is carried out in several different environments. The subjects do not know what principal dimensions influence their perception of heaviness nor how many there are, nor does the experimenter. The example now falls within the MDS category for the dimensions are undetermined. The MDS approach can be metric or nonmetric.

The advances in MDS emerging today deal with ways of simplifying the process by decreasing the number of judgments required of each subject, reducing the algorithms and computer processing, developing means for relating dimensions to parameters, grouping or clustering subjects on the basis of the similarity, of their judgments and, of course, developing experience by broadening the range of applications. Probably the most important theoretical and methodological development entails the new "3-way" models and methods for dealing with individual differences among subjects or other data sources, as exemplified by the INDSCAL model and method to be described later.

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The focus of this report is on the application of MDS to psychophysics, specifically to the perception of displays. MDS is not limited to psychophysics, it can be applied to areas involving broad and narrow societal questions and human relations as well as such personal values as cognitive styles and political ideologies.

A typical data base for MDS consists of measures of the similarities or dissimilarities between objects or other "stimuli." These data are the expressed judgments of observers. Out of such data, differences in similarity judgments or preferences are quantified often with considerable accuracy -- "this pair is 2.6 times more similar than that pair," or "I prefer this object 1.7 times more than that one." (This last on the basis of a preference scale of 10, say, being the difference in preference in relation to that of a standard pair). In the process, the principal parameters that affect these differences are also identified as well as the degree to which each contributes to the differences in judgment. Differences in the judgment of individuals can also be quantified showing differences between an individual and the "normal" members of his peer group.

The basic process of multidimensional scaling is to represent in a multidimensional space n objects, or stimuli, by n points using as many dimensions as may be necessary for achieving a spatial representation which

accounts closely for the information, metric or nonmetric, contained in the whole data base. When this spatial representation is achieved, the geometrical distances between these points are the measures of the psychological distances that separate them. In this space, called "psychological space," the objects of a pair that are similar are close together and those that are not are proportionately further apart.* The spatial representation is difficult to present with more than two dimensions and difficult to visualize with more than three, but the concept is easy to understand.

The capability to represent an individual's perception of a stimulus by a point in n-dimensional space gives concrete expression regarding our process of perceiving and judging. It says in fact that we use n principal dimensions, independent of each other, to achieve our perception of a stimulus. When we try to relate these dimensions to recognizable parameters we may find a one-to-one correlation or we may find that good correlation with each dimension occurs only with a non-linear function of several interacting parameters.

Technically, to develop a psychological space, a computer is used. The algorithm, the process that the computer follows to carry out the calculations, finds the solution that makes the psychological distances of the stimuli as nearly as possible a monotonic function of similarity, meaning that it so orders the similarities of the pairs of objects that, as the rank of a pair as judged by the observer increases, so the distance between the objects of the pair also increases or remains unchanged.

In the area of displays, we already have considerable knowledge of the parameters involved, but even with this knowledge it is important

* The geometry of the multidimensional space for calculating distances is generally taken as Euclidean. Other geometries are not excluded.

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to know whether other parameters affect appreciably the judgements of viewers. To what extent, for instance, is it affected by the subject matter of the picture? It is also important to know whether there are psychological dimensions that were not expected, the relative importance of all the dimensions and the relation of physical parameters or combination of parameters to these dimensions. Important also is the variation of psychological dimensions between individuals and between groups.

In the work in this field, on the analysis of human response to picture quality, which is in progress at Eastman Kodak today, no dimension that was not expected has yet emerged, but there has emerged, or will emerge, what was not previously known, namely the quantification of human judgment of picture quality in terms of psychological dimensions, and the correlation of these dimensions with a more or less complex function of recognizable parameters such as modulation transfer, noise, contrast, etc.

Of special importance to the planning and development of goals for high quality TV, particularly for the home where viewing distance is limited, is the relationship between size of screen, viewing distance and resolution (one item of which is the number of scan lines). This relationship was given some consideration in the early fifties while the present TV standards were being developed and also more recently involving scaling and statistical analysis. (84) MDS is currently being used for photographs, but has not been applied to television. Quantitative measurements

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are essential in order to engineer and establish standards or goals for the overall system performance for home or theater, involving balancing cost with a quantitative measure of human response to quality.

B.2 SOME OPERATIONAL VALUES

Two characteristics of MDS techniques are particularly critical to their practical application. One is credibility. Logically it would focus on consistency and reliability. In this case, however, there is an additional element. There exists widespread incredulity among decision-makers and laymen generally, in the ability of subjects to estimate human perception with any useful degree of accuracy. This attitude is often supported by a mild feeling of the impropriety of attempting to express the intensity of a human perception by a number. The other critical characteristic, carrying also some degree of incredibility, is the ability of a technique to identify the dimensions on which the judgments of an individual are based, and to correlate them quantitatively with recognizable physical and behavioral parameters. Possibly the more recent developments of MDS plus some more newsworthy, down-to-earth applications than have yet been carried out, will begin

*A summary list of the principal characteristics of MDS is given in Table 4 at the end of this section (P. 43).

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to overcome the existing resistance to its broader employment. At this stage, there is appearing the beginnings of interest in applying MDS to marketing.

The credibility of psychological measurements has a long history. Most methods have to some degree been suspect. In 1940, a committee of the British Association for the Advancement of Science composed of physicists and psychologists came out in its final report with the opinion that measurement in any true sense is impossible in psychology. They based this conclusion on the fact that none of the attempts as of that time had been able to meet the necessary logical requirements of fundamental measurement.⁽⁸⁵⁾ This report had considerable influence on the credibility of psychometrics in spite of many arguments against its findings.^(86,87) Controversy lasted a long time. It seems to have gradually subsided among professionals, but resistance to the application of psychometrics to practical matters of importance has abated but slightly.

Since that time, there have been a great many measurements made involving quantitative estimates of perception of stimuli which have been consistent and reliable. Among these can be cited the "Munsell Color Notation"⁽⁸⁸⁾ based on "Interval Scaling" in which a complete color scale is produced by selecting a number of stimuli separated by equal subjective steps. The color notation has been very successful and is broadly used

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by industry. A scale for hue developed with MDS agrees closely with its major outline and required relatively little effort to produce. Interval Scaling is the method most frequently used for metric MDS. A technique broadly used is "Threshold Scaling" in which the unit used is the j.n.d. (just noticeable difference).* It assumes the unit to be constant or follow some mathematical relation throughout the scale, such as exponential or logarithmic.⁽⁶⁹⁾ It is questionable whether many small differences can be added together to represent large differences and whether random variations (or noise) may not affect the subjective estimate of j.n.d.

One of the most frequently used techniques is "Direct Magnitude Estimation" in which quantitative estimates are made of a characteristic of a set of stimuli, as in the first example outlined above of relating heaviness to weight. S.S. Stevens⁽⁹⁰⁾ has used that technique in a great many cases and has obtained good reliability. This kind of scale, in contrast with an interval scale, has a well-defined zero -- an object of zero heaviness has zero weight. This technique is usually applied to measure the perception of one characteristic in which case it is unidimensional; it can be used, however, to measure the relative importance

*The basis of the decibel is commonly ascribed to a j.n.d. of a sound.

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of several dimensions. It has been so applied for example by K.R. Hammond et al in an interesting approach for developing the reasons for the differences of opinion between two negotiating parties.⁽⁹¹⁾ The parameters involved are predetermined and the stimuli are made up of these parameters combined in different ratios. It is assumed that there are no dimensions other than those corresponding to the predetermined parameters. From the subjective estimates of preference of each stimulus, the relative importance of each dimension on the opinion of each of the negotiating parties is calculated. A curve can then be drawn showing the relation of each dimension with the corresponding parameter over the range of values covered. The process is comparatively simple, generally simpler than MDS.

These methods involving subjective quantitative estimate are known as semantic differential techniques. They require the dimensions to be known, and they are generally subject to the criticism that the relative importance of the dimensions may be affected by the selection of the scale by the experimenter and by the subjects' knowledge of the dimensions. MDS overcomes these uncertainties for the dimensions are not predetermined, but inferred from the subjects' responses.

MDS has an inherent weakness in that, since the dimensions are undetermined, the confidence with which the dimensions are identified and

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correlated with known parameters may be questioned. Depending on the subject and the stimuli that can be developed, the confidence may range from close to certainty, as in judging the quality of a photograph, to considerable uncertainty as in judging preference for famous people. Nonmetric MDS, however, has particularly strong grounds for claiming credibility for its operation. Judging whether a pair is more dissimilar than another pair is so simple, requires so little directed thought, that a high degree of consistency and repeatability is intuitively expected. And indeed such has been the practical experience. Important also is an aspect of the manner of processing the data. In the iterative process used, the residual uncertainties of the result are clearly spelled out; in this way an assessment of the degree of confidence that can be given to the result is automatically worked out by the process itself. This is an important aspect of the technique, the value of which is seldom fully appreciated.

When comparing the multidimensional scaling approach to the common questionnaire approach of surveys, the difference between them as regards the objective character of the results where either approach can be applied, is strikingly evident. It is important to realize that the basic approach of MDS is an analysis of the perception of each individual observer; the difference between observers may be analyzed, but

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the result is not dependent on the statistics of the judgments of a group of observers. It is because of the individual analysis in relation to the stimuli that MDS can provide a useful basis of comparison of subjects relating to such criteria as opinions in economic, social and political areas.

Another important value, particularly for the decision-maker, is the balance between confidence and accuracy; the two are not synonymous, although accuracy is often interpreted to imply confidence. If a problem contains 10 unknowns, they can be established unequivocally mathematically by 10 equations with the only uncertainty being human error. But that uncertainty may be appreciable for, if a human error has been made, the effect on the result may be considerable. The confidence can be increased by checking the analysis over and over or by a feedback error-detecting process. But even when the probability of human error has been reduced to a negligibly small quantity, there remains the probability of error in each of the quantities other than the unknowns contained in the ten equations. The results of such an analysis have, therefore, a probability of error, but seldom is this uncertainty evaluated or presented. There are two reasons for this: first, it may be difficult to evaluate; second, it may not be easy to explain in a manner easy to understand and useful to a non-expert decision-maker. Thus, one can broadly state that ten

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equations will generally provide high mathematical accuracy with relatively low confidence and uncertainties poorly defined.*

Nonmetric MDS, as will be explained, provides not a set of equations (equalities) but a much larger set of inequalities. If fifty equalities obtained with MDS are used as an alternative to ten equations, the result will have no clearly defined mathematical accuracy, but will give with high confidence a quantitative answer with a quantitative and clearly defined uncertainty. Thus, fifty inequalities can be expected to give less accuracy but more confidence than ten equations. Where the residual uncertainty, mathematically known as "stress", is reasonably low and the correlation between the psychological dimensions and the technical parameters reasonably high, the probability of a significant error should be negligibly low. When the stress at some point in the analysis is high, the process is extended until the uncertainty is reduced to an acceptable level. The development of the stress and of differences between subjects are inherent in the analytical process, and are, therefore, clearly evident to the analyst. Both are important to

*An actual example demonstrating the possibility of high accuracy with low confidence was the case of design of complex hardware in which two highly competent engineering teams participated. They arrived at different numbers in their conclusions. It took them some time to locate the reason for the difference. It turned out that one team had omitted a π in one of its analyses -- a human error, easy to make, which could have led to a serious mistake.

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the decision-maker. They are developed in such a graphical form that they should be easy to explain and, with a little practice, easy to understand.

For the decision-maker, confidence is always the most important element, clear understanding of uncertainties is next and accuracy generally last. Of the two alternatives discussed, the soft data subjectively derived leading to 50 inequalities should be preferred over the hard data of ten equations. This conclusion is the opposite of the usual reaction where hard data have commonly dominated the soft, but with the application of new techniques it appears that past priorities should be reversed.

In this discussion of operational values it may appear that MDS has been favored over other techniques. The reason is that it is the most sophisticated one and for practical operation, for reaching the decision-maker, it may often be the most effective. It may not be, however, the simplest approach. As explained, when the dimensions are predetermined, multiple regression analysis may be simpler*; so may also be the application of direct magnitude estimation. In fact, in many cases the most effective process may be a hybrid combining several techniques applied in a way to make the best use of their special values.

There is clearly much work to be done in this area and much experience to be gained, but there is little doubt that a great step has been taken in a very right direction.

A summary list of the principal characteristics of MDS with emphasis on nonmetric form is given in Table 4 which follows:

* Regression analysis can also be used with MDS when the dimensions are determined in order to predict or account, for instance, for preference judgments.

TABLE 4

Summary of Characteristics of Multidimensional Scaling
With Emphasis on the Non-metric Form

Basic Types of Application

1. Development of reliable quantitative guide for the design and the selection of alternative systems. The data base of this guidance is developed not from the opinions of experts on what is a good system or what are the needs of people, but from the measurement of the perception of individuals representative of the people (or groups) who will benefit or suffer from the system. (The guide can be as exact as a specification. It can be applied to broad or narrow societal, institutional or engineering systems.)
2. Establishment of the existence and degree of coherence within groups as regards their judgments (or perceptions) of the alternatives (or stimuli) presented to them. (See Characteristic 10)
3. Particularly suitable:
 - (a) when credibility is critically important (see Characteristic 16);
 - (b) when the number of significant factors (or dimensions) underlying judgments are not definitely known;
 - (c) when distortion of the result through prejudice (or bias) must be avoided. It commonly arises from professionals who collect the data or from subjects whose judgments are the source of the data. (See Characteristics 13 and 14).

Output of Technique

4. Determination of the number n of major dimensions underlying individual judgments of a set of alternatives.
5. Accurate quantification of the relative importance (or weighting) of these dimensions.

6. Determination of the residual uncertainties (or "stress"). The process is an iterative one searching the "best fit" to the ideal solution by reducing the stress to a minimum.
7. Presentation of individual or group perception of each stimulus by a point in an n-dimensional stimulus psychological space.
8. Presentation of the perception of an individual (or group) by a point in the n-dimensional subject psychological space, the n co-ordinates of this point are proportional to the relative importance he attaches to each of the dimensions. *
9. Spatial presentation in subject psychological space of the relationship of the perception of individuals to each other, to the average of the peer group and their distribution within the peer group.

Direct Deductions from the Output

10. Correlation of the psychological dimensions established with known or recognizable physical or behavioral parameters. (Experience indicates that such correlation is consistently obtainable)
11. Establishment of coherent group from commonality of perception indicated by clustering in relation to certain dimensions in the subject space. (Such clustering is a more accurate indication of the existence of commonality as regards these dimensions than from such usually applied criteria as appearance, background, work habits, income, etc.)

Credibility and Freedom from Prejudices (Non-metric data is the most potent)

12. The judgments of subjects are repeatable. The non-metric judgments asked of the subjects are so simple that responses seem bound to be consistent, and have been so found.
13. The alternatives presented are, or can, generally be made such that the subjects will not be aware of the dimensions involved, so that the judgments they are required to make are unlikely to be willful or subconscious distortions of their natural perceptions.

*The INDSICAL procedure (See Section B7) developed the concept of subject space. In that procedure stress is not used.

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14. The process generally makes the output substantially independent of the prejudices of the professionals who apply the technique.
15. The n-dimensional perception of each individual is identifiable independently of the group; it is not tied to the statistics of a group response.
16. The non-metric form of data, supported by characteristics 12 to 15, seem to overcome much of the professional doubts of the reliability of psychological scaling and, possibly more important, seem in at least one case to be acceptable to a committee and series-of-approvals decision process comprising non-professionals as well as professionals.

B.3 EXAMPLES OF NONMETRIC SCALING

B.3.1 One Dimension

To explain the principle of nonmetric scaling, consider first a single dimension or axis with points on it marked A, B, C ... (see Fig. B1). The axis can represent any type of variable -- distance, sharpness, contrast, aspect ratio, etc. Whatever the nature of the dimensions the separation between points is referred to as "a psychological distance." In order to relate the distance between points to the concept of dissimilarity, one can view these points as "positions" on the line AE. A "position" should be viewed as a stimulus. The measure of the dissimilarity of a pair of positions is then the distance between the two stimuli.

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The distance between all possible pairs of positions was measured and listed in order from the shortest to the longest. With five positions, there are a total of ten pairs. Arbitrary distances from a set of random numbers were used to draw Fig. B1. The distances between pairs of positions in ranking order are shown in line marked C. The question is: if one is given only the set of nine inequalities of the top line can one establish the location of the five positions relative to each other? The answer is yes! -- with a certain degree of tolerance.

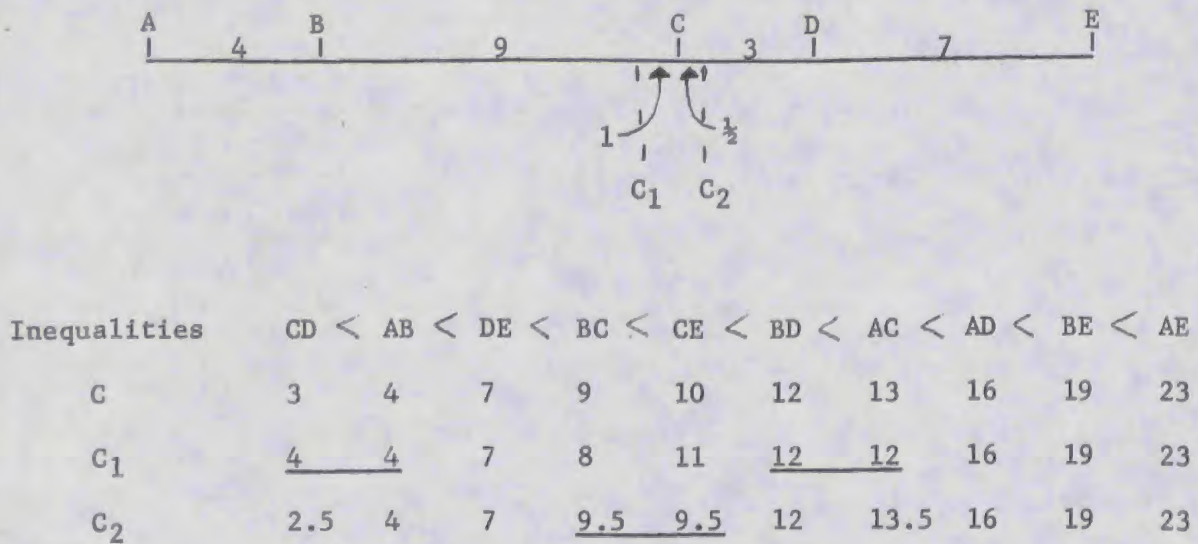


FIG. B1 Unidimensional example showing the limits of the motion of point C beyond which some inequalities would be violated.

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This can be demonstrated by considering the effect of moving the location of position C a small distance. If it is moved one unit to C_1 , it will be seen from the line marked C_1 that inequalities of CD to AB and of BD to AC are violated. If it is moved $\frac{1}{2}$ unit to C_2 as in the line marked C_2 , the inequality of BC to CE is violated. It is seen that if the set of inequalities is to be maintained, C cannot be moved more than 1 unit to the left or $\frac{1}{2}$ unit to the right. On the basis of the inequalities alone, the location of C can therefore be established within -1 and $+\frac{1}{2}$ units. This argument is not completely correct, for C might be moved a greater distance, if other positions were also moved, but it is clear that the range of possible locations of C will be restricted, if all the inequalities are to be maintained. In other words, it is possible to establish the location of all the positions relatively to each other with varying degrees of accuracy on the sole basis of the inequalities. The larger the number of positions the more accurately will their relative locations be established.

This proposition, surprising as it may seem at first, on deeper consideration is to be expected. To make the explanation clearer, suppose that instead of five positions there were ten. There would be 45 pairs of points producing 44 inequalities. A set of 44 inequalities contains a lot of information from which certain deductions can be reached. It is

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demonstrated in the next section that these 44 inequalities contain enough information to establish the relative location of ten positions in the more difficult situation of two-dimensions with an average inaccuracy of slightly more than one percent.

Thus, out of the soft information of many inequalities of a ranked order can emerge, not the exactitude obtainable from the hard information of a smaller number of algebraic equalities (or equations), but a range of values, a range small enough that inaccuracies of only a few percent can commonly be obtained.

A rough rule of thumb for the number of stimuli needed to provide a good approximation is three to five times the number of dimensions. The smaller number can be satisfactory if the stimuli are well spaced over the environment.

It will be realized from this example that a basic principle of the nonmetric technique is the comparison not of individual stimuli with other stimuli, but of a pair of stimuli, such as BD, with other pairs as to their dissimilarities. The reason for taking pairs is that when many pairs are compared, information develops about the psychological distance between the members of a pair in relation to that between

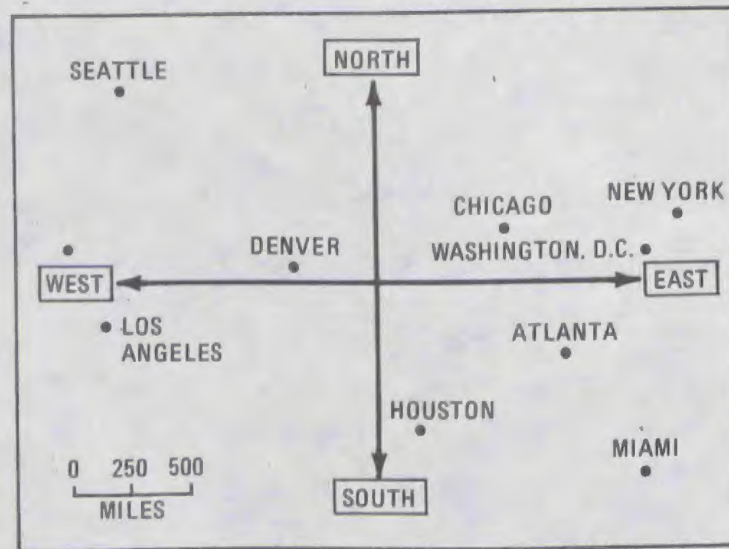
numbers of the other pairs. Comparing individual stimuli with the other individual stimuli instead of pairs will produce only a rank ordered list of the stimuli. As long as the list follows the transitivity rule, (that if A is better than B and B better than C, then A is better than C), it is not possible to develop from such a list alone the psychological distances that separate A, B, C, etc.

B.3.2 Two Dimension

A simple example with more than one dimension was calculated by Wish for the location of ten cities in the United States (Fig. B2-a)⁽⁹²⁾. The distances between all pairs of cities, forty five of them, were ranked in order. The only information given to the computer was this rank-ordered list. It was asked to locate all ten cities relatively to each other. The result is shown in Fig. B2-b. Note that the computer did not know the direction of North so that its answer had to be rotated to compare it with a true map.* Its accuracy is best demonstrated in Fig. B3 where the distances between pairs calculated by the computer are plotted against the actual distance. The result, if perfect, would be a straight line; the average error is 1.1%.

*The map might also have had to be inverted, for the inverted map would fit the judgment data equally well as the map itself.

(A) GEOGRAPHIC LOCATIONS OF TEN U.S. CITIES



(B) MD-SCAL SPACE FOR DISTANCES BETWEEN CITIES

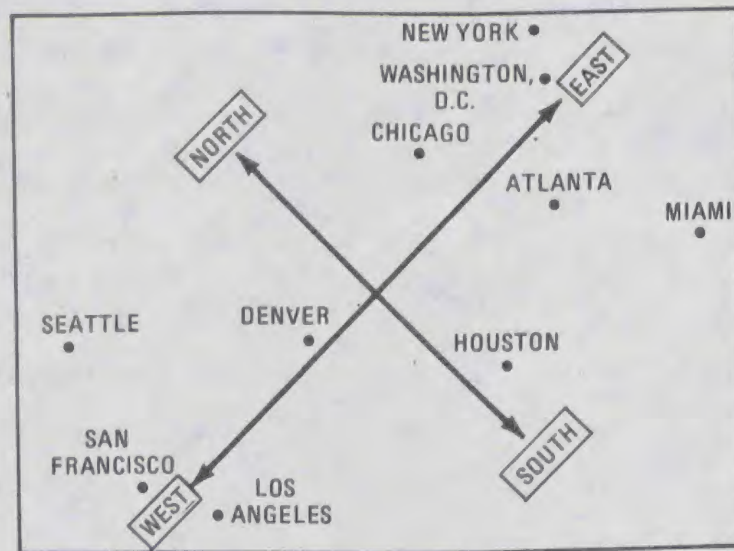


Fig. B2 MULTI-DIMENSIONAL SCALING

Application of Multidimensional Scaling (Source: Myron Wish (92))

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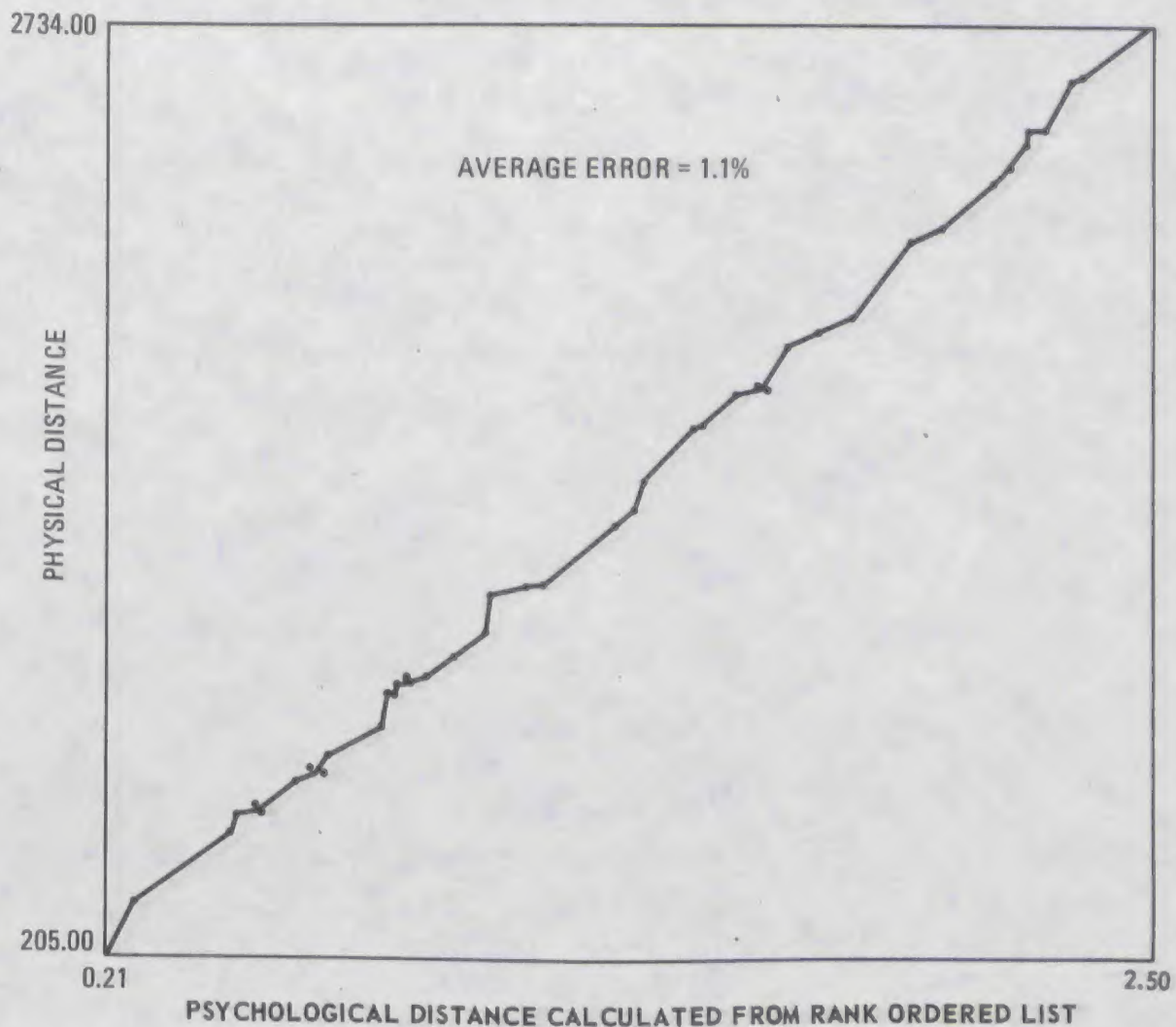


Fig. B3 PHYSICAL vs PSYCHOLOGICAL DISTANCE

Two-dimensional space from a multidimensional scaling analysis of the geographical distance between ten U.S. Cities
(Source: Myron wish (92))

B.3.3 Nonmetric Versus Metric Scaling

Both metric and nonmetric MDS are based on judgment data of pairs of objects or psychological stimuli.

Metric scaling, since it requires quantitative judgments, makes strong assumptions about the relation between similarities and distances. The correct relationship is often not known, in which case some assumption is made.

Nonmetric scaling liberalizes these assumptions not requiring a quantitative estimate of the psychological distances, but only a rank ordering of these distances. In other words, the distances need only be monotonic. It relieves the subject from having to quantify his judgment, to support it with a number. It also allows among other things a much wider variety of data, including many aspects of human relations.

Perhaps the most important impact on theory of the nonmetric breakthrough was the confidence that it gave that the psychological dimensions of a set of judgments could be identified and that none of them were concealed by the assumptions inherent in multidimensional scaling. That confidence is increasing as methods are developed to apply the principles to comparing the judgments of individuals and their relationship to their peer groups and gradually removing one-by-one the assumptions of the approach.

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As regards the relative practical importance of the metric and nonmetric forms of MDS, Douglas Carroll interestingly points out ". . . we are increasingly finding that for practical data analysis the distinction between metric and nonmetric methods is not often as important as it once appeared. The difference between metric and nonmetric solutions for the same data is not usually very great. To use statistical terminology, we can say that the metric methods are surprisingly 'robust' against a wide variety of violations of the assumptions on which they are based. It required the development of the nonmetric methods, however, to provide the comparison that has made this degree of robustness apparent."⁽⁹³⁾

It seems that the selection of metric or nonmetric approach will generally depend on the care with which subjects reach their judgments, the number of judgments that are necessary, the complexity of the applicable algorithm and the importance and effect on the user's sense of confidence. With a metric approach, however, there may remain an element of uncertainty whether some of its assumptions have concealed some important aspects of the analysis.

Before describing some practical applications and the technical process of MDS, it is important to note that there often is a technical difference between psychological distance for dissimilarities and for

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preferences. A preference implies a dissimilarity but of a special kind. One can like equally well objects that are very dissimilar. The preference judgments of any one individual are often one-dimensional, similarities and dissimilarities on the other hand are more likely to be multidimensional. For these reasons, the identification of the dimensions of preferences and dissimilarities may require different treatment.

B.4 PREFERENCE AND SIMILARITY TYPES OF JUDGMENT

In making judgments subjects are asked to express their perception of some attribute of the single stimulus of pairs presented. Examples of attributes are preference, weight, similarity of pairs, etc. These judgments may be based on one or more dimensions of the stimuli.

The non-metric comparison of a pair of stimuli, A and B, can generally be expressed as

$$A > B \quad \text{---(1)}$$

where " $>$ " may mean "preferred to."

Similarity requires the comparison of pairs of stimuli. The comparison is to be based on the difference between the stimuli of a pair AB compared with that of CD, which can be expressed by the inequality

$$AB > CD \quad \text{---(2)}$$

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For all attributes except similarity types, the pairs have an algebraic sign. For the preference attribute, if A is preferred over B one can write for the pair AB

$$P(AB) = - P(BA) \quad - - - (3)$$

For the similarity attribute, however,

$$S(AB) = S(BA) \quad - - - (4)$$

(Where P \equiv degree of preference, and S \equiv similarity)

There is, therefore, an important psychological difference between similarity (expression (4)) and other attributes (expressions (1) and (3)). It is reflected in the results of certain applications of MDS and the development of certain techniques for identifying psychological multi-dimensions from preference-type data.

In the two examples given in the previous section, the unidimensional one of Fig. B1 and the two-dimensional one of Fig. B2, show that the criterion for a set of judgments to be unidimensional with MDS processing requires the psychological distances to be monotonic. It must also follow the rule that the psychological distance between stimuli A and B plus that between stimuli B and C approximately equals that between stimuli A and C, or geometrically that

$$d(AB) + d(BC) = d(AC) \quad - - - (5)$$

(where d \equiv distance)

If A, B and C lie in two or more dimensions, the following inequality holds:

$$d(AB) + d(BC) > d(AC) \quad - - -(6)$$

This inequality should be more than marginal, if the fact that the stimuli have more than one dimension is to be clearly indicated. For this reason it is desirable to select stimuli covering a wide range of values of parameters, often extending beyond the range of practical interest.

It is very easy for a subject to compare a pair of stimuli and decide that stimulus is preferred to the other. We make such comparisons all the time; we do so whenever we buy anything, so that such comparisons come naturally to everyone. Because it is so simple and reliable, this simple rank ordering is commonly the first step in the non-metric identification and quantification of the dimensions of preference judgments. Such rank order can be considered to be the unidimensional representation of the attribute being judged. As previously explained, as long as this order is transitive, as it almost always is for preference data, the identification of dimensions will require additional data. It is much more difficult to compare the difference in preference between pairs, to decide for example that "the difference in my preference between stimuli A and B of pair AB is greater than that between stimuli C and D of pair CD." There appears to be a tendency under such conditions to switch the judgment

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unconsciously from difference in preferences to dissimilarities, or to pick on some dimension unconsciously and judge on the basis of the differences in it rather than on overall preference. The mental process that takes place may distort the result of the analysis.

When applying the nonmetric MDS process, comparison is made between differences in the attribute between pairs of stimuli. Various techniques are used presenting three or four at a time, referred to as triads and tetrads. The process requires first obtaining the best fit of the non-metric data of the pairs to monotonic ordering assuming only one dimension. If the residual stress is large, then the best fit is developed for two dimensions, and so on until the residual stress and other considerations indicate that the principal dimensions have been identified.

Eastman Kodak has carried out a long series of tests on the human perception of photographs. Among them were tests on the dissimilarities and on the quality of a number of photographs of the same scene, but differing in quasi-random fashion in three parameters -- modulation transfer (a major characteristic of resolution), contrast and noise. The subjects were not told which parameters were different. In a series of tests, the stimuli were presented in tetrads and the subjects were asked to indicate which pair of two pairs presented showed the greater difference. In one set of data collected the subjects were asked to compare the pairs on the

basis of the dissimilarities, that is the difference in general appearance between the pictures of each pair, and in another set on the basis of the difference of the general quality between the pictures of each pair. (94)

The result was surprisingly consistent. The tests were repeated using various techniques -- tetrads and triads, metric and nonmetric, different groups of subjects, different scenes in the photographs. The MDS analysis of the data showed negligible difference between scenes, techniques, metric and nonmetric, and even between groups -- professionals and non-professionals. There was one consistent difference, however: the MDS analysis of the perception of individual subjects obtained from dissimilarity data showed clearly three dimensions, while the difference-in-quality data always showed one dimension. In both sets the residual stress was very small, indicating that all the major psychological dimensions had been identified for each individual. Essentially, the result means that for difference in the quality of pictures equation (5) applies, while for dissimilarity inequality (6) does. Unidimensional results were obtained with attributes other than quality such as sharpness and skin color.

From a unidimensional spatial representation of an individual's perception such as may be obtained from preference data, it is not possible to identify directly the parameters which influence the judgment of preference. There are, however, several models from which the dimensions of

such preference judgments can be identified. These models are based on the differences in the perception between individuals. Two of them are outlined below. The vector model assumes that preferences are linearly related to its dimensions (see Section B.8.2), and the unfolding model takes into consideration that this relationship may not be linear nor even monotonic (see Section B.8.3).

B.5 EXAMPLES OF JUDGMENTS OF PHOTOGRAPHIC PICTURE QUALITY

Two examples are given. One, sharpness, which was handled unidimensionally and the other, the hue of color, which is clearly two-dimensional. An overall preference model for picture quality is being developed. There is little doubt that its many psychological dimensions will be identified and in due course correlated with known physical parameters.

B.5.1 Sharpness

A dimension of picture quality is sharpness. Higgins⁽⁶¹⁾ made a study of the sharpness of photographic images of pictorial subjects. Sharpness is not a technical, measurable quantity. When tests were started by Eastman Kodak, it was not known what physical measurement would correspond to the subjective assessment. It could reasonably be expected to be related to the physical curve known as the system modulation transfer function (MTF), the latter being a combination of the MTF of the photograph and associated optics and the MTF of the human eye. (An MTF is expressed as a plot of

modulation transfer against spatial frequency -- see Appendix A). Groups of about eight viewers were shown a number of photographs having different MTF's, but the same contrast and graininess or noise, and asked to rank the dissimilarities in sharpness between pairs of these photographs. The data were the input to an MDS computer program. The result was a one-dimensional solution. Various functions of MTF were tried before a good correlation was found between the psychological and parametric distance.

Fig. B4 shows the plot of observed sharpness of pictures with negligible noise, that is the one-dimension solution from the ranked ordering of one group of observers, and a calculated function of the MTF.* The correlation is substantially perfect. As the noise in the picture was increased the linearity of the correlation remained excellent, but the slope of the line dropped until with a lot of noise it came close to the horizontal axis.

Especially important were the results obtained with other observer groups and with several variations of the measuring technique, that all groups and all the variations gave substantially identical results. One of the

*The function was of the "Modulation Transfer", that is the area under the curve obtained by squaring the ordinates of the System Modulation Transfer Function.

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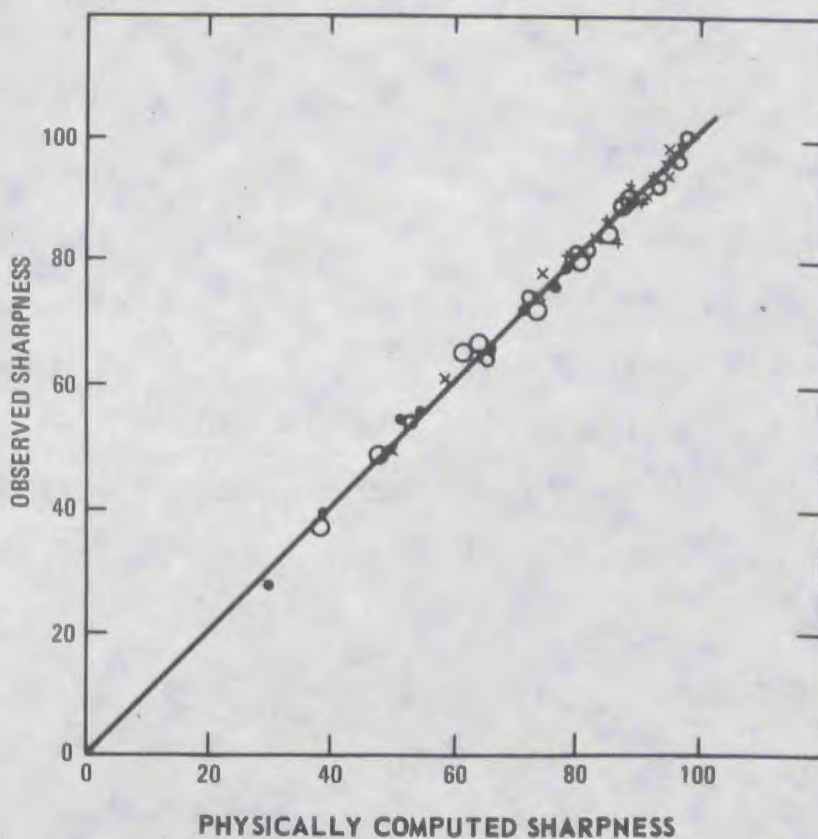


Fig B4 EXAMPLE OF APPLICATION OF SCALING HANDLED IN ONE DIMENSION

A number of pairs of photographs were ranked by the judgment of several observers in accordance with their sharpness. Sharpness can be measured physically as a function of "modulation transfer." The plot shows the excellent correlation between the sharpness dimension from subjective ranking and the physically calculated sharpness from measurement of modulation transfer. Several groups of observers were used giving substantially identical results (Source: G. C. Higgins (61.))

variations used was interesting because of the ease with which judgments can be made. It was based on presenting three pictures at a time instead of two pairs. The most and least sharp selected by the viewer were placed at specific points where he could see both simultaneously. The viewer was then asked to place the third at a spot which he felt represented its sharpness in relation to the other two.* This method could be used to provide both metric and nonmetric data. Both types of data gave substantially similar results. This variation, presenting items in groups of three, has the additional advantage over comparing two pairs in that with eight pictures there are 378 combinations for comparing all possible pairs with each other and only 56 for comparing a triad of items.

B.5.2 Color -- Hue

Color comprises three parameters -- luminance, saturation and hue. Hue has been analyzed over a period of a great many years because of the commercial need to be able to describe a color accurately. One of the results of this work has been the "Munsell Color Notation" of which

*The placing of the third picture was in this case one-dimensional, that is, it was placed in the line joining the first two. It can be two-dimensional. In studying dissimilarities of colors, Helm used a process by which the viewer would judge the distance from each of the first two pictures so that the placement of the third would be at the apex of a triangle (95)

the Munsell Hue Notation is a part. It was developed by Munsell and his corporation. (88, 96) The hue notation was obtained by the judgment of many people on the dissimilarity of colors, building the full scale of colors in equal dissimilarity steps, covering all visible hues. The presentation is a circle rather than the linear plot that would be obtained were it based on the physically measurable parameter of the wavelength of light; when based on psychological dissimilarities, it is circular because the red and red-purple, which lie at opposite ends of a spectrum, are subjectively similar in appearance.

In 1964, Helm⁽⁹⁵⁾ attacked the problem using only 10 hues of equal luminance and saturation. He had 14 subjects judge dissimilarities of pairs of colors according to the multidimensional technique. He obtained from ten subjects, considered to have normal color vision, a spatial configuration very similar to the circle of the Munsell Hue Notation. A later analysis of his data by a recently developed individual multidimensional differences scaling model (the INDSCAL model) described in Section B.6, developed the circle of Fig. B5, very close to the Munsell circle, and identified two axes which appear to correspond to the blue-yellow and Magenta-green response of the eye-brain complex.*

*The eye has three types of color cones sensitive respectively to blue, green and red. These are combined by interconnecting nerve fibres leading to the brain and producing the sense of yellow for which no cones exist in the eye. This eye-brain combination produces the blue-yellow and magenta-green psychological dimensions (97).

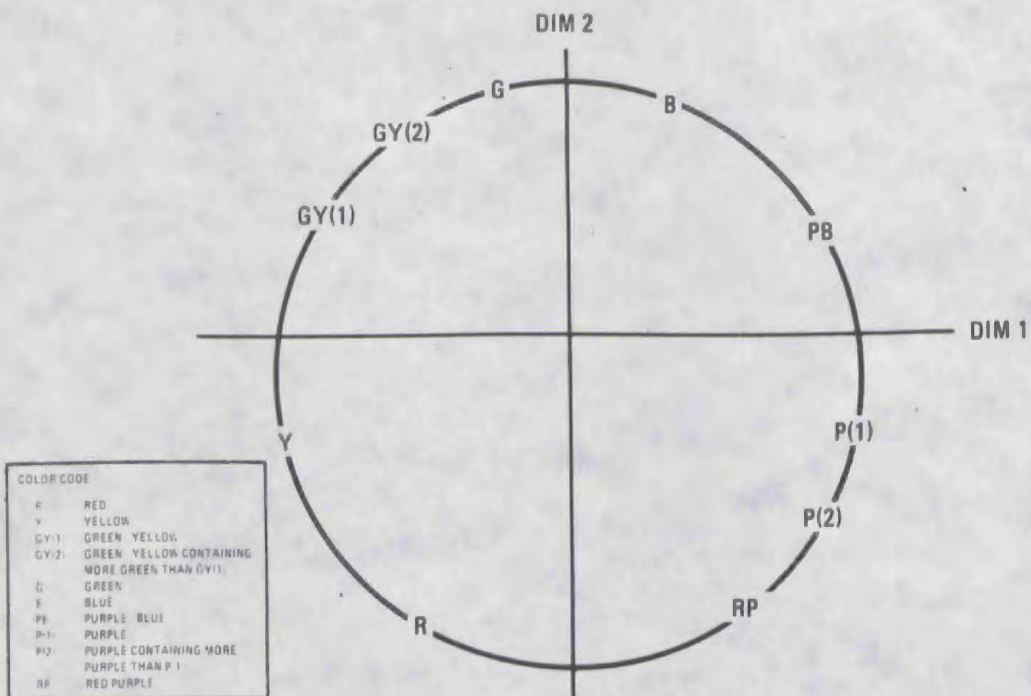


Fig. B5 MULTIDIMENSIONAL CONFIGURATION
Dissimilarities of colors (Source: Carl E. Helm (95))

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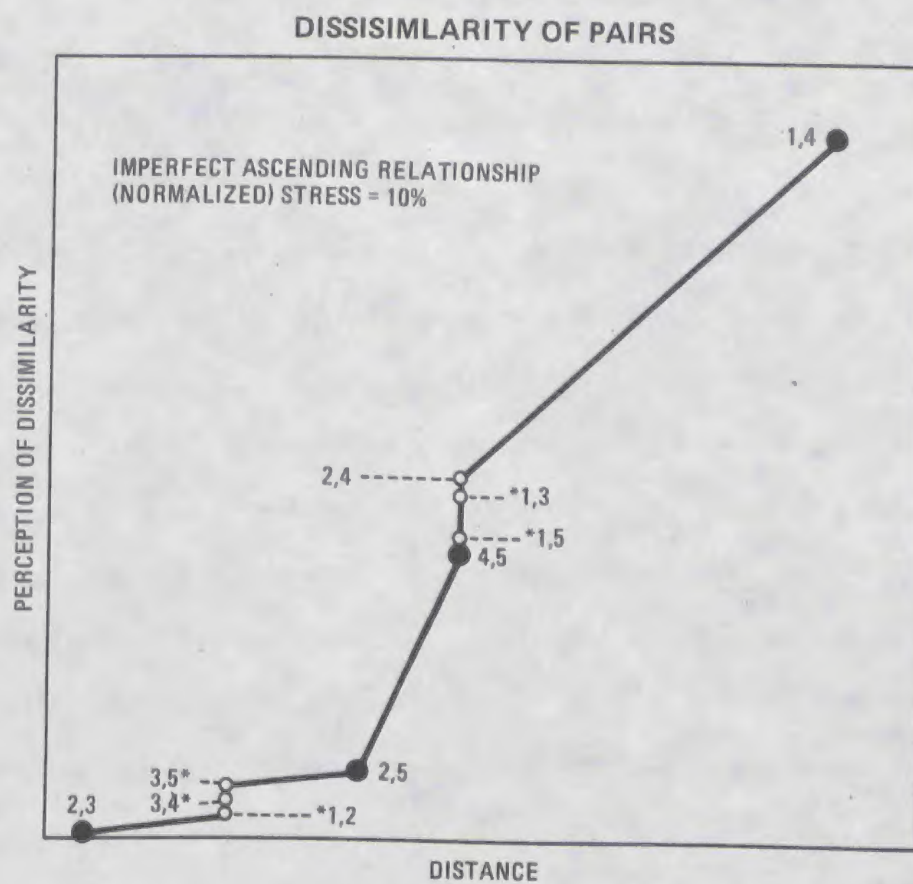


Fig. B6 SHEPARD DIAGRAM
 Ten pairs of five items showing monotonic relationship between dissimilarity & psychological distance for pair (2,4) (Source: J. B. Kruskal (83))

B.6 PROCESS OF NONMETRIC MULTIDIMENSIONAL SCALING

B.6.1 Relating Rank to Psychological Distance

The following examples used for explanation were given by Kruskal.⁽⁸³⁾ One example comprises 15 items providing $(15 \times 14)/2$ or 105 pairs. The data consist of a rank ordered list of the dissimilarities of these pairs. The list in effect says, for instance, that pair (13,21) is more dissimilar than pair (48,72). With 105 pairs of dissimilarities there are 104 such inequality relations. In the ideal final spatial representation, the relationship between the distances and the ranking order of the dissimilarities would be perfectly monotonic. An example of a plot showing the distances versus the rank order of dissimilarities is shown in Fig. B6 for the case of ten pairs. The pairs (1,2), (3,4), (3,5), (1,5) and (1,3) had already been shifted as indicated by the dotted lines. At this stage the fit would become perfect, if pair (2,4) were shifted as shown. Such a plot is often called a "Shepard diagram."

B.6.2 A Two-dimensional Example

Returning to the case of 15 items and 105 dissimilarities, Figs. B7, B8, and B9, originally presented by Coombs and Kao,⁽⁹⁸⁾ and described in Kruskal's papers,⁽⁸³⁾ represent configurations arrived at three stages of the iterative process for two-dimensional scaling.

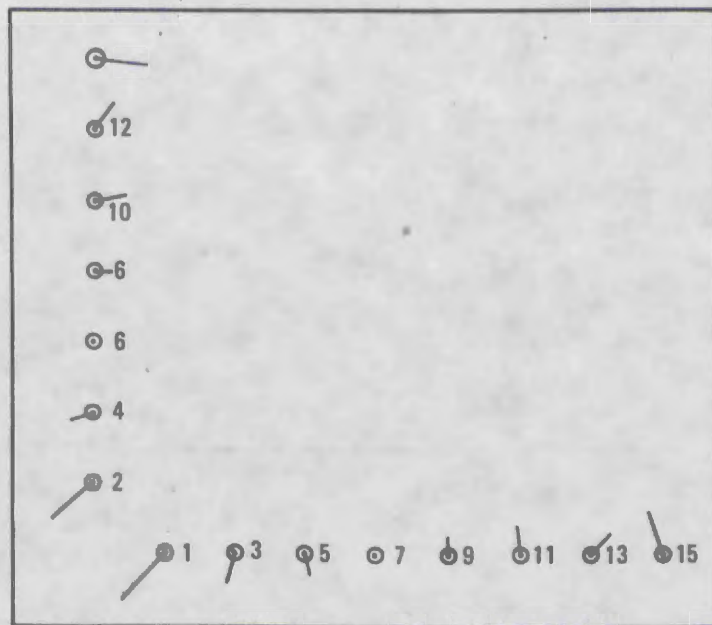


Fig. B7

INITIAL CONFIGURATION

(Source: Coombs and KAO Data (105))

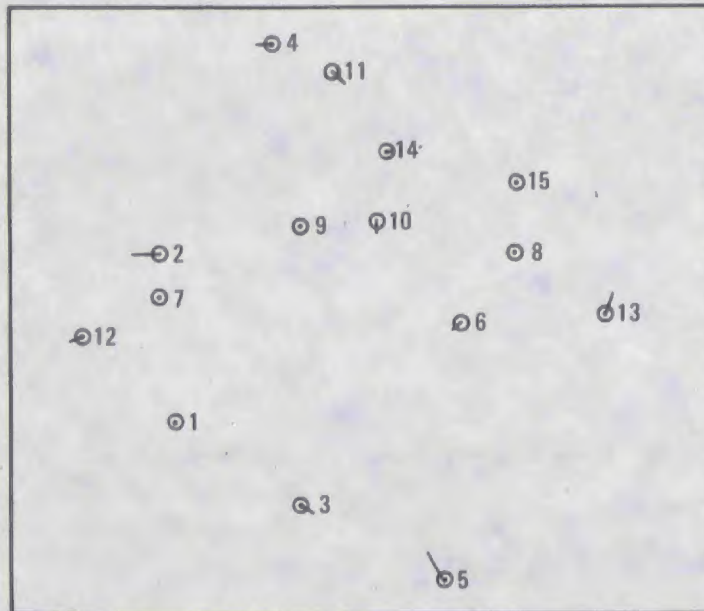


Fig. B8 CONFIGURATION AFTER 10 ITERATIONS

(Source: Coombs and KAO Data (.98))

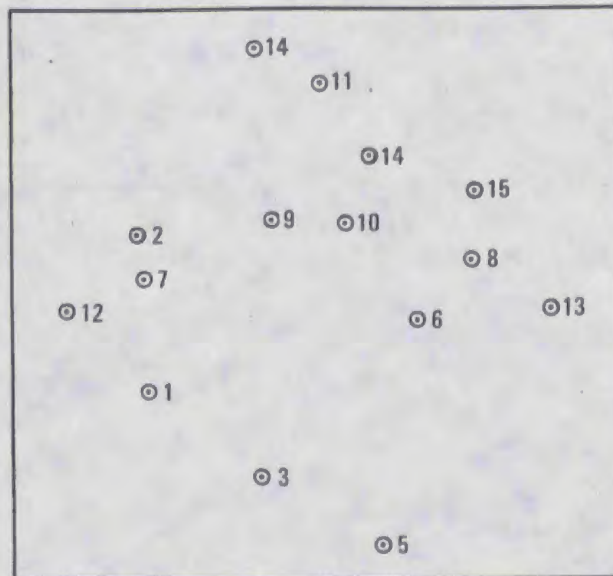


Fig. B9 CONFIGURATION AFTER 50 ITERATIONS

(Source: Coombs and Kao Data, (98))

The initial stage (Fig. B7) is arbitrary. The 15 items are laid out in any convenient configuration. For the first iteration, all the points are moved a little to bring the inequality relationships of the pairs more closely to the ultimate monotonic ideal. To carry this out, there is a widely used iterative technique known as the "method of gradients" or the "method of steepest descent." The short lines associated with each point in Fig. B7 indicate the change at the first iteration. After each iteration a figure for the remaining stress is calculated. Stress is a measure of the departure from the ideal monotonic relationship. A best fitting function can always be obtained even when the fit is poor. The algorithm used provides simultaneously the best fitting function of the dissimilarities and the stress, that is the deviation between the actual distances from this best function.*

Fig. B8 shows the spatial configuration after ten iterations and Fig. B9 after 50.

Generally, from 50 to 100 iterations may be necessary. (Computer programs are available). The stress is seldom reduced to zero, the iterative process is stopped when the stress changes but little with each additional iteration. Stress is expressed as a percentage. Kruskal assesses the goodness of fit as follows:

* The stress is the square root of the sum of the square of these deviations, divided by an appropriate normalizing factor.

TABLE 5

<u>Stress</u>	<u>Goodness of Fit</u>
20%	Poor
10%	Fair
5%	Good
2½%	Excellent
0%	Perfect

B.6.3 Establishing the Number of Dimensions

When the stress has reached a stable level and is still high, the reason is likely to be that the number of dimensions is not adequate. To establish the number of the major dimensions of the judgment data, the stable values of stress reached is plotted against the number of dimensions. Fig. B10 shows such a plot for two cases studied by Indow and Uchinzo⁽⁹⁹⁾ and by Indow and Kanazawa⁽¹⁰⁰⁾ dealing with color varying in hue and chroma. The sharp angle at the points on both lines corresponding to two dimensions indicate, probably for both cases, but certainly in the case represented by the solid line, that three dimensions represent sufficient improvement over two to warrant the third dimension being taken into consideration.

Practical experience shows that increasing the number of dimensions beyond a certain number may reduce the accuracy of the information developed because the higher dimensions may merely be accounting for the noise in the data. In other words, the noise can lead one astray by distorting the

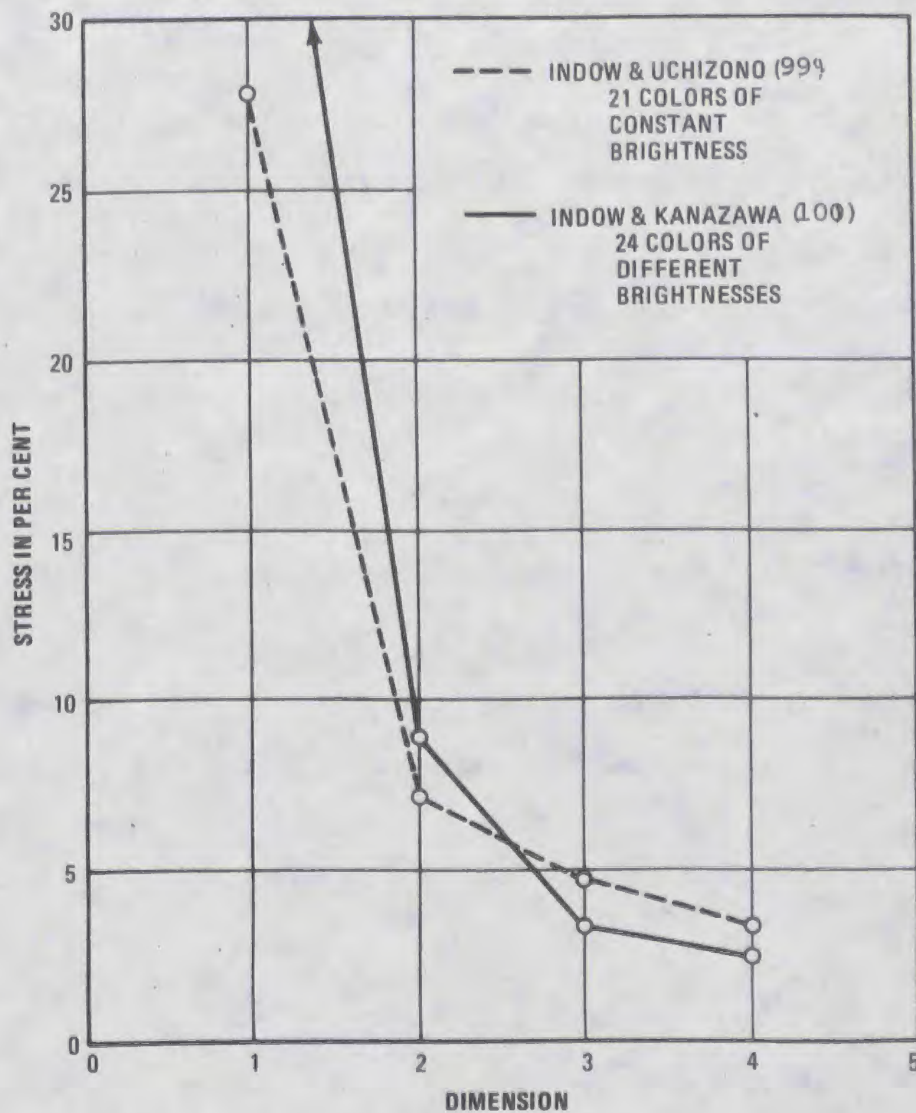


Fig. B10 EXAMPLE OF ESTABLISHING THE NUMBER OF DIMENSIONS

development of the less important dimensions. It is necessary to judge at what point additional dimensions will provide no useful information. The criterion of usefulness is often the development of correlation between psychological dimensions and recognizable parameters. Barbara McDermott points out that "interpretability is the most useful way of finding an appropriate balance between accuracy and parsimony."⁽¹⁰¹⁾

The orthogonal axes may be statistically well defined, but unless a special model is used, such as the INDSCAL model described in the next section any other set of orthogonal axes is equally correct. Correlation of the psychological dimensions with physical parameters will require that the axes be rotated until some correlation is recognized. This process of rotating axes becomes rapidly more difficult as the number of dimensions increases, becoming almost impossible with more than three.

B7. INDIVIDUAL DIFFERENCES SCALING (INDSCAL)

Just as the dissimilarities of stimuli perceived by an individual can be represented in a "stimulus" space, so can the perceptual differences of individuals be represented in a "subject" space. This subject space depicts individual differences and from this information psychological dimensions can be determined. A model has been developed by Carroll and Chang⁽¹⁰²⁾ to do this and has been given the name INDSCAL.

INDSCAL is a recent development from which several important features appear. Its principle is the development of the differences between subjects brought out by the dissimilarities data collected from each in order to establish the axes of the spatial configuration. A joint representation of stimuli and subjects is developed from which a stimulus space, called the "group stimulus space," is produced. The group stimulus space defines the stimulus dimensions. In this process the assumption is made that all the subjects respond to the same dimensions. The differences in their perception lies in the difference in the weight each subject gives these dimensions. On the basis of this assumption, the INDSCAL computer program, in contrast to that used in the ten-city example (Fig. B2), establishes the set of axes which provide the best spatial representation of the perception of the group. These axes therefore are not to be rotated. The solution represents a set of characteristics unique for the group up to permutation of co-ordinate axes. One of the outputs is the "subject space" produced by using the weights for dimensions as coordinates for each individual.

Experience with INDSCAL has been that its uniquely oriented axes usually correspond to psychologically meaningful dimensions. Where there are known physical parameters, they often correspond in a one-to-one fashion to these axes.

An interesting application was to hue, already mentioned, in which the relation between physical parameters and psychological dimensions is somewhat more complex. Fig. B5 showed the group stimulus spatial dissimilarity configuration of ten hues based on the dissimilarity data collected by Helm referred to earlier. It is repeated in Fig. B11a. It clearly shows two dimensions. Ten "normal" subjects cooperated in the test, four others were color deficient. INDSCAL established the "subject" space configuration of Fig. B11b. The weighting applicable to subject N1 for instance, is proportional to OX in dimensions 1 and to OY in dimension 2. The distance from the origin can be interpreted as the "communality" of that subject with the group, or as the variance accounted for by the group stimulus space for that subject's data.

The stimulus space for four individuals is shown in Fig. B11 c, d, e, and f. While the group stimulus space is a circle, some individual stimulus spaces are ellipses with well-defined principal axes. The individual subject spaces that vary substantially from a circle indicate a color deficiency and provide a quantitative measure of that deficiency. It is particularly noticeable in subjects CD4a and CD1.

INDSCAL establishes the unique direction of the axes of the group from each individual deviation from the group. It is seen that the extreme points of dimension 1 extend from the purplish-blue at one end to the yellow at the other, and those of dimension 2 from the red to the bluish-green.

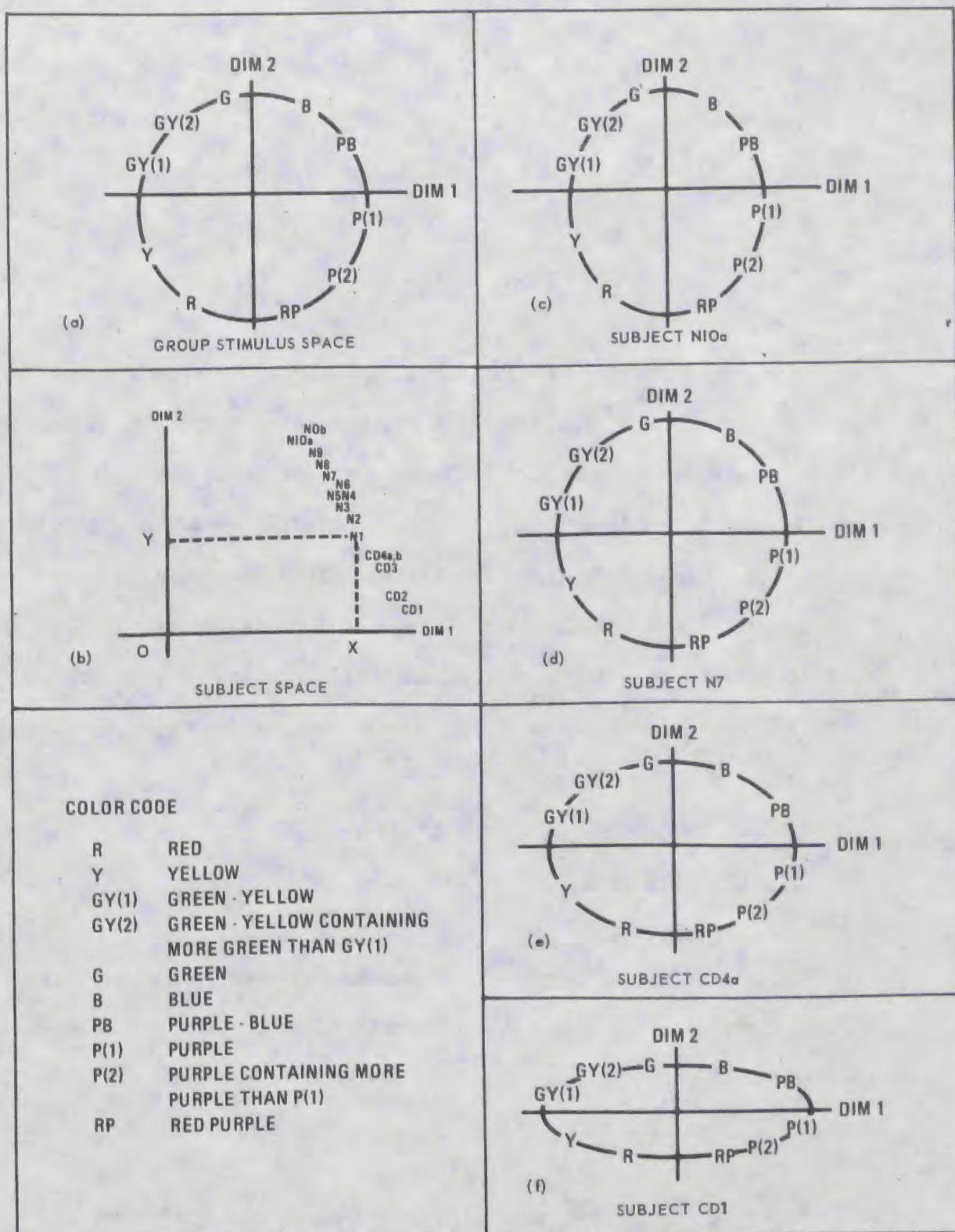


Fig. B11 INDSCAL PROCESSING
Color data of Helm (U_B). (Source: Carroll & Wish (1963))

As already mentioned, these axes correspond well with "blue-yellow" and "magenta-green" response of the eye-brain complex.⁽⁹³⁾ Over 90% of the variance for all subjects was accounted for by a two-dimensional INDSCAL solution.

Another example of the application of INDSCAL involved developing a stimulus space configuration of audible tones. The stimulus involved the 24 combinations of four different tones, three percentage modulations and two wave forms (sinusoidal and square). One would expect the stimulus configuration to be three dimensional. And indeed this was the finding. The correlation was considered excellent. Without rotating the axes, which INDSCAL avoids, the orientations of the three psychological dimensions were found to be less than 15° away from that of the physical parameters. The cosine of the angles between the psychological and the physical axes were .990, .995 and .968.^(10 2)

B.8 PREFERENCE ANALYSIS

B.8.1 Types of Analyses

A number of multidimensional models have been proposed to analyze individual differences where the available data for an individual is unidimensional as is often the case when analyzing preferences and certain other attributes (see Section B.4). These also enable the measurement of

the relative importance of the dimensions underlying the subjects' preference judgments. In these cases, the multidimensional analysis of preference data is derived from the differences in preference between individuals.

Preference models most widely known are the vector model first proposed by Tucker,⁽¹⁰⁴⁾ and the unfolding model proposed in uni-dimensional form by Coombs,⁽¹⁰⁵⁾ and generalized to the multidimensional form by Bennett and Hays.⁽¹⁰⁶⁾

The models discussed assume a multidimensional configuration of stimulus points. An excellent summary of these models is that given by Carroll.⁽⁹³⁾

B.8.2 The Vector Model

In the vector model a subject is represented in the group stimulus space by a straight-line, a vector. Each subject has his individual vector.

Fig. B12 shows a group stimulus space configuration with five stimuli and two subject vectors in a two-dimensional space. The projection of the stimuli on the vectors represents the preferences of the subjects for the stimuli. The projection of the stimuli on the vectors shows the monotonic sequence to be different for the two vectors, being ABCDE for one

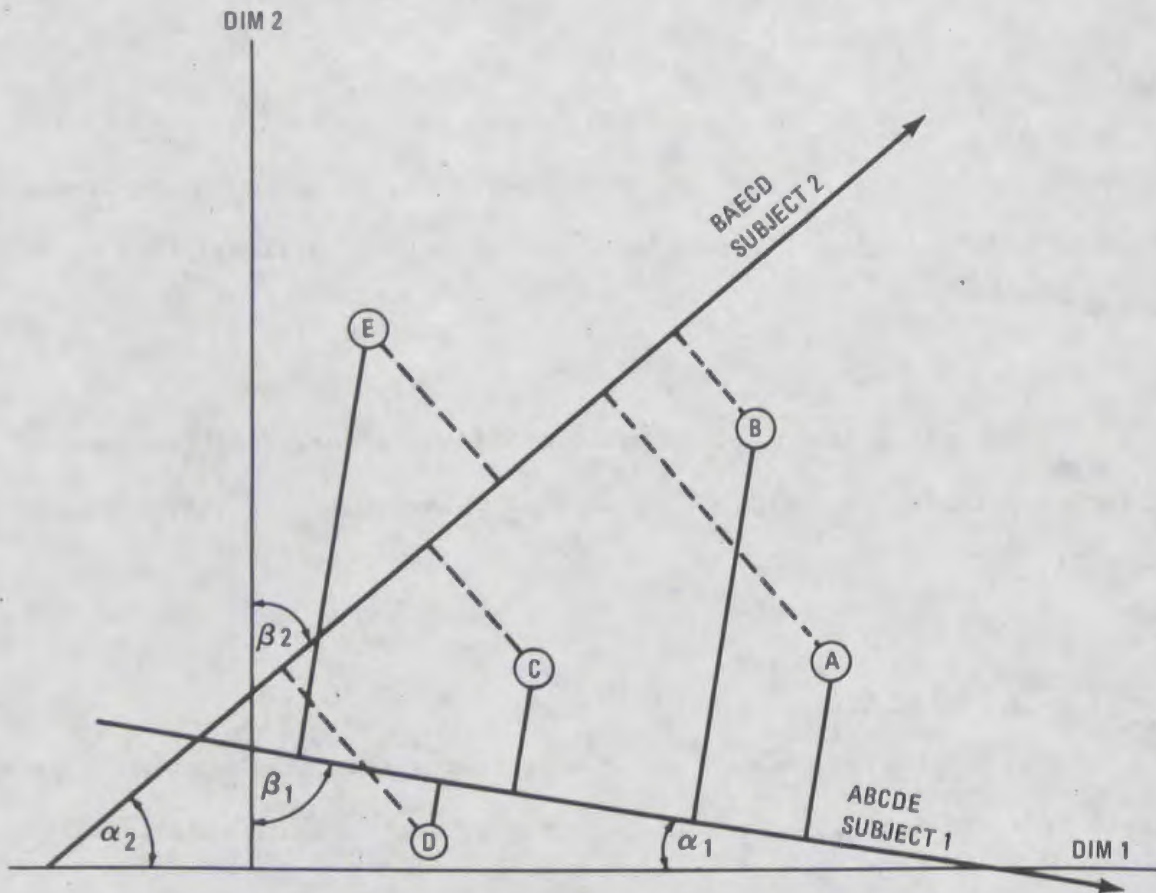


Fig. B12 **STIMULUS SPACE WITH PREFERENCE VECTORS FOR SUBJECTS**
Two subject vectors in a group stimulus space of two dimensions

and BAECD for the other. Thus, the orientation of the vectors defines the relative importances of the dimensions for these subjects. The importance of a dimension is proportional to the cosine of the angle between the vector and the dimension. The relative importance of dimension 1 to subject 1 and subject 2, for instance, is $\cos \alpha_1 / \cos \alpha_2$.

The stimulus space configuration should not be expected to be the same for similarity and preference judgments. Sometimes they are closely similar as in the example that follows. When they are not the same, the stimulus configuration can be obtained from the differences in the preference judgments of individuals on the assumption that their psychological dimensions are the same, but the weights applied to these dimensions are different.

In some cases, as in the analysis of the quality of pictures by Eastman Kodak referred to in Section B.4, the difference between individuals can be very small. In the case of Eastman Kodak tests, not only was the configuration for all subjects found to be unidimensional, but was also very nearly the same straight line except for a very few whose configuration was so radically different that the data they provided were considered inappropriate for use in the analyses of the group. In cases of this kind it will generally be satisfactory to assume that the dimensions obtained from dissimilarity tests, after reliable correlation has been obtained with known physical parameters can be applied to the preference data. The weighting, however, will generally be different. By multiple regression analysis it is then possible to establish

the relationship of these parameters with the common unidimensional configuration obtained. Thus, the subjective judgment of quality, sharpness or other attribute which produced the unidimensional result, can be expressed as a mathematical function of the known physical parameters.

Barbara McDermott^(10¹) applied the vector model to a study she carried out on the preference of 31 subjects for speech transmitted through 22 simulated telephone circuits that had been submitted to a variety of linear and non-linear distortions. Three dimensions emerged. They were "Degree of distortion in signal", "Degree of distortion in background", and "Loudness Level". These three dimensions accounted very well for the preference judgments of all subjects. The subjects preferred the circuits that had the least distortion, but they differed with regard to the relative importance of the three dimensions.

The analysis was carried out by two methods. The first assumed that the configuration of the stimulus space would be the same for dissimilarity and preference judgments. This method is said to be "external" because it makes use of data other than preference data. The second, said to be "internal", used only preference data; it used the difference between individuals to determine the preference dimensions. Both methods produced substantially the same results. The configuration of the stimulus space in this case proved to be very similar for both dissimilarity and preference.

B.8.3 The Unfolding Model

The vector model makes a serious assumption although it is known in general not to be true; it is often, however, a reasonable approximation within a certain range of values. When such an assumption is made, the range of its validity should be clearly indicated in reporting an analysis using the model. The model assumes that preference varies monotonically with all dimensions -- if a certain amount of a thing is good, more is better. Actually, for most dimensions there is an optimal value. Optimal values are directly contained in the unfolding model of Coombs.⁽¹⁰⁵⁾ The concept in one-dimension is shown in Fig. B13 for three subjects. Each subject is assumed to have his individual "ideal points" which represent his optimal values. His preference is assumed to decrease symmetrically on either side of these points. The monotonic preference order for stimuli A, B, C, D, E is indicated for each subject.

This concept was expanded to several dimensions by Bennett and Hays⁽¹⁰⁶⁾ as depicted in the two dimensions of Fig. B14. There, the location of the optimal values are shown for each of the three subjects in relation to the position of the five stimuli in the two-dimensional space.

The iso-preference contours (loci of equal preferences) are a family of concentric circles centered at each subject's ideal point. In three dimensions they are concentric spheres, in more they are concentric hyperspheres.

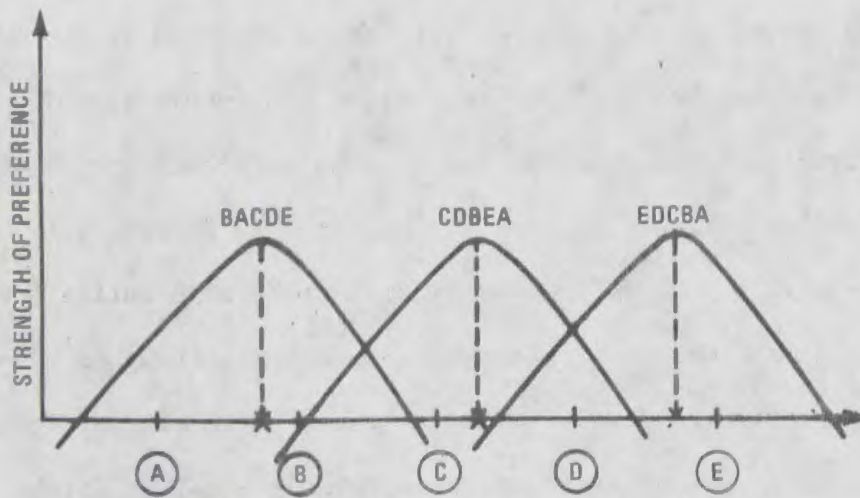


Fig. B13 UNIDIMENSIONAL UNFOLDING MODEL

Distance of stimulus from subjects "ideal point" (this optimal value on the unidimensional scale) is assured to define (inversely) the preference scale of that subject) (Source: Douglas Carroll (93))

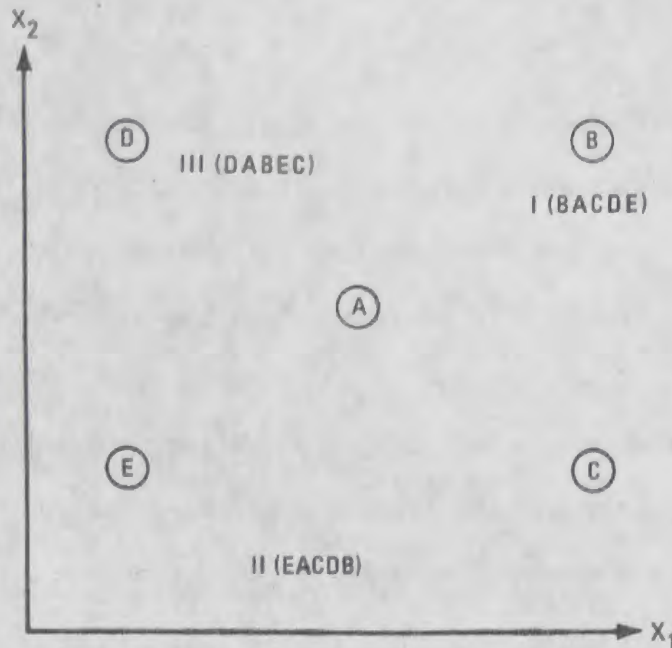


Fig. B14 MULTI-DIMENSIONAL UNFOLDING MODEL

Distance from subject's "ideal point" (inversely defines his preference scale). No preference contours are concentric circles centered at "ideal points". They would be spheres or hyperspheres in higher dimensions. (Source: Douglas Carroll (93))

Other unfolding models liberalize the assumptions and constraints. In the first liberalization the "Weighted Unfolding Model" retains the ideal points for different individuals, but allows individuals to weight the dimensions differently in a manner analogous to the INDSCAL model. It should be stressed that these weights need not reflect different perceptual configuration, but different degrees of significance of the dimensions. As pointed out by Carroll,⁽⁹³⁾ a man may perceive perfectly well the difference between a blonde and a red-head, but this "dimension" may be irrelevant to his choice, his preference of partners, but to another it may make all the difference in the world. In a weighted unfolding model the isopreference contours are ellipses, ellipsoids or hyperellipsoids.

In the second liberalization, the "General Unfolding Model Allowing for Differential Rotations and Weights," the model allows differential rotation of the dimensions.

The four preference models outlined -- the vector model and the three unfolding models -- are each special cases of the one following. The vector model is the special case of the unfolding model in which the ideal points are at infinity. The three unfolding models are three stages of liberalizing the constraints on the differences between subjects as regards their perceptual dimensions. As discussed by Carroll, a variety

of techniques are available for internal and external analysis in terms of these four preference models, called by him the "linear-quadratic hierarchy of models."⁽⁹³⁾

APPENDIX C

NARROW BAND TV OF VISIBLE QUALITY

G.E.'s "SAMPLEDOT"

PERFORMANCE ACHIEVED

Robert Stone of G.E.'s Valley Forge Space Center has developed a very narrow band TV system with good potential for meeting a need when the available band is too narrow for regular TV, or when it is important to provide several TV programs where there is spectrum room for only one.

The practical application of this system does not currently compete with present entertainment TV, for the quality of the display is noticeable less. It could be a strong contender for picturephone and teleconferencing, providing a stride toward substitution of telecommunication for travel. It is probably acceptable for TV broadcasting in remote areas like Alaska difficult to reach economically by regular TV broadcasting. Of special importance to the allocation of spectrum space is its potential application to many kinds of institutional types of services such as education, health delivery, under water exploration, traffic and security controls including monitoring of parking lots, streets, shipping, etc.

Each presentation media whether theatre, movie, television have its special limitations. The producer adapts his scenes to the limitations of the medium he is using. With experience in handling a medium techniques are found to overcome some of these limitations. The zoom lens, for instance, greatly helped the limitation due to the small size of the TV screen. An important limitation to Sampledot will be the handling of scenes having many rapidly moving objects. It may not be possible for instance with a Sampledot-type

system to swing or "pan" the camera across a scene.

Except for the scanning sequence, the standards of the system are compatible with NTSC. The resolution of stationary and slow-moving objects is the same as for regular entertainment TV. The reduction in bandwidth is in a ratio of about 4 to 1.

The bandwidth of the system (at the 3 dB points) in the two models developed is 600 kHz and 900 kHz, respectively. This performance has been achieved at the cost of some, not very complex, additional circuitry (two cards 4-1/2" x 4-1/2" in each of the transmitter and receiver), and some degradation in the quality of the picture. In one respect the quality is improved over regular TV, in others it is worsened, but overall the quality is not as good. The improvement is in the smear that often follows moving objects. The deterioration is principally in the background and in some cases in the resolution of fast-moving objects.

The performance varies with the decay time of the phosphor of the TV screen. With long decay phosphor (P40) the resolution of rapidly moving objects is reduced, a degradation which is not usually important. With short decay (P4), there is no apparent loss of resolution. The reason is particularly interesting; a small fraction (one sixteenth) of the picture is produced every thirtieth of a second, each time with a different random pattern; human perception reconstructs the object almost as completely as if it were continuously scanned. With both phosphors the smear associated with moving objects is noticeably improved. The principal degradation is in the background. At close distances a pattern is noticeable -- referred to by the G.E. group as "artifacts of sampling." For many professional applications, it

is not destructive and, interestingly, after some use the viewer is no longer conscious of its presence. The viewing distance at which the structure of this background is considered not to be disturbing is about 9 times the picture height with a P4 phosphor, and 6 times with P40 phosphor.

With a 5" tube, such as one might have on a desk, this viewing distance would be 2 ft. and 3 ft. for P4 and P40 phosphors, respectively. For professional operation, shorter viewing distances may often be usable and acceptable. These estimates of viewing distance are the opinions of engineers. No psychometric measurements have yet been made.

The following table shows the performance features of the TV part of the sampledot compared with other TV systems.

COMPARISON OF TV SYSTEMS STANDARDS
(Information provided by G.E. Co.)

	<u>CCTV</u>	<u>Stand. TV</u>	<u>Pict. Phone</u> (est.)	<u>Sampledot</u>	
				<u>SD900</u>	<u>SD600</u>
Video Bandwidth (--3 dB points)	5	3	1	0.9	0.6 MHz
Horiz. TV Resolution (Effective Chart Lines)	500	300	100	*670	*450 Lines
Vert. TV Resolution (Active Scan Lines 2)	370	370	200	370	370 Lines
Video Frame Rate	30	30	30	2	2 Fr/Sec
Field Rate	60	60	60	60	60 Fld/Sec
Type of Scan	Seq. Lines	Seq. Lines	Seq. Lines	Pseudo-Random Dot Pattern	

(*Integrated over 32 fields)

HOW WAS PERFORMANCE ACHIEVED

The smallness of the degradation in visible quality in view of the compression in bandwidth achieved, and the simplicity of the added circuitry seemed truly remarkable. How was it achieved?

The eye-brain complex has three characteristics important to the design of TV displays and basic to efforts for minimizing the bandwidth for a given picture quality. The first is that the display of a shape seldom has to have all its elements covered 30 times a second to be recognizable; with stationary or slow-moving objects, the repetition rate can be much slower without substantial degradation of quality. The second is that with rapid-moving objects, details and accuracy of outline lose their significance, most of them are not seen, but mentally reconstructed particularly when the object is clearly seen at the start and after it has slowed up. The third is that systematically repeated distortion or visible picture elements, even of low intensity, which are not part of the original scene, can be noticeably disturbing.

The first two are the fundamental characteristics which permit and give hope of compressing the bandwidth; the third is constantly frustrating that effort. Some years ago Sidney Deutsch and others working to overcome the third characteristic suggested that instead of scanning a TV screen in a regular sequence of lines, better results might evolve by illuminating randomly the picture elements (or dots) which make up the picture. It was hoped that the full picture could be produced over a much longer period than a thirtieth of a second with relatively little degradation in quality, thus greatly reducing the bandwidth. It

was an interesting concept, which, however, was not satisfactorily implemented at the time. Robert Stone picked up the pseudo random concept and after considerable imaginative effort produced what is now Sampledot.

Thus sampledot is a pseudo random system, which means that the picture elements are illuminated in a sequence which gives the appearance of randomness within a small segment of a TV picture. The whole TV picture is divided into these segments -- 64 or 96 of them. The pseudo-random pattern in each segment consists of one picture element in each of the 16 horizontal lines contained in a segment. This pattern is repeated from segment to segment in one thirtieth of a second. The process is carried out 16 times with different random patterns for a total of close to half a second (actually $1/1.875$ seconds) covering all the elements of the picture.

The major part of the development was the discovering of a pseudo-randomness which induced little disturbance to the viewer. In this respect sampledot seems to have been successful. It has permitted the frame time of a TV picture to be extended from a thirtieth of a second to about one half second or a ratio of 16 to 1, out of which an ultimate bandwidth compression of 4 to 1 has been obtained.

It will be noted that extending the full time of scanning a whole picture from one thirtieth of a second to a little less than half of a second shows the theoretical possibility of 16 to 1 bandwidth compression. While the theoretical limit will probably never be achieved in practice

a close approximation to it may be expected. Further compression however may be expected by introducing some memory techniques such as those described in Appendix D. In addition when flat screen displays are fully developed they may be found to be particularly well suited to pseudo-random scanning because of each picture element having individual circuit and may be able to approach more closely the theoretical limit of bandwidth compression.

SPECTRUM REQUIREMENTS

The emergence of a television system requiring a fraction of the bandwidth of the present system immediately raises the question of the possibility of a demand for spectrum space for this type of service. Sampledot looks well enough for practical operation, its equipment cost is only slightly higher than that of present TV, but for many operations that cost may be more than balanced by the saving of bringing its narrow instead of wide band TV programs to the input of the system.

Sampledot is the first example of a TV system which may prove serious contender for spectrum space, bringing in its wake a multitude of allocation problems with associated societal-economic and technical considerations directed to ensure the delivery to the public of its potential benefits. Existing allocation rules may be adequate, but until the applications and needs are estimated and psychometric measurements made on the quality of the display, that question will be left unanswered.

Among the technical considerations will be the type of modulation -- AM probably not; PCM probably for long distance; FM possibly, even turning back to the advantages of narrow band FM proposed during the FCC color television hearing of 1949-50.

The advent of Sampledot is a warning to be on the alert and be prepared for the emergence of a demand in the years to come for this new type of television service. It is likely to become important in view of the consistent increase in the demand for pictures in communication and the cost of wide band transmission.

APPENDIX D

CHANNEL CONSERVATION VIA
DIGITAL CONVERSION

The title of the Appendix is channel conservation rather than bandwidth compression of television because the direction of this work was primarily to be able to transmit television signals by means of pulses instead of digits. Pulse Code Modulation (PCM) will normally require a very much larger bandwidth than analog. The problem was therefore to reduce the bandwidth as much as possible, but it was not expected to reduce the bandwidth below that of analog.

Pulse code modulation consists of a series of pulses. Each pulse provides an on-or-off type of information expressed by whether the pulse is there or not. One on-or-off piece of information is known as a "bit." With nine pulses in a sequence, for instance, there are 512 ($= 2^8$) different arrangements possible, each of which can be given a special meaning according to a pre-arranged code. The measure of the quantity of information in a message is the number of bits of information it contains.

In a color television picture with an aspect ratio of 4/3 containing 525 x 525 x 4/3 or 370,000 picture elements (pels) flashed on the screen 30 times a second, with each pel having the equivalent of 512 levels plus one bit for the color, the total number of bits of information the signal carries is

$$525 \times 525 \times 4/3 \times 30 \times 9$$

or nearly 100 million bits per second. The Nyquist principle states that the minimum analog bandwidth required to carry this information is half the number of samples per second or 50 MHz. But the theoretical Nyquist ratio is not achieved in practice. Normally, the bandwidth to carry that signal is about equal to the number of bits per second. The practical bandwidth is therefore about 100 MHz. The actual bandwidth that currently carries the television signal is 4.2 MHz wide. If the particular problem that the NTSC standards present to conversion into pulse code modulation, the conventional bit rate would probably be about 50 MHz. Assuming that the PCM system is not degraded in the transmission and processing, a more accurate pair of comparative bandwidth figures for carrying an average good television picture by analog and PCM today are, therefore, 4.2 MHz versus about 50 MHz, or about twelve to one in favor of the analog.

This bandwidth penalty exists because PCM does not duplicate the analog signal; it is an approximation to it. A visible effect of this approximation arises from the great sensitivity of the eye to small differences in intensity in adjacent areas. This sensitivity makes the conversion from analog to digital particularly burdensome for television. (107) In analog operation, a change in intensity which increases gradually is represented by a continuous change in the signal so that no sharp lines appear in the reproduced picture. With digital signals, however, changes in intensity are discontinuous;

they take place in discrete steps. As a result, with PCM the change in intensity, when it occurs gradually, will be represented as a series of steps with the boundary of each step identifiable as a line; its visibility will depend on the size of the step. (108).

These lines are disturbing to the viewer. They are referred to as "contour" lines because of their resemblance to height contours of geological maps. For these contours to be undetectable using uniform digital steps, 8 bits or 256 grey levels have been found to be necessary. The ninth bit referred to is required for color.

In converting to digital modulation for channel conservation, two areas must therefore be considered, one counteracting the damaging effect of digital quantization, the other eliminating as much redundancy and unnecessary information as possible.

The deficiency due to quantization can largely be eliminated by making the steps very small in the areas of the picture where the intensity changes little from picture element to picture element (pel to pel), and compensating for this by making the steps large where the changes are large. (109) While the eye-brain combination is very sensitive to small changes in intensity level, it is inaccurate in assessing large changes. As a result the sense of sharpness is little affected by errors where the changes are large, and is affected only when the changes are small.

An effective technique for implementing these characteristics of the eye-brain combination is called differential pulse code modulation (DPCM). Instead of a sequence of pulses defining the intensity level of each pel, the sequence defines the difference in intensity between adjacent pels in a horizontal scan line. In a picture the changes in intensity from pel to pel as a line is scanned are generally small, only occasionally are they large and seldom do they extend over the full range of the extremes of black and white within the space of two adjacent pels. In fact, if occasionally in a picture the change in intensity is sufficiently large that it requires two or even three such spaces instead of one, no reduction in observed sharpness would be noticeable provided the change in the first space is a substantial percentage of the total change.

Taking account of all these factors leads logically to making the steps of different size. When the difference in intensity between adjacent pels is small, the steps are small with the smallest step small enough that contour lines will not be noticeable. The steps are made larger in some practical relation to the difference between adjacent pels up to the point that the possible error in intensity which may occur becomes noticeable. Thus, the variable step technique overcomes the contour problem that DPCM would otherwise have. In addition, DPCM itself has a capability of reducing without loss of sharpness a certain type of redundancy. This redundancy exists because there are many substantial areas in a picture, areas comprising many

pels, which are of uniform intensity. To transmit the intensity of each pel in those areas is clearly unnecessary. The same is true to a less degree in areas where changes in intensity are small. DPCM reduces this type of redundancy because it transmits only the difference in intensity between adjacent pels. (107) The technique presented some technical difficulties which seem to have been largely overcome. (109, 110)

By this means, variable level DPCM can reduce the nine bits per pel required to carry the picture outline and the color, the luminance and the chrominance, and to overcome the contour defect by reducing this type of redundancy to 4 bits.* To produce a television signal of today's average quality which requires a 50 MHz bandwidth with PCM, requires therefore only about 25 MHz bandwidth with DPCM.

As previously mentioned, digital operation has the additional characteristic that nearly all the noise introduced in the system after the analog signal has been converted to it, can readily be removed at all points of the system where a circuit can be introduced to regenerate a clean stream of pulses. The effect of noise will be to produce some errors, some pulses will be present that were not and some absent that were. The error rate can generally be kept down to

*To achieve 4 bits/pel for color TV requires the addition of certain improving techniques such as described by J. E. Thomson in his paper on "Predictive Coding of Composite PAL & NTSC Signals" published in the Record of the International Conference for Communication 1973. p. 48.

an acceptable amount by never allowing the signal-to-noise ratio at any point in the system to drop below a certain level. Digital operation is not, therefore, generally needed for transmission over distances short enough for analog to be transmitted effectively. It is interesting to note, however, that the British Broadcasting Company, troubled by interactions between the many cables that carry television to their studios, in its large studio complex is reported to be applying Digital operation to remove the distortions they introduce. The advent of the fiber optics with its complete freedom from interactions is likely to soon supersede the use of the present type of cable in order to eliminate the types of problems that the British Broadcasting Company faces in the studios.

An important aspect of this capability of PCM is that it permits a trade-off between bandwidth and signal-to-noise ratio (SNR). The process is as follows: The conversion from analog to digital is commonly made by sampling the analog waveform at a rate equal to three times the color subcarrier frequency. Each sample is coded into a sequence of equal height equally spaced pulses that defines its amplitude. Suppose, for instance, that the SNR is 25 dB (voltage ratio of 18). Each pulse could operate with negligible loss of information with an SNR of 15 dB (voltage ratio of 6), or one third of the voltage ratio. The 10 dB of signal that can be spared can be turned into bits of information, in fact into 1.6 bits corresponding to three amplitude levels ($2^{1.6} = 3$). To develop this information, each pulse is transmitted in one of three amplitude levels, each one of which has a meaning. These

three levels form an additional code. They can therefore be used to divide the previously required bandwidth of 25 MHz by 1.6, and make the new requirements 15 MHz.*

The process that has been described is within the state of the art. When attacking additional means of reducing redundancy, we enter an area of technology which is in the process of emerging in the laboratory.

One principle used is based on the difference in resolution required for portions of the scene that are stationary and those that are in motion. Those that are stationary need high resolution but do not have to be brought up to date with each frame. Those that are moving must be brought up to date with each frame, but do not need high resolution. Both conditions are clearly just right to reduce the information transmitted without reducing the quality or clarity of the communication. Its application is independent of the amount of motion that exists in the picture; it is just as effective whether nearly all the picture elements are changing or are stationary as it does when the camera pans the scene or the magnification is changed by zooming. The principle requires memorizing the pels of the last frame so that they can be compared to the pels of the new frame to check which ones have changed.

*The trade-off of bandwidth for signal-to-noise ratio can be achieved in several ways. That described involves using several levels of amplitudes. It can also be carried out when a pulse is distinguished by a frequency or phase shift [Frequency shift keying (FSK) or phase shift keying (PSK)]; the frequency and phase shifts can be divided into a number of levels. The type of modulation which appears most satisfactory is PSK usually with four phases, but usable also with 8 or 16.

In an implementation of this principle only every other pel in each frame is transmitted, thus reducing the bandwidth in half. (109, 111)

The missing pels are replaced in accordance with one of two modes, depending on whether that part of the picture is in rapid motion or not. If in rapid motion, the missing pels are replaced by the average of the two adjacent pels in the same scan line; if stationary or moving slowly, the missing pels are replaced by the corresponding pels in the previous frame. The criterion for deciding which mode to use is the difference in the intensity of each of the pels adjacent to a missing pel with the corresponding pel of the previous frame. The principle has been demonstrated. It was found to require 1.5 bits per pel. It has been extended to require $3/4$ of a bit per pel. (112).

The need for a memory of the size of a frame presents a practical problem, for such a memory is costly. This high cost is likely to be overcome by the application of the recently developed charge coupled and charge injection devices.

A variety of techniques generally having smaller effect than the above are under study. It includes a technique which can be used to improve the appearance of the picture or alternatively to reduce the number sampling pulses by shifting half a sample space in the horizontal direction from field to field. A report from the German Post Office (113) indicates reduction in sample rate of 25%. The technique is based on the fact that both the luminance and chrominance signals have peaks with frequency separation equal to the line frequency. Filtering out the

signal between peaks produces no noticeable degradation of the picture. The luminance and chrominance can therefore be interleaved and separated by comb filters. By so doing it is found that the sample rate can be decreased. Golding and Garlon (114). decreased it to 6 MHz from 10 MHz -- a ratio of 0.6. In Appendix C the technique for reducing the television bandwidth by psuedo-random scanning has been described. A next step in the development of this field is likely to be the application of the research carried out on digital modulation to the psuedo-random scanning technique.

APPENDIX E

PERSONS CONTACTED

The following persons other than of the FCC staff have been contacted by personal visits or by telephone, and have provided valuable information. Each is listed under the subject heading to which his information was most closely related.

Cameras

Channel Conservation

Computer-generated Displays

Displays -- Flat and Large Screens

Educational Applications

Electronic Circuitry and Hardware

Graphics and Text

Medical Application

Miscellaneous

Multidimensional Scaling

Picture Quality -- Characteristics

Programs -- Direction/Technical

Resolution -- More Than 525 Lines

Satellite Communication

Video Tapes

Wide Band Service -- Rural and Urban

Cameras

King, Dr. Donald, President, Philips Laboratory, Briarcliffe, N. Y.
Levitt, Ralph, Amperex, Project Manager, A Electronic Corporation
Schade, Dr. Otto, formerly RCA, Consultant RCA Electron Tube Division
Wolthers, Walter, Philips Broadcast Equipment Company

Channel Conservation

Golding, Leonard S., Branch Manager, Communication Theory Branch, Comsat
Labs
Heiges, Lynwood, Comsat Labs
Limb, John, Head, Visual Communications Research Dept., Bell, Holmdel, N.J.

Computer-generated Displays

Johnson, Mel, General Electric Company, Daytona Beach, Florida
Rosenfeld, Dr., Professor, Computer Sciences, University of Maryland

Displays -- Flat and Large Screens

Biberman, Dr. Lucien, Institute for Defense Analysis
Brody, Dr. T.P., Manager Thin Film Devices, Research & Development Center,
Westinghouse Electric Corp., Pittsburg, Pa.
Good, Dr. William, General Electric Co., Syracuse, N. Y.
Haase, A.C., General Electric Company, Syracuse, N. Y.
Kloss, Henry, Advent Company, Cambridge, Massachusetts

Educational Applications

Bitzer, Dr. Donald, Director, Computer Based Educational Research Labora-
tory, University of Illinois
Bunderson, Dr. Victor, Brigham Young University, Utah
Burr, M.E., Mitre Corporation, McLean, Virginia
Dewire, Kenneth, Health, Education and Welfare
McAnany, Dr. Emil, Stanford University
Naben, Michael, Health, Education and Welfare, Washington, D. C.
Schramm, Dr. Wilbur, Stanford University
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Electronic Circuitry and Hardware

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Graphics and Text

Biderman, Daniel, Bureau of Social Science Research, Washington, D. C.
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Green, Dr. Robert, IBM Labs, Gaithersburg, Md.
Kellog, Dr. Donald, IBM Labs, Yorktown Heights, New York
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Shank, Dr. Russel, Director of Library, Smithsonian Institute, Wash., D.C.
Tomkin, Dr. Howard, Director Computer Services Dept., Indiana University
Wallace, Dr. Curtis, Ampex Corpoeation, Redwood City, California
Zurkowski, Paul, Director, Information Industries Association, Bethesda, Md.

Medical Application

Abrams, Dr. Herbert, Obstetrics and Gynecology, Havard Medical School
Benshuter, Mrs. Reba, Director, Biomedical Communication, University of
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Bird, Dr. Kenneth, Radiologist, Massachusetts General Hospital
Feiner, Albert, Director, Lister Hill National Center for Biomedical Com-
munications
Felson, Dr. Benjamin, Radiologist, Professor of Radiology at Cincinnati
General Hospital
Kranin, Mr. Stanley, Manager, Program Development, CBS Laboratories
Kundel, Dr. Harold, Radiologist, Temple University Medical School
Mark, Dr. Roger G., Associate Professor Internal Medicine, Massachusetts
Institute of Technology
Murphy, Dr. Raymond L. H., Assistant Clinical Professor of Occupational
Medicine, Harvard Medical School
Pace, Dr. William G., Professor of Surgery, Ohio State University Hospital
Ruchoff, Dr. Maxine, Mathermatician, Chief, Logistics Unit, Health Care
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Miscellaneous

Bartlett, George, Vice President, National Association of Broadcasters
 Cahan, Paul, National Communication System, Washington, D. C.
 Enzer, Selwyn, Institute for the Future, Menlo Park, California
 Head, Howard T., Senior Partner, A. D. Ring Associates
 Meadows, Jeffries, British Broadcasting Company, New York, N. Y.
 Messerschmidt, John, Communication Division, U.S. Department of Commerce
 Mrozinski, R. V., Executive Secretary Telecommunication Committee,
 National Academy of Engineering
 Polishuck, Paul, U. S. Department of Commerce
 Vrentos, M. J., Post Office, Washington, D. C.

Multidimensional Scaling

Carroll, Dr. Douglas, Technical Staff, Bell Telephone Labs, Murray Hill, N.J.
 Green, Dr. Paul, University of Pennsylvania, Philadelphia, Pa.
 McDermott, Barbara, Bell Telephone Labs, N. J.
 Trapka, Eugene, Eastman Kodak Labs

Picture Quality -- Characteristics

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 DeMarsh, Leroy, Eastman Kodak Labs, Rochester, N. Y.
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 Herold, Edward, RCA Labs, Princeton, N. J.
 Higgins, George C., Associate Head Physics Dept., Eastman Kodak Labs.
 Myers, Charles, Eastman Kodak Labs, Rochester, N. Y.
 Nelson, Clarence N., Eastman Kodak Labs, Rochester, N. Y.
 Nicholson, Reuben S., Eastman Kodak Labs, Rochester, N. Y.
 Simons, Dr. Norwood L., Assistant Vice President in Charge of Motion
 Picture and Education Market, Eastman Kodak, Rochester, N. Y.
 Taylor, Archer S., Malarkey, Taylor and Associates
 Yellin, Dr. Herman, Senior Electronic Engineer, Perkin-Elmer Corp.
 Zwick, Daniel, Eastman Kodak Labs, Rochester, N. Y.

Programs -- Direction/Technical

Barbera, Joseph, President, Hanna Barbera Productions, Inc.
Detmers, Frederic, Technicolor Corporation
Gibault, Robert, Walt Disney Enterprises (Studios)
Vlahos, Petro, The motion Picture and Television Research Center of AMPTP
Wilton, R. Holm, Vice President Association of Motion Pictures and
Television Producers, Inc.

Resolution -- More Than 525 Lines

Blair, Lewis R., U. S. Army
Egbert, John, Federal Aviation Administration
Fink, Donald, Director, IEEE
Fouse, George, AF Wright-Paterson Field, Dayton, Ohio
Franseen, Richard, U. S. Army, Ft. Belvoir
Silverstein, Harold, Asst. Chief of Staff for Communications and
Electronics, U. S. Army

Satellite Communication

Marsten, Richard, Director Communication Programs, NASA
Metzger, Sidney, Chief Scientist, Technical Department, Gomsat

Video Tapes

Bluth, Joseph, President, Vidtronics Corp., California
Ringer, Robert, Image Transform, California

Wide Band Service -- Rural and Urban

Baer, Walter, Rand Corporation, California
Behringer, Joseph, President, Theta-Com Corp., California
Fellman, Nathaniel, Rand Corp., California
Hibner, Dr. Cal, HUD
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Schlafly, Hubert, Senior Vice President Teleprompter, New York
Sonnerschein, Abrams, Theta-Com Corp., California
Stern, Joseph, Vice President Engineering, Goldmark Communications, Conn.

APPENDIX F

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OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON

satellite → UHF translator ?

① OTP Study of Video Technologies

② Dr. Wilmotte's study for FCC

③ RAND study of the Future of TV

④ OTP Ancillary Signalling study (Denver Research Inst.)

⑤ Pay-TV study by OTP (Stanford Res. Inst.)

⑥ Roger Salaman

303-499-1000

X-4205

⑦ Paul Bortz - DRI ←

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OTP rural TV study.

World Telecom Study

Ed Grothorn

Cliff Bean 617-864-5770.

L.L. Bean 617-864-5769

OCE REPORT

December

74

OFFICE OF CHIEF ENGINEER

FEDERAL COMMUNICATIONS COMMISSION

Technological Boundaries of Television

VOLUME

1

Findings &
Recommendations



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Raymond E. Spence
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Dear Mr. Spence:

I am pleased to submit herewith the study report on the Technological Boundaries of Television.

The report has been based on information collected over a period of two years. In this period a surprising amount of the emerging technology has become visible. There has appeared in the laboratory and in pilot operations prior to practical implementation a solid state, high-resolution television camera; a practical pseudo-random scanning sequence reducing the television bandwidth to a fraction of that presently required; point-to-point communication by cable with fantastic bandwidths, (up to 70 GHz); advances in research bringing some flat screen displays into the development stage; the transmission simultaneously with a television program of a large amount of data, announcements, news, and stills as a service to home and office.

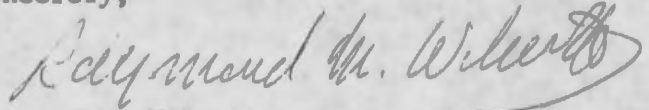
It has been possible to gain a fair overview of what the television technology may be able to provide in the next decade, which would not have been possible two years ago. Nor would it have been possible to present the Eastman Kodak's simulated pictures in Volume II of what television displays might be in the future compared with what they are today.

Important contributions to this report have been made by Eastman Kodak. That company devoted considerable effort to applying its long experience in measuring the perception of the quality of photographs to the quality of television displays.

In the process a great deal has been learned in the field of psychological dimensions or subjective judgments, and their quantitative measurement. It is a field that has made great strides in the last decade, is growing in importance and is almost unknown to the engineering community. Contributors to this learning have been Eastman Kodak and the Bell Telephone Laboratories, a leader in the advanced area known as "Multidimensional Scaling".

I believe that the overview of the emerging television technology of this report will help the Federal Communications Commission guide the commercial introduction of the coming increase in scope of television systems and components in the service of the public.

Sincerely,

A handwritten signature in cursive script that reads "Raymond M. Wilmotte". The signature is written in dark ink and is positioned to the right of the typed name.

Raymond M. Wilmotte

TECHNOLOGICAL BOUNDARIES
OF TELEVISION

PREPARED FOR
THE FEDERAL COMMUNICATIONS COMMISSION

By Raymond M. Wilmotte
Consultant

November 1974

TECHNOLOGICAL BOUNDARIES

OF TELEVISION

VOLUME I

STUDY OF THE NATIONAL OUTLOOK FOR THE
QUALITY OF TELEVISION DISPLAYS

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- 2.0 THE TECHNOLOGICAL BOUNDARIES OF TELEVISION
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625-line Station Monitor
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TECHNOLOGICAL BOUNDARIES
OF TELEVISION

VOLUME I

PART I

OVERVIEW AND RECOMMENDATIONS

PART I

1.0 TELEVISION EXPECTATIONS

The purpose of this report is to seek an answer to the question: What can be our expectation of television technology and its implementation within the next decade? Much, of course, depends on the economics of the Western world, but assuming that economic conditions and processes are not drastically different from what they have been in the past, we can expect the technology to advance rapidly on nearly all the television fronts. At the production end, we can expect the camera to be smaller, more reliable, less costly and able to be designed for 1,000 scan lines, possibly more; the transmitter completely automatic, also small, more reliable, and less costly, self-operating and able to send an SOS signal in case of defective operation; without interrupting his program or being noticed by the viewers, a television broadcaster can send a message, a chart, or a picture which a viewer having the necessary equipment can "snatch" for viewing or studying it on his television screen for as long as he desires (equivalent of up to 96,000 words); the bandwidth requirement possibly dropping radically as much as one tenth of present requirement; the bandwidth for long distance transmission from studio to television stations becoming practically unlimited; large, flat screens displaying high resolution pictures at a price, probably well within the capability of the high middle class home; and finally, the television disc with its low production cost for home use.

These advances are not visionary blue-sky concepts, they have all at least reached an advanced stage in the laboratory, some have reached the stage of a planned pilot operation.

Of these advances, the one which is likely to have the greatest impact on the application of television and the allocation of spectrum space to it, is bandwidth compression. The first step has been a reduction to a quarter of the present broadcast television bandwidth. Its inventor, Robert Stone, and sponsor General Electric, suggest its application to institutional needs, not to entertainment because of certain impairments of picture quality. However, the invention has been developed up to the present with relatively little funds and many of the ideas for the improvements, application, and full understanding of the concept it engenders have yet to be studied in depth. In my opinion, I would be surprised if the present impairment were not reduced to the point of being barely noticeable for practically all types of scenes. I would be further surprised if the bandwidth could not be compressed to somewhere between one-tenth and one-twentieth of the present broadcast bandwidth for a sharpness of picture equal to that of present television broadcast. Advances along these lines would open the door to the production of systems with large screens of considerable sharpness. I make this prediction in spite of the conservation opinion of its sponsors, for past experience indicates that engineers, par-

ticularly good engineers, being very much aware of the technical problems involved in improving an existing component, are poor judges of the probability of the emergence of techniques yet to be discovered. Many authors of science fiction have proved more reliable in predicting the future than the professionals.

Whether my prediction comes about or not, the results already achieved are sufficient warning that technology can provide much spectrum space than had been expected, in fact, it may be possible to make available adequate spectrum space for a long time to come. If society is to benefit from television bandwidth compression, dialogues should be started on the social and economic steps for introducing the technique as smoothly and effectively as possible.

There are special pitfalls on the way tied to the glamour aspect of television. The first deals with the availability of entertainment programs. By this time, we have learned that good programs are scarce and very costly. It is not always realized that effective programming represents a greater problem - economically and administratively - than obtaining a license and the equipment for their delivery.

In spite of these high costs, mass audiences seem to be well served, but smaller groups seeking more specialized fare find not enough of it. Other forms of television, less costly in bandwidth may make such specialized programs economically possible. Expansion of the scope of programs appears to be badly needed by the program production industry of Hollywood. Much unrecognized talent would probably emerge out of the university campuses.

The second glamour pitfall arises when television is an option among others to provide a certain service. The charisma of television broadcasting tends to bias the assessment of the options in favor of television, leading to its selection over possibly less costly alternatives. The danger of a wrong selection is particularly great when the assessment of the benefits is more a matter of opinion than of fact. In some of these cases, possibly in many, recent advances in psychometrics -- quantitative measurement of the perception of individuals -- may be called effectively into play. They certainly can prove practical quantitative data on the subjective judgment of the quality of pictures and may be applicable to the judgment of the relative usefulness of various applications.

These two pitfalls may lose much of their importance if the bandwidth of television is drastically reduced. The emergence of the practical implementation and delivery to the public of these advances will depend on two factors - the economic status of the nation and the actions of the FCC in view of its responsibilities and authority to

- 3 -

develop efficient use of the spectrum, to stimulate the evolution of telecommunication and to overview a fair delivery of the services television can render to society. Industry tends to seek FCC action to meet its immediate needs. The great technical strides that can be expected in television will require that more attention be given to future conditions and new alternatives of television delivery than has seemed necessary in the past.

2.0 THE TECHNOLOGICAL BOUNDARIES OF TELEVISION

In connection with a broad overview of the future of television, there was found no disagreement to the prediction, though intuitive, that communication through pictures is likely to become increasingly important. It is undoubtedly a coincidence, but an interesting one, that the ratio 1200 to 1 of the bandwidths for television and for voice closely confirms the much quoted Confucian proverb "a picture is worth a thousand words."

Telecommunication, particularly television, is certain to be a major force on the way men think and learn to think. The economic, technical and administrative structure for the delivery of television, developed under the joint effort of Government and industry, can therefore be expected to have a primary influence on the way society will change. There lies a great responsibility and a great opportunity, for in effect it is the basic structure of the overall system that defines the type of audience, the type of program content and the type of picture quality. * Today's structure of television broadcasting has been a phenomenal success with 60 million homes averaging at least five hours of viewing a day. It seems ideal for mass audiences. Tomorrow, it may be possible to add to this service by providing for other types of audiences and other types of services.

THE IMPORTANCE OF QUALITY

Inevitably in the entertainment area controversy waxes uninterruptedly on program content between the demand of the market place for mass entertainment and the search for literary, artistic and intellectual satisfaction to minority audiences. In some way both demands need to be met. The expectation is that these minority interests will gradually broaden the scope of programs. What would be the import of improved picture quality on these two types of audiences?

* Wilhelmsen and Bret, 1/, cite Spain as an example of a nation that ignored the possibilities and threats of television and allowed introduction of programming foreign to its culture. The Spanish have been exposed to a different culture and life-style in the form of stoic American Westerns, trivial situation comedies, and the slick presentation of news and advertising in the French and American style. The broadcasters, programmers, and technicians were men basically out of sympathy for the Franco Government, which now lost the battle for the minds of the sons of the Nationalist Armies of 1936.

High quality of display could well become a status symbol in certain groups if the improvement is significant enough, much as high fidelity did for music.

The question then arises what is needed technically to make a significant difference in quality and how to decide what is a significant improvement?

This report provides two specific answers to this question.

First, simulated pictures of various degrees of quality, prepared by Eastman Kodak, are shown in Volume II of this report and the reader can judge for himself whether the differences in quality presented are significant. Second, there is now available a technique which makes it possible to measure quantitatively an individual's judgment of quality. These measurements can be made with considerable accuracy. This technique is described in Appendix B.

The quality of TV pictures is commonly prepared with that of photographs, sharpness being the characteristic commonly used. The sharpness of the average home TV is about the same as that of super 8 film, a station monitor approaches the 16 mm film and an 1100-line station, if one were available, would be very good indeed, but still not quite perfect and would not quite reach the sharpness of the 35 mm film. Minor improvement of the official broadcasting standards neither at home nor abroad would produce much more than a barely visible effect on picture quality, obtainable with a good receiver. The effect of doubling the number of scan lines would make a difference very noticeable to some, not very significant to others. Generally speaking the quality obtainable today on a good television set can be considered as very good. It is indeed surprising that the complex standards established over twenty years ago were so good, that in this age of rapid technological advance, no truly significant improvements have been found. It is indeed a tribute to the band of wise and competent men who developed them.

Sufficient degradation in quality is mainly due to deficiencies in operation and equipment. In the home, and particularly in many schools the quality left much to be desired. The sets were often not easy to adjust. The settings might drift and the broadcast stations adjusted their transmissions differently making it theoretically desirable, but practically a burden for the viewer to readjust the controls as he switched from one station to another. There has been significant progress in all these respects during the last two years, and further improvements are on the way. We feel that television quality has reached a high and completely satisfactory level for the size of screen currently found in the home.

Two areas of technology that might improve the displayed television picture are the automatic transmitter and the Vertical Interval Reference (VIR) signal. The automatic transmitter will result in hands-off operation, and will signal any straying from modulation or frequency parameters by means of an alarm. An alternative is to have the transmitter correct itself automatically. 2/ The VIR is a reference signal inserted in an unused interval in the television transmission and is intended to reduce undesirable variations in color throughout the television system. 3/ It could provide one input to the automatic transmitter, but may eventually be used at the receiver itself.

In the search for information to make projections on changes likely to take place in television displays, several producers of television programs were interviewed. The television system is the communications channel between the director of a program and the viewer whether for entertainment or other purposes. Goals should therefore initially focus on what the director needs to convey his thoughts and his views, and what the viewer needs to understand and appreciate them. The director needs the freedom of choice to convey the scene he has in mind, not only to focus on the action but he may also want to depict the environment in which the action takes place, for indeed that is what a picture can do easily, and what words do only with great difficulty. What is needed to provide this freedom?

An effort to obtain some kind of answer to this question by discussions with persons associated with producing programs developed no useful information. The response was uniformly that the director's thoughts concentrate on how to use the system as it exists, not how he would like to see it modified. The study has therefore been unable to contribute to this very important aspect in the formulation of television goals. Discussion of this question with a variety of viewers led to the conclusion that the improvement most likely to have a substantial impact on the view is a television screen that can carry an enlarged view of a scene, enlarged from the simple "window" that Allen Dumont visualized in the early days of television, to the "picture window" that it might become. Such broadened potential of the medium might bring out a wider range of production techniques and provide more opportunity for truly great talent to stand out and flourish, and for news and sports to give a broader sense of scene and action.

While the study has not been successful in establishing the needs of the director, it has had more success with techniques for assessing the needs of the viewer for picture quality. Specific answers have not been obtained, but the way they can be obtained has been uncovered. The quantitative assessment of the judgment of the viewer, substantially free from controversial personal opinions, seems close at hand. Nearly everyone is surprised, sometimes to the extent of finding it unbelievable, at

the advances that have been made in the quantitative measurement of human perception. An example will give an idea of what the most advanced technique -- multidimensional scaling technique --- is able to do. An observer is presented with a dozen or so stimuli -- pictures, for instance -- two pairs at a time and asked to state which of the two pairs is the more different. Nearly everyone feels that anybody can make such a judgment reliably. This information is fed to a computer and the following answer comes out: "You based your judgment on three principal dimensions. You weighted these dimensions in the ratio of 2.6 to 5.7 to 11.3. These numbers are probably accurate to better than $\pm 5\%$ ". The science within which these measurements fall is known as psychometrics. It is a science known only to a few psychologists who specialize in it and almost totally unknown to anyone else, including engineers and scientists. In Appendix A, a brief introduction is given to the principal characteristics of the eye-brain complex as it relates to the quality of pictures, in both the subjective terms of the viewer and the technical ones of the technologist. The eye-brain complex is a truly remarkable system, the characteristics of which are well worth understanding. The psychometric technique, or rather family of techniques, able to quantify human perception, is briefly described in Appendix B. For significant improvement of TV quality one must look for something substantially different from current operations. Two areas of improvement present themselves -- a screen measured in feet rather than inches and a drastic reduction in bandwidth. The early beginnings of both appeared on the market during the last year.

THE LARGE SCREEN

The big screen, 4 ft. x 6 ft., as it exists today, is a projection of the 525 line picture priced at \$2700, which for the first time puts it within reach of some homes and small audiences suitable for bars and the like. Prior to this development professional projection systems ran in the \$50,000 range and above. Nearly everyone prefers a large screen to a small one even when the angle of view remains the same. It is an odd preference characteristic, but a very real one. A large screen could have another psychological value. A large screen would permit the viewer to see at one time the whole of a sports arena, such as a football or baseball field. If he came close enough to the screen, he would barely be aware of the edges of the picture, as he is with today's television; his peripheral vision could then give him the impression of being part of the scene itself rather than an outside observer. The effect can be surprisingly impressive as many visitors to Disneyland's Circarama have observed. The impression which a large screen may produce in a living room is shown by photographs in Volume II.

With large screens the desirability of more scan lines than 525 will become more evident particularly if the large screen is to provide a wide angle of view. Technology is showing considerable promise to be able to provide this evolution if called upon to produce it -- not today but not many years from now. Well advanced in the laboratory is a television camera technology likely to produce 1000 scan lines at regular television readout rates. There is also the emergence of flat screen displays with each picture element controlled by its individual circuit. Some display panels of 100x100 elements have been operated in the laboratory. It is still a long way from a wide screen of dimensions 2 1/2x 5 feet, say, with 500,000 picture elements; it is probably well within the potential of technology to produce such a display in the future.

BANDWIDTH REDUCTION

Reduction in television bandwidth has been in the laboratory for many years, based on converting a scanned picture into digital form, processing the digits and converting back to the normal analog form at the receiver. Great bandwidth reduction has been obtained in the laboratory. Recently a different approach has emerged which does not need such transformation. It replaces the usual scanning process by a pseudo-random one. Practical designs have reduced the bandwidth to 1 MHz, or a quarter of the regular broadcast bandwidth. The picture produced has the same resolution as regular television with 525 lines but suffers from having a pattern visible in the background. It is noticeable at first, but after a while the viewer is no longer conscious of it, very much as one becomes no longer conscious of the visible scan lines in a regular television display. However, because of the background pattern, the developers of the system are not presenting it for entertainment except where transmission cost of the normal wide band is unusually high. Improvements may be expected, possibly putting it in a competitive position for entertainment. The probability for major improvement is very good, besides that of reducing the background effect, in that, the bandwidth can probably be reduced further. The theoretical limit with the pseudo-random sequence now used is one fifteenth or 300 kHz. If a process could improve it to that extent a new and major problem would face the FCC as to how to take full advantage of this advance in view of the existing huge investment in television broadcast frequency bands.

OTHER EMERGING TECHNICAL ADVANCES

The advent of the concept of narrow band pseudo-random scanning may well stimulate new thinking in the application of television for other areas than entertainment, such as closed circuits, surveyance, education and a wide range of commercial uses. In considering such applications the limitation of television should be realized, for its glamour often carries sellers and users beyond the range of economic wisdom. As a means of communicating information, it is generally one of the most inefficient and costly methods ever devised by man, for it is not only



Mainly
WET in
West

DRY in
East

WARMER in
South

FIG. 1

A DISPLAY OF GRAPHICS WITH ALPHANUMERICS

very redundant but it also usually carries a lot of useless information. Its value often lies in its psychological effect. That, of course, is the reason for its glamour but that effect may be of limited duration. It is also uniquely effective for conveying something of such complexity that words are not adequate and also to recognize an object whose location and exact shape are only approximately known. For surveying an area, for instance, television has no equal.

One of the most important advances in recent years has been in cable technology, with cables able to carry 40 or more standard television channels; in the laboratory there is rapidly evolving a new type of cable; a glass fiber not more than a few ten thousandths of an inch in diameter, potentially able to carry a wider band than any electrical cable. Cable TV has appeared as an alternative mode to broadcasting for delivery television programs to the home. Out of it has arisen the concept of the wired city, with a large majority of homes and businesses connected by wide band cables to centers and subcenters providing all kinds of TV and other services. But the concept is a long way off in time and would require an enormous investment. The advantages and limitations of wide band is likely to lead this new industry into paths very different from those of TV broadcasting. In the appropriate environment it will tend to focus on those areas of programs and other television services not presently satisfied, but not without competition. It has hanging over it two possible competitors for special services -- the unglamorous telephone line and the regular TV broadcast system. The regular telephone service could readily be adapted to provide such services as reading meters and requires no addition to make it two-way.

An alternative method of delivering information via broadcast television is still pictures of text or graphic material. One device to accomplish this is called a "frame grabber", that is a device to extract still picture information from the television transmission. The "grabbed" frame can be from the viewable picture on the TV screen or built up from information sent in a blank interval in the picture transmission process.

The British are furthest along in developing a system called (CEEFAX/ORACLE) that uses the blank interval, while the Japanese and mitre in this country are working on "frame grabbers." CEEFAX/ORACLE puts a "page" of some 120 words into each frame and can build up a "magazine" of 100 pages every 15 seconds. Up to eight of these 100 page magazines can be carried on each TV channel. 4 /

This volume of information, a possible 96,000 words per channel each two minute period, is the equivalent to 21 full sized newspaper pages. An example of one sort of "graphic-plus-text" information that would be carried is shown in the digitalized weather map of the British Isles in Figure 1.

The cost of the two systems is uncertain at this time and is probably dependent upon development of integrated circuitry and image-storing devices. Mitre has estimated an eventual level of \$100 per unit in volume production, and BBC assumes an additional \$125 per set for CEEFAX.

Although video tape recording (VTR) has been a commercial reality for some years it has not yet become a consumer item. There are a number of firms -- primarily Japanese -- producing both the Sony U-Matic 3/4" tape cassette system and the Electronic Industries Association of Japan's 1/2" cartridge system. Added to the confusion are one-inch systems, 1/4" systems, and systems using 8 mm film. The drawbacks are the expense (\$2,000 up) of the VTR systems, and the number of mutually incompatible systems on the market. 5/

Standing in the wings, waiting for the economy to justify a new consumer product in the \$500 category, are television disc recordings. The two prime systems are RCA's mechanical pick up similar to a phonograph and the joint Phillips-MCA laser play-back system. Each system offers about 30 minutes of play-back for each disc, each disc probably costing around \$2-\$10.

The timetable, barring economic consideration, calls for production of the disc systems in late 1975 or early 1976, whether the two prime systems are then compatible or not. 6/ MCA says they have more than 11,000 movie and TV titles available and at least one cigarette company has considered publicly the idea of giving away 10-minute entertainment discs containing commercials. 7/

SPECTRUM SPACE USED IN PROGRAM DELIVERY

Technical advances have also been made in the delivery of programs from the studio to the broadcast station or head of a TV cable operation. The bandwidth which microwave relays can carry has been greatly increased and communication satellites are planned for the delivery of television programs. Both of these take up spectrum space and interfere with each other; satellites are severely limited in power in order to protect ground microwave relays from interference. These modes of transmission are being developed because at this time they cost less than cable. Much spectrum space is used up in telecommunication of all kinds not because it is the only way, but because it is the more economical way. This condition typifies the process by which a scarcity of frequencies becomes apparent.

The picture of scarcity of frequencies should be viewed in its correct perspective. Contrary to the impression created by the continuous struggle for frequencies, for the reduction of interference, and general statements and articles on the shortage of spectrum space, the fact is that technology has kept well ahead of the demand. Overall there is no scarcity. In certain bands there is the appearance of congestion, in many others there seems to be little activity much of the time. The cause of the struggle is not so much a struggle for frequencies per se, as a struggle by each type of service, by each operator of a service for the most economical form of operation. At some frequencies a services can be delivered better and at less cost than at others; with some systems the operation may be better, the cost less but the spectrum may be less efficiently used.

The individual operator generally has little choice, and to him the spectrum often appears crowded. Only the Federal Communications Commission can relieve the congestion of an area of the spectrum or the unsatisfied needs of a service. The assignment of a frequency band to a service opens the opportunity for developing that service for government purposes or for profit. After the opportunity has been provided, forces develop which make it difficult to withdraw it. The tendency is for spectrum allocation to become more and more rigid. If assignment rules are changed, it is usually for the purpose of increasing the number of stations providing the same kind of service, rather than freeing some of the spectrum for another kind of service. Such changes are usually initiated by would-be operators and tend therefore to be more for the benefit of these operators than the public; they may often merely provide additional service where adequate service may already exist.

As the number of stations increases the allocation process loses flexibility, the benefits of improved and new technology become more and more difficult to introduce even when it could significantly improve the efficient use of the spectrum. The FCC has provided flexibility by leaving certain portions of the spectrum partially vacant. But the pressure is continually growing to use up such space for a current need on the basis of today's technology, with only secondary consideration of tomorrow's. Television is particularly vulnerable today because the time lag for implementing and introducing many of the technical advances described is considerable -- ten years or more perhaps. In addition, risk capital is scarce in the present financial atmosphere of the nation. There is a business situation, however, which is likely to help stimulate the implementation of new technology. The television industry sees its principal market approaching saturation in spite of its high size. Industry is likely to develop a special interest in markets which new

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products and techniques may open, concepts such as CEEFAX competing with existing new media and video disc recordings with the specialty programming of cable and broadcast television. These conditions make it particularly important to look as far and as deeply as possible into the future.

The work of the decision-maker whether in government or industry is becoming much more difficult. As he looks back, he will perhaps recall the time when there was only one way to broadcast, only one obvious way to convey information over long distances from one point to another, only one way -- the mails -- to transmit written material. He may recall the time when the difference between telegraph, voice, and television was clear and simple to understand and generally accepted. There are now many ways to do one thing, things once separate now interact in complex patterns, and little of all this remains still for very long. It is no longer possible to regulate a telecommunication service or a part of the spectrum without affecting other services. And as decisions become more difficult their economic implications and long range social consequences grow in importance and visibility.

Things have changed, new opportunities have opened up too fast perhaps for us to understand what they mean. But the opportunities are there to do a great job for society, and, with them, more opportunities also to make mistakes. Stangely it is technology which has made planning and decisions difficult by providing many ways of achieving a desired result without explaining how to unravel the complexities it has introduced.

Television has proved itself to be the most effective communicator yet developed, able to gain the attention of mass and limited audiences with evident results. In the expansion about to come, television will assuredly play a major role, - a role which will depend on what is envisioned and planned today for its future -- its availability, the quality, variety and range of its programs, and the quality of its pictures. Pictures not only contain factual data, they also influence the psychological environment.

3.0 RECOMMENDATIONS

Each of the following recommendations is supported by a section entitled "Justification". These sections represent also a summary of Part II of the report.

The recommendations deal with the principal elements that affect television display, focusing on the importance from the public's point of view, and including consideration of incentive for operators to provide the service.

Television quality has been interpreted broadly to cover the whole technical system. Quality is viewed as the quality of the whole system. For that reason, the whole system has been considered from the director of the program to the viewer through reception and display.

The problem of frequency allocation has not been considered because it involves the basic question of the relative importance of different services, which is beyond the scope of the study.

3.1 PRELIMINARY PREPARATION FOR THE IMPACT OF TECHNOLOGICAL ADVANCES IN TELEVISION

Recommendations

The following studies are recommended for the purpose of developing indicators of future needs and demands.

- A1. Establish a study group to keep in touch with the advances in technology and prepare data likely to be needed for its effect on spectrum allocation.
- A2. Quantitative measurement of individual subjective judgments of the characteristics of television displays (present and future) for the purpose of indicating the likely nature of public demand on the quality of pictures.
- A3. The study of the desirability of having broadcast stations transmit information by using the vertical interval, frame snatching or other means without significantly degrading the quality of the TV broadcast.

JUSTIFICATION

Probably the most important of recent advances is the indication that the bandwidth required for television may be drastically reduced even for good quality television. G.E.'s pseudo-random scanning technique called Sampledot has achieved a considerable reduction in bandwidth but with some degradation in quality. I am predicting that this degradation will in due course be eliminated for nearly all types of scenes. Sampledot makes use of certain NTSC equipment with some additional circuitry. Its display has certain impairments but its reduction in bandwidth to about one-quarter of the present broadcasting bandwidth outstrips this deficiency for many purposes. I also predict that the bandwidth compression will greatly exceed that already achieved. Other band compression techniques are also in the laboratory.

An opportunity for using television in a way not previously used in practice is the transmission of information simultaneously with a television signal. The British Broadcasting Corporation has been experimenting with what they call CEEFAX. The concept is to send a message during the vertical interval of the television signal. A receiver with the appropriate adapter can select the message, present and hold it on the television screen. It is also possible to select and hold a whole frame containing special information which can then be examined at the viewer's leisure. Many of the special one-way services envisioned by Cable TV could be provided by broadcasters by such techniques.

These varied opportunities for television and for combining data with television transmission have started to emerge recently. They will no doubt play important roles in the growth of telecommunication. It seems important to develop a capability for keeping in touch with emerging socio-economic needs, the evolving technology, spectrum space and other consideration that may be needed for government and industry to respond most effectively to the changes as they appear.

Techniques are now available to obtain relative quantitative measurements of preference of the quality of pictures including for instance sharpness, contrast, color balance, etc. This had been done for photographs but not for TV. The most important features here would be such items as size of display, viewing distance, sharpness and the ever present constraint of cost. Quantitative assessment of these attributes would give both the FCC and the industry guidance on what changes to expect in public demand.

The psychological analysis of the subjective value of TV pictures will be different depending on its application. For entertainment, quality is paramount; for other purposes quality is often of little value beyond the point of ease of identification of certain elements of the picture, for instance, in closed circuit surveyance and much of education.

For the purpose of establishing the need for high quality television, for entertainment, the subjective tests should focus on two areas of special interest to the public; first, on the general preference for large screens with little regard to the viewing distance, the second, being able to come close enough to the screen that the large angle of view gives the viewer a more intimate sense of being part of the scene he is watching, an effect important for dramatic presentation and certainly for sports. The first area of interest, the large screen, can and is currently being operated with the standard 525 lines. The second also needs a larger screen to be also to provide a wide angle of view, but in this case the problem arises that the viewer becomes disenchanted, if he finds that beyond a certain distance, he gains nothing in greater definition by moving closer to the picture. If he wished to go as close to the picture as three-quarters of its width, corresponding to the view of the stage from a good seat in a theater, it may be necessary to provide a horizontal resolution corresponding to 1000 scan lines.

In the non-entertainment areas, broad acceptance of new systems having the potential of a substantial market will be very sensitive to cost. Bandwidth will be particularly important if long distance transmission is involved. Compatability with current receivers will also be of major importance. The mass production of receivers has reached such a high stage of sophistication and efficiency that systems are more likely to succeed if they can use these receivers.

Though important for government and industry, no specific recommendations are made for graphics (e.g. text, line drawings, and the like) because the private sector is likely to carry out the analysis of need and foster development without government support of any kind and find its niche within existing spectrum allocations. In this area the current television system is effective only for titles and short announcements. To display full size sheets (8 1/2 x 11") on a TV screen requires about 1000 scan lines, but it need not require a wide frequency band, for it can be slow scan (see section 4.3.2). The Japanese have in operation a system using 1425 lines which is apparently needed for their writing. 8/ Comparison of displays with 525 and 1100 lines is shown by pictures in Volume II.

3.2 QUALITY OF PRESENT BROADCAST AND CABLE OPERATIONS

- B1. Require the Vertical Interval Reference (VIR) to control automatically the color balance and contrast of the transmitter signal.
- B2. Development of procedure for monitoring the performance of broadcast stations by assessment and measurement of the signal with minimum control of the way the output is produced.

JUSTIFICATION

One of the principal findings of the study is that the basic NTSC standards cannot be materially improved as regards quality for entertainment for the current size of display in the home. For many years, however, there has been serious complaint that the quality was poor compared to that found in Japan even though Japanese standards are identical to American. This was the unanimous verdict of the persons with whom the question was discussed. In Europe reports indicated also superior performance except for a barely visible flicker due to fifty fields per second compared to sixty in America. The principal reason consistently given was not directed to any specific element of the system, but to the attention and care given to details at all levels of production and operation (See Section 4.1). Of recent years it has been interesting to note a marked improvement in the performance of American receivers.

One of the main problems was color balance, which was different for different stations, putting the burden on the viewer to change his controls if he wanted to retain the balance as he switched from one station to another. Most of the time he would not bother to do so. This problem may soon be corrected because the FCC has recently issued rules requiring television broadcast stations to adopt a recommendation of the EIA. The rule involves inserting in a space available within the NTSC standard a signal called the Vertical Interval Reference (VIR)(9) (see section 5.2.1 under Color Quality). The VIR should overcome some current practices which cause deviation from the color portion of the NTSC standards and make a major improvement in quality and uniformity between stations. In addition, the VIR is likely to be used in due course for automatically controlling the color balance in the receiver itself. The VIR can be modified at the studio so that the producer can control the color balance to suit his artistic need.

Other characteristics of quality could be corrected and controlled in a similar manner. The most important one is contrast. The good start made with VIR for color control should be extended to other quality characteristics. The VIR rule should also be extended to require automatic rather than manual control. The work of industry in this area seems to have been so productive that the process by which VIR was established should be continued for the extension of this type of technique.

As regards Recommendation A2, there is currently little economic incentive for the operator to give much consideration to television quality. The compulsion comes principally from the satisfaction of rendering a public service, and from the pressure of government regulations. But the present regulations cover only a small part of the total system. True public service would require monitoring the quality of the whole system as measured by its output, the operator being responsible for the quality of the inputs, as well as of the operation he controls directly. There is not much point in monitoring the broadcast station, if the quality of the input to it is poor.

The development problem of a technique for measuring and monitoring system performance would make it possible to remove most of the present detailed standards and replace them by output measurements. It would greatly simplify the problem of monitoring the performance of television stations and would leave it to the station operator as to how to correct any defects that appeared in the output. Some of the advantages of such an operation and some of the problems are discussed in Section 4.2.3.

3.3 STANDARDIZATION

Recommendation

C1 Establishment of a policy of systematic review of the need for balancing the benefits of standardization against those of innovation.

JUSTIFICATION

The great value of standardization lies in reducing costs and increasing flexibility of operation. This flexibility arises from lower costs, availability of parts from multiple sources, simplifying repairs and permitting the easy introduction of a variety of standard parts into a system. In this area, monopoly is pre-eminent, particularly if it controls the system from transmitter to receiver, but it tends to focus on its particular interest and makes little or no provision for others who could benefit from connecting into or from modifying the system. In a competitive environment, however, the imposition of standards carries the danger of inhibiting innovation. When government has the obligation or the opportunity to intervene for the benefit of the public, it should try to establish the optimum combination of innovation and standardization.

In the coming decade, because of the current technological revolution produced by the advent of integrated circuits (IC's), the problem will be more important than it has been in the past. The

reason: IC units are very costly to develop and cheap to reproduce in very large quantities. * Economic production will, therefore, depend on the number of different designs being few and the production very large. If many entrepreneurs enter an area and each one develops his own designs in every detail, some of the benefits of IC's may be lost to the public. Many areas of telecommunication and their application will depend on IC's for the extent to which they will grow and in some cases for their very existence (see Sections 5.1 and 6.2).

The matter of standardization is emphasized here because effective standardization may be a key requirement to the development of CATV. It is not clear at this stage how important CATV will become, but the evolution from CATV to the wired city concept, considered probable by many, may be so crucial to be alert to the need for standardization in order to be prepared for it and not wait until it is too late to act or excessively costly to do so. Other areas similarly affected by standards are tape and disc television recordings.

3.4 COMMUNICATION SATELLITE

Recommendation

- D1 Consideration of desirability to review the frequency allocation of broadcasting by communication satellite.

JUSTIFICATION

The concern about the spectrum allocation for broadcasting by communication satellite has its base in the history of the microwave spectrum allocation. There is little question that the basic performance characteristics of the communication satellite are ideal for broadcasting. Its signal can be received equally well over a hugh service area; it has no serious problems with ghosts, and has the ruggedness of a very wide frequency band. The disadvantage of six-tenths of a second delay, troublesome in two-way communication, does not matter in one-way broadcasting. Yet its initial and principal application has been for point-to-point communication. When the microwave bands began to be available, the communication satellite was a glamor concept for the distant future; active interest was in the use of these new channels for point-to-point communication by microwave relays. As might be expected microwave relays were assigned in the lower, less costly channels

* The cost of designing a relatively simple unit may be about \$30,000; for a complex unit it may be many times this amount. The cost of a complete circuit comprising three or four active elements may fall as low as one cent.

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and satellites were permitted to operate on some of these channels provided they caused no interference to the relays, some of which might look straight at a satellite. The power limit permitted usually gave the relays a more than ample factors of safety. Satellites, when they came into practical existence, were used with low power and a few costly ground receiving stations as point-to-point relays. Since the principal cost item of a broadcasting-satellite system is the cost of a very large number of ground receivers, the cost of the whole system drops as the power in the satellite is increased and the cost of each ground station is decreased. Existing rules strictly limiting this power effectively closed the opportunity of developing efficient broadcast-satellite systems. It was not until July 1971 that the World Administrative Radio Conference allocated frequencies for broadcasting satellites at a time when the lower microwave frequencies had been pre-empted or their use and power limited by other services. Only one band 11.5-12.2 GHz was unlimited in power. At that high frequency the electronics equipment is significantly more costly.

In addition, a suggestion has been made for the 11.7-12.2 GHz band to be shared between broadcasting service and fixed point-to-point services. This sharing may mean having satellites of different power on the same frequency, possibly as much as 1000 to one. This condition raises the question whether sharing would limit broadcasting satellite power. There are reasons for it to do just that. This effect should be taken into consideration when a decision is to be made. Particularly in this connection, one should be aware of the common tendency to underestimate the long range potential of technological development, and to view the future aspirations of the public as unlikely to change.

There have been many good technical studies made over the years on the subject of broadcasting from satellites. These studies have consistently concluded that satellite broadcasting direct to home would not be as cost effective as the present terrestrial broadcasting systems even though it would be much superior in the uniformity of the service rendered. There remains, however, an uncomfortable feeling of uncertainty regarding this conclusion, largely because of the history of the allocation of the microwave spectrum which never gave satellite broadcasting a real chance to compete with other uses of the spectrum. One questions also whether the benefits of uniformity of service, of providing rural and even remote and mountainous areas with the same quality of service available to large cities, were given the consideration they deserve..

The possibility of reopening international rules of allocation for review is too horrendous to be given any serious thought. However, it might be possible to limit the high signal strength within the boundaries

of one country (such as the U.S., USSR, India, China, Brazil, Canada) without violating the spirit of international agreements.

The technical problem is much more complicated than this brief outline indicates, and it may be that the allocation and regulations are satisfactory. The reason for having reservations about this conclusion is that interest by telecommunication organizations has been largely focused on point-to-point services, and as far as is known, did not consider long range changes in population distribution. It is not unreasonable to think that earlier studies might have been inhibited by the state of the art at the time they were made, the then existing international regulations and the pressure of other services for the more desirable lower frequencies. (See Section 6.2.2.1).

3.5 RESEARCH

Recommendation

- E1 Retention of the unwritten policy that hardware research be left to the private sector with only such direction as can be provided by publishing desirable national goals.
- E2 Adoption of the policy that the public sector carry out socio-economic and psycho-physical research necessary to formulate goals and standards, and to plan the flow of evolution from research to the formulation of goals and then to the formulation of standards.
- E3 Retention of the unwritten policy that the public sector limit its hardware research to the development of information in support of the decision-process, to the monitoring of the implementation of decisions, and to fill the void when it appears that the private sector has missed or is avoiding an area of value to the public.

JUSTIFICATION

The goals should be established but they will be meaningful only if they are based on the findings of research. Research is needed as a foundation for goals, to develop a better understanding of the impact of various forms of communication on society. This is primarily a responsibility of the government, not of the private sector.

The history over the last fifty years or more shows that the private sector has been able, in fact remarkably successful, in funding and carrying out its own research and development. The substantial fall-out of the research of the Defense Department probably had the effect of speeding the development rather than changing its nature. There are many areas where the support of government for hardware research is urgently needed. Telecommunication is not one of them.

Telecommunication is a huge industry which has had no need for government subsidy. Perhaps it can continue this way.

Where research subsidy is most likely to become increasingly important and increasingly needed is in the costly development of software, of programs that are simultaneously imaginative, instructive and attractive. That field, however, is far outside the scope of this study.

TECHNOLOGICAL BOUNDARIES

OF TELEVISION

VOLUME I

PART II

FINDINGS AND THEIR IMPLICATIONS

4.0 ESTABLISHMENT OF GOALS

4.1 PRESENT OPERATION

4.1.1 NTSC Standards

One of the principal findings of the study is that in spite of the relatively infant state of the electronics art at the time that the NTSC standards were adopted, those standards have stood the test of time and the onslaught of technical evolution. Mono-chrome standards were approved by the FCC on July 1, 1941, and color standards on December 17, 1953. With the technological evolution that has taken place since those days, it is indeed remarkable to be able to state today that these standards can hardly be faulted.

This eulogy of the NTSC standards does not mean that they are perfect, but they are not too far from perfect as far as picture sharpness is concerned. A perfect picture appears to the viewer to be as sharp as he would see it in real life. Viewed at a distance equal to five times the screen height, a station monitor would be 82% perfect in this sense. The meaning of expressing a quality as a percentage of perfection can be gauged from measurements with film. Eastman Kodak has measured the sharpness of the Super 8 film at 70%, and receives sufficient complaints from professional photographers to consider it only marginally acceptable. The 16 mm film measures 85%, which is about the same as television viewed at a distance of five times the screen height. Kodachrome measures 98% and no complaints are received, in fact appreciation is expressed about its sharpness. There are other factors besides sharpness however which affect the quality of a picture. Television suffers from a variety of things ranging from ghosts, snow, interference and distortions of various kinds.

From many interviews, there appear to be only two areas for which 525 lines are considered inadequate. One is for the transmission of graphics or text and the other is for large screen display of pictures. Both of these are discussed in more detail in Sections 4.3.2 and 4.3.1, respectively, on the Display of Pictures in Motion and Display of Stationary Pictures. With large screens there is often no satisfactory compromise between being too far and unable to see details of interest, and being too close and disturbed by the visibility of the scan lines and other defects. With graphics, it is not possible to present, in a form agreeable to read, a full 8 1/2" x 11" page of type or a page of an average magazine or of a book. (See Fig. 2)

The overall satisfaction with present standards was also confirmed by discussion with educators (see Section 6.4.2) and medical practitioners (see Section 6.4.1) who had practical and working experience with the use of TV. There was a strong consensus among them that the present 525 line standard was satisfactory for their needs. The value of greater resolution would at best be marginal except possibly for special applications.

In contrast with the confidence that we can generally have in the quality of our TV standards, there is a strong consensus of dissatisfaction with the quality of their implementation. Two factors are involved here. The first is the ability, or lack of ability, of the layman to adjust the controls of his set; the other is the failure of broadcast stations to provide signals having characteristics sufficiently similar that a set adjusted to one station would remain in good adjustment when switched to another. As regards the first, an enlightening pattern of family behavior was found. Professional and engineering types interviewed were without exception clearly sensitive to picture quality. They stated that they could obtain good quality pictures on their TV sets, but they consistently saw their wives and children watching programs with sets horribly out of adjustment. It was apparently not so much that their families could not learn how to adjust the sets, but rather that they could not be bothered to do so; it was fine if someone was willing to adjust the sets for them. This pattern tends to the conclusion that the quality of the TV picture is not important to the large majority of viewers. There are, however, reasons to believe that demand for higher quality TV may develop. Technological and market reasons are given in Section 6.3.1.

Regardless of whether the demand for higher resolution for home TV develops or how fast it does so, two things would be immediately beneficial to the public. The first of these could be economically carried out in a relatively short time. It would require the output of TV stations to abide to close tolerance standards. The second would require set manufacturers to provide circuits capable of making full use of the quality contained in the received signals, as well as more stable or self-adjusting circuits so that, once adjusted, no further adjustment or only minor ones would be necessary. At present, most sets do not make full use of the bandwidth transmitted mainly because of cost, though the cost of doing so would be small. Engineers see the improvement as substantial, marketeers see it as marginal and not worth the cost, particularly since people are willing to watch poorly adjusted sets. The sharpness of the "home set" shown in Fig. 1 of Volume II is 74%, that of the station monitor 82%. The marketeers will be right for some people but not for others.

CHARACTERISTICS OF THE TELEVISION SIGNAL

The television signal (1) contains information in electrical form, from which a picture can be recreated with fidelity. A still monochrome picture may be expressed as a variation in luminance over a two-dimensional field. In a moving picture, however, the luminance function also varies with time. The moving picture, therefore, is a luminance function of three independent variables.

The electrical signal consists of a current or voltage amplitude which is a function of time. At any instant, the signal can represent the value of luminance at only one point in the picture. It is necessary, therefore, in the translation of a complete picture into an electrical signal, that the picture be scanned in a systematic manner. If the scanning pattern is sufficiently detailed and conducted rapidly, a satisfactory reproduction of picture detail and motion is obtained. The basic system consists of a series of scans in nearly horizontal lines from left to right, starting at the top of the image field. When the bottom of the field is reached, the process is started again from the top with alternate fields interlaced. This scanning process is illustrated in Fig. 29-1.

For the successful decoding of the signal into a picture at the receiver, it is necessary to transmit a key to the scanning pattern. In the standard signal, this consists of frequent short-duration pulses (synchronizing or sync pulses), indicating characteristic points in the course of the scanning pattern such as the beginning of scanning lines and fields. This is coupled with the condition that the motion of the scanning spot between pulses is uniform with the time in the field of view.

The synchronizing pulses must be distinguishable from the picture signal. This is accomplished by time and polarity separation. An illustration of a portion of the signal is shown in Fig. 29-2.

The picture signal is interrupted during retraced time and replaced by a black signal known as a blanking pulse. Because of this, the retraced trace will not be visible in the picture. The line synchronizing pulses are superimposed on the blanking pulse and occupy the amplitude range from b to c . Since the picture signal extends from white at a to black at b , this region is "blacker than black," and the sync pulses do not register in the picture.

The line pulses synchronize the individual horizontal scanning lines. Similarly, it is necessary to synchronize field (vertical) scans. This is done by a longer pulse in the same amplitude range, as shown in Fig. 29-3. Deviations in this pulse maintain horizontal line synchronization, and the horizontal and vertical sync pulses are identified at the receiver by their greatly different durations. During the field retraced time, the picture is again blanked.

Fig. 29-2 FULL SCALE REPRODUCTION OF TEXT

Reproduced from 8½" x 11" page with standard broadcast quality camera (one inch plumbicon type PK 330L) and broadcast station quality monitor receiver.

There has been significant improvement in the receiver quality during the last two years. Also in this period the FCC has taken its first procedural step to require stations to introduce a control signal in the TV transmission which will bring uniformity of the color balance among broadcast stations. Receiver manufacturers are considering the possibility of using that same control signal to maintain the set automatically adjusted to the correct color balance.

Two organizations have been working on technical standards through a group of technical committees. The Joint Council for Intersociety Coordination (JCIC) handles television broadcasting and the Cable Television Advisory Committee (C-TAC), recently organized, handles Cable Television.

The two most commonly maladjusted elements of picture quality are color quality and contrast. Some present operating practices tend to distort them away from intended NTSC standards (see Appendix A, Sections A3 and A4). These two elements could be automatically controlled at the transmitter permitting introduction of effective circuits for automatic adjustments in the receiver. Other performance characteristics that need improvement are discussed in Section 5.2.1. The Electronic Industries Association (EIA), following findings based on the excellent work of JCIC (10, 11) recommended the introduction of a reference signal (Vertical Interval Reference -- VIR) (12) for the control of color quality. The FCC has proposed adopting rules along the lines of the EIA recommendations (9). Another characteristic which needs improvement is the accuracy of the interlace of the scan lines. Coordination of transmitter operation and receiver design, particularly if both parties are interested in seeking the common goal of overall system quality, can be expected to produce a significant improvement in average home reception.

Television comprises both picture and sound. What has been said about the quality of pictures can be said of the quality of sound. The quality of sound in television broadcasting is generally second-rate, at least when the program has been carried over a long distance. The sound system of the receivers is also generally poor using small speakers and reducing the low frequencies to prevent high peaks. The causes of deficiency in sound quality and various alternatives for improving it need study and consideration for corrective action. The JCIC is beginning to study this area and will undoubtedly report on the causes and cures. The development of effective dialogue between set manufacturer, broadcaster and the telephone company is indicated.

4.1.2 Overall Quality of the System -- Effect of Inputs

Another major component affecting the quality of the television system, one for which no standard exists, is the input to the system -- motion pictures, video tapes and studio operation. Conditions range from very good to very bad. Major networks monitor the quality of these inputs at least for their prime hours of operation.

Fortunately for the quality of the inputs, there exists an interesting protective mechanism in the behavior of producers and directors. Frequently, they see much of their more subtle efforts degraded by poor technical quality. One would think that they would not care since the viewer is far more interested in program content than picture quality. But the viewer is not their main concern; their main concern is the opinion of their peers -- the other directors. It is that concern that makes them use their influence to maintain high quality. This reaction is a powerful force currently available for upgrading the quality of the inputs. That force is valuable, but alone is not adequate. There is, of course, a wide range of talent among directors and an equally wide range of their understandings of the capacities and limitations of the television camera and of the system as a whole. It might be helpful to develop professional competitive interest in the quality of the inputs, but such interest is likely to be dormant until home television displays become consistently of a higher quality.

4.1.3 The International Scene

In the international arena, there has been controversy among experts, (with some patriotic overtones), on the relative merits of the NTSC standards of US and the PAL (13) and SECAM (14) standards of Europe. The fact that the controversy has been acute and has existed for many years indicates that the differences from the viewer's point of view are minor. Technically, there is a difference between the desirable European 625 scan lines and the American 525, the desirable American 60 fields per second and the European 50. Other differences affect color. PAL exists in three different forms. The new and super forms produce the appearance of more stable color balance than does NTSC but with somewhat reduced vertical resolution. SECAM is broadly similar but reduces the vertical resolution by one half which is more than for PAL. The color stability of the receivers under the NTSC standards where the automatic control of the VIR signal is implemented, is expected to become as good as those under PAL and SECAM and be without loss of resolution.

Another European standard was one using 819 scan lines. It was introduced in France, but is now being phased out. (15)

The situation in Japan raises a problem which is of national concern, if indeed the reports are correct because it reflects a trend visible also in other industries. It brings out a possible important reason for the penetration of Japanese products in the electronic market of the U.S. The symptom is not related to price but to quality. The reports without exception were that television quality is substantially better in Japan than in U.S., although the standards are identical. The reason consistently given did not point to any specific defective area, but to the care bestowed on each of the many component elements and operations of the whole system.

4.2 SYSTEMS GOALS

4.2.1 System Quality

The hardware part of the television system generally comprises the input, camera or tape, transmission equipment, long distance transmission channel, local distribution, receiving equipment and display. The design of each of these components is tailored to the desired output -- the final display is the controlling factor. A defect in the desired performance of any component degrades the display. The design of each component reflects the pressures of competition and the requirements of government regulation, leaving little margin to extend performance beyond the official NTSC standards. For this reason, a relatively small change in standards could require a technological step beyond the current state of available facilities affecting possibly all major components, with the probable exception of the long distance transmission channel where ample margin could be made available at a price.

The practical limits of current television technology were discussed very informally at a CCIR meeting by a small group of engineers of several countries. They came up with what they called the 6-6-6 standard -- 60 per second field rate, 600 scan lines, 6 MHz video bandwidth corresponding to a total bandwidth of about 8 MHz, possibly less with some sophistication. Somewhat more resolution than represented by 6-6-6 could be probably squeezed out of existing technology without requiring the development of new components. The degree of improvement in the sharpness of the picture is shown in Fig. 1 of Volume II. The percentage of perfect sharpness is 82% for NTSC monitor and 86% for 6-6-6 monitor.

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Judging from these pictures it does not seem likely that a strong demand will develop to improve on the NTSC's standards unless it is to produce a very large flat screen display. It would seem a horrendous problem to modify the NTSC standards in any significant manner, but it does not seem impossible that such changes might evolve in connection with wide band cable, pay TV, or broadcasting from satellites.

The immediate attitude of designers regarding higher quality TV is that every part of the system would become much more difficult to design, on the premise that no fundamentally new technology over that currently applied would be available. Since the number of picture elements increases as the square of the number of scan lines (for the number of picture elements should increase equally along both the horizontal and vertical axes), the complexity of each of the major components can be expected to increase at a rate somewhere between the square and the third power of the number of lines, affecting the cost proportionately. These projected conditions present strong obstacles to change. They are based, however on the assumption of an essentially unchanged technology, and that assumption is clearly false.

There is no indication that a plateau to technical innovation has been reached in electronics, quite the contrary. In fact one can see some of these innovations emerging in two key television areas - radical reduction in bandwidth and a significant improvement in the design of television cameras with the discovery of charge coupled devices (CCD) and charge injection devices (CID). But change, however imminent it may seem, always requires much time for practical implementation and wide economic distribution.

At this stage, there is not yet enough information on subjective response to quality to establish system goals, but the principle can be expressed that goals set for any individual component are of limited value, for the whole system must be viewed as one unit. At the interface between components, the output of one must conform to the required input of the next in both nature and quality. Effective interface performance with the object of providing quality service to the public will never be consistently achieved without close cooperation of both sides of each of the interfaces and coordination for the overall performance of the system. The JCIC is working toward such a goal within the NTSC standards.

4.2.2 Compatibility

A goal for high quality television is compatibility, meaning that while special sets would be required to produce high quality display, sets designed to NTSC standards could receive the high quality signals and display them with NTSC quality. While the best method of achieving this result is not known, it can probably be achieved at relatively little additional cost.

In discussing high quality television, the question of compatibility was often raised with the implication that it might prove a stumbling block to practical implementation. Compatibility may not be very difficult to achieve. If the number of scan lines of the high quality is in a simple ratio to 525, say 2:1, then the picture information contained in only two scan lines of the high quality signal carries information from which one NTSC scan line can be constructed. Compatibility of pseudo-random scanning with NTSC is probably impossible, because the bandwidth compression requires the total scanning time to be several times that of one NTSC frame.

4.2.3 Maintenance of System Quality

Would a viewer decide to turn to a program merely because the picture quality was particularly good? He would be exceptional if he did. He watches a program because he likes it and will do so even if the picture quality is quite poor. The content of the program dominates other considerations. What, then, is the incentive for the operator to maintain high quality? Government regulations are effective up to a point, but nothing can replace the natural interest and desire of the management and the staff, and the personal satisfaction of the professionals associated with producing, directing and operating a good quality picture. Detail controls undermine the professional desire to produce something to be proud of. Turn this knob, push this button, look at that meter - these are instructions which may be excellent, except that they tend to kill interest and initiative.* Can detail controls be removed? If they were, the good stations, good managers seeking to develop respect of the public for the industry as well as for their corporation, would probably operate without impairment of quality, but the poor ones would probably go rapidly downhill.

*The actual government regulations do not spell out the process in this degree of detail. The description is literary license to dramatize the fact that the operating engineer has little freedom for independent action.

The first question is whether maintenance of quality is worth the effort, since a great many viewers continue to view extremely low quality pictures with but little complaint. Taking the broad view it is certainly worthwhile. It is worth the effort largely because poor quality of anything has a subtle, demoralizing effect, while near-perfection, as argued elsewhere in this report (Section 6.3.1), is a psychologically elevating force. The implementation of high quality is particularly important where government has a controlling voice.

The basic quality requirement for true public service is the quality of the overall system. The process desired is the physical measurement of the quality of the output. Undoubtedly there are problems, but the ultimate objective is difficult to fault. Is it possible to set a goal, a goal toward which government and industry might strive? The desirable goal should be the elimination of the current standards controlling quality and replacing them by measurements of the output of the whole system. The operator would then be responsible for meeting the required minimum quality in anyway he desires.

It would be desirable to introduce at the input of the system - on the tape, film, record, camera - a set of indicators of quality which could be used for manual or automatic maintenance of quality throughout the system and for monitoring its output. The VIR is such an indicator which uses an unused portion of the TV signal. Turning to film, it is found that there is no room on the film outside of the scene for introducing information on the quality which the system is capable of carrying. A conceivable solution is to replace a whole frame at intervals, containing quality information. It should be remembered that the producer should decide the desirable color balance, contrast, sharpness for his particular scene, and his particular scene, and his deviations from the norm should not be corrected. There is therefore a need for transmitting information through the system which would result in the quality which the director seeks to produce. This information could also be used for monitoring the quality. Clearly the monitoring standard should not be high; its purpose would be to protect the public from unacceptable low quality.

Could such a monitoring process be implemented? The question has not been studied, but a few, to whom it was presented while approving the purpose and value of the concept, felt it would engender resistance from some operators. The principal objection expected was the increased responsibility for the quality of the input on the part of the broadcaster -- the tapes, films, etc., that he uses. The process would relieve the operator of some problems, but the addition of others is likely to raise objections. From

the point of view of the public, however, someone should be responsible for the quality of the whole system or at least for the quality of the signal that is broadcast to the public. The responsibility should be on the broadcaster, for he is responsible for requiring certain minimum quality of the input, including the transmission of the material to his station as well as that of his own operation. The present process does not monitor the whole system; it relieves the operator of responsibility for the quality of the input.

The suggestion is presented here for discussion. In urging that it be considered, its psychological values are offered: first, it would give greater freedom and a proportionately increased sense of responsibility to the operator for the quality of the system as a whole. Second, the technical staff would have greater latitude for innovation and improvement -- implementing the principle proposed years ago of giving the engineer freedom of action in his domain rather than detailed instructions. Third, it would greatly simplify the government process of monitoring the technical performance of TV stations. Fourth, individual component groups and the industry as a whole would develop a deeper and quantitative understanding of the way its various technical parts intermesh. Fifth, possibly it would also bring to the surface how the artistic and technological elements could best interact.

4.3 VIEWING GOALS FOR HIGH QUALITY TV

The display of pictures represents very different technical problems depending on whether the scene presented is in motion or stationary. They are therefore treated separately. The NTSC requirement of thirty frames and sixty fields per second was established to take care of rapid motion. When the motion is slow, resolution should be high but when changes are slow, a rate of sixty fields per second is unnecessarily high and is wasteful of bandwidth. If the motion is fast, the eye-brain complex cannot detect the sharpness of outlines, so that bandwidth is wasted as it is for slow changes but for another reason. Thus the NTSC standard is wide in bandwidth in order to meet the highest requirements of both slow and fast moving objects. In view of the capability of the eye-brain complex to integrate and fill gaps in the flow of redundant information that is normal in television, it is to be expected that some compromise with these high requirements will be found which would produce an acceptable picture and substantially reduce the bandwidth required. The Sampledot technique of General Electric described in Appendix C may have started an important move in that direction.

4.3.1 Display of Pictures in Motion

4.3.1.1 Scope of High-Quality Goals

It would be inappropriate for the next step in the quality of television to be only a slight improvement over today's already good, or more correctly potentially good, pictures. In the next step, the characteristics of the picture should be adapted to the needs of the producer and the aspirations of the viewer rather than, as has been the case, of adapting them to the technical characteristics of the display. The goal should include at the production end consideration of the range of scenes that the picture may have to depict, and at the viewing end consideration of the environment or surroundings within which it is to be seen. In the recent past, the zoom lens came as an outcome of the need for adapting a complex scene to a small screen. While it had a major impact on the production of TV programs, there remained an unresolved need to be able to see simultaneously the whole of a large scene and some part of it in considerable detail. In sports, such as football, it has been partly satisfied by slow speed replay. The need may prove important for the talented director of drama who cannot fall back on the replay technique.

At the viewing end, the need to adapt the picture to the environment involves consideration of the desirable viewing distance, the importance of peripheral vision, the harmonious merging of the screen and equipment into the home, and the effect of these environmental constraints on the characteristics of picture quality -- resolution, contrast, color balance, etc.

Until recently, there was little information reliable enough on which to base goals. Some quantitative information has been collected on the appreciation of photographs for various degrees and combinations of resolution, contrast, color balance and noise using psychometric scaling techniques. Similar information is needed for television including such additional factors as size of display, viewing distance and aspect ratio. A quantitative assessment could also be made of the appreciation between the high-quality level that might be and today's level that is. From these data, goals could emerge and could be established for high-quality TV. Later, as the technology developed toward these goals, standards would evolve to assist the development of components of systems to meet measured popular taste and requirements.

4.3.1.2 Optimum Viewing Distance

Especially important to quality viewing is the complex relation of three key factors -- image deficiencies (e.g., visibility of scan lines), viewing distance and size of screen. In motion pictures, some subjective tests on desirable viewing distance indicate that the quality of the film as projected on the screen controls the best desirable seating distance. The shortest good viewing is apparently limited by the granular structure and other deficiencies of the film; the worse the film the farther back one wants to sit. (See Appendix A, Section A.3) Not infrequently, the best seats it would appear should lie outside beyond the back wall of the theater!

The criterion for the greatest good viewing distance was not ascertained. One would expect it to be the distance beyond which certain important details, such as facial expressions, began to be lost.

The demand for very high-quality TV for the home may arise because of the general preference for large screens and the limited viewing distance that is practical in a home. A feeling of frustration is a common experience of persons approaching a television screen to see more detail and finding that beyond a certain point approaching further provides no additional detail. Short viewing distance will be limited by this effect and will be a good viewing distance, if the scan lines are many and barely visible. These requirements will undoubtedly involve design compromises. The establishment of useful goals for high quality will therefore require determining the ranges of acceptable design of home television systems. This is an engineering problem which can be solved. Here we can turn to psychological scaling. First establish the quantitative relation expressing viewer response in terms of the three principal parameters of size of screen, viewing distance and number of scan lines. Preliminary indications lead one to feel confident that desirable goals could be established which would be satisfactory to a large majority of viewers. (See Appendix B). A discussion based on simulated pictures of the conditions that can be projected is given in Volume II.

4.3.1.3 The Illusion of Depth

It is essential that a television picture for entertainment purposes, though presented in one plane, produce the illusion of depth. Professionals often place special importance on this aspect, and indeed, where properly implemented, it can give the viewer a very real feeling of being "within" the scene he is watching as no other characteristic is able to do. The impression is easy to achieve, but no technique has yet been devised which is fully satisfactory.

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Various schemes have been offered for making use of stereopsis by having each eye see the scene from slightly different angles. The depth impression produced is very realistic, but the viewer is constrained in ways he does not like, either by wearing special glasses or having to keep his head in some particular position. The hope that the remarkable discovery of holography might solve the problem has not materialized. 3-D motion pictures have been made, but they seem to attract an audience mainly because of the novelty. The vogue has come and gone several times and has always been of short duration. (16)

Simulation of depth is normally achieved by using other faculties than stereopsis. It is common experience that a sense of depth does not disappear when one eye is closed. Our normal sense of depth arises most frequently by comparing the object receiving attention with other familiar objects seen at the same time in the same general direction. Apparent comparative size is an important criterion for judging distance, so are real or illusory perspective effects. Without such guides, psychological tests show that estimates of distance can be grossly in error (See Appendix A, Section A2), as is also evidenced by innumerable examples of optical illusion.

Another approach for the viewer to feel "within" the scene he is watching is to give him the opportunity of applying his peripheral vision -- the extent to which he sees the scene over a wide angle on either side of the area on which he focuses his attention. The wide screens of motion pictures such as Panavision, I-Max, the three projectors of Cinerama, the six of Disney's Circarama (forming a complete circle), are examples of techniques for achieving this effect. Technically, they achieved successfully the effect sought, but only when seen from a limited viewing area. The few producers interviewed felt that the effect was important in a few types of scenes, but seldom warranted the cost. It would seem also that the viewing area within which the effect was truly impressive was generally too small to hold a large audience and, therefore, not acceptable to show business from an economic point of view.

Sound may also provide, to a degree, an impression of depth. A sense of depth, it has been found, can be enhanced when the picture is accompanied by stereo sound. Early evaluations of this effect showed no important impact, but the impression might be different with large screens.

There is not enough reliable information to establish goals for the effective simulation of depth. It would be possible to make subjective tests, but it may be difficult to stimulate sufficient interest to have them funded and carried out at this time.

4.3.2 Display of Stationary Pictures

The display of pictures with little motion includes graphics, stills such as X-rays, photographs and anything which moves sufficiently slowly that substantially less than thirty frames per second would be satisfactory. The field is being led by graphics, particularly text, because of its importance.

From the technical point of view the telecommunication of text for display has different requirements from those for pictures. For text there are usually only two levels of luminance -- black and white -- and intelligibility is dependent on the edges between black and white being sharp. Very low and very high spatial frequencies are therefore prominent. For that reason the transmission of colored text is not possible on NTSC standards because the chrominance signal does not contain high frequencies. In contrast the special spectrum of pictures is low for the high spatial frequencies and, surprisingly, varies but little with the scene.

There is a strong consensus that graphics require about 1000 scan lines. The form of writing used in Japan and China requires more scan lines. The Japanese have in actual operation at this time a system using 1425 scan lines^{8/} In the case of X-ray photographs, there appears to be no need for more than 525 lines, and no advance in medical science is envisioned which will require more (See Section 6.4.1). It is not possible to predict, however, that advances would ever need more resolution. If such an advance should occur, the development for graphics already taking place and still developing is likely to be able to meet the need. Details of surgical operation as is sometimes suggested to be needed for teaching, is probably most effectively provided by optical magnification at the scene of the operation.

One of the important differences between requirements of graphics and text on the one hand and pictures on the other is the lack of redundancy in the communication of certain symbols. Many sentences and even words can readily be correctly understood even when several symbols are illegible, but with numbers, a distorted or misread symbol may lead to serious error. The same is true in reproducing mathematical expressions where every symbol is usually essential to the correct meaning. The reproduction may be particularly difficult in this case because symbols in superscripts and subscripts are deliberately made small. Another special problem is the Kel factor which arises because of the scanning process of television reproduction. Taking the letter e, for instance, if the horizontal line falls between two scan lines, it may appear as c. The Kel factor is generally taken to be 0.7 of the actual number of lines. This is

a rule of thumb that does not properly relate to the resulting errors. The Kel factor is not limited to text, it applies to all types of displays when considering resolution in the plane perpendicular to the scan lines.

A conclusion from the perusal of a number of studies (17, 18, 19, 20) is that the number of scan lines for each symbol should be a minimum of 5 to 7 for recognition and 7 to 10 for comfort. The Videofile of Ampex, which is being marketed successfully, uses 1240 lines. In an 8 1/2" x 11" page a fully resolvable symbol 70 high is scanned by 7 or 8 lines. The frame rate is 15 per second.

The acceptance of the display of text goes beyond legibility. The psychological factors of how much text is presented at one time, the size of the margins, length of lines, all affect reading fatigue and reading pleasure. There is a certain satisfaction in finishing a page, if it is not too long or too short, and to a less extent, in finishing a line or paragraph. Many psychological tests have been made (17, 18, 19) in the reproduction and legibility of various types of print, but none were found on the preferred format of a page, a paragraph or a line.

A group which includes the Information Industry Association, feels at least in part that the 8 1/2" x 11" page is a relic of a past age which should be abandoned as soon as possible. Indeed, there are many applications where it is more convenient for the text to flow continuously from top down rather than from page top down and then from page to page.

At this stage, it would be desirable to establish goals for resolution, format and readability. They would almost certainly be of value to the public and helpful to industry. Information on the importance of the rate of flow needed for reading and of scanning text would also provide valuable guidelines.

There is too little known about the impact of these several factors on the subjective appreciation of display of graphics for various applications to develop reliable goals. The necessary information could probably be obtained without very great effort.

5.0 EVOLUTION OF TECHNOLOGY

5.1 THE CURRENT ELECTRONIC REVOLUTION

In the last fifty years or so, we have seen a series of developments each of which has revolutionized the communication technology. The one which today is revolutionizing technology, the economic application of much that we already know is the integrated circuit (IC). This technology permits the production of extremely reliable complex circuits in microscopic dimensions. While the saving of space growing out of microscopic dimensions is of special value to the computer, its primary value lies in the enormous speed with which signals travel from one circuit to another. When once designed, these circuits can be duplicated in large quantities at very low cost.

Complex circuits which were prohibitively costly for home or industrial use can be considered. Complex components of special interest to high-quality TV which ICs might make practical are converters between analog and digital forms of signals, signal processing for channel conservation, switching and logic components for distribution networks, flat screen displays. A valuable outgrowth of IC's which is to be expected, when made in sufficient quantities, is the frequently small difference in cost between a good and a poor circuit, thereby reducing the initial price advantage associated with poor design and production.

The electronic technology has been currently spawning many new techniques to simplify circuits and increase the speed of their operation. The most recent ones which seem to have the potential of wide application are the Charge Coupled Devices (CCD), Charge Injection Devices (CID), Surface Acoustic Wave (SAW) Devices and Integrated Optics. (21,22) Among other applications, the CCD has been used in the development of a new type of television camera. These techniques and a host of others will be available should demand develop for an economical, high quality TV system. Perhaps the most difficult component to develop will prove to be a large flat screen display. (See Section 5.3.1).

An important trend which started many years ago, the application of which is rapidly increasing, being greatly helped by the appearance of ICs, is the conversion of signals into digits (Pulse Code Modulation -- PCM). Its effect is to permit transmission over long distances with very little impairment of the signal and provide great flexibility in the processing of signals for many purposes. The potential of this trend can be judged from some of its more

important performance characteristics. Noise and ghosts, introduced in the process of a signal or in the transmission path, the intensity of which is substantially less than that of the signal, can be effectively removed; the signal can be regenerated at repeaters so that noise and distortion can be negligible over long distance transmission; bandwidth can be compressed by reducing the redundancy of the information transmitted; signal-to-noise ratio can be exchanged for bandwidth; the serious problem of distortion and cross-modulation that appeared when the transistor replaced the vacuum tube largely disappear with PCM. This latter problem lost its importance with the recent advent of the field effect transistor (FET).

5.2 THE TECHNOLOGY OF 525 LINES

5.2.1 Transmitter-receiver Interface

The following are a few items were transmitter output and receiver design could coordinate to produce more satisfactory television for the public:

BANDWIDTH: The NTSC standards are a remarkably fine compromise for representing with an analog signal within a narrow bandwidth both color and the high resolution required for the outlines of a picture. The luminance signal contains the high resolution information; the sharp outlines of the picture are contained in this signal. The chrominance signal provides the colors within the outline and is much less sharp, taking up, therefore, less bandwidth. The result is somewhat like a child's coloring book where the colors follow the outlines only roughly. The acuity of the eye varies with color being highest for black and white, somewhat less for green, still less for red and least for blue, so that good design saves bandwidth by providing less resolution in the colors. Many receivers, however, for various design reasons have filters introduced in the luminance circuit in order to minimize interference with the chrominance. Several design techniques can be used to reduce the probability of undesirable interference. The most effective is the comb filter which would allow the frequencies of the two signals to overlap and yet be able to be separated. (23) Comb filters would require one or preferably two delay lines. They are low in cost, but not negligibly low from the point of view of the marketplace. Engineers generally see improvement with comb filters as substantial, and marketeers as marginal.

COLOR QUALITY: It is clearly important for all stations to maintain the same color balance. As already mentioned, the Joint Committee for Intersociety Coordination (JCIC), which oversees the broad effort of a number of industry committees on various aspects of television quality, has carried out excellent studies on the practicality of doing so and has suggested the introduction of a "Vertical Interval Reference" (VIR).

The VIR is introduced at the point where artistic judgment is made regarding the color balance. This takes place where the original signal is being produced, that is at the studio or control room. The establishment of color standards was the subject of international controversy. The NTSC standards were developed to conform to the phosphors used in kinescopes at the time of their development (1953). Since then, new phosphors have been developed, producing greater brightness, but somewhat more restricted in their range of color. A controversy is in progress as to whether the NTSC standards should be retained or whether they should be modified to conform to the new phosphors. U.S. experts favor retaining the NTSC standards and those in Europe favor adopting new ones. The basic reason for the difference in point of view is probably the difference in the age of color sets in public use. In the U.S. many color sets are relatively old and use the early phosphors, while in Europe most color sets are relatively new and use the more modern phosphors (See Appendix A, Section A.4).

The VIR will not remove the distortion of color which may develop when a multi-path condition exists between transmitter and receiver. Then the received phase and therefore the color may be affected. It is worth noting that with pulse code modulation this multipath defect would largely disappear.

CONTRAST: The two levels, for black and for white, establish the contrast range and the maximum degree of blackness and whiteness which is best for a picture. Those two levels should be a matter of artistic judgment and should be established at the studio or control room by the producer of the program rather than by a station operator. The VIR signal referred to in connection with color quality will also correct a frequent type of operation, generally referred to as "pulling the blacks," which often leads to reducing contrast and loss of color in dark areas.

The purpose of pulling the blacks is to improve the picture in areas where the signal strength is weak and thereby reduce the "snow" effect. The penalty is to reduce contrast and color in dark areas where the signal-to-noise ratio is high. Improved operating procedures may help, but better still another special control signal to which new sets would respond would be transmitted. The regular transmission would transmit with 100% modulation all areas of the picture which were darker than a certain gray level, thereby making all these areas appear black in existing sets, but it would reduce the "snow" where the signal was weak. New sets fitted with an automatic contrast control which responded to the special control signal could display the picture with the correct contrast. (See Appendix A, Section A3).

INTERLACE: The effective number of scan lines is often reduced because of poor interlace. The degradation generally occurs when the signal-to-noise ratio is low; it is more prevalent in color receivers than in monochrome. The effect is to reduce the vertical resolution, but the lines are still effective in reducing the flicker even when the interlace lines completely overlap. The interlace accuracy could be made close to perfect by including a counter in the receiver. IC's may make this additional complexity sufficiently low in cost to warrant its introduction in home receivers.

DISTORTION DUE TO VESTIGIAL SIDEBAND TRANSMISSION: Vestigial sideband with the common envelope detector produces distortion; it affects color by changing the luminance level in relation to the chrominance. It also reduces the requirement on the sound trap, resulting in less distortion of the picture. This type of distortion is particularly important in CATV because the distortion becomes squared as the distortion at the CATV head adds to the distortion at the home receiver. A synchronous detector replacing the simpler envelope detector would effectively solve the problem. Perhaps with the aid of IC's, the extra cost will be sufficiently reduced to make the synchronous detector a practical improvement. (24, 25). A number of manufacturers in Europe presently use synchronous detectors in their receivers. They are used not so much for the effect on the color as on the sound trap.

Another problem arises with color because incidental phase modulation at the transmitter appears in the TV display exactly like differential phase distortion. Until the advent of the field effect transistor solid state devices introduced more such incidental phase modulations than did tubes.

5.2.2. Inputs -- Films, Tapes and Studio Operations

Pictures produced from video tapes today are close in quality to those from good 35 mm film. They compare favorably with 16 mm. The quality of tapes is constantly improving; it is expected that they will compete and, in fact, are likely to supersede film in due course. The quality of the display depends more on the equipment than on the film or tape when good quality material is used. Taping has a substantial advantage over filming in that a television camera is faster than commercial film, about four times as fast, requiring an exposure of only 1/200 seconds. With tape there is therefore less blurring due to someone or something moving. Film has the advantage over tape in that it can carry a much higher density of information, so that the physical volume of a program on film is of the order of one tenth of the volume on tape. Tape, on the other hand, has the production advantage over film of being ideal for editing and cutting. It is also possible to modify electronically

certain aspects of a picture such as the contrast curve, sharpness, etc., in order to improve the overall effect of a picture or correct for known deficiencies in the system. Much development has been carried out in this area by the military who were interested in increasing their ability to recognize certain objects in aerial photographs. (26, 27) These advantages of the two media are often combined by having a video program first recorded on tape and, when fully edited, transferred to film for shipping and storage.

In England, the BBC has developed a system for correcting films that have been taken under adverse conditions, or have suffered from exposure errors or have deteriorated, or have been shot under widely varying conditions of lighting, etc. During previewing of a film a program is made on a tape of the desirable corrections to be made. The tape now becomes associated with the film. When the film is used the tape excites circuits in the film scanner which introduces the desired corrections. Corrections can include color, contrast, etc. (28) Similar corrective techniques have been used in the United States.

A common technique which is often carried out directly on the luminance portion of the TV signal is to modify sharp edges, making them sharper; whenever a sharp edge appears, the luminance of a picture element is adjusted on the basis of the luminance of the picture elements close to and on either side of it. The adjustment is preferably made both vertically and horizontally. Vertical adjustment requires a memory covering three scan lines. Noticeable improvement in a picture is reported generally when the controlling picture elements are very close, requiring a resolution corresponding to 300 or more picture elements in a scan line. Effective operation is reported to require a wider bandwidth for the luminance than is normally available, in fact, comb filters may be needed to achieve it.

As regards studio operation, there exists a wide range in the quality. Some studios are reported consistently excellent, some consistently poor. It was not possible to establish any specific reason for the difference. Work is going on to find the causes of degradation of quality. Some of the technical problems are discussed above in connection with color quality and contrast. A general impression, however, was the importance of the degree of attention to detail by all levels and the willingness to systematically monitor the operations.

5.3 THE TECHNOLOGY OF MANY SCAN LINES

5.3.1 The Display

High resolution carries along with its inherent high quality the greater visibility of defects, and technical defects more than almost anything else detract the viewer from his intellectual and emotional interest in the picture. It was interesting to note that the engineering-type, when he seeks to obtain a better "definition" of a picture, moves closer to it in order to examine the nature of the defects. A producer or director-type, on the other hand, moves further away in order to assess the overall artistic effect and incidentally, or perhaps not so incidentally, to escape from seeing disturbing defects.* Throughout the part of the study covering the direction of programs, the intellectual gap, the difference in thinking, in approach, in observation between director and engineering-types was striking. It is unfortunate that better understanding and communication seems so difficult to develop, for it would benefit everyone concerned. This relationship, or lack of it, is an example of the "Two Cultures," the communication gap between humanists and technologists so well described by Lord Snow, the gap which he felt, could eventually prove a serious threat to our civilization. (29)**.

* One exception was encountered -- an engineer who walks away from a picture to see its "definition" more clearly. His deviation from the norm was explained when he admitted that an important avocation in his life was painting -- "I walk away from my picture as I paint it to see it better."

** An interesting study of the history of the two cultures has been made by Schroerer (30). He treats them in considerably more depth than does Snow and sees the gap as caused by basically different views of man and nature. The engineer sees himself and his environment as a mechanical device "which can be understood by taking it apart and studying the pieces separately." The humanist sees them as an organism where the overall picture is the most significant aspect; he feels that the "whole is greater than its parts ..", that man is something more than a collection of atoms and nature takes on a personality of its own." The opposite reactions of the program director and the engineer to a television picture exemplify in a simple situation this basic gap between the two cultures. One might summarize: the scientist (including the engineer and the economist) is coldly factual, experiencing but paying little attention in his conscious thinking to emotional values of the scene. The humanist on the other hand focuses on emotional values -- pleasant and unpleasant -- accepting in a reluctant way the material benefits, but basically revolted by the trained mental process and interest that has burst upon the world since the time of Newton. The existence of the gap is understandable, but the lack of mutual understanding should not be the serious limitation to effective communication and mutual appreciation which it seems to be.

For television quality, the point of interest is the automatic reaction of the artist to move away from the picture to reduce those features that disturb his assessment or appreciation of it. The average viewer is likely to act like the artist rather than the engineer. If he is under no constraints for selecting the viewing distance, the important element may be more the ratio of the size of the defects (such as the spacing between the scan lines) rather than the commonly used criterion of the ratio of the height or width of the screen to the viewing distance.

One noticeable defect in television is the space between the scan lines. Interestingly it is a defect to which most people become accustomed, soon becoming unconscious of its existence. Its effect can be reduced by increasing the number of lines, maintaining accurate spacing and spreading the lines to fill the gap between them, by moving away from the screen or by introducing noise, or, better still, a well-designed disturbance. Noise, though itself viewed as a disturbance, sometimes helps by concealing other more disturbing forms of defects. In so doing, however, it reduces resolution. A better form of concealing disturbing visual effects than random noise, is a pseudo-noise designed to optimize the ratio of the benefit of concealing defects and the loss due to reduction of resolution. Various types of noise signals have been suggested for reducing the visibility of the line structure, but most of these require very accurate interlace and have not proved uniformly effective.

Turning to the area of specific mechanisms for the display component, one finds active development areas. The flat screen display in which the picture elements are discrete, excited from a conductor matrix controlling the voltage of each element, is being studied by a number of corporations. Most of them are under contract to the Defense Department whose need is the accurate and rapid display for command and control operations.

A successful development of a flat screen could provide important advantages. They include: essentially no constraints for locating the display in a room (on the wall, on the top of a desk, or even on one's lap), within reason no limit to size from the very small to the very large, no constraints on the aspect ratio, accurate interlace of the scanning lines, no significant reduction of sharpness from that available in the input signal, no distortion at the edges or corners of the screen, ideal for bandwidth reduction by quasi-random scanning (See Section 5.3.3). There may also be a valuable by-product for channel conservation in the possibility that the display will be able to act as a memory for one whole frame. (See Section 5.3.3).

Current developments of flat screen displays cover a wide range of techniques. Corporations known to be doing such work are Burroughs, Hughes Aircraft, Northrop, RCA, Texas Instruments, and Westinghouse. The developments are differentiated by the illuminating technique used for the picture elements. They include liquid crystals, plasma, electro-luminescence, light-emitting diodes, and a system involving a flow of electrons through a binary system of openings in a series of glass plates with secondary emission maintaining and increasing the flow until it reaches a phosphor-coated surface. Generally the materials used are not costly but the circuitry required to excite each element represents in fact an enormous integrated or thin film circuit with the extremely difficult production problem of uniformity over the whole area. Hughes Aircraft has produced a 100 x 100 picture element display using undegraded circuit technology and Westinghouse a 240 x 240 picture element display using thin film.

Expectation of successful development of large flat screen displays range from its being just around the corner, that is within the present decade, to feeling that no technique now being studied is likely to be the answer and that some invention not yet visible on the horizon is required. The present status is that progress is slow, in spite of substantial funds expended by the military on its development. Among some active workers in the field, there is a feeling that the research is largely complete and the stage is set for starting the development. Others say it is not going to be easy for the flat screen display to supersede the present CRT techniques. Whether its advantages represent in the mind of the public an important improvement and whether it is capable of making an improvement or not may be judged from the pictures presented in Vol. II. Technically, the CRT is by far the most versatile piece of equipment for displaying all kinds of pictures and data. It has been developed to a high state of perfection both in its technique and method of production. Its versatility has been analyzed and well expressed by L.K. Anderson. (31).

An alternative to flatscreens is the optical projection of a small display. It is the only type of large screen display presently available. Two techniques of excellent quality developed by General Electric are based on the Swiss Eidophore invention. In this technique, a cathode beam carrying the picture information distorts the surface of an oil film. The distortions are converted into a visible picture by the Schlieren technique, well known in optics. The cost is low compared with some competing techniques for commercial application but still high (about \$45,000), far beyond reach of the average home user. Currently NTSC standards are used. Higher resolution display is apparent but currently limited by two main factors -- high resolution camera and the ready availability of telecommunication channels able to carry a wide frequency band.

Several projection techniques have been or are being developed for home use. Among them are Advent and the Japanese Sony. The Advent uses three kinescopes, one for each basic color, projected and accurately registered on a large screen. The Advent system is being marketed at a price of \$2700.(32) The Sony system uses a standard trinitron picture tube with augmented brightness. A critical problem of low cost projectors is adequate illumination of the picture. The public seeks a display than can be seen comfortably in a normally lighted room. Reports from those who have seen the Advent system in operation are very favorable and indicate the the illumination is adequate.

5.3.2 The Camera

The incentive for the development of high resolution cameras for TV lies in two principal areas -- the presentation of graphics and text on a television screen and the possibility that video tape will in due course replace film for motion pictures.

The overall impression had recently been that the development of the original design concept of cameras had reached a plateau, and either new materials must be discovered or new concepts attacked, if substantial improvements were to be made. A new and very promising approach has now appeared, and the plateau is likely to be left behind.

The history of the development of the television camera has continued at a steady pace since its earliest days with great growth in understanding of the complex mechanism of its basic operation, but no revolutionary advances. The one-inch vidicon and its later modification, the plumbicon which is now much used, have for many years, and are still doing yeoman service for the industry.

The basic limiting problems of high resolution electronic cameras arise after the photons from the picture are converted into electrons and produce on the "target" a distribution of electric charges which depicts the picture. The first problem is the tendency of the charge to spread laterally, reducing the resolution; the second is the focusing and the strength required of the electron beam to read out the charge at the speed required by television. In order to reduce lateral spread, the target is made thin. But the thinner the target, the higher the capacity and the longer the lag time -- the time to read-out. The higher the capacity the stronger must be the read-out beam and the more difficult it is to focus it -- a particularly demanding requirement for high quality television since high resolution already requires a small focus. These requirements are in conflict with each other, with the result that for a given type of construction an optimum balance appears to be reached beyond which it is difficult to stretch the performance without important compromises. One approach for higher resolution is to increase the area of the target, and indeed that is one path that practical units have taken. Targets have been increased from 1" to 2" in diameter.

It sounds simple, but it isn't. The practical penalties apart from cost are two: First, the reduction in the depth of focus for a given lens opening, and second, the size of the camera, which with a 1" target, is conveniently small for field use, but cumbersome with a 2" one. It is not only the size of the vidicon, but the associated optics, which seem to increase more than proportionately in overall size and required accuracy.

Amperex has in the laboratory a 2" vidicon with a resolution of nearly 1000 lines for 30% response and 1400 lines for 5% response. (33) It is still far from, but is approaching the goal of 1500 lines to compete with 35 mm film (34) (see Figure A1 of Appendix A).

Cameras with very high resolution have been built by RCA, reaching up to 10,000 lines and higher in the laboratory. NASA's Earth Resources Satellite carries an RCA Return Beam Vidicon (RBV) camera providing 4000 lines. But these units are not for rapidly moving scenes; they require slow scan read-out. Write-in is fast, about 1/200 seconds, but read out takes about 8 seconds. A comparison with high quality film showed Eastman Kodak having a film with a resolution corresponding to 10,000 TV lines and requiring about the same exposure of 1/200 seconds. In the case of film, however, there is nothing to correspond to the read-out time. This high quality film could be used for motion pictures, but is too costly for common applications.*

There are a number of companies marketing high resolution cameras able to produce up to 1000 scan lines or more for special purposes. Most of them can operate at the television rate of 30 frames per second. The pictures obtained are useful principally when there is need for high resolution of some special area. On the whole, however, they are poor except for special purposes; the noise is high, the contrast poor, and in an effort to display high spatial frequencies, high video frequencies are generally deemphasized, producing disturbing edge effects.

A really promising approach is based on the recent solid-state charge-coupled device (CCD) and the even more recent charge injection device (CID) which have the advantages of being small, having no vacuum and being operable

* For a thorough technical review of the whole field of television cameras the reader should consult reference (34).

from a battery, characteristics which are ideal for field use. A unit with a resolution corresponding to 1000 lines is reportedly planned.

This camera will probably be able to be held in one hand. The television picture which it will produce is likely to be recorded on tape which will have many times the volume of the camera.

Besides resolution capability and lag time, random noise in the output of the camera is particularly important, for nothing, not even pulse code modulation, can remove it. Noise peaks tend to bring some white into black areas and some black into white areas. The result is to reduce the contrast. Ultimately, it also reduces the sense of sharpness. In fact, any statement on resolution or the number of scan lines that can be developed should in some form include noise. In this respect, the above description has followed a common and misleading error of characterizing high resolution cameras by the number of scan lines without additional qualification. Sharpness depends on a combination of the number of scan lines and the signal-to-noise ratio. The figures quoted on the number of lines are not therefore strictly comparable. At this stage, there is no generally accepted standard. The problem is recognized and work is going on to formulate an acceptable common terminology.

5.3.3 Bandwidth Compression

The true measure of the capacity of a communication channel is not its bandwidth, but the quantity of information it can carry. The bandwidth used in transmissions involves a cost trade-off with other parameters of the channel and the limitations of practical equipment. It is often necessary or more economical, for instance, to increase the bandwidth in order to obtain a desired signal-to-noise ratio at the output.

A feature of picture transmission is the large amount of redundant information it contains. It may be necessary to include all or some of it in the output for display in order to be easily understood and pleasing to the viewer, but it may not be necessary to transmit it; it need not take up channel space. Information that need not be transmitted is of three types -- either it is redundant; or it could be omitted from the display at the receiver because it would not add to the appreciation or understanding of the message being conveyed, or the material omitted would not be significantly noticeable by the eye-brain complex.

There are two principal approaches to applying these concepts. A recent one uses a pseudo-random scanning technique, the other involves converting the analog display signal to pulse code modulation (PCM), processing the result in a variety of ways and converting back to analog.

The pseudo-random system is being marketed under the name of Sample-dot by General Electric. It is based on the limitation and special characteristics of the eye-brain complex. It depends on the inability to discern sharp edges of objects in rapid motion and the possibility of displaying stationary and slow moving objects in slow scan. The process is to cover the whole screen by a series of pseudo-random dots in a period of about one-half a second instead of the one-thirtieth of a second of the NTSC standards. The theoretical gain is about 16 to 1, the practical gain is about 4 to 1. The resolution of stationary objects is the same as with the NTSC standards. Most objects in motion are not visibly distorted. There is little difference, for instance, in the presentation of a football game with Sample-dot and with NTSC broadcasting. A major defect is a pattern that appears in the background produced by the "pseudo" part of the pseudo-random scanning sequence. A viewer becomes accustomed to that background and soon loses his consciousness of it. Currently equipment is being marketed providing a bandwidth reduction of 4 to 1, producing a good picture of NTSC standard quality except for a pattern in the background.

The PCM approach is based on reducing redundancy. It has been under serious study for a number of years by the Bell Laboratories, Comsat and others. The result to date indicates that good acceptable contrast and color balance, which would require nine bits of information by the routine application of PCM, can be produced with as little as 3/4 of a bit per picture element -- a compression of 12 to 1 of the normal PCM bandwidth. But the bandwidth gain compared with amplitude modulated TV is considerably less because of the increase in the initial analog to digital conversion. With PCM an additional bandwidth compression can be obtained because it can be traded for signal-to-noise ratio. When it is economically possible to reduce the signal-to-noise ratio substantial bandwidth reduction can be obtained.

A more detailed description of the Sample-dot technique of pseudo-random scanning is given in Appendix C and of the current status of bandwidth compression by PCM in Appendix D.

6. OPERATOR INCENTIVES

6.1 INCENTIVES FOR TELEVISION DELIVERY

6.1.1 Cable Television

The 20% a year growth of Cable Television was impressive, so was the success of large organizations such as Teleprompter in raising substantial sums from experienced financial sources, so was also the large number of applications on file with the FCC to build Cable Television -- or so it appeared in 1971. A major incentive was undoubtedly the expectation that fortunes awaited the owners of good franchises. That the early acquisition of franchises is an important incentive is confirmed by constantly repeated examples of opportunities missed in the early days of television broadcasting. The cable industry is receiving a high degree of attention because of the belief in its potential not because of its size -- today, 1974, the total volume of its business is less than \$600 million. The rate of growth seems to have decreased to a little over 11%, indicating still considerable strength (particularly in view of constraints to this burgeoning industry by high interest rates) and local and FCC regulations. Its leaders are rapidly learning its special problems, are becoming more wary in selecting franchises; they have actually given some up.

Notable is the continual growth in those areas where broadcast quality is poor and the number of available programs small. In the cities, the penetration of Cable Television has been a disappointment to the operators and is particularly difficult to develop at this time because of the large amount of capital required. We can probably expect Cable Television to reach a point of saturation in areas where it is currently expanding within the next few years. It is difficult to foretell its near-term future in large cities. The glamorous concept of the wired city appears to be a long way in the distance. A still unknown potential is pay TV which might well prove critically important to the full evolution of Cable Television.

The evolution of this industry is of particular importance to the present study because of the ways in which new types of programs and new telecommunication services are commonly expected to enter the homes is through CATV. The introduction of additions to the present fare and services of television may depend heavily on the growth and profitability of Cable Television.

Much of the current expectation of Cable Television lies in the anticipation that the distribution of remote broadcast programs will stimulate customer interest in programs of special value to limited

audiences, as well as provide a host of special services designed to make many routine chores simpler, more efficient, and in some cases less costly. Some persons interviewed directly connected with Cable Television were very optimistic about rapid growth in these areas, visualizing the manufacturers of Cable Television components being overwhelmed by the sudden demand for equipment as soon as a few pilot experiments have demonstrated the potential public demand. Others on the fringes of the industry were skeptical, raising many questions regarding the cost of special programs of interest and quality suitable for limited audiences, and the effectiveness and cost of two-way services. In addition, there is the natural reluctance of many toward anything new until others have led the way and, possibly more important, the competition of other means for providing some of these same services.

A form of service which has been suggested as particularly well-suited for Cable Television may appear in over-the-air broadcasting, and if it does, might inhibit its application by Cable Television. It is being sponsored by the BBC CEEFAX. It consists in transmitting special messages simultaneously with a television program in such a manner that the viewer of the program is now aware of its existence. A brief outline of the process is described in Part 1 in the next section.

Several pilot studies are in preparation. They may, however, be difficult to interpret in terms of predicting public response in a real life commercial environment, when experimental money, experimental interest, and talent and the ambience of innovation are no longer present, and when these are replaced by normal profit-dependent management. There is a tendency to consider a pilot operation as a stage of development because the research has been completed on the hardware. But actually a pilot study is the research stage of a social experiment. One can project that stage into the real operational stage, but the reliability is poor and few studies analyze the nature and extent of its unreliability.

It is particularly difficult to make a prediction of expected operation from the pilot or research stage because the effective environment extends beyond the geographical boundaries of the pilot test. The operational environment will include and is likely to be greatly affected by the quantity and quality of available programs -- something extremely difficult to predict.

The current consensus seems to feel that there will be a steady evolution from the interest in the availability of broadcast programs of better than over-the-air quality to something approaching the concept of the wired city. The basic value of wide band cable, however, is likely to remain focused for a long time on its ability to deliver television programs. It could be in a unique position to extend this

value for purposes other than entertainment to services which need television, but require some other facility besides one-way television. For services which do not require television the situation is different, because some form of competition is likely to exist, and cost can then be expected to be the dominant criterion of public acceptance.

Whatever its initial problems, cable television has appeared, and is likely to grow and play an important role in the telecommunication field. It is well set to fill an important gap in the national telecommunication complex. The telephone network, which in due course will probably include picturephone, is a highly complex switching system, having the ultimate objective of everyone being able to communicate with everyone else. Switching, with its associated needs, is the principal cost of the telephone system. At the other extreme, is broadcasting, which requires no switching except to the extent that it uses the telephone system. Until Cable Television appeared there was nothing focusing its attention on an in-between service, a service which would provide a limited amount of switching. One would expect Cable Television to find its place in the national telecommunication complex by becoming expert -- financially, managerially, commercially and technically -- in this in-between area where it can provide a service more cheaply than can the telephone company, and more complex and more personal than can the broadcasters. Many aspects of the wired city concept fit this role. Some over-optimistic enthusiasts of this broad concept see a ready expansion from the present economic backbone of Cable Television of providing good broadcasting type of service where it is now poor, to the multi-service concept of the wired city.

A substantial number of studies and a host of articles and papers have appeared on the prospects of broad band cable operation, covering expected costs, growth and expansion into services beyond the basic one of better-than-over-the-air television. Eleven of these studies are listed in references (35 - 45). It was beyond the scope of the present study to analyze these and other reports but some general impressions were developed.

In seeking how the wide band capability available in a cable can be used, impressive lists of home services not currently available have been drawn up. Many of these services take up a negligible amount of the available bandwidth; cable may not be particularly well suited to them compared with other modes, including for instance the television network or even the unglamorous, but for many purposes quite effective, mail service. In developing such lists, the competition of other modes has not always been adequately considered.

In the technical area, the limitation to the area served from a cable head is the number of amplifiers that are needed along each radial to keep the noise down to acceptable limits. When the amplifiers are operated at a high signal level, the noise is low and the cross-modulation high. The length of cable that can give good service depends on its size -- the smaller the cable the greater the loss. The greater the loss the greater the number of amplifiers needed. A rough rule of thumb for currently available equipment is about 30-35 repeater amplifiers, giving service for a distance of about twelve miles. Pulse code modulation would open the way to removing the technical limitations to the size of the area which could be served, but the cost of conversion from analog to digital and back is today prohibitive.

In the non-technical area of program production, there is little indication that the public will be attracted by poor acting and poor direction. Good acting and good direction are costly; even local news and sports require talent for effective presentation. Many special programs are likely to require substantial audiences to pay for the quality likely to be demanded. They can be expected to need complex organizations and costly overhead to reach adequately large audiences through many cable organizations. As regards talent, the opinion has been expressed that there exists a supply of undeveloped talent, particularly in universities. Perhaps CATV will bring them to light.

In the assessment of the economics, costs are divided into two groups: the cost to the operator and the cost to the customer. The sum of the two is a measure of the national resources consumed, but for the marketplace the two costs have to be considered separately. There is a tendency to analyze in detail the cost to the operator without comparable attention to the cost to the customer in the way of special equipment, its upkeep and the services that must be provided for its operation.

Two other great unknowns studied by Barnett, (43) are the legal controls and the political environment with the federal, state and local levels of government directly interested. There is little doubt that much of the future of CATV lies in the interlocking hands of governmental institutions.

The industry has undoubtedly a great, publicly important and interesting future. If some of the expectations expressed in many quarters are to come about, large investments will be involved.* Its

* The British "Report of the Television Advisory Committee 1972" of the Ministry of Posts and Communications estimates the capital cost of 96% market penetration for a six channel network for Great Britain at \$1.2 billion (~~£~~500 million), and a 24 channel at \$3.7 billion (~~£~~1.5 billion) at \$220 per outlet. The corresponding capital outlay for the United States for 60 million hours at the current estimate of \$400 per outlet is of the order of \$2.5 billion.

leaders seem well aware of the conditions and risks they are likely to face.

In the small fraction of the literature roughly perused, the focus was almost completely on the operator, on his technical and economic problems. The cost of equipment to the customer was referred to, but little was found on assessing his needs and aspirations, on the importance to him of the quality of the picture, on the importance to him of picture quality and specialized programs, and the numbers of viewers that would be attracted. The psycho-physics of picture quality can now be measured; perhaps past and current studies, records of ratings of special television programs and their distribution, and the results of pilot experiments might provide more objective estimates and a better understanding of the amount, distribution, and nature and demand of the interest in special programs and the cost of providing them.

6.1.2 Over-the-Air Broadcasting

Over-the-Air Broadcasting is perennially faced with the VHF/UHF fact that operators like VHF and do not like UHF, with the result that VHF is densely populated with broadcast stations while at UHF many spaces go begging. Can something be added to the UHF service to make it more attractive to the public and therefore to the operator? Is there some public need which requires broadcasting to satisfy it?

An example is the British Broadcasting Company's CEEFAX. Another possibility of similar type is to introduce a TV frame containing some specific type of information at convenient breaks in a program when an interruption of one-thirtieth of a second would not be noticeable. The viewer with suitable equipment would be able to "grab" a frame of special interest to him and retain it on his TV screen for as long as he needs it. The Mitre Corporation has worked on developing such equipment for educational purposes. (46)

Then, there also is the possibility of higher picture quality than is presently available while still retaining compatibility. Increasing the bandwidth is fraught with excessive difficulties even in the relatively sparsely populated UHF band.

The possibility represented by the radical decrease in bandwidth by pseudo-random scanning demonstrated by General Electric's Sampledot (see Appendix C) opens up a totally new perspective to television and possibly to television broadcasting. High quality television with large displays such as those depicted in Volume II becomes a real possibility not only for Cable Television but also for broadcasting. With bandwidth compression of 10 to 1 and probably more, such displays could be provided without reduction of the present service areas. Alternatively many more stations with narrow bands could be introduced into the present spectrum space with today's quality.

Thus, there appear to be many important and and yet untouched values. It is clear that the whole field of television and its spectrum allocation will soon need to be serviced.

Perhaps a review of allocation and regulation of the UHF television band would represent an opportunity to consider the field, to analyze in more detail and more accuracy the needs and aspirations of the public, to ascertain which of these the broadcasting technology could provide and whether incentives can exist, or be made to exist, for the operator to become interested in providing some of these services that are found to be of special interest to viewers.

Regarding present operation, studies have predicted continued increase in broadcasting advertising in spite of the rapid growth of CATV. While CATV advertising has been predicted to increase from 17 cents to \$36 and \$60 per home by the end of the decade, for broadcasting it is predicted to increase from \$60 to \$100 per TV home. (47) Such predictions are classically unreliable; they indicate, however, with reasonable confidence that present broadcasting operation will not suffer financially by the introduction of CATV. While there may be an overlap, CATV is likely to, and hopefully will, provide a service which the public aspires to and needs, but is one which is not of major commercial interest to broadcasters.

6.1.3 Picturephone

As television is likely to become more common for purposes other than entertainment, so the demand for its application is likely to spread to many services, and the willingness of the public to pay for it can be expected to increase. An initial trial of associating television with the telephone did not develop a serious demand, but the concept is still alive. Picturephone is receiving substantial attention in the research program of the telephone company. The emphasis is on narrow bandwidth and digital modulation for long distance transmission while maintaining the low cost of the terminal equipment.

Some interesting preliminary psychological experiments have been made in England by Alex Reid on the differences of communicating face-to-face, by telephone and with the support of picturephone. The differences were apparently great enough to be noticeable, how significantly so it is difficult to judge. (48)

6.1.4 Other Emerging Systems

The most interesting of emerging techniques is General Electric's Sampledot. Only very recently has it been offered on the market; at present it is being sold mainly for the purpose of checking its applicability to a variety of operations.

It is too early to foretell the outcome of this development. Its sponsors view it as neither technically nor economically feasible to use the system as it now exists for entertainment because of the visible background pattern the pseudo-random scan produces. The future, however, should not be so limited. The background pattern is visible because the light intensity from each element of the picture decays gradually during the period of half a second between the time it is excited. If this defect can be solved, the scanning raster can be designed to produce maximum reduction in bandwidth for the particular application, depending on the amount of detail required for rapidly moving objects to be visible.

It would be surprising if no one found how to remove almost all of the background defect. A possibility lies in the development of a flat screen display in which each element is excited by a network of cross wires, so that each element is selected by applying voltages on two wires crossing at the element to be excited. A scanning is achieved by switching the voltages from one pair of crossing wires to another. Today, switching can be carried out in a time negligible even in terms of television or scanning speeds, so that the time required for illuminating each picture element is pseudo-random fashion is only a fraction of the time which is required at the present time by scanning with the cathode ray of a television tube.

6.1.5 Video Tape and Disc Player Systems

Standardization is likely to be important to the budding industry of video player systems. Some feel that its existence depends on the way the problem of standardization is met. As of late 1974 it was reported that there were 20 video-player systems under development, and 8 or 9 had been publicly demonstrated. (49) All of these produced as good or better pictures than the average over-the-air broadcasting. But few of them were able to use video software designed for any other. This condition is an excellent example of the need from the point of view of the public for a sound balance between the innovative benefit of freedom of design on the one hand and the economic loss, due to the lack of standardization on the other. The need for standardization is becoming evident in the relatively new technique of helical scan for video tapes, the economic advantage of which is being recognized for professional application. Its evolution is likely to be seriously handicapped by the wide diversity of standards that has arisen because this field has stimulated considerable commercial interest.

Although video tape recording (VTR) has been a commercial reality for some years, it has not yet become a consumer item. There are a number of firms -- primarily Japanese -- producing both the Sony U-Matic 3/4" tape cassette system and the Electronic Industries Association of Japan's 1/2" cartridge system. Added to the confusion are one-inch systems, 1/4" systems, and systems using 8 mm film. The drawbacks are

the expense (\$2000 up) of the VTR systems, and the number of mutually incompatible systems on the market.

Standing in the wings, waiting for the economy to justify a new consumer product in the \$500 category, are television disc recording. A number of systems have been developed. The two prime systems are RCA's mechanical pick-up, similar to a phonograph, and the joint Phillips-MCA laser play-back system. Each system offers about 30 minutes of play-back for each disc, each disc probably costing around \$10.

The timetable, barring economic considerations, calls for production of the disc systems in late 1975 or early 1976, whether the two prime systems are then compatible or not. MCA says they have more than 11,000 movie and TV titles available and at least one cigarette company has considered publicly the idea of giving away 10 minute entertainment discs containing commercials.

The problem of standardization for the disc is likely to be as important as it has been for the tape.

6.2.1 Local Distribution

Until recently, local distribution was almost exclusively the province of the broadcaster. Three other modes have become practical: CATV directly to the home by cable; video tape, by mail or by local recording of programs transmitted by broadcast or other telecommunication means; and by the microwave non-directional multi-point distribution system now allocated in the 2150-2160 MHz band. (50). A fourth mode which might be technically possible, but seems at this stage to be administratively impractical, is direct broadcasting to the home from satellite. The satellite situation is discussed in Section 6.2.2.1.

In considering high resolution TV, the research approach has been to convert the television signal from its original analog form into digital for efficient long distance transmission to local distribution centers and then converted back to analog for short distance local distribution. The cost of digital to analog converters is likely to be too high for a considerable time for the home subscriber, so that the conversion would have to be carried out at the cable head from which they wide band analog television signal would be transmitted to the subscribers. CATV should be well-suited to provide this service, because the service conforms to CATV's basic function of providing service with a network of relatively short cable lengths.

The local use of video tape players as a competitor to cable and broadcasting is still an unknown quantity. Several companies are active in the field. The present status has been described briefly in Section 6.1.5. No effort has been made in this study to obtain opinions of the effect of this competition on over-the-cable and over-the-air broadcasting.

6.2.2 Long Distance Distribution

Transmission over long distance of television programs is in four modes -- the mails (video disc and tapes), cable, microwave networks and satellites.

The technology is able to provide wide band channels for long distance transmission. Their easy availability, however, is a management decision stimulated and controlled by the demand. Because of television and the demand for its transmission over long distances, channels with a bandwidth of about 5MHz are readily available. Any operation requiring even a slightly wider band, such as is needed for some large projection displays of television is limited by the unavailability of wider band channels. It may become practical in some cases to design a converter which would provide the increased quality within the same bandwidth for purposes of transmission, to be converted back for display with NTSC standards.

6.2.2.1. The Communication Satellite

Of the three modes for television broadcasting, the communication satellite is the only new one for which the potential is very uncertain. Many suggestions have been made for its use. One of its aspects is psychological; its glamour colors the views of those who seek to use this mode. In such cases there is a tendency to become an advocate of the technique rather than of its purpose, to seek "what the satellite can do for me," rather than analyze the needs and desirable communication performance, and study which of the alternative modes would be most suitable.

The place of the communication satellite in the telecommunication of the future may be of great importance. The distribution of population in the long range future will be different from what it is today. Certainly, it is not static. The change may be radical; there are opinions but none backed with confidence. Telecommunication is likely to have considerable influence on the direction it takes. We do not know whether the concentration into a few megalopoli is likely to continue indefinitely or whether the associated pollutions of all kinds will force dispersion. Intuitively, the general feeling is that dispersion is desirable, but in two key areas that affect population distribution -- communication and transportation -- the economic demand of daily activities tends to accelerate the current move from low to high density areas; the private sector responds to it, the public sector not so completely. The visible trend today is for more concentration.

The attractions of the city for many are the variety of opinions it offers in business, employment, education, culture, purchasing, entertainment. Many of these options could become available over broad areas by means of telecommunication. Transmission of pictures and text of various kinds, generally requiring broad band service, is likely

to be essential. There are three modes possible -- the cable, microwave relay, and the communication satellite. Each has its economic place. The satellite has the unique property that it provides identical quality and quantity of service to all points within its service area. With satellites, rural and mountainous areas would receive the same number and quality of entertainment or educational programs as would the cities. This is a characteristic that would seem to have great potential for the future, and could in fact be an essential stimulant, particularly if a serious organized policy ever develops for the dispersion of the population. What would be desirable and what could be done in the next decade in view of the uncertainties of these future needs, the existing spectrum allocation and regulations, the international agreements, it is not possible to say. A study in considerable depth with the long range future in mind is clearly indicated. The question of the desirability and practicality of using satellites for bringing some of the values of the city to sparsely populated areas with improved quality of television has been proposed by Peter Goldmark and is under active study. (51, 52)

As already mentioned, some inherent performance characteristics of the communication satellite seem excellent for broadcasting. Probably most important is the cost of programs for sparsely populated areas. There population cannot pay directly or indirectly for good programs delivered by regular broadcasting or CATV. The service area of the communication satellite, being practically unlimited, would seem well suited to this purpose. Today, however, it is used principally for point-to-point communication.

The economic design of a satellite communication system requires a balance between the radiated power of the satellite, and therefore its cost, and the total cost of all the ground stations it serves. The higher the radiated power of the satellite the lower the cost of the ground stations. When there are thousands of ground stations, it is, therefore, economical to have high power in the satellite. In fact the optimum cost effectiveness of satellite power occurs when an increase in the cost of the satellite equals the resulting decrease in the cost of all the ground stations.

The low cost of ground stations, due in part to being able to use small antennas, is not obtainable without a secondary effect that limits service. Ground antennas of low cost stations are small; with small ground antennas the spacing of satellites operating on the same frequency band must be large, and the number of these satellites that can be so used simultaneously is, therefore, proportionately small. An optimum engineering solution involves a trade-off between the three factors -- the satellite power and its cost, the number of satellites, and the total cost of all ground stations. Thus, an important unknown element

in this trade-off is the number of satellites likely to be required in the distant future. The principal key to public acceptance, however is not optimum engineering cost effectiveness of the system, but the low cost of a ground station which any layman can operate.

System tradeoffs between satellite power and ground station costs are limited, however, by national and international regulations. Communication satellites for broadcasting may be operated in the frequency bands of 620-790 MHz (in the UHF band), 2.5-2.69 GHz, and 11.7-12.2 GHz. In the two lower bands the cost of a ground station is higher than it might be because the satellite radiated power is strictly limited by regulation; in the highest band the ground equipment is costly and the satellite power limited not by regulations but by the technology. These conditions operate to reduce the incentive for initiating a broadcasting-satellite service to the public.

On the face of these facts it might seem desirable to review the whole situation, having in mind the possibility of limiting the service to the United States.

For individual broadcasting to homes, a non-directional antenna in the home is out of the question because it must provide some gain to the system and it would limit the number of satellites operating on the same frequency. A small antenna with a broad beam, about 50 (say), however, might be practical. Individuals may be willing to pay an extra price for the antenna and front end of the receiver for the service they could obtain. Some imaginative design, which would require no technical knowledge or skill on the part of the homeowner, might emerge in an effort to develop wide acceptance.* The cost may not be very high, if large production were possible and if the frequency allocated was not too high. But in order to keep this cost down, high power will be needed in the satellite. This is not permissible except at the 11.7-12.2 GHz band where the equipment cost may remain too high for practical use. The incentives and prospects for the evolution of this kind of service can be said at this time to be far from good.

The possibility that it might be found to be truly valuable should, however, not be discarded. CCIR has issued an instructive report on the possible service of broadcasting satellites under current allocation (53) and Greg Andrus has analyzed the current status of high power communication satellites. (54) A computer program sponsored by NASA has been

* One suggestion for instance, optimistic perhaps, was a small adaptive receiving antenna array that points its beam automatically to the satellite from which the program is to be received, with the claim that it could be made very cheaply in large quantities.

developed and is available for evaluating broadcasting satellite systems.

Suggestions have been made for the 11.7-12.2 GHz band for broadcasting to share the band with fixed point-to-point services so that both high and low power satellites could be operated.

Initial considerations of such operations generally assume that satellite signals on the same frequency will not be received if they fall outside the main beam of a receiving station so that co-channel satellites may be spaced about two ground antenna beamwidths apart. This assumption is satisfactory for separating satellites radiating about the same amount of power, but breaks down when they are of considerably different power. For economical broadcasting the satellite power might be very large. For economical broadcasting the satellite power might be very large, so that ratios of power between satellites used for different purposes on the same frequency could be as large as 20 dB or 30 dB or even more. In that case the ground station used for receiving the signals of the low powered satellites would appear to be almost non-directional to the signals from the high powered ones.

Putting aside the possibility of individual satellite broadcasting to the home, one can turn to satellite transmission for simultaneous reception to communities and to a large number of centers for local distribution of programs. This possibility is very much alive. Thousands of such ground centers may be required for various purposes. Entertainment and education are the principal contenders. Optimum system design under those circumstances is likely to require high power in the satellite. The designer and the operator would be happier with frequencies lower than the 11.7-12.2 GHz band. The power within this band is not limited by regulation, but it is by the technology. The limit is currently about 1Kw and may be raised shortly to 2 Kw. (55) This band is also shared by other services with the danger that sharing might in due course cause the power to be limited. However, in Docket No. 19547, the FCC is likely to so set the regulation that high power will be permissible for broadcasting.

6.2.2.2 Long Distance Ground Communications

Technology has continually increased the bandwidth of long distance communication channels. The coaxial line originally carried black and white TV on about 3.5 MHz bandwidth. It was increased to around 5 MHz with the advent of color. Microwave relay because able to carry 1800 voice channels.

Ready for pilot operation is the 18 GHz relay having a bandwidth of 2 GHz able to carry about 30,000 two-way voice channels. The millimeter wave guide, also ready to be tested in a pilot installation, has still wider bandwidth, its bandwidth is 70 GHz in the frequency band from 40 GHz to 110 GHz.

It can carry 230,000 two-way voice channels. With these operations in the offing there does not appear to be any serious question of being able to transmit all the wideband signal likely to be required for a long time to come. Simultaneous with this advance it seems that the bandwidth required for television will be radically reduced in the relatively near future.

There is clearly no lack of technical alternatives. Which one to use in any particular case is a matter of the cost effectiveness including the value of the spectrum space occupied.

6.2.2.3. The Mails

Vehicle transportation is not the most glamorous form of communication, but where it can be used it is nearly always the cheapest. The transmitted message can be in the form of hard copy, a disc, tape or film for audio, video or data. For those cases, and there are many, where real time communication is not required or where time has little value, it could be expected to remain for many years more economical than telecommunication.

In many instances the mails seem to be an economical alternative for transmission of television using video tapes rather than telecommunication. An application that comes to mind is education, where real-time delivery of a lecture or demonstration is seldom important, and the need for two-way student teacher communication can often be delayed or satisfied locally. Real-time two-way communication over substantial distances can be effective between student and computer, (56) but is often limited between student and teacher because of the large number of students involved.

6.3 INCENTIVES--TOWARD MANY SCAN LINES

6.3.1 Display of Pictures in Motion

The photographs of volume III show that the improvement derived by increasing resolution beyond the NTSC standards is noticeable, but not enough to create a significant demand. It is only if large displays are contemplated that increasing the number of lines might become

sufficiently important to stimulate a serious demand. There are several factors that may cause such a demand to appear.

First, there is a strong consensus, almost unanimous among the persons contacted, that more lines than 525 will become available sometime, somehow. Some seem to take it for granted that they will. There is, however, no sense of urgency. This attitude represents a strong force for the ultimate development of large screens with high resolution.

Second, there seems to be a strong preference for large screens in the home, certainly larger than those of today's sets. The best viewing distance might however, be too great for a home with a system providing only 525 scan lines. Possibly a different aspect ratio and greater horizontal resolution may prove to be important. Psychological tests will be able to show the extent to which larger screens and a greater number of lines are preferred, including the desirability of presenting the area surrounding the main action of the scenes and giving the viewer an impression of being within the scene he is looking at. How a large screen might look in a home is depicted in Volume II.

Third, the color television market is approaching saturation, putting pressure on receiver manufacturers to develop a market for a new generation of receivers and a new system of television.

Fourth, there has been a growing interest, particularly in Japan. Japan submitted in December 1971 to CCIR study groups (Document 11/31-E) a Proposal for a New Study Programme - High Definition Television. The proposal was approved by Working Group 11-A in July 1972 (Document 11/170-E).

Fifth, there is much development and research work in progress on components which would be needed. Flat screen displays are being researched and developed by each of the three services of the Defense Department for their command and control displays; although their needs are very different from those of commercial television, much of the technology could be transferred to the latter. Techniques for bandwidth compression are being researched by Bell Telephone Laboratories, Comsat and others using pulse code modulation (PCM) and by General Electric using pseudo-random scanning.

The design of wide band cable is well advanced and still advancing. Interest in the development of high resolution television cameras is active, stimulated by the economically interesting possibility of video tape replacing film for motion pictures. When all these components have been developed sufficiently to be readily combined into an operating system and the competition has shaken out the less satisfactory alternatives, industry may well be expected to convert what is now a vague public aspiration for larger screens and high resolution TV in the

home into an active need, or at least an important status symbol. While the evolution of some components is developing faster than might reasonably have been expected, the full development of a working system for the home is many years in the future, certainly more than a decade.

Sixth, theater displays requiring very large screens may make their appearances in due course in competition with motion pictures. (The resolution of 35 mm film is estimated to correspond to 1500 television scan lines).

Seventh, 525 lines are inadequate for reading text except for short paragraphs and titles. Professional and business requirement may establish a need. That need, however, might be satisfied adequately with slow scan.

Eighth and last, there is the special and important psychological value of perfection. Something not far from what could be considered near perfect might well become available in the quality of an image on a large screen. Something that strikes one as close to perfect leaves in one's consciousness a special often uplifting and lasting impression.

This feeling of seeing something close to perfect is supported by several practical experiences. The marketing of Kodachrome film, for instance, was delayed because many in Eastman Kodak held the opinion that people were interested in a picture of the baby or of a vacation scene, but not in its quality, and they were not likely to pay the higher price. When eventually Kodachrome was put on the market, it developed into the best profit-maker of the company. The experience that followed has generally been expressed as demonstrating the special value of truly high quality -- a desire for more of the same. In connection with Disneyland and Disney World it is probably not so much the concept of their size, but the perfection of the implementation that is the principal reason for their success. These examples indicate that the current trend of seeking to increase profits by reducing quality are actually counter-productive.

Intuitively, it seems that an approach toward perfection may have public value economically and psychologically over and above -- possibly considerably above -- the simplistic, immediate sense of preference.

6.3.2 Stationary Display

The application for the presentation of graphics are numerous, covering a wide range of display requirements. Current home television is satisfactory for short paragraphs or titles. The need for viewing computer outputs and reports on demand with negligible delay is growing.

It must be remembered, however, that the common written or printed material is an excellent medium for communication and that the telecommunication of text does not represent for the written word as big a step as did the telecommunication of the moving scene. In fact, while the display of graphics will assuredly become important in many applications, it is likely to require in most cases to be accompanied by the ability to produce hard copy. The technology of the written word of hard copy, is not standing still. Already microfilm is much cheaper compared with paper, more rapidly produced and duplicated, easier to store, less costly to mail, the information more easily retrievable. (57) The only reason it does not supersede paper is that it seems less pleasant to use. Perhaps in part that is because we have not yet become accustomed to it.

Eventually, there is likely to be the development of the concept, yet only vaguely visible, of the "library without books". Its implementation, however, seems to lie a long way in the future. It will first be necessary to develop a retrieval system which is effective, simple and broadly adopted. There are many ideas, but no consensus seems yet to be forming.

6.4 PUBLIC SERVICE APPLICATIONS

Health delivery, education, library service, "culture" activities, law enforcement, governmental announcements, etc., are services that have been and are likely to be increasingly supported by subsidy. The financial support to the introduction of television to these services may follow the same pattern. Part of this subsidy is taking the form of imposing a burden on the operator by requiring that he make certain of his facilities and services available for certain purposes. Some other special service may become candidates for subsidy or operator-imposed burden.

Public subsidized services present very different administrative conditions from those of the profit-dependent services to the public. Competition seldom exists, in fact it is frowned upon, being called "duplication"; the principal concern is more political than economic; the attitude of management is totally different, accountability being on performance rather than profit, on political rather than marketing

expertise. These differences often put a special and difficult burden of responsibility on the allocation of communication facilities where these are limited.

Health delivery, education and some special service areas are briefly covered in the following.

6.4.1 Application to Medical Practice

The importance of television in medical practice is tied to two characteristics of the discipline -- specialization and diagnosis by expert judgment. The field is so broad that specialization is inevitable, the science so complex that diagnosis must involve a considerable amount of judgment. This judgment is learned by practical experience and takes into account an enormous number of complex factors, two of the most important of which are the physical appearance of the patient and the assessment of X-ray photographs. In short, effective diagnosis and treatment often require visual examination by specialists.

For these reasons, television seems bound to play an important part in future medical practice. It will probably be recognized as critically important in view of the enormous increase in demand, particularly in the less densely populated areas of the country where specialists are few and far between. (58,59)

In the relatively few places where television has been regularly used it is generally reported that it was started with over-enthusiastic expectation and, like any such glamorous new tools, those who used it found that it was indeed very useful, but its effective application required experience and the understanding of its limitations. Those who are in the waiting line tend to feel that they are being deprived of a key, if not the key, to their many problems.

Although the medical field was suggested by many as likely to be a prime application area for high resolution than the present NTSC standard, with surprising unanimity the eleven technologists and medical practitioners contacted stated clearly that they saw no need for more resolution than was now available except for one area -- the transmission of text. There were much more concerned with other characteristics. In order of importance these were signal to noise ratio, contrast, and color. In those cases where enhancement techniques, similar to those developed for the military and space agency to bring out outlines, have been tried they have proved more effective than increased resolution. In any case, increased resolution can generally be achieved by zooming on any area of special interest.

As regards assessment of X-rays, there is sometimes the need to identify very fine lines. It was pointed out, however, that no physician would make a difficult diagnosis without examining the original photograph regardless of the quality of TV transmission. It is very rare that the urgency is such that mailing it would not be adequate. A test of the effectiveness of assessment of X-rays was carried out in Boston; diagnoses based on the original photographs of 100 X-rays were compared with diagnoses based on their video transmission. The result: 100% correlation.

A few medical practitioners left open the possibility that there might develop a need for greater resolution than 525 lines permit, but in no case was there serious expectation that this would occur.

In summary, all the practitioners considered that the 525 lines standard was adequate except for the transmission of text, but that improvement of average TV quality should and could be drastically improved.

6.4.2 Education

Education is a field where telecommunication is likely to prove very important. While the total national expenditure is about \$90 billion a year and is increasing rapidly, parents are seriously concerned about the quality of education and the behavioral problems of drugs, violence and the radical change in moral standards. The whole field is in turmoil and will undoubtedly undergo important changes. Attention turns to what technology can do, and much of the focus is on the application of television for two purposes: to increase the productivity of the teacher, which has remained surprisingly static, and to improve the learning process of the student. In discussions these two purposes have not always been separated, making it difficult to gauge the specific benefits of television.

As stated elsewhere, there seems to be no demand at this time for high quality TV, but there were complaints about the generally poor quality of the picture that they were often much poorer than could reasonably be expected. The whole area of education is in such an evolutionary state that it is impossible to foretell what real demands are likely to develop for television. An overview follows of the type of demand being made and the current pattern of evolution.

Many educators intuitively feel the need for television. The requirements can be divided into two parts, real time and delayed presentations. Real time is generally required in order to multiply the classes a lecturer can address and still give the students some sense of his presence. It can be provided by broadcasting or cable.

Delayed time presentation is used to aid the learning process by means of recordings. These can show the teacher or can be used to support him, to plan ahead for his lecture the material that he will want to use. One can imagine his having at his disposal a local library of tapes and records and also being able to call on a larger central library for subjects less frequently required. Suggestions have been made to broadcast lectures or even full courses, allowing local teachers to receive and record them for their local library. Whether the distribution of tapes is best carried out by telecommunication such as cable, satellite or broadcasting or by mail seems to be a matter to be decided by comparing the cost effectiveness of these alternative modes in which the cost of administration, the centralization versus the dispersal of recording facilities and the reliability of having a desired material at the desired time are taken into account.

There have been many pilot studies in the use of television to take care of overflowing classes, to provide several simultaneous classes at a distance, or to increase student interest. In some cases, the transmission was one-way TV, in other a telephone return was provided to permit some student-teacher interaction. These studies have shown various degrees of success; in that the grades of students so taught have usually advanced about as much as with regular teaching routines, sometimes somewhat more. For many reasons, it is difficult, however, to measure the true benefits of these experiments.

There is a natural tendency to extrapolate the experience of a limited pilot study into a program for supplying a rounded education. Such extrapolation is subject to many uncertainties, which require careful study before taking non-reversible action. The FCC has in effect ruled on the limitation of broadcasting in this regard when it stated that "broadcasting is not suitable for specific instruction." (60)

Considerable educational interest is currently directed toward using telecommunication to give students more freedom in their learning process, dropping the "lock step" of current education in which every student must synchronize with the whole class and with the teacher in time, location and subject matter. The trend is to permit students considerable selection in what they study, to allow them to do it at their own pace and at convenient locations, possibly at times in their homes. Two major programs in this area are being funded for development and assessment; the University of Illinois' Plato and Mitre Corporation's TICCITT -- to be evaluated by an independent assessor. Plato (56) does not use television; it uses a plasma display, suitable for text graphics. A large center computer is the key element of the system. Each student uses a narrow telecommunication band carrying two-way communication with a computer. A coaxial line such as is used for transmitting television has a bandwidth suitable for serving 1000 students working independently of each other. Plato has also produced

a noneducational by-product; it has stimulated the active development of plasma technique for general displays. TICCITT uses television. (46) Its operation depends on the transmission of a series of television frames each of which covers different educational material. A student "grabs" the frame of interest to him with a coded address as it passes, and keeps it on his television screen by means of a unit which "refreshes" the picture, maintaining it on his screen for as long as he needs it.

The two techniques represent extreme alternatives in the use of time and bandwidth. In Plato, each student uses a narrow frequency band for a long time, in TICCITT he uses a wide frequency band for a very short time (one thirtieth of a second). Plato has little redundancy in the display, but much in the signal in order to reduce the probability of error. TICCITT has much redundancy in the picture, as do all TV pictures, but little in the signal. The point that these two techniques exemplify is the different trade-offs; one has selected time and the other bandwidth to carry the information; one has selected the signal, the other the display to carry the redundancy needed for reliability. Particularly notable is the similarity of purpose -- freeing the students from each other in their learning process.

The two techniques have been preparing for nearly three years for field tests of their educational potential. But met important debugging problems in both software and hardware and consequent unexpected delays. The tests, sponsored by the National Science Foundation are expected to start soon.

Plato, TICCITT and other techniques indicate great promise for the future contribution that telecommunication in the form of displays can give to education. Its rate of development in this area will depend greatly no doubt on wise application in the early stages and the most economical form, including the telecommunication channel, suited to each educational subject, both for teaching efficiency of the teacher and the learning of the student.

6.4.3 Special New Service Areas

Two new areas may be candidates for subsidy because of excessive cost or the needs of those close to or below the poverty line. These needs arise in areas of very low density population which are poorly served by television broadcasting and are uneconomical for cable TV, and for low income groups that cannot afford the cultural type of service that it is hoped CATV will provide.

For the problem of the low density areas, a measure has already been introduced in the House by Representative Robert O. Tierman (D. R.I.). Senate Communication Subcommittee Chairman John O. Pastore (D. R.I.) has indicated his interest. The concept is to follow the successful pattern of Rural Electrification.

No public dialogue has been developed on the problem of service for the low income groups. For these, the present broadcasting system is ideal, since it involves NO direct operating cost to the viewer, except for the receiving equipment, but, if CATV develops to the point of providing good programs of interest to groups of limited size, the question might well be raised how to insure that some of these benefits become available to all.