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ABSTRACT

The Media and Technology section of these proceedings contains the following six papers: "The Effects of Tabular and Graphical Display Formats on Time Spent Processing Statistics" (James D. Kelly); "Program Choice in a Broadband Environment" (Steven S. Wildman and Nancy Y. Lee); "Visual Crosstabs: A Technique for Enriching Information Graphics" (James W. Tankard, Jr.); "The Influence of Statistical Graphics on Newspaper Reader Knowledge Gain" (Jeffrey L. Griffin and Robert L. Stevenson); "Tradition, Confusion, and Multimedia: Balancing Stability with Change in Setting Standards" (John E. Bowes and Scott D. Elliott); and "Regulating the Kaleidoscope: An Analysis of Policy in the Information Age" (Steven Dick). (SR)

PROCEEDINGS OF THE ANNUAL MEETING OF

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Part IX: Media and Technology.

The Effects of Tabular and Graphical Display Formats on Time Spent Processing Statistics.

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An experiment using a 3 X 3 X 4 fractional design tested the effects of display format (table or graph), data density (number of data points), and visual attractiveness on time spent answering questions about statistical information. The design counterbalances effects of stimuli ordering and individual subject differences while randomizing the effects subject matter of the displayed data. The dependent variable is the time a subject spends answering specific questions about the information while the data are in view rather than from memory recall.

Results confirm earlier studies that graphs are more accurately read than tables, but show an interaction between display format and data density. The interaction is such that tables are read more quickly when there are only eight data points but graphs are read more quickly when there are sixteen. Graphs were also rated as more attractive than tables and as facilitating more accurate recall from memory of overall trend information. Controlling for the effects of attraction level makes no significant difference in the effects of either display format or data density. The author speculates that unlike tables, graphs may be stored in memory as visual images that can be recalled and searched for answers to specific questions.

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The Effects of Tabular and Graphical Display Formats on the Time Spent Processing Statistics

Recent research on statistical displays in the mass media divide roughly into two distinct areas. One investigates the role of graphics within an overall story or page of various elements[1]. The other examines specific attributes of particular display formats—tables, bar charts, line graphs, etc. This study fits within the latter category in that it experimentally contrasts alpha-numeric tables with vertical bar graphs and examines the possible influence of visual attractiveness on the time required to answer questions about the displayed information.

Early experiments by psychologists compared text, tables, and graphs but findings were inconsistent and failed to establish a clear rank order for general effectiveness.[2] According to an extensive critique of research on statistical display by Stephen Kosslyn, the inconsistencies and contradictory findings of these and several other studies on graphics were most likely due to

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[1]For example, Steve Pasternack and Sandra H. Utt, "Reader Use & Understanding of Newspaper Infographics," Newspaper Research Journal, 11:28-41 (1990); Pegie Stark and Brad Hollander,"Information Graphics: Do They Help Readers Understand News Events?" presented to the Association for Education in Journalism and Mass Communication, Minneapolis, Minn., 1990; S. Shyam Sundar, Joseph Perkins, and Doff Zillmann,"Perception of an Issue as a Function of Info Graphics," presented to the Association for Education in Journalism and Mass Communication, Boston, Mass., 1991.

[2]John Noble Washburn, "An Experimental Study of Various Graphic, Tabular and Textual Methods of Presenting Quantitative Material. Part I," The Journal of Educational Psychology, 18:361-76 (1927); Launor F. Carter, "An Experiment on the Design of Tables and Graphs Used for Presenting Numerical Data," Journal of Applied Psychology, 31:640-50 (1947); and Magdalen D. Vernon, "The Use and Value of Graphical Material in Presenting Quantitative Data," Occupational Psychology, 26:22-34 (1952).

poorly constructed stimuli and problematic measurements of the dependent variable.[3]

However, two more recent studies by mass communication researchers have used well designed stimuli and reached similar conclusions regarding the relative merits of text, tables, and graphs. In both Feliciano, Powers, and Bryant[4] and in Wilcox,[5] results showed higher subject response accuracy for graphs than for tables or text. In the Feliciano et al. study, responses were made in the presence of the stimuli, but subjects in the Wilcox study answered from recall after the stimulus was removed from view. Both studies discussed, but did not measure, the displays' abilities to attract attention.

Still more recent studies[6] do specifically examine differential effects of various attraction features of graphs such as 3-D depth illusion, background illustrations, oblique presentation of pie graphs, and other artistic enhancements credited by their makers as increasing reader attention and interest. Both used accuracy of recall as the measure of cognitive processing.

But Kosslyn's critique argues that recall from memory of specific facts presented in stimuli as complex as a graphs is extremely problematic in that it

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[3]Stephen M. Kosslyn, and Steven Pinker with Leon Parkin and William Simcox, Understanding Charts and Graphs: A Project in Applied Cognitive Science (Washington, D.C.: National Institute of Education, January 1983. Text-fiche. ED 238 687).

[4]Gloria D. Feliciano, Richard D. Powers, and Bryant E. Kearl, "The Presentation of Statistical Information," AV Communication Review, 11:32-39 (1963).

[5]Walter Wilcox, "Numbers and the News: Graph, Table or Text?" Journalism Quarterly, 41:38-44 (1964).

[6]James W. Tankard, Jr., "Effects of Chartoons & Three-Dimensional Graphs on Interest & Information Gain," Newspaper Research Journal, 10:91-103 (1989); and James D. Kelly, "The Data-Ink Ratio and Accuracy of Newspaper Graphs," Journalism Quarterly 66: 632-9 (1989).

is too dependent on individual's reading and short-term memory skills.[7] Individual differences in these skills vary widely and therefore preclude reliable measurement of the display's attributes. Significantly, Feliciano et al.[8] and a study last year by Kelly[9] accounted for individual differences by using within-subjects designs which measured the dependent variable while subjects viewed the stimulus. In this way they controlled for individual differences, eliminated the memory recall task, and effectively answered Kosslyn's two primary criticisms.

Unlike Feliciano et al., however, Kelly measured the time spent reaching a response to a question as well as the accuracy of the response, and he measured display attractiveness. He found no difference in response time between tables and graphs, but both were read more quickly than text at the same level of accuracy. Subjects rated the attractiveness of the three display forms in a clearly hierarchical fashion where tables were rated twice as attractive as text, and graphs were rated three times as attractive as text.[10]

The findings do not so much contradict those by Feliciano et al. and by Wilcox as they do extend them beyond simple accuracy to notions of reading time efficiency and attractiveness. One possible weakness of the Kelly experiment is that response time may be inflated by the attractiveness of the stimulus, thereby masking" the efficiency of a graph over a table. In other words, subjects may look at graphs longer than tables simply because they are

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[7]Kosslyn, et al., op.cit., pp. 157-159.

[8]Feliciano et al., op. cit.

[9]James D. Kelly, "The Effects of Data Complexity and Display Efficiency on Time Spent Reading Statistical Information in Text, Tables, and Graphs, presented to the Association for Education in Journalism and Mass Communication, Boston, Mass., 1991.

[10]Ibid.

more interesting, regardless of statistical content or the immediate demands of the experimental task.

And Kosslyn speculated that because of the pictorial nature of a graph, a reader is more likely to form a picture-like mental representation of the display in memory that can somehow be accessed directly during recall of general themes.[11] Such imagery may account for occasional findings in the literature that graphs are better recalled than tables or texts, even though there is no apparent advantage when the data is visible during response.

Purpose of the Study

Although this study does not directly address the role of mental imagery in the processing of visual displays[12], it does test for differences in the ability of subjects to recall general trend information displayed in either a table or a graph (display format) from memory. It also tests for the effect of attractiveness on the response time of subjects using tables and graphs at low and high levels of information (data density).

A clearer understanding of the relationship between the two principal reasons for using statistical displays in the mass media (attraction and content)[13] should both improve the practitioner's ability to communicate and perhaps increase our general understanding of the human visual processing system.

Since the statistical information would be in clear view of the subject during questioning, and viewing time would be unlimited, it was assumed that

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[11]Stephen M. Kosslyn, op. cit., pp. 235-240.

[12]See Kosslyn, Image and Mind (Cambridge, Mass.: Harvard University Press, 1980) for an overview of the role of imagery in mental processing.

[13]Pasternack and Utt, op. cit.

neither display format nor data density would affect accuracy. Additionally, since tables and graphs are so prevalent in modern society, it was assumed that basic demographic characteristics would have no effect on any of the dependent measures.

Based on the limitations of short-term memory, the following hypothesis is made:[14]

H1: Response time will be shorter for questions asked of a display of eight data points than for a sixteen-point display.

Based on earlier findings regarding visual attractiveness of statistical displays:[15]

H2: Graphs will be rated higher on a visual appeal index than will tables.

To test for a possible masking effect of visual appeal on the response time:

H3: Response time will be shorter for questions asked of a graph than of a table when the visual appeal of the displays is controlled.

Based on the notion that pictorial displays are more likely stored as images than are alpha-numeric displays:

H4: Overall trend characteristics in the data will be recalled more accurately from graphs than from tables.

Method

The experiment used a 2 X 2 X 4 fractional design where the first two factors (display format and data density) are full factorials and the third factor (stimulus topic) is randomly applied. The four possible treatments of the first two factors (a table or graph of eight or 16 data points) were presented across

[14]For the classic discussion of short-term memory limitations see George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity For Processing Information," Psychology Review, 63:81-97 (1956).

[15]Tankard, Jr., op. cit.; and Kelly, op. cit.

the four levels of the third factor to counterbalance learning effects that would likely have resulted if all stimuli used identical data. Subjects were randomly assigned to one of four groups and were given one treatment per stimulus presentation. The order of the third factor was consistent across all groups, but the treatment ordering was determined by one of four 2 X 2 Latin squares. The effect of the third factor on either of the first two was thereby controlled through randomization. See figure 1.

The design counterbalances order effects as well as the effects of individual differences while randomizing the effects of stimuli characteristics. However, this "mixed" design means that first order interactions are confounded with the main effects of the other factor and are reliable only if it is additive and appropriate statistical correction is made.[16] Unfortunately, the factor used here (stimulus topic) is qualitative. Therefore, interpretation of the interaction between display format and data density is tentative.

Dependent Variables. Three dependent variables were measured. One (response time) was the length of time a subject took to read and answer five questions about the stimulus. Each question requested a different type of information.[17]

A second variable (response accuracy) was percentage of correct responses to the questions.

A third variable (display appeal) was the subject's score on an index comprised of six semantic differential-type scales selected to measure the

[16]See Everet F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Hougton Mifflin, 1956), pp. 292-297, for a complete description of the design.

[17]Questions asked subjects to identify of a specific value, compare two values, calculate a sum total, calculate a difference, and compare two sum totals.

visual interest or appeal of each display. The scales were interesting-uninteresting, dull-exciting, pleasant-unpleasant, weak-strong, appealing-unappealing, and unattractive-attractive.[18]

A fourth variable (recall accuracy) was the accuracy of a subject's response to each of four questions asking which of the displays had specific overall trend characteristics.

Independent Variables. The first factor (display format) was either a alphanumeric table or a vertical bar graph. The second factor (data density) was the total number of data points, either two variables of four values each (eight in total) or four variables of four values each (16 in total).

The third factor, (stimulus topic) was the subject matter of the stimulus. All were time series over four periods. The topics were: weekly wages of U.S. production workers, foreign investments in the U.S., coin production by the U.S. Treasury, and U.S. feed grain production.[19]

Demographic variables were subject age, gender, academic major (journalism or not), prior course work in graphics, grade point average, and whether or not subject "generally reads graphs in newspapers and magazines."

Subjects. Forty-eight subjects recruited from an undergraduate journalism course reported individually to a small, well-lighted room where a receptionist sat them at the computer. All who reported completed the procedures.[20]

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[18]With the exception of the sixth scale, this index is identical to one used to measure the appeal of statistical displays in Tankard, "Effects of Chartoons. . .," op. cit., pp. 95-96.

[19]The statistics used in stimuli were taken from The World Almanac and Book of Facts (New York: Newspaper Enterprises Association, 1991), pp. 117, 123, 129, 142.

[20]Subjects received extra course credit for participation.

Apparatus. A Macintosh LC computer with a 12-inch, high-resolution monochrome monitor running HyperCard software presented all instructions and stimuli, randomly assigned subjects to groups, and timed and recorded responses.

Procedure. All subject responses were made by clicking the computer's mouse on any one of the multiple-choice answers presented.[21] After an introduction and practice session, the first stimulus was presented along with a question and three possible answers at the bottom of the screen.[22] Upon response, another question and answer set replaced the first and so on until all five questions had been presented.

Question order was randomized. The computer recorded the total time spent reading and answering the five questions as well as the correctness of the responses. Then, underneath the same data display, an array of six semantic differential-type scales was presented and a cumulative score was recorded. The subject was then given an opportunity to rest and upon signal, a new stimulus with its attendant questions and scales was presented in identical fashion.

Once all four stimuli were presented, six demographic questions was asked and responses were recorded. Finally, the four questions about overall trends were asked, and subjects were debriefed.

Results

Overall, subject response differed according to both display format and data density.

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[21]All members of the class were familiar with a Macintosh computer and mouse because of previous course work.

[22]The actual black on white image was eight inches wide and six and a quarter inches high.

Preliminary analyses produced no significant effects for any of the six demographic variables on either response accuracy, response time, display appeal, or recall accuracy. Additionally, no significant effect was found for either experimental factor on response accuracy. These findings do little to challenge the stated assumptions.

With response time dependent, ANOVA was done where subject, display topic, data density, display format, and an interaction between format and density were independent. Subject, $F(46,52)=2.36$, $p<.0001$, and display topic $F(3,52)=17.69$, $p<.0001$, were significant but of no direct impact on hypothesis testing. Rather, they simply account for variance that would otherwise have been included in the model's error term.

Data density was significant, $F(1,52)=29.77$, $p<.0001$, but display format was not, $F(1,52)=0.00$, $p>.94$. This result confirms the first hypothesis that response time would increase as data density increased. There was, however, a significant interaction effect between display format and data density, $F(1,52)=4.16$, $p<.05$, where tables produce shorter response times at eight data points but graphs produce shorter response times at 16 data points. See figure 2.

To test for display appeal's hypothesized masking effect on the format's response time effect (the third hypothesis), the scores on the visual appeal index[23] were added as a covariate to the model just described. This covariate, however, was not significant $F(1,52)=.051$, $p>.82$, and the null hypothesis of no difference could not be rejected.

The Student's t-test was used for the testing the second and fourth hypotheses. Display format's effect on both the visual appeal score, $T=9.85$,

[23]Cronbach's alpha for the four stimuli ranged from .92 to .95.

$p<.0001$, and on the accuracy of display recall, $T=2.79$, $p<.01$, was significant, confirming both hypotheses. Subjects rated graphs as more visually appealing than tables (mean score for graph=29.6, for table=19.4; possible range from 6 to 42). And subjects were also better able to recall which of the four displays exhibited the requested trend characteristic from graphs than from tables (mean score for graph=.745, for table=.553; possible range from 0 to 1).

Discussion

The significant main effect of data density on response time confirmed the first hypothesis that time spent answering will be longer for 16 data points than for eight.

However, the interaction of data density and display format was also significant. Tables yielded shorter response times than graphs when there were just eight data points, but graphs performed more efficiently when there were 16 data points. This suggests that professional practice guidelines cautioning against the use of bar graphs for large data sets may be overly conservative.[24] Not all tables can be rendered as graphs, but when possible it may well be best to do so, even with fairly large amounts of data.

The effect of attractiveness was less clearly evident. Although the reliability of the visual appeal index was reasonably high, its inclusion in the model as a covariate had virtually no influence on the effect of display format on response time. The third hypothesis is unsupported; it does not seem that a display's attractiveness keeps readers reading even after their curiosity has been satisfied. While it is perhaps unfortunate that a difference between

[24]For example, see advice by Nigel Holmes, Designer's Guide to Creating Charts & Diagrams, (New York: Watson-Guptill, 1984), p. 24.

graphs and tables was not discovered, the nearly complete inability to reject the possibility of no difference because of appeal does provide some additional support for the validity of the dependent measure. The time spent responding does indeed seem to reflect the time spent mentally processing the displayed information.

Although attractiveness had no observed effect on response time, graphs were most definitely rated as more attractive than tables. Unsolicited comments from eleven subjects added confirmation to the statistics when, without exception, they mentioned that they liked the graphs better than the tables.

The subjects' ability to recall the topic of the display exhibiting a specific overall trend was also significantly better when the display was a graph than a table, but even performance based on tables was better than chance. Those who had seen the requested trend in the form of a table recalled the topic correctly at twice the chance probability, and those who had seen it in a graph recalled it at three times chance. It is at least possible that graphs are stored in memory differently than are tables, perhaps in a visual image that can be recalled for latter reference.

Generally then, graphs not only more attractive than tables, they also appear to be more efficient in terms of processing time at displaying data—even more data than had previously been thought wise. And graphs also appear to be better at getting the main point across when that point concerns trends. If this was true in an experimental situation where subjects were asked to perform tasks other than overall trend identification, it is perhaps even more likely true in a natural setting where information seeking is dictated by an individual's own interest rather than an experimenter's demands. And since the primary role of statistical displays in the mass media is exactly to

illuminate trends and patterns, graphs should probably be used whenever possible.

While the results provide comfortable reassurance to professionals that graphs are even more efficient and appropriate that previously appreciated, they also provide limited support to the notion that graphs and other pictorial displays are encoded into memory in a different fashion than alpha-numerics (even spatially displayed alpha-numerics).

Additional studies using the visual appeal index and designs that account for individual differences in reading and memory skills are needed to more fully understand the role of attraction on information processing. More research is also needed that specifically considers the possibility that graphs are placed into memory differently than is text. While mass communication research is unlikely to resolve basic questions about how humans encode information, the theoretical possibility that graphs are encoded differently than words and numbers may contribute to our understanding of how text and graphics support and enhance each other in contemporary mass media messages.

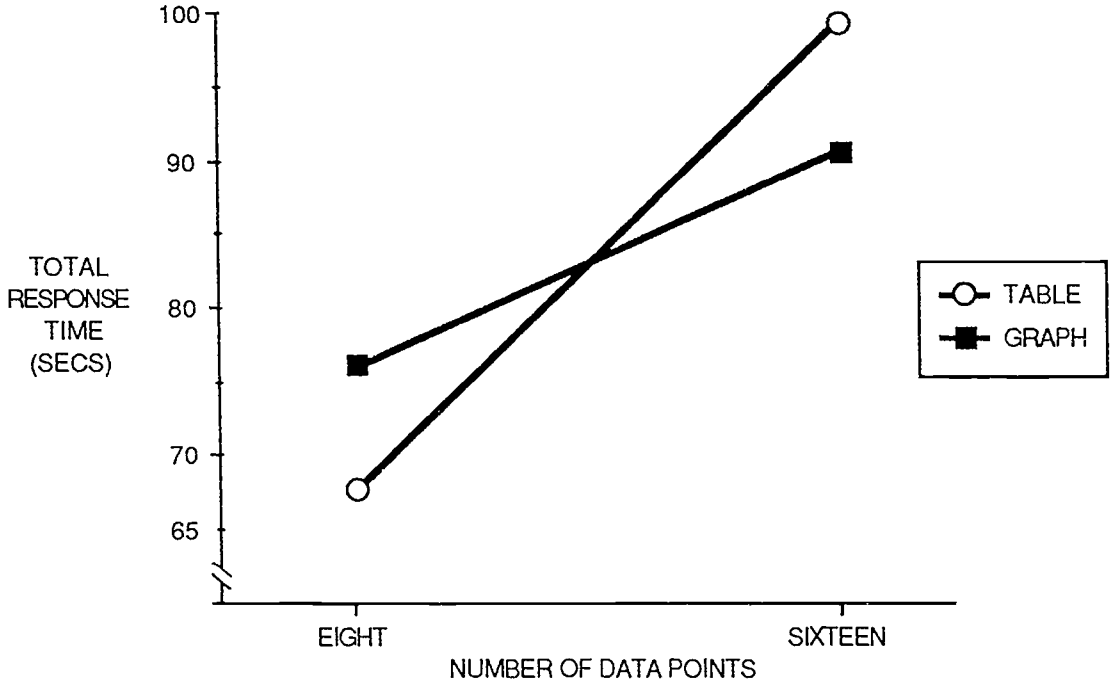
Figure 1.

Experimental Design

	Topic1	Topic2	Topic3	Topic4
Group 1	8 graph	16 table	8 table	16 graph
Group 2	16 table	8 graph	16 graph	8 table
Group 3	16 graph	8 table	8 graph	16 table
Group 4	8 table	16 graph	16 table	8 graph

Figure 2.

Mean response time scores as a function of display format and number of data points



Program Choice in a Broadband Environment

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PROGRAM CHOICE IN A BROADBAND ENVIRONMENT*

I. Introduction

New broadband technologies hold the promise of an abundance of video channels delivered at a fraction of the cost of current multichannel delivery systems. Whether such a change in the economics of television delivery would transform television service into something far different from what we know today, or perturb but slightly the path along which television service currently is evolving with VCR and cable technologies is far from certain. The analyses described below focus on the implications of an increased number of widely available television channels for the following aspects of television service: (1) *Quality of programs.*[1] We define quality to be audience appeal. We assume that this is a function, at least in part, of the resources consumed (measured in dollars) producing individual programs. That is, at least on average, quality (viewer appeal) reflects the size of the production budget. (2) *Program diversity*. In the analysis that follows, diversity refers to the range of differentiation among programs provided by program services. (3) *Quantity of programs*. This could be defined in various ways. For example, a current episode and older, sydicated episodes of a network series could be counted as a single program or as different programs. For the purposes of this paper, each episode is counted as a distinct program, but repeated showings of the same episode do not count as additional programs. (4) *The ease with which viewers may access specific programs*. The simplest way to make a program more accessible is to show it more often. The more frequently a program is repeated, the more likely it is that it will be convenient, or accessible, to any given viewer. Therefore an assessment of likely broadband television futures should consider repetition. Futhermore, as we show, repetition and quality are jointly determined.

Much of the anlaysis that follows is based on formal economic models of programming strategy. We describe the models verbally and discuss their implications for the future of television service in the next section The formal models are presented in

Appendix A. We discuss the implications of relaxing certain of the models' assumptions in Section III. A study of channel programming patterns on broadcast and cable television networks is presented in Section IV. Section V summarizes the analysis.

II. Programming strategies in a broadband environment.

A. A model of programming strategy

The model described in this section is a model of competition among profit-maximizing, monopolistically competitive programmers, each of which selects programs for a single broadband channel.[2] From the perspective of viewers, each program is differentiated, even if only slightly from other programs on the same channel and from programs on other channels. Viewers select programs according to their perceived qualities and how well they match their own unique personal preferences.

Program production budgets play a central role in the competition among program services in this analysis.[3] By increasing production budgets, programmers can increase the basic audience appeal of their programs, the sizes of the audiences they attract, and their revenues. This is because viewers value programs both for their basic "quality," which is affected by production budgets, and for nonqualitative attributes, such as plot line and subject matter. Thus a programmer[4] may increase its revenue by increasing the production budgets for its programs. Programmers incur costs of two types in producing programs—a fixed, minimum set up cost per program, and variable expenditures on production elements, such as talent and special effects, that contribute to perceived program quality.

A final assumption employed to make the mathematics of the model tractible is symmetry among program services. That is, program cost and revenue functions are the same for all programmers. An implication of the symmetry assumption is that all firms look alike in equilibrium in terms of audience, revenues, and production budgets. Since we are comparing alternative equilibria, this simplifies the analysis. A drawback symmetry is that the model cannot be used to examine competitive outcomes when viewer preferences

are unevenly distributed over program types.[5] Thus we cannot formally examine issues that arise when some types of programs appeal to much larger groups of viewers than do others, although we argue that certain extrapolations from our analysis are probably justified. A second drawback of the symmetry assumption is that, while the model is sufficiently general to apply to competition among advertiser supported services and to competition among pay services, symmetry precludes formal examination of competition among pay *and* ad supported services.[6]

We explored two versions of the model. The simpler version, like most models of program choice, assumes competition takes place within a single program period, for example 8:00 to 9:00 PM on Thursday evening. To allow for repetition, we add a second program period to the program day. The same viewers are in the audience in both periods.

B. Results

There is a clear quantity-quality trade-off in the single period version of the model. Because each program is differentiated from all others, there is also a diversity-quality tradeoff. The greater the number of programming services, the smaller are production budgets. This is illustrated in Table 1, which shows the effects of changes in the number of channels (or program services) on the production budget for a representative program for one specification of the model in which the total revenue generated by all channels during a program period is assumed to be constant (invariant with respect to the quality and number of programs), and viewers' perception of program quality increases with increases in production budgets, but at a decreasing rate.[7] Note also that production budgets increase with increases in the revenue generated by a program period if the number of channels programmed is held constant. Both relationships hold for all specifications of the model.

Another feature of the model illustrated by Table 1 is that the free entry, competitive equilibrium number of programmers (or channels programmed) rises as the revenue generated by a time period increases. Thus, without restrictions on entry, the number of

channels programmed rises from 19 to 37 to 56 as the revenue produced within the period grows from $5 mil. to $10 mil. to $15 mil. The policy implication is that program quality can be increased by reducing the number of networks, but at the expense of diversity.

The intuition underlying the relationships illustrated by Table 1 is straightforward. Programmers spend more to improve the quality of their programs when the revenue to be divided among them is larger, because, at the margin, the increase in audience share generated by a small increase in the production budget is worth more if the revenue generated by the audience is larger. While diminishing returns imply that, eventually, an additional production dollar will bring in less than a dollar of additional revenue, this point is reached at a lower budget if the revenue for a program period is small. Thus, holding the number of competitors constant, small market budgets will be smaller. Because viewers value both diversity and program quality, a competitive programming industry provides more of both if the revenue generated by a television audience grows.[8]

A similar logic explains why production budgets might fall if the number of competitors increased. As programs proliferate, viewers find better matches between programs available and their own particular preferences for the nonqualitative aspects of programs. This makes it more difficult for any given programmer to woo viewers away from their more "natural" choices by spending more on its own programs.

To examine the effects of variation in channels available on program repetition we added a second period to the program day. For any channel, the same programmer selects programs for both periods The entire audience from the first period is assumed to carry over to the second period with no new additions. The revenue generated by the second period audience is equal to that of the first, so the second period doubles television industry revenues in this model. Programmers have the option of producing an entirely new program for the second period or showing the first period program again in the second period. Viewers who have seen a program in the first period will not watch it again if it is repeated in the second period, but will watch a program on another channel.

By repeating its first period program in the second period, a programmer saves the production costs of a second program, but gives up the chance to have viewers who watched the program in the first period in its second period audience. Therefore, a programmer's second period ad revenue is lower if it repeats the first period program.

Table 2 compares, for the specification of the model used to generate Table 1, the difference between a programmer's profits if it shows the same program in both periods with its profits if it produces a different program for each period, under the assumption that all other channels follow the second strategy of producing two programs, one for each period.[9] Negative numbers indicate that separate programs for each period are the most profitable strategy. Positive numbers indicate situations in which a programmer could increase its profits by repeating a single show if competing programmers provided two shows on their channels. Table 2 shows that if the number of channels programmed is small, an equilibrium in which each programmer provides different programs for each period may be stable. However, as the number of channels programmed increases, at some point it becomes profitable for at least one programmer to switch to a strategy of showing the same program in both periods.[10]

The reason why some programmers begin to repeat their programs as the number of channels programmed increases is fairly intuitive. The fraction of the potential audience that views a program in the first period, and thus is eliminated from its potential audience in the second period, is likely to be large if only a few channels are programmed. That is, when few channels are programmed and each programmer's share of the first period audience is large, the potential audience available for a second showing of the same program is reduced considerably. The potential audience for a second showing increases as the first period share declines, which happens as the number of channels programmed increases. For example, if three channels are programmed, and they share the first period audience equally, one-third of the second period audience would be eliminated as potential

viewers of a program that was repeated. If ten channels were programmed, ninety percent of the second period audience members would be potential viewers of a repeated program.

A comparison of production budgets for aggregate program period revenues of $5 mil. and $10 mil. in Table 1 allows us to see what happens to program budgets when programmers switch from two programs per day to single, repeated programs. If all programmers repeat their first period programs, then all expect to share equally in each period's revenue. This doubles the revenue per program, so that competitive equilibrium budgets will be the same as for the single period model with twice the aggregate revenue for the period. Thus, in the two period model, we find that program quality declines initially as the number of channels increases, but that it rises again as programmers switch to schedules of repeated programs, which effectively halves the number of programs and diversity. Program budgets resume their downward march as the number of channels programmed increases once all programmers have switched to repeated schedules.

C. Video on demand

It is conceivable that future broadband television services might store programs for release to viewers on an on-demand basis, thereby freeing them from the tyranny of program schedules. If so, distinctions among television dayparts (prime time, day time, early fringe, etc.) would vanish and all programs would compete for shares of an audience consisting of the aggregate of all viewing throughout a day, or perhaps longer periods. For the programmer there would be but a single period with aggregate revenue equivalent to the total of all revenue generated by viewing throughout the day. Equilibrium program budgets and variety would be the same as for the single period version of this model with aggregate revenue equal to the total of revenues generated by viewing throughout a day.[11]

III. Alternative Broadband Futures

An important difference between the current television industry and the one modeled is that today only a few programmers, the three major broadcast networks, are

able to reach nearly all U.S. television households, while, given symmetry, each channel is available to every television household in the model.. The effect of restricting all but three program services to less than 100 percent reach is fairly clear. The return on a dollar added to the production is greater for the program services with greater reach because for them that dollar has the potential to attract more viewers, simply because the number of viewers with access to the program is greater. Therefore, programmers able to reach all television households will produce higher quality (larger budget) programs than those whose reach is more limited.[12] This is why, in today's television industry, the majority of the high budget programs, especially series, are produced for the three major broadcast networks, although for one time events, such as made-for-television movies, the larger cable networks (HBO, Showtime, and USA Network) sponsor some productions with budgets approximating those of the major broadcast networks.[13]

Increased penetration of broadband services would reduce the disparity in reach between the current over-the-air networks and other networks. If broadband television service approached 100 percent household penetration, all networks would become similar in terms of program budgets and audience size.[14] Such a process is underway, with the broadcast networks' audiences dwindling in the face of increasingly strong competition from cable services and independent television stations, whose penetration has been increasing. Whether the current broadcast networks will suffer the fate of blending gradually into a large pack of national networks, all of which would be comparable in the quality (expense) of their offerings, depends on a variety of factors that may affect the spread of broadband gateways and consumer enthusiasm for the services they carry, and on whether viewer preferences over program types are evenly distributed, as assumed in our model, or exhibit distinct and significant clumpings around particular program types.

Today cable is not available in sparsely populated areas because the cost of cabling these areas is prohibitive. This could be the case for IBNs in the future, especially if telephone service is provided by means other than wire. To extend their reach, IBN

program services would have to employ spectrum using technologies, such as DBS, as cable networks do today. The problems with franchising and regulation at the local level that have retarded the growth of cable systems in major metropolitan areas may also hinder the provision of IBN based video services in the future. Finally, prices may have to be significantly less than current cable prices to generate penetration levels much beyond what is currently achieved by cable. Approximately fourty percent of households passed by cable do not subscribe. More homes passed would subscribe, of course, if the price for cable service were lower. That it is not reflects the judgements of cable operators that profits gained on additional subscriptions at a lower price would not be enough to offset revenues lost on current customers who also would benefit from the lower price. Because both demand and cost considerations are reflected in video service prices, it cannot be taken as given that use of a lower cost broadband delivery technology would result in subscription prices significantly below current levels.

Even if the penetration of broadband services approaches that of the three broadcast networks, if the distribution of viewers preferences over program types is highly uneven, the eventual equilibrium structure of the television industry may still be one in which some networks have large audiences and large program budgets while others produce less expensive programs for smaller audiences. This type of structure is especially likely if one or a few program types are preferred by a majority of viewers. For example, assume that every viewer has a preferred program type and refuses to watch anything else. Most viewers like type A programs and the rest like programs of type B.[15] If there is sufficient channel capacity, the two viewer populations and the channels that served them would constitute distinct television markets for all practical purposes. Thus, by the logic of the model described in Section II, we should see more channels devoted to type A programs than to type B programs and type A programs would be more expensive.

Finally, the tendency for program budgets to fall with the addition of new channels may be limited to some extent if new services generate additional viewers and new revenue.

The tendency of budgets to increase with market revenue would offset to some degree the negative effect of increased competition.

IV. Patterns of Repetition and Diversity on Broadcast and Cable Networks

A. Repetition

The models described in Section II predict that increased fragmentation of the television audience due to the addition of new channels will eventually lead to increased repetition of programs within program schedules. Similar reasoning suggests that for a television industry in which some programmers have much larger audience shares than others, the firms with the smallest shares should be most likely to repeat their programs. Since the major broadcast networks still command shares of audience many times larger than the shares of even the most popular cable services, the broadcast networks should repeat their programs less often than cable networks.

Tables 3 and 4 report four measures of repetition in the monthly and daily[16] program schedules of the Chicago affiliates of the three major broadcast networks, four superstations, and 27 cable-only networks, for January 1989.[17] The first measure, "repeat hrs/total hrs", is the sum of program hours accounted for by the second and subsequent showings of programs shown during the specified period (month or day) as a percentage of all program hours during that period. That is, this is the fraction of program hours that are not occupied by programs receiving their initial airing during that period. This measure increases with increased repetition.

"Repeat hrs/1st showing hrs" is the sum of program hours accounted for by the second and subsequent showings of programs divided by the hours accounted for by the first showings *of the same programs*, again for the specified time period. This is not a measure of repetition, per se, but a time-weighted measure of the number of times that programs that are repeated get repeated. However, this measure generally should vary positively with "repeat hours/total hrs."

"Single showing hrs/total hrs" measures the time accounted for by programs that are not repeated within the program period as a fraction of total hours programmed. That is, this is the fraction of program time accounted for by programs that are not repeated. This measure should be inversely related to "repeated hrs/total hrs."

The final measure, "avg. airings per program," is the average frequency with which all programs are repeated by a programmer during the specified time period. This is the combined average over programs that are repeated and programs that are not repeated.

The patterns reported in Tables 3 and 4 are generally consistent with the theoretical prediction that greater repetition will be observed on cable networks than on the major broadcast networks.[18] The largest differences in all of the measures are between cable networks as a group and the broadcast networks and superstations, which are nearly indistinguishable by these measures.[19] Similarity between the broadcast networks and the superstations probably is accounted for, at least in part, by several factors. First, each of these stations is a major independent in a large television market, thus its cable share understates its actual share of its combined cable and broadcast audiences. Second, the networks provide programming for only about two-third of the broadcast time of their affiliates. Network affiliates behave as independents in programming the nonnetwork portions of their schedules.

In general, the measures of repetition show more repetition in monthly schedules than in daily schedules. Thus there is repetition from day-to-day, as well as during the day. While monthly and daily repetition figures are fairly close for the broadcast networks and the superstations, the increase from the daily to the monthly schedule is quite dramatic for some of the cable only channels. For example, on the Discovery Channel nearly ninety-six percent of program time is accounted for by programs shown only once during a day, but less than half of the monthly schedule is accounted for by programs shown only once. Comparable differences between daily and monthly repetition measures are observed for several of the pay services. In general, these measures show that while pay and basic

channels appear fairly similar in terms of repetition in daily schedules, the pay channels rely much more heavily on repeated showings of programs over a longer period of time.[20]

Viewer's Choice, the only pay-per-view included in the sample, repeats its programs more frequently than any of the basic or pay channels, whether measured on a average daily or a monthly basis. Since the cost to the viewer of an hour of programming is higher for basic channels than for broadcast channels, higher still for pay channels, and highest for pay-per-view, Tables 3 and 4 describe a pattern of greater reliance on program repetition the higher the charge to the viewer for program time, a relationship that should be studied more closely in the future.

B. Diversity

It might be argued that each program is unique and contributes to diversity even if it is one of many episodes in a series with a continuing cast of characters and similar plots. By this argument, repetition and diversity are two sides of the same coin. The more frequently programs are repeated within a channel's schedule, the less diverse is the programming. This definition of diversity is the only type of diversity that can be examined with the models described in Section II of this paper. If diversity is measured in this way, Tables 3 and 4 also provide measures of diversity. The channels with the least repetition, the broadcast networks and the superstations, have more diverse programming.

This is not the way diversity traditionally has been measured in the literature on diversity in television. The standard procedure has been to classify programs according to some program typography and then calculate some measure of the distribution of programs among the types.[21] This approach has been criticized as an attempt to impose an arbitrary structure on the unobservable preferences of viewers. (Owen (1978)). It is true that the typographies employed have varied from researcher to researcher. Here we offer, without apology, yet another typography as the basis for a diversity analysis. The fact that the typographies are derived subjectively practically guarantees that typographies will differ

among researchers. However, we also note that there is a great deal of similarity among the program types used in the various diversity studies, and would argue that the common acceptance and usage within the television industry of program classifications such as "situation comedy", "action adventure", "game show", "news", "western", etc. support the hypothesis that there is general agreement as to what constitutes significant differences among program types.

With a few exceptions, we employed the syndicated program typography of the A.C. Nielsen Company.[22] The Nielsen typography is justified by the fact that Nielsen's commercial clients find it of some value. We added seven categories for cable programs that did not fit the Nielsen typography. In all, we assigned programs among twenty-seven program types. Table A2-1 in Appendix 2 lists these program types and gives the percentage allocations of program time among them, for each network in the data base.

Two indices of diversity based on these percentage allocations in monthly program schedules are reported in Table 5. The index is the sum of the squares of the percentages in each program category.[23] This index is higher the more a channel's program time is concentrated in a small number of program types. For example, if two of the twenty-seven program types each accounted for fifty percent of a channel's total program time, the channel's score for the first diversity index would be $50^2 + 50^2 = 5000$. If program time were spread evenly among four program types, index 1 would be $4 \times 25^2 = 2500$. The maximum score for this index is 10000 and the minimum score is 370. The higher the score, the less diverse is a channel's programming.

The squaring of percentages in index 1 means that greater weight is assigned to large numbers than to small numbers. Thus a program type accounting for five percent of a channel's program time would contribute twenty-five to the index, while a program type with fifty percent of the channels time would contribute 2500 to the index. That is, increasing the percentage of program time allocated to a program type by a factor of ten increases its contribution to the value of index 1 by a factor of 100. This means that

reallocating program time from a category with a small percentage of total program time to a category with a larger percentage of program time increases the value of index 1.

Although the choice of an index must be based on subjective considerations to some extent, it might be argued that index 1 assigns too much weight to program categories accounting for large fractions of program time. As an alternative, we constructed diversity index 2, the value of which varies linearly with the percentages of program time allocated to particular program types. Index 2 assigns weights to each program type that are proportional to the absolute value of the difference between the percentage of time accounted for by a program type in a channel's schedule and the percentage of programming time that would be allocated to each program category if program time were distributed evenly among the categories. With 27 program types, an even distribution of program time among the types would assign 3.7 percent of program time to each. Maximimum diversity would produce an index 2 value of zero, while allocating all program time to a single program type would produce a value of 192.6 (rounded to 193 in Table 5). Thus, as with index 1, a higher value for index 2 indicates less diversity for a channel. The rank ordering of networks according to schedule diversity is nearly the same for the two indices. Therefore, for our purposes, the choice among them is of little consequence.[24]

A comparison of Tables 3 and 4 with Table 5 shows high repetition values are closely associated with low diversity values and vice versa. This is reflected in the correlation coefficients reported in Table 6. The statistical association is strongest for the monthly measures of repetition, probably because the diversity indices are also based on monthly schedules. While there are exceptions, the general pattern is that, at least within monthly schedules, program services that rely heavily on repetition as a programming strategy tend to select programs from a fairly narrow range of program types, while program services that employ very little repetition generally include a wide range of program types in their schedules, a relationship that should be explored in more depth in the future.

The models described in Section II predict that audience fragmentation resulting from the growth in the number and household penetration of broadband networks will lead to greater reliance on repetition as a programming strategy by all networks. The data analysis presented in this section shows a strong negative correlation between within channel program repetition and the diversity of the programs in network schedules. This suggests that in a future with many high-penetration broadband networks, the vertical (within-channel) diversity that currently characterizes the major broadcast networks will be a thing of the past. Networks will be more clearly differentiated according to program type and the diversity available to the viewer will reflect the degree of diversity among programmers, much as is the case in local radio markets today.

V. Summary

Our formal models of network programming strategies suggest that if in the future broadband technology makes possible a significant increase in the number of television networks reaching most American television households, networks are likely to respond by increasing their use of within-schedule program repetition as a programming strategy. Further, the strong inverse correlation between within channel diversity and program repetition that characterizes the current network services suggests that within channel diversity is likely to diminish with increased repetition, resulting in more specialized program services. This future may be forestalled if factors such as pricing strategies, regulatory policies, and cost considerations, which have limited the penetration of cable television, also limit the penetration of new broadband technologies to a figure signficantly below 100 percent.

Recently some observers of the television industry have decried the fact that program patterns on a number of the cable channels are very similar to those on the major broadcast networks. A closer look at these channels shows heavy reliance on off-network product. At least to some extent, it is the availability of off-network series which has

prevented the emergence of more of the specialized cable programming that was so eagerly anticipated when cable was a new service. While all of the hoped for diversity has not materialized, this disappointment is counterbalanced, at least to some degree, by the fact that increased repetition slows the decline in production budgets, and thereby production values, that must accompany an increase in the number of channels.

Appendix 1

I. Monopolistic Competition among Programmers

A. The basic single-period model

This is a model of competition among profit maximizing, single channel programmers within a single programming period. Competition is Nash in program production budgets. Each firm observes its competitors' production budgets and sets its own production budget to maximize its expected profits, taking the number of competing programmers and their production budgets as given. The number of channels available for television is a binding constraint on the number of channels programmed.

The model assumes symmetry among programmers, so we can work with profit and revenue relationships for a representative firm, indexed by i. We first develop a fairly general form of the model and then describe the functional form used for the simulation exercises reported in Section II of the text.

Define r_i to be the revenue of programmer i, let e_i be the variable portion of i's production budget, and let k_i be i's fixed costs. Included in k_i are fixed production costs, administrative costs, and any transmission/distribution costs. There are n competing programmers. Then the profits of the ith programmer, $\prod_i$, are given by

$$\prod_i = r_i - e_i - k_i, \tag{1}$$

where $r_i = r_i(e_1,..., e_n)$. We assume $\partial r_i/\partial e_i > 0$, $\partial^2 r_i/\partial e_i^2 < 0$, $\partial r_i/\partial e_j < 0$, and $\partial^2 r_i/\partial e_i \partial e_j < 0$ for $j \neq i$. In words, a programmer can increase its revenue, but at a decreasing rate, by

increasing the size of its production budget. A programmer's revenue and marginal revenue are both reduced by increases in the production budgets of its competitors.

Equation (2) is the first order condition for profit maximization for programmer i.

(2) $$\partial r_i/\partial e_i - 1 = 0.$$

Differentiating (2) totally with respect to n and solving for de_i/dn, we have

(3) $$de_i/dn = - \frac{\partial^2 r_i/\partial e_i \partial n}{\sum_j \partial^2 r_i/\partial e_i \partial e_j}$$

for j = i,..., n. From our assumptions, we know that both numerator and denominator are negative, so $de_i/dn < 0$. Production budgets fall as n increases.

While the program production budget was treated as the sole control variable in the preceding analysis, as long as we are not concerned with the values of other control variables, such as subscription price or ad time, we can allow for the existence of other control variables by letting them be arguments in r_i, so that a programmer selects the values of these other control variables to ensure that they maximize profits given the size of the production budget. This makes the model sufficiently general to encompass competition among ad supported programmers, competition among pay programmers, and competition among programmers supported by advertising and viewer payments. Symmetry rules out consideration of competition among programmers that differ in their revenue sources.

B. The simulation model

Simulating competitive outcomes when n varies requires that we employ an explicit functional representation of the model. Therefore, define R to be the total revenue generated by all programmers , and define s_i to be i's share of R. Now $r_i = s_i R$, so

(1') $$\prod_i = s_i R - e_i - k_i.$$

Let $g_i = g(e_i)$ be the quality (or audience appeal) of i's program as perceived by a representative audience member. We make the following additional assumptions.

$g(e_i) > 0$, for $e_i > 0$; $\partial^2 g/\partial e_i^2 \leq 0$; $g(e_i) = g(e_j)$, for $e_i = e_j$, $i \neq j$.

$R = R(g_1,..., g_n)$; $\partial R/\partial g_i \geq 0$; $\partial R^2/\partial g_i^2 \leq 0$ and $\partial R^2/\partial g_i \partial g_j \leq 0$, for all i, j = 1,...,n.

$s_i = g_i/\sum g_j$, j = 1,..., n.

In words, the perceived quality of a program increases at a nonincreasing rate with the size of its production budget, and the perceived quality of one program is not affected by the budgets of other programs. The total revenue generated by all programs is a nondecreasing function of the perceived quality (or budget) of any programmer's program. Because programs are partial substitutes, the aggregate and marginal contributions of any program to total revenue is reduced by an increase in the perceived quality of another program.[25]

For this specification of the model, the first order condition for profit maximization for programmer i is

$$(2') \qquad [R(n-1)\cdot\partial g_i/\partial e_i]/n^2 g + (\partial R/\partial g_i \cdot \partial g_i/\partial e_i)/n - 1 = 0$$

where g=g(e), and e is the value of program expenditures common to all programmers.

(2') was used to solve for the equilibrium budgets reported in Table 1, with g(e) assumed to equal e. (1') was used for the profit calculations underlying Tables 1 and 2.

Table 1 assumes a one period programming day. Table 2 reports results for an extended model with two program periods in a day, where programmers have the option of showing a different program each period, or showing the same program in both periods. Table 2 compares profits from the two strategies for a single programmer when all other programmers show different programs in each period and R is the same in each period.

In deciding whether to switch to a strategy of repeating its first period program in the second period when no other programmers repeat their programs, a programmer compares expected profits for the two options and selects the one with the highest profits. If all programmers program the two periods independently, then it is as if each period were a one period model, and the analysis developed above applies to each period. Let

programmer i be the programmer considering a switch to a schedule of repeated programs. We may use s_i, as defined above, as i's share of first period revenue. This would also be i's share of second period revenue if it did not repeat its first period program in period 2. Define $s_{i,r}$ to be i's share of aggregate second period revenue if it repeats its first period program in the second period.

Let $\prod_{i,n}$ be i's profits from a nonrepeating schedule and let i's profits with program repetition be $\prod_{i,r}$.

$$\prod_{i,n} = 2s_iR - 2e_i - 2k_i, \text{ and}$$

$$\prod_{i,r} = R(s_i + s_{i,r}) - e_i - k_i.$$

Define $D_i = \prod_{i,r} - \prod_{i,n}$. Then

$$D_i = R(s_{i,r} - s_i) + e_i + k_i.$$

A reasonable assumption is that the second period share of a program shown in both periods would be its share calculated as if it were not repeated, but applied only to those viewers who did not see it in the first period. That is, $s_{i,r} = s_i(1-s_i)$. Substituting into the equation for D_i we get

(4) $$D_i = -Rs_i^2 + e_i + k_i.$$

Equation (4) was used to calculate the entries in Table 2 for e_i set at its equilibrium value for the single period equilibrium analysis.

II. A Single Programmer Model

In this section we examine programming strategies for a monopolist programming all video channels. Maintaining the symmetry assumption, we can express the functional relationship between production budgets, the number of channels programmed, and R as $R = R(e_S, n)$, where e_S is the common value of the production budget for programs on each channel programmed. Profits are

(5) $$\prod = ne_S - nk.$$

(6) and (7) are the first order conditions for profit maximization.

(6) $$\partial R/\partial e_S - n = 0.$$

(7) $$\partial R/\partial n - e_S - k = 0.$$

Since an increase in n is taken as a given in this analysis, we work only with (6). To examine the effect on e_S of an increase in the number of programmed channels we totally differentiate (6) with respect to n and solve for de_S/dn.

(8) $$de_S/dn = - \frac{\partial 2R/\partial e_S \partial n - 1}{\partial^2 R/\partial e_S^2}.$$

From the assumptions concerning R set out above, we know that de_S/dn must be negative.

For unit changes in n, and e_S set at its profit maximizing value, e_S^*, (7) becomes

(7') $$\Delta \prod/\Delta n = R(e^*,n) - R(e^*, n-1) - e^* - k \geq 0.$$

Let n* be the profit maximizing number of channels in the single period version of the discrete channels version of the model. With two periods, profits when no programs are repeated are

(9) $$\prod n = 2[R(e_S^*, n^*) - n^* e_S^* - n^* k].$$

Assume the first period program is repeated in the second period on one channel. Consumers who view the repeated program in the first period will pay only the value of a service with n-1 channels of programming for the second period. For all other consumers, the value of the second period of television service is unchanged. Therefore, for e_S set at e_S^*, profits with one channel showing the same program in both periods and all other channels showing different programs in each period are

(10) $$\prod r = R(e_S^*,n^*)(2n^*-1)/n + R(e_S^*, n^*-1)/n - (2n^*-1)(e_S^*+k).$$

Subtracting equation (9) from equation (10), we have

(11) $$\prod r - \prod n = [R(e_S^*,n^*-1)-R(e_S^*,n^*)]/n^* + e_S^* + k.$$

If n* is large and R increases in n at a decreasing rate, then (7') will be close to zero and $R(e_S^*,n^*)]/n^* - R(e_S^*,n^*-1)$ will be approximately equal to e_S^*-k. Therefore $\prod r - \prod n$ will be positive and at least one channel will have repeated programs.

Appendix 2

I. Data for Repetition Analyses

The data set consists of the starting and ending times and titles for each program episode in the January 1989 schedules for the the 3 Chicago broadcast network affiliates, 4 superstations, 19 basic cable services, 8 pay cable services and 1 pay-per-view service. Cable services were selected from the October 1988 Cablestats listing published by *Cablevision* on the basis of subscriber count. Services whose subscriber count exceeded 3.5 million were included with the following exceptions. Satisfying the criterion, but not included were the Travel Channel, Alternate View, Silent Network, home shopping networks, Telemundo, music channels and news services, such as CNN Headlines News, which consist of repeated, but continously updated, "wheels" of news.

The Travel Channel was excluded because much of its programming is supplied by sponsors, a practice that differentiates it from the networks retained in the data set. Alternate View and Silent Network were excluded because they are weekend-only networks. Telemundo was not included because the service did not provide the requested schedules. Home shopping networks were excluded for the same reason as the Travel Channel. On the music channels, it was unclear whether individual videos or larger units of time should count as individual programs. In either case, given the number of videos aired and the fact that individual video titles are not reported in program guides, it was not feasible to measure repetition for these channels.

The news and financial channels, consisting primarily of repeated "wheels" of news, were also excluded from the data set because the nature of the content made calculation of repetition measures infeasible. The program content for the repeated "wheels" of news is updated on a schedule dictated by the progression of current events. Therefore updating, or repetition, of content does not take place according to a

predetermined schedule. This means that repetition cannot be reflected in monthly schedules published in advance, unless the "wheel" is viewed as a repeated program, regardless of updates, in which case repetition is at or near 100% for most news channels.

Cable network schedules were provided directly by the individual services. In some cases, the services provided generic weekly schedules. In these instances, we supplemented the information with telephone calls to programming and public relations personnel at these services. Information for the Chicago broadcast affilates was based on the *Chicago TV Week* guides for January 1989.

To calculate daily measures of repetition it was necessary to divide the monthly schedules of the twenty-four hour cable services into day-length segments. A day was defined as a twenty-four hour period starting and ending at six a.m. For channels which did not program a full twenty-four hour day, we used the daily period specified by the service's schedule. This generally fell within the six a.m. to six a.m. block of time. Some cable services do not provide a full twenty-four hours of programming daily and lease the surplus channel time to other programmers. This type of paid programming was not included in the data set.

II. Determination of Program Types

To examine diversity within a service, we allocated the service's monthly programming among 27 program types and calculated the percentage of total programming hours accounted for by each program type. The program types are the twenty Nielsen program types used in Nielsen's *Report on Syndicated Programs*, February 1989, with seven additional categories. The seven program types were added to account for programs that did not fit the Nielsen categories. These seven program types are biography, film, magazine, news, performance, shorts, and travel. The adventure true-to-life category was expanded to include science and nature programs. For programs that were listed in the February 1989 *Report on Syndicated Programs*, we used the Nielsen program

classifications with the exception of the following seven programs which in our opinion fit better in categories other the ones specified by Nielsen. We made the following changes in program type classification: (1) *The Judge* from "adventure" to "general drama"; (2) *The Untouchables* from "general drama" to "mystery & suspense"; (3) *The Wonderful World of Disney* from "how-to-do & unclassified" to "children"; (4) *Monsters* from "how-to-do & unclassified" to "mystery & suspense"; (5) *Arsenio Hall Show Original* from "talks & educational" to "comedy variety"; (6) *Morton Downey Jr.* from "talks & educational" to "interview" and (7) *Inside Edition* from "general variety" to "news."

The twenty-seven program types and the percentage allocation of program time among them for all network services in the data set are shown in Table A2-1.

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1 Program quality has received relatively little attention in the economics literature on television. Noll (1978), Waterman (1988a, 1988b), and Wildman and Siwek (1987, and 1988) are exceptions. Park (1980) and Owen, Beebe, and Manning (1973) examine the effect of commercial rivalry on program budgets, but do not consider the effect of changes in budgets on audience appeal.

2 The formal analysis underlying the model described here is presented in Appendix 1. In addition, we also show in Appendix 1 that a single firm programming all of the channels for a broadband service is likely to exhibit the tendencies demonstrated in the the model of a monopolistically competetive industry.

3 See, Waterman (1988a) for a monopoly model of program choice in which the production budget is permitted to vary. Program quality was ignored in previous models of program choice because these studies focused on the diversity implications of limited channels..

4 Throught this paper we will use the terms "programmer," "program service," and "channel programmer" interchangeably.

5 Competition among programmers when viewer preferences are unevenly distributed traditionally has been studied with models of the type introduced by Steiner (1952). See, e.g., Owen, Beebe, and Manning (1974) and Beebe (1977). The program choice model described here is similar to the models of Spence and Owen (1977) and Wildman and Owen (1985) in assuming an even distribution of viewer preferences.

6 To our knowledge, Wildman and Owen (1985) contains the only published attempts to formally model simultaneous competition among pay and ad supported services.

7 More specifically, the results reported in Table 1 (and in Table 2) are based on a specification of the model in which revenues are allocated among channels in proportion to the relative qualities of their programs as perceived by viewers, viewers see program quality increasing in proportion to the fourth root of the variable portion of production budgets, and the fixed cost of producing a program is $200,000.

8 The effects of market size on production budgets and diversity in this model are similar to those observed in recent work on the economics of international trade in video products. See Wildman and Siwek (1987, 1988) and Waterman (1988b). These relationships are also implicit in the model developed by Park (1980) to assess the viability of a fourth commercial television network.

9 The comparisons in Table 2 assume that when a programmer switches from showing different programs in each period to acquiring a single program that is shown in both periods, production budgest for the programs acquired remain the same. A more complete analysis would probably show that production budgets would be larger for repeated programs, since the effects of increased budgets would be felt in two periods instead of one. See Waterman (1988a) for a discussion of the effect of repeated showings on program budgets.

10 In other exercises with this model, we have found that for some specifications of the model, an equilibrium in which all firms repeat their programs is not stable if only a few channels are programmed because at least one programmer will find it profitable tc switch to a strategy of providing a different program for each period.

11 Near video-on-demand -is created by running the same program on several channels simultaneously, with a different start time on each channel. Because continuous availability is approached as the number of channels carrying the program increases, in the limit the effects would the same as for video-on-demand.

12 This is similar to the explanation offered in recent studies of international trade in films and programs for the positive relationship observed between the size of production budgets for films and television programs and the size of the linguistic markets for which they are produced. (Waterman, 1988; Wildman and Siwek 1988) A likely positive relationship between geographic reach and investments in program quality is demonstrated formally and supported empirically in Wildman and Cameron's (1982) study of radio stations.

13 However, for one-time events, such as made-for-television movies, the larger cable networks (HBO, Showtime, TNT, The USA Network, etc.) frequently produce programs with budgets approximating those of the major broadcast networks. The ability of these cable networks to finance relatively expensive productions reflects the importance of viewer payments as a source of revenue not available to the broadcast networks.

14 Differences in the economics of pay and advertiser support may produce differences in pay and advertiser supported networks, which are not addressed in this paper.

15 There may be some variation among programs within these types.

16 The daily measures of repetition are thirty-one day averages of measures calculated on a daily basis.

17 A more complete description of the data set is provided in Appendix 2.

18 While their is variation, most channels that regularly repeat programs on different days during the course of a month also repeat programs within their daily schedules. Correlation coefficients for the same measures of daily and monthly repetition varied from 0.712 to 0.765, with a .001 level of confidence (by a two-tailed t-test) in each case.

19 Each of the three major broadcast networks' Chicago affiliate repeats the network's evening news at the end of the broadcast day, which accounted for almost all repeated program hours. The Chicago affiliates are nearly unique in employing this strategy.

20 There is also considerable month-to-month repetition in the pay services' schedules.

21 E.g., see Greenberg and Barnett (1971), Dominick and Pearc (1976), Litman (1979), Jackson (1986), and Waterman and Grant (1989).

22 Neilsen relies on program distributors to assign their programs to Nielsen's categories. There were a few instances in which, in our judgement, a syndicated program did not fit well with others listed by Nielsen for the same program type. In these cases we reassigned the program to the category we deemed most appropriate. See Appendix 2 for details.

23 This is the Herfindahl-Hirshman index (HHI) that is applied to market shares by the U.S. Department of justice to measure market concentration.

24 The coefficienty of correlation for the two diversity indices is 0.926 and is significant at the .001 level with a two-tailed t-test.

25 Schmalensee (1972) discusses functional representations of this version of the model in examining the nature of competition among advertisers.

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Table 1

Production Budgets as a Function of Market Size and Number of Competing Channels

Period Revenue ($mil.)	No. Channels 2	3	4	5	6	7	8	19*	37*	56*
$5	.31	.28	.23	.20	.17	.15	.14	.06	--	--
$10	.63	.56	.47	.40	.35	.31	.27	.12	.07	--
$15	.94	.83	.70	.60	.52	.46	.41	.19	.10	.07

* 19, 37, and 56 are the largest numbers of channels that can be programmed by competitive firms without generating negative profits in markets with per period revenues of $5 mil., $10 mil., and $15 mil. respectively.

Table 2

Programmer Profits with a Single Program Repeated
Minus Profits with Two Programs

Per Period Revenue ($mil.)	No. Channels 2	3	4	5	6	7	8	19*	37*	56*
$5	-.74	-.08	.12	.20	.23	.25	.26	.25	--	--
$10	-1.68	-.36	.04	.20	.27	.30	.32	.30	.26	--
$15	-2.61	-.63	-.03	.20	.30	.35	.38	.35	.29	.26

* 19, 37, and 56 are the largest numbers of channels that can be programmed by competitive firms that do not repeat their programs without realizing negative profits in markets with per period revenues of $5 mil., $10 mil., and $15 mil. respectively.

Table 3

Repetition in Monthly Schedules

Service	Repeat Hrs/ Total Hrs %	Repeat Hrs/ 1st Showing Hrs %	Single Showing Hrs/ Total Hrs %	Avg. Airings per Program
BROADCAST AFFILIATES*				
ABC	1.6	1.6	96.8	1.0
CBS	6.6	7.1	86.8	1.1
NBC	2.8	2.9	94.3	1.0
Average	3.7	3.9	92.6	1.0
SUPERSTATIONS				
WGN	2.9	3.0	94.6	1.0
WPIX	7.5	8.1	87.2	1.0
WTBS	3.8	4.0	92.4	1.0
WWOR	0.4	0.4	99.2	1.0
Average	3.7	3.9	93.4	1.0
BASIC CABLE				
CBN	16.0	19.1	69.6	1.1
TNT	2.3	2.4	96.5	1.0
USA	6.3	6.7	87.7	1.0
ACTS Satellite	58.1	138.5	7.9	2.3
A & E	61.0	156.1	24.2	1.9
BET	47.0	88.6	25.3	1.9
CNN	17.7	21.5	69.7	1.3
Discovery	55.4	124.1	10.3	2.2
ESPN	27.5	37.9	47.4	1.4
Eternal Word	53.2	113.5	18.8	2.2
Familynet	49.7	98.9	23.0	1.9
Learning Channel	46.2	85.7	23.2	1.9
Lifetime	17.0	20.5	73.6	1.3
Nashville	63.4	173.5	2.6	3.0
Nickelodeon**	0.3	0.3	99.3	1.0
Nostalgia	69.7	230.1	0.6	2.6
TBN	11.0	12.4	80.2	1.1
Univision	30.1	43.1	41.3	1.4
VISN	48.5	94.3	2.9	1.9
Average	35.8	77.2	42.3	1.7

Table 3

Repetition in Monthly Schedules
(cont'd)

Service	Repeat Hrs/ Total Hrs %	Repeat Hrs/ 1st Showing Hrs %	Single Showing Hrs/ Total Hrs %	Avg. Airings per Program
PAY CABLE				
AMC	77.4	343.0	0.0	4.5
Bravo	68.9	221.2	4.8	3.2
Cinemax	67.3	205.7	3.7	3.0
Disney	46.1	85.7	35.5	1.4
HBO	79.1	379.0	1.7	4.5
Movie Channel	73.5	277.4	4.3	3.9
Playboy	85.3	581.3	0.0	7.0
Showtime	71.4	249.4	3.4	3.4
Average	71.1	292.8	6.7	3.9
PAY-PER-VIEW				
Viewer's Choice	94.9	1841.2	0.0	19.3

* Repetition for the broadcast affiliates is due almost entirely to repetition of the late evening newscast, a practice particular to the Chicago market.

**Includes Nick at Nite.

Sources: January 1989 program schedules provided by individual services and Chicago TV guides for broadcast affiliates.

Table 4

Average Repetition in Daily Schedules

Service	Repeat Hrs/ Total Hrs %	Repeat Hrs/ 1st Showing Hrs %	Single Showing Hrs/ Total Hrs %	Avg. Airings per Program
BROADCAST AFFILIATES*				
ABC	1.4	1.5	97.1	1.0
CBS	6.6	7.2	86.8	1.1
NBC	1.8	1.9	96.4	1.0
Average	3.3	3.5	93.4	1.0
SUPERSTATIONS				
WGN	0.3	0.3	99.3	1.0
WPIX	4.4	4.6	93.3	1.1
WTBS	0.9	1.0	98.1	1.0
WWOR	0.1	0.1	99.8	1.0
Average	1.4	1.5	97.6	1.0
BASIC CABLE				
CBN	12.7	15.5	76.2	1.1
TNT	0.6	0.7	98.8	1.0
USA	3.5	4.2	92.9	1.0
ACTS Satellite	38.4	64.0	32.3	1.5
A & E	32.2	49.9	37.0	1.5
BET	43.7	81.0	28.7	1.8
CNN	13.9	16.4	73.9	1.2
Discovery	2.2	2.2	95.7	1.0
ESPN	10.0	11.5	79.4	1.1
Eternal Word	8.7	9.6	85.9	1.1
Familynet	39.0	68.1	34.8	1.6
Learning Channel	11.5	13.9	77.2	1.1
Lifetime	16.7	57.1	76.3	1.5
Nashville	51.5	107.1	17.2	2.3
Nickelodeon**	0.0	0.0	100.0	1.0
Nostalgia	25.0	33.5	49.9	1.4
TBN	3.8	4.0	94.8	1.1
Univision	29.1	41.6	41.8	1.4
VISN	13.8	26.3	72.4	1.3
Average	18.8	31.9	66.6	1.3

Table 4

Average Repetition in Daily Schedule
(cont'd)

Service	Repeat Hrs/ Total Hrs %	Repeat Hrs/ 1st Showing Hrs %	Single Showing Hrs/ Total Hrs %	Avg. Airings per Program
PAY CABLE				
AMC	61.8	174.4	0.0	2.8
Bravo	40.0	72.2	22.4	1.7
Cinemax	3.5	3.8	92.9	1.0
Disney	16.3	19.8	68.6	1.1
HBO	14.2	17.3	71.6	1.2
Movie Channel	23.3	31.2	51.7	1.3
Playboy	49.7	98.8	0.7	2.0
Showtime	16.3	20.2	66.2	1.2
Average	28.1	54.7	46.8	1.5
PAY-PER-VIEW				
Viewer's Choice	65.3	220.8	10.9	3.2

* Repetition for the broadcast affiliates is due almost entirely to repetition of the late evening newscast, a practice particular to the Chicago market.

** Includes Nick at Nite.

Sources: January 1989 program schedules provided by individual services and Chicago TV guides for broadcast affiliates.

Table 5

Measures of Diversity in Monthly Schedules

Service	Diversity Index 1	Diversity Index 2
BROADCAST AFFILIATES		
ABC	1366	123
CBS	1270	113
NBC	972	107
Average	1203	115
SUPERSTATIONS		
WGN	1747	128
WPIX	1113	110
WTBS	2201	129
WWOR	1208	112
Average	1568	120
BASIC CABLE		
CBN	1483	126
TNT	5564	164
USA	1728	133
ACTS Satellite	2752	142
A&E	1374	108
BET	4851	152
CNN	4625	165
Discovery	3951	167
ESPN	7586	176
Eternal Word	10000	193
Familynet	5767	164
Learning Channel	3619	166
Lifetime	1663	146
Nashville	1747	143
Nickelodeon*	2732	151
Nostalgia	4416	140
TBN	9709	190
Univision	1969	117
VISN	10000	193
Average	4502	154

Table 5

Measures of Diversity in Monthly Schedules
(cont'd)

Service	Diversity Index 1	Diversity Index 2
PAY CABLE		
AMC	10000	193
Bravo	3858	160
Cinemax	9331	186
Disney	3244	149
HBO	6453	159
Movie Channel	9715	190
Playboy	2122	117
Showtime	7114	165
Average	6840	165
PAY-PER-VIEW		
Viewer's Choice	10000	193

*Includes Nick at Nite.

Sources: January 1989 schedules provided by individual services and Chicago TV guides for broadcast affiliates.

Table 6

Correlation of Repetition and Diversity Measures
(Correlation Coefficients)

Repetition Measures	Diversity Indices	
	1	2
MONTHLY		
Repeat Hrs/Total Hrs	.5145*	.4675*
Repeat Hrs/1st Showing Hrs	.3995**	.3278***
Single Showing Hrs/Total Hrs	-.5188*	-.4992*
Avg. Airings per Program	.4050**	.3400**
DAILY		
Repeat Hrs/Total Hrs	.2155	.1917
Repeat Hrs/1st Showing Hrs	.2819***	.2654
Single Showing Hrs/Total Hrs	-.1773	-.1410
Avg. Airings per Program	.2854	.2627

* Significant at .01 level of significance. Levels of significance were determined according to a two-tailed t-distribution.
** Significant at .05 level of significance.
*** Significant at .10 level of significance.

Table A2-1. Breakdown of Monthly Programming Hours by Program Type

Service	Adventure	Adventure True-to-Life	Audience Partic.	Biography	Children	Situation Comedy	Devotional	Documentary	Drama	Feature Film	How-to-do & Unclass.	Interview	Magazine
BROADCAST AFFILIATES													
ABC	0.0%	0.0%	0.0%	0.0%	2.5%	5.4%	0.0%	0.0%	13.6%	23.4%	7.9%	14.6%	1.5%
CBS	0.3%	0.0%	2.8%	0.0%	3.1%	1.5%	0.0%	0.0%	18.3%	8.4%	1.9%	10.9%	1.6%
NBC	0.0%	0.0%	0.0%	0.0%	3.3%	4.0%	0.0%	0.3%	13.6%	10.5%	4.0%	10.2%	2.0%
Average	0.1%	0.0%	0.9%	0.0%	3.0%	3.6%	0.0%	0.1%	15.2%	14.1%	4.5%	11.9%	1.7%
SUPERSTATIONS													
WGN	0.7%	0.0%	0.0%	0.0%	14.1%	20.4%	3.7%	0.0%	0.0%	30.7%	0.8%	4.3%	0.0%
WPIX	0.0%	0.0%	1.5%	0.0%	14.2%	16.9%	2.0%	0.1%	10.5%	17.3%	0.5%	2.1%	0.0%
WTBS	0.0%	0.0%	0.0%	0.0%	9.5%	20.9%	4.2%	2.8%	3.0%	39.3%	0.0%	0.4%	0.0%
WWOR	2.4%	0.0%	3.2%	0.0%	18.4%	7.7%	2.4%	0.5%	0.2%	6.3%	3.2%	12.6%	0.0%
Average	0.8%	0.0%	1.2%	0.0%	14.0%	16.4%	3.1%	0.8%	3.4%	23.4%	1.1%	4.9%	0.0%
BASIC CABLE													
CBN	3.8%	0.4%	0.0%	0.0%	4.7%	12.8%	25.0%	0.0%	9.3%	16.0%	2.3%	3.2%	0.7%
TNT	1.7%	0.0%	0.0%	0.0%	16.1%	0.1%	0.0%	1.5%	4.2%	72.6%	0.0%	0.0%	0.0%
USA	0.6%	0.0%	0.0%	0.0%	17.4%	2.3%	0.0%	0.0%	3.4%	19.2%	0.0%	1.8%	0.0%
ACTS Satellite	4.4%	0.0%	0.0%	0.0%	8.1%	0.0%	47.2%	0.0%	0.0%	16.3%	0.8%	0.9%	0.0%
A & E	0.0%	6.0%	0.0%	12.0%	0.0%	2.9%	0.0%	18.1%	6.0%	26.7%	3.1%	0.0%	5.4%
BET	0.0%	0.0%	0.0%	0.0%	0.4%	2.6%	15.2%	0.0%	0.0%	2.6%	0.0%	2.9%	0.0%
CNN	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	16.0%	0.3%
Discovery	0.0%	42.3%	0.0%	0.2%	0.0%	0.0%	0.0%	45.9%	0.0%	0.0%	0.0%	0.0%	0.0%
ESPN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	7.6%	0.0%	0.0%
Eternal Word	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Familynet	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	74.3%	0.3%	0.0%	14.2%	2.4%	0.0%	0.0%
Learning Channel	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.8%	0.0%	0.0%	26.0%	2.1%	0.0%
Lifetime	0.0%	0.0%	0.0%	0.0%	0.0%	12.4%	0.5%	0.0%	4.5%	18.4%	6.5%	16.4%	0.0%
Nashville	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	11.5%	22.0%	0.0%
Nickelodeon[a]	3.6%	0.0%	0.0%	0.0%	43.1%	23.5%	0.0%	0.0%	0.0%	9.1%	0.0%	2.1%	0.0%
Nostalgia	5.9%	0.0%	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%	1.2%	65.2%	2.6%	0.4%	0.0%
TEN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.5%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%
Univision	0.0%	0.0%	0.0%	0.0%	6.5%	7.9%	1.0%	0.3%	0.0%	18.3%	0.5%	5.0%	1.8%
VISN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Average	1.1%	2.6%	0.0%	0.8%	5.1%	3.4%	24.3%	4.4%	1.5%	15.0%	3.5%	3.9%	0.3%
PAY CABLE													
AMC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
Bravo	0.0%	0.0%	0.0%	12.2%	4.2%	0.6%	0.0%	6.2%	0.0%	57.5%	0.0%	0.0%	0.0%
Cinemax	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.9%	0.0%	96.6%	0.3%	0.2%	0.0%
Disney	2.7%	3.0%	0.0%	0.8%	35.2%	6.3%	0.0%	2.2%	1.7%	44.0%	0.1%	0.0%	0.0%
HBO	0.0%	0.9%	0.0%	0.0%	7.3%	2.0%	0.0%	1.7%	1.5%	79.8%	0.5%	0.5%	0.0%
Movie Channel	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.6%	0.0%	0.0%	0.0%
Playboy	0.0%	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	0.0%	3.9%	41.9%	8.4%	6.5%	10.0%
Showtime	0.0%	0.0%	0.0%	0.0%	6.1%	2.2%	0.0%	0.0%	3.2%	84.0%	0.2%	0.0%	0.0%
Average	0.3%	0.5%	0.0%	2.3%	6.6%	1.4%	0.0%	1.4%	1.3%	75.3%	1.2%	0.9%	1.3%
PAY-PER-VIEW													
Viewer's Choice	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%

Table A2-1. Breakdown of Monthly Programming Hours by Program Type
(cont'd)

Service	Miniseries	Mystery / Suspense	News	Perform-ance	Game/ Quiz	Science Fiction	Shorts	Sports	Talk & Educ.	Travel	Comedy Variety	General Variety	Musical Variety	Western	Total Hours
BROADCAST AFFILIATES															
ABC	0.0%	1.9%	16.1%	0.0%	4.4%	0.0%	0.0%	6.0%	1.6%	0.0%	0.0%	1.0%	0.2%	0.0%	100.0%
CBS	0.0%	4.9%	23.5%	0.0%	5.9%	0.0%	0.0%	8.3%	1.9%	0.0%	6.4%	0.7%	0.1%	0.0%	100.0%
NBC	0.0%	6.2%	15.4%	0.0%	11.0%	0.0%	0.0%	8.5%	1.9%	0.0%	7.2%	0.7%	1.2%	0.0%	100.0%
Average	0.0%	4.3%	18.3%	0.0%	7.1%	0.0%	0.0%	7.6%	1.8%	0.0%	4.5%	0.8%	0.5%	0.0%	100.0%
SUPERSTATIONS															
WGN	0.0%	9.0%	8.9%	0.0%	1.8%	0.0%	0.0%	2.6%	1.7%	0.0%	0.3%	1.2%	0.5%	0.3%	100.0%
WPIX	1.2%	9.7%	9.3%	0.0%	3.0%	4.3%	0.0%	1.5%	2.7%	0.0%	1.5%	1.1%	1.9%	0.0%	100.0%
WTBS	0.0%	2.8%	1.8%	0.0%	0.0%	0.0%	0.0%	6.1%	0.3%	0.0%	0.0%	1.2%	6.7%	1.1%	100.0%
WWOR	0.0%	21.2%	7.9%	0.0%	1.8%	0.6%	0.0%	6.2%	0.3%	0.0%	5.2%	0.0%	0.0%	0.0%	100.0%
Average	0.3%	9.4%	6.7%	0.0%	1.6%	1.2%	0.0%	4.1%	1.3%	0.0%	1.7%	0.9%	2.3%	0.3%	100.0%
BASIC CABLE															
CBN	0.0%	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.7%	0.0%	0.0%	0.0%	0.0%	16.8%	100.0%
TNT	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.7%	0.0%	1.1%	100.0%
USA	0.0%	26.6%	0.0%	0.0%	16.8%	0.0%	0.0%	5.1%	0.0%	0.0%	0.0%	2.2%	3.8%	0.8%	100.0%
ACTS Satellite	0.0%	0.0%	4.4%	0.0%	0.0%	0.0%	1.1%	0.5%	11.4%	0.0%	0.0%	0.0%	0.0%	5.0%	100.0%
A & E	1.2%	1.6%	0.0%	4.0%	0.0%	0.0%	3.8%	0.8%	0.0%	1.2%	7.1%	1.2%	0.9%	0.0%	100.0%
BET	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	4.3%	0.0%	2.5%	0.0%	0.5%	67.6%	0.0%	100.0%
CNN	0.0%	0.0%	65.1%	0.0%	0.0%	0.0%	0.0%	6.8%	9.3%	0.4%	0.0%	0.0%	0.0%	0.0%	100.0%
Discovery	0.0%	0.0%	3.9%	0.0%	0.0%	0.0%	0.0%	6.4%	0.0%	1.0%	0.0%	0.4%	0.0%	0.0%	100.0%
ESPN	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	0.0%	86.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Eternal Word	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Familynet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	4.4%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Learning Channel	0.0%	0.0%	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	51.4%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Lifetime	0.0%	21.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.6%	0.0%	0.0%	0.5%	0.0%	0.0%	100.0%
Nashville	0.0%	0.0%	0.0%	0.0%	6.6%	0.0%	0.0%	14.8%	0.0%	2.7%	0.0%	9.3%	27.2%	0.0%	100.0%
Nickelodeon*	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	0.9%	0.0%	0.0%	0.0%	14.6%	0.7%	0.5%	0.0%	100.0%
Nostalgia	0.0%	7.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	4.7%	2.2%	4.6%	0.0%	100.0%
TBN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Univision	37.9%	0.0%	3.6%	0.0%	1.9%	0.0%	0.0%	3.3%	2.4%	0.0%	0.7%	4.7%	4.4%	0.0%	100.0%
VISN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Average	2.1%	3.3%	4.6%	0.2%	1.4%	0.0%	0.3%	7.0%	5.3%	0.4%	1.5%	1.2%	5.7%	1.2%	100.0%
PAY CABLE															
AMC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Bravo	0.0%	0.0%	0.0%	18.6%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Cinemax	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	1.0%	0.0%	100.0%
Disney	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	1.5%	0.0%	100.0%
HBO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	3.2%	0.0%	0.1%	0.0%	100.0%
Movie Channel	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Playboy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%	0.0%	1.3%	4.8%	5.8%	4.8%	3.2%	0.0%	100.0%
Showtime	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	1.2%	1.3%	0.5%	0.0%	100.0%
Average	0.2%	0.0%	0.0%	2.3%	0.0%	0.0%	1.0%	0.3%	0.2%	0.6%	1.3%	0.9%	0.8%	0.0%	100.0%
PAY-PER-VIEW															
Viewer's Choice	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%

* Includes Nick at Nite.

Notes: January 1989 program schedules provided by individual services and Chicago TV guides for broadcast affiliates.

Visual Crosstabs:
A Technique for Enriching Information Graphics

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Abstract

One technique for introducing more analysis into information graphics is the use of what we are calling here visual crosstabs (or Vis Tabs) — the graphical presentation of statistical crosstabulations. This paper looks at some examples of current use of two-way visual crosstabs (by USA Today); presents an example of an analysis involving two-way, three-way and four-way visual crosstabs; makes some suggestions for using visual crosstabs effectively; and raises some questions about the sources of data for information graphics that become particularly acute when visual crosstabs are attempted.

Visual crosstabs offer the journalist the opportunity to use information graphics in a more powerful way. They offer the potential for exploring relationships and beginning to investigate causes. They also offer some resolution to the Tufte-Holmes debate over the use of decoration in information graphics. As information graphics move toward exploring relationships and investigating causes, they take on additional complexity (as well as interest) that probably makes decoration less necessary.

Visual Crosstabs: A Technique for Enriching Information Graphics

Journalists who work with information graphics have sometimes had difficulty accepting Edward Tufte's criticism of quantitative graphics in the mass media as being information-thin and cluttered with unnecessary decoration.[1] A common reaction is to protest that decoration is needed to attract readers to graphs that are competing with other mass media content for readers' attention.[2] Nigel Holmes, graphics director for Time magazine, has suggested that charts presented without "visual help" will soon all look the same and lose the interest of the consumer.[3] A way out of this apparent Tufte-Holmes dilemma might be to push mass media information graphics in the direction of greater complexity, with this complexity coming from the use of more analytical or explanatory graphics. One technique for introducing more analysis into information graphics is the use of what we are calling here visual crosstabs (or Vis Tabs) — the graphical presentation of statistical crosstabulations. This paper looks at some examples of current use of two-way visual crosstabs (by USA Today); presents an example of an analysis involving two-way, three-way and four-way visual crosstabs; makes some suggestions for using visual crosstabs effectively; and raises some questions about the sources of data for information graphics that become particularly acute when visual crosstabs are attempted.

As information graphics in the mass media become more analytical through greater use of visual crosstabs, the addition of decoration may become less appropriate. The graphics themselves

will be telling more of a story and added pictorial elements will be less necessary. Information graphics should become more interesting as they move beyond description into explanation.

The Concept of Crosstabulation

The basic function of crosstabs is to investigate relationships between variables. A crosstabulation is a tabulation of the distribution of one variable (usually shown by percentages) by the categories of another variable. Crosstabulations have long been a mainstay of survey analysis.[4] Crosstabs are a basic technique for exploring data, and for moving from a descriptive examination of data to analysis of relationships. Crosstabs let the researcher begin to investigate causal relationships (although there are pitfalls in this process and cross-tabulations never give complete closure in the search for causes). For news work, an approach using visual crosstabs should probably emphasize exploring and demonstrating relationships rather than attempting to prove causality.

Crosstabs are normally presented in tables, and are commonly generated by a computer program such as the crosstabs subprogram of SPSS. But there are reasons to believe that a visual or graphic form of presentation might be more effective than tables. Washburne[5] found that tables were more effective for having subjects learn specific scores, but that bar graphs and pictographs were more effective for having subjects make comparisons between quantities. In addition, Standing, Conezio and Haber[6] have shown that people have an extraordinary capacity for remembering pictures.

Visual crosstabs can provide added impact to data emerging from precision journalism and social indicators.[7] They can be useful for more effective presentation of data that journalists may already be investigating. Thinking in terms of visual crosstabs might also encourage journalists to seek kinds of data they are not obtaining. And thinking about them might encourage journalists to explore data they already have in different and more thorough ways.

Examples of Visual Crosstabs from the Media

Examples of visual crosstabs can already be found in the mass media, although they are not referred to by that name. The following examples are taken from USA Today, probably the easiest place today to find examples of different kinds of information graphics.

The first example is a graphic reporting the percentage of male and female adults who sleep in the nude (Figure 1). The pillows are in the shape of pie charts reporting the percentages for each sex. The relationship being investigated is between gender and sleeping in the nude. The effectiveness of the pie charts may be questionable in a graphic of this type where the focus is on comparison of quantities.

Another USA Today graphic reported the percentages of home ownership for married couples, single persons and single parents (Figure 2). In this graphic, the height of the steps leading into a house are columns in a column chart reporting the different percentages. USA Today also ran the same data a couple of weeks later in a different graphic with houses of different sizes as columns

reporting the different percentages (Figure 3). The relationship in these graphs is between marital/parental status and home ownership.

Another graphic shows the percentages of smokers for teenagers of different grade levels (Figure 4). The percentage seems to be shown two ways — by the heights of the cylinders and by the pie charts on the top of the cylinders. The relationship here is between grade level of teenagers and smoking.

Still another chart shows the percentages of male and female state legislators who oppose various policies, including abortion limits, the death penalty and nuclear power (Figure 5). The heights of the podiums that people are standing behind become the columns in a column chart representing the percentages. The relationship is between gender of state legislators and opposition to various policies.

Another graphic shows the percentages for men victims and women victims of violent crime for attackers who were strangers and attackers who were family members or friends (Figure 6). The pie charts — one for men and one for women — show the percentages for strangers versus family or friends. The relationship is between gender of the victims of violent crimes and whether the perpetrator of the violence was a stranger as compared to family member or friend. This graphic again presents the problem of requiring the viewer to compare the sizes of pie slices in two different pies.

One more example shows the percentages of college students who say they are extra selective about choosing a sexual partner in 1990 and 1991, and also the percentages who say they are using condoms in 1990 and 1991 (Figure 7). The percentages are shown in

column charts superimposed over a drawing of a scene through a bedroom window. The relationship being shown is between the year and the taking of sexual precautions by college students.

All of these graphics from USA Today show relationships between two variables. They are not typical of USA Today information graphics. The more common USA Today information graphic shows descriptive information about one variable rather than a relationship between two variables. A more conventional USA Today graphic is the one in Figure 8, which shows percentages of American adults who "sleep fine," "have occasional insomnia" and "have chronic insomnia." This graphic almost cries out for additional investigation through visual crosstabulations. Do some kinds of people have insomnia more than others? What kinds of people are most prone to insomnia?

An Extended Example of Visual Crosstabs — Incidence of High Blood Pressure

An extended discussion of one example might help to illustrate some of the concepts and procedures of using visual crosstabs. We have selected for this discussion some data derived from the Health Interview Survey conducted periodically by the Bureau of the Census for the National Center for Health Statistics.[8]

The most basic descriptive information about high blood pressure that comes from the survey is that 26% of the adult population has this chronic condition. This information could be put in a pie chart that might look like Figure 9. With some added pictorial or cartoon elements — the pie chart might be embedded in

the gauge for a blood pressure instrument, for example — this would be similar to many charts in USA Today.

A second level of analysis of the blood pressure data could involve two-way visual crosstabs. The public health survey also classified respondents on the basis of age, sex and race. Creating visual crosstabs of high blood pressure frequency by these three variables could produce visual crosstabulation charts like those in Figures 10, 11 and 12. These charts show that each of these three variables is related to high blood pressure.

It is possible to move on to another level of analysis that involves three-way crosstabulations. In fact, data analysis expert Hans Zeisel states that the correct procedure when looking at crosstabs for more than two variables is to introduce each factor simultaneously with the other factors.[9] Taking the three-way relationship of high blood pressure incidence, sex and age as an example, we might come up with a visual three-way crosstabulation in the form shown in Figure 13. Or, another form of visual presentation of the same data appears in Figure 14. In this second case, three dimensions are used to represent the three variables.

Finally, we can move to a still higher level of analysis and attempt to look at a four-way crosstabulation of high blood pressure incidence by sex, age and race. The use of four variables begins to strain our ability to represent a crosstabulation visually. The most effective forms of visual display for four-variable relationships may not have been invented yet. One approach to presenting a four-way crosstabulation visually is the grouped-column chart.[10] Figure 15 uses a grouped-column chart to present the four-way visual crosstab

of high blood pressure incidence data. The chart also follows Zeisel's advice of introducing each factor simultaneously with all the other factors. The figure probably takes a few minutes to comprehend. One way to approach it is to look at each independent variable — sex, age and race — one at a time. The effect of sex can be analyzed by comparing the top line of bars with the bottom line of bars.[11] This comparison suggests that sex doesn't make a consistent difference in high blood pressure incidence. Sometimes the males show more high blood pressure and sometimes the females do.

The effect of age can be looked at by dividing the chart into three large groupings vertically. This comparison suggests that age does make a difference in high blood pressure incidence. In particular, the last two large groupings — 45 to 59 and 60 to 74 — are showing higher values than the first large grouping.

Analysis by race can be carried out by comparing the three columns joined by each horizontal line — a visual element that occurs six times. In each of the six cases, blacks are showing a higher percentage of high blood pressure than the other racial groups. Another way to look at it is to try to determine where the tallest columns in the whole chart occur. It is readily apparent that the four tallest columns are all for blacks.

This four-way visual crosstabulation is a rather sophisticated analysis, asking the question of what is the relationship between race and high blood pressure while controlling for sex and age? And it shows that race makes a difference even when we control for sex and age. The analysis is being presented visually, and it may even be easier to see this way than if it were presented in a table.

Of course, this analysis still leaves some important questions unanswered, such as what are the ultimate causes of more frequent high blood pressure in blacks. We would probably be in a better position to answer this question if some other variables — education and income, for instance — were brought into the analysis. But the journalist cannot easily consider these variables if they were not introduced by the original data gatherer/analyst. And ultimately the question of the causes of higher incidence of high blood pressure in blacks needs to be answered by the medical researcher rather than the journalist.

Constructing Visual Crosstabs

Visual crosstabs require certain kinds of data. Basically, they work best with frequency data that can be converted to percentages, although they can also be constructed from data presented in terms of frequency per thousand or even in terms of raw counts (the number of wins and losses by a football team at home versus away, for instance). The dependent variable (that is, the variable that is a likely effect rather than a cause) should probably have two categories — yes or no, win or lose, the presence or absence of a phenomenon — so that percentages can be used to show its presence by degree.

The best form for representing visual crosstabs is probably the bar or column chart. Lewandowsky and Spence[12] report an experiment by Spence that compared people's judgments of the size of elements in pie charts, disk charts (pie charts that are tilted so that they look elliptical), bar (or column) charts, box charts, cylinder

charts, horizontal line charts, vertical line charts, and table elements. People were most accurate in their judgments of the size of elements in tables, pie charts and bar (or column) charts. People were least accurate in judging disk charts (the kinds of charts used by USA Today in Figures 1 and 4). Another study by Hastie and Simkin, however, suggests that bar (or column) charts lead to greater accuracy than pie charts when subjects are attempting to make comparisons, as they typically are when viewing crosstabs.[13]

Pie charts would seem to be particularly ineffective in three-way or four-way visual crosstabs.

Another basic question is whether bar charts (or pie charts) should be presented with a third dimension added for aesthetic effect, making the bars (or pies) into solid objects. Research reported by Lewandowsky and Spence[14] indicates that adding a third dimension does not lower the accuracy of perceiving graphical elements if the base remains the same. Furthermore, Tankard[15] showed that adding the third dimension can lead to greater viewer interest. In light of these findings, it does not appear that the creator of visual crosstabs should avoid the use of three-dimensional columns, bars, or pies, although disk or tilted pie charts probably should not be used.

A third basic question involves the use of decoration or "chartooning"[16] with visual crosstabs. Research by Tankard provided some evidence that readers prefer chartoons, a kind of decorated graph, to unadorned graphs.[17] Furthermore, use of pictorial elements may in certain cases make a graph more

memorable (see previously cited research by Standing which indicates the extraordinary ability of people to remember pictures).

As more variables are brought into a visual crosstabulation analysis, however, it may be less suitable and less necessary to add pictorial elements or decoration. These more complicated visual crosstabs take on a richness of their own that might make decoration less necessary.

Suggestions for Improving Visual Crosstabs

As visual crosstabs become more complicated — i.e., as they move toward involving more variables — it becomes a problem to make them interpretable by the ordinary reader. One way of looking at it is that they are data-rich — there are a lot of things to look at. One advantage of this state of affairs is that the viewer can explore the data and come up with his or her own conclusions. But some people might be baffled by many three-way or four-way visual crosstabs. What are they supposed to look at? What are they supposed to see? Are there any ways to help readers interpret complex visual crosstabs? Here are some suggestions:

1. Arrange the elements in the most meaningful way. For instance, in a three-dimensional graph, put short columns in front of tall columns. Or in a bar chart comparing the 50 states on amount spent on education (or some other variable), put the list in rank order rather than alphabetical order.

2. Use captions, or discussion in the text, to direct attention to particular parts or aspects of the graph.

3. In a four-way crosstabulation, put the variable you want to focus on in a position so that columns or bars representing its different levels are adjacent to each other or in as close proximity as possible so that visual comparisons can be made.

4. When you bring in new variables, follow the Zeisel recommendation of bringing them in simultaneously with previous variables rather than through a series of two-way tables.

In the construction of elaborate visual crosstabs, analysis questions begin to become entangled with design questions. Which variable do you put in which location? Probably you should try to place the variables that people would be most interested in comparing side by side. In a four-way visual crosstab, it might be useful to place the variables being used as controls along the side (on the vertical axis) and across the top and the levels of the independent variable of focus across the base of the small separate column charts.

What about analyses that examine more than four variables at a time? It may be difficult to go beyond four variables with the grouped-column chart used in this paper. One innovative approach suggested by Chernoff uses drawings of human faces to represent multivariate data, with different facial features standing for as few as eight or as many as 18 variables.[18] Lewandowsky and Spence[19] used Chernoff faces to display eight kinds of economic data for various countries, with population represented by shape of the face, area represented by size of the face, GNP per capita represented by curvature of the mouth, life expectancy represented by length of the nose, radios per 1,000 represented by location of the eyes, number of

tourists represented by separation of the eyes, food supply represented by location of the mouth and school enrollment represented by location of the pupils.

Getting Data for Visual Crosstabs

A topic in the use of information graphics that has probably not been discussed enough is the issue of where the data come from. Most books or articles dealing with information graphics stress the presentation of the numbers, but not the source of the numbers and what has happened to them on their way to the journalist. Often the numbers come from a government agency or private interest group and they may have been heavily processed by the time they get to the journalist. To some extent, the journalistic graphics creator is limited by what information the releasing agency supplies.

Journalists may obtain the information for finished information graphics in several ways: 1. A government agency or private interest group may hand out charts in a more or less finished form. These charts may be used as is or altered. 2. A government agency or interest group may release information resulting from crosstabulations but in the form of tables or text. This information could then be put into graphical form by the journalist. 3. The journalist may take more initiative and seek data from printed sources or experts to answer certain questions. These data can then be put into graphic form. 4. The news organization may conduct its own survey or other research study and then analyze the data as the journalist sees fit. 5. The journalist may obtain raw data (perhaps in

the form of computer tapes or other electronic files) and then analyze the data as he or she sees fit.

In order to look at new and enlightening visual crosstabs that may occur to the journalist, it may be necessary to get access to data in the form of raw data rather than pre-processed tables or figures. If crosstabs are already prepared by the releasing agency, it may not be possible to get back to the original numbers that would allow the journalist to do new and original crosstabs. The journalist can be handicapped by the analyses that the releasing organization decided to carry out. The very fact that the design and planning of the research has been done by the releasing organization imposes limitations — the journalist is restricted to the conceptualization of the problem and selection of variables that the original analyst formulated.

A position being advocated in this paper is that journalists should push as much as possible for getting raw, unanalyzed data and doing the visual crosstabulations and other analyses themselves. This may require that developers of information graphics have more training in statistics and data analysis. The information graphics designer must become to some extent a data analyst. At this point the need for original data sets in order to create more meaningful information graphics begins to merge with the recommendations by Elliot Jaspin and others that journalists obtain records in computer-readable form and conduct their own analyses.[20]

Implications for Theory and Research

Visual crosstabs that are rich in data are more in tune with a uses and gratifications approach to communication than a communication effects approach. Different users can look at complex visual crosstabs and come away with different conclusions because they are focusing on different variables or different aspects. It is like looking at a painting or a photograph — there may not be just one correct interpretation.

The use of data-rich visual crosstabs complicates effects-oriented research on information graphics such as experiments aimed at testing learning or information gain. With multivariate visual crosstabs, there may not be one clear intended effect. In that case, what does the experimenter measure as a dependent variable?

Conclusion

Visual crosstabs offer the journalist the opportunity to use information graphics in a more powerful way. They offer the potential for exploring relationships and beginning to investigate causes. They also offer some resolution to the Tufte-Holmes debate over the use of decoration in information graphics. As information graphics move toward exploring relationships and investigating causes, they take on additional complexity (as well as interest) that probably makes decoration less necessary.

Visual crosstabs call for greater research skills on the part of the developer of information graphics. The information graphics journalist may need training in statistics and survey research. At the

same time, visual crosstabs call for greater creativity. In particular, we need new forms of graphics that haven't been invented yet to display the more elaborate three-way and four-way crosstabulations.

In addition, use of visual crosstabs brings home the point that creators of information graphics should pay more attention to where the numbers come from and who is releasing them for what purpose. The full power of visual crosstabulation analysis comes into play when the journalist has access to the basic data and can conduct some analyses of his or her own.

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[1]Edward R. Tufte, The Visual Display of Quantitative Information (Cheshire, Conn.: Graphics Press, 1983), p. 167; Jean Evangelauf, "An 'Information Designer' Strives for the 'Elegant and Beautiful," Chronicle of Higher Education, May 1, 1991, p. A3.

[2]See the comments by various art directors and graph makers in James D. Kelly, "The Graph Makers: A Survey of the Newspaper Editorial Workers who Create Charts and Graphs," a paper presented to the VisCom Division of the Association for Education in Journalism and Mass Communication at the annual meeting in Minneapolis, Minnesota, August, 1990.

[3]Nigel Holmes, Designer's Guide to Creating Charts and Diagrams (New York: Watson-Guptill Publications, 1984), p. 9.

[4]See Herbert Hyman, Survey Design and Analysis: Principles, Cases and Procedures (Glencoe, Ill.: The Free Press, 1955); Travis Hirschi and Hanan C. Selvin, Delinquency Research: An Appraisal of Analytic Methods (New York: The Free Press, 1967); Hans Zeisel, Say It with Figures, 5th ed. (New York: Harper & Row, 1968).

[5]John Noble Washburne, "An Experimental Study of Various Graphic, Tabular and Textual Methods of Presenting Quantitative Material" Journal of Educational Psychology 18:361-376 and 465-476.

[6]Lionel Standing, Jerry Conezio, and Ralph Norman Haber, "Perception and Memory for Pictures: Single-Trial Learning of 2560 Visual Stimuli," Psychonomic Science 19:73-74 (1970).

[7]Maxwell McCombs, Donald Lewis Shaw and David Grey, Handbook of Reporting Methods (Boston: Houghton Mifflin, 1976).

[8]Social Indicators 1976: Selected Data on Social Conditions and Trends in the United States (Washington, U.S. Government Printing Office, 1977), p. 207.

[9]Zeisel, Say It, p. 146.

[10]The idea of using the grouped-column chart for four variables came from a chart in Anna C. Rogers, Graphic Charts Handbook (Washington, D.C.: Public Affairs Press, 1961), p. 75. The chart in the Rogers book was used to show the

relationship between whether a wife was working and the husband's income, presence and age of children, and education (presumably the wife's).

[11]One problem that becomes apparent at this point is that we do not have adequate terminology developed for discussing this kind of a four-way visual crosstab chart.

[12]Stephan Lewandowsky and Ian Spence, "The Perception of Statistical Graphs," Sociological Methods and Research 18:200-242 (November 1989/February 1990.

[13]David Simkin and Reid Hastie, "An Information-Processing Analysis of Graph Perception," Journal of the American Statistical Association 82:454-465 (June 1987).

[14]Lewandowski and Spence, "The Perception of Statistical Graphs."

[15]James W.Tankard, Jr., "Effects of Chartoons & Three-Dimensional Graphs on Interest and Information Gain," Newspaper Research Journal 10:91-103 (Spring 1989).

[16]James W. Tankard, Jr., "Quantitative Graphics in Newspapers," Journalism Quarterly 64:406-415 (Summer-Autumn 1987).

[17]Tankard, "Effects of Chartoons."

[18]Herman Chernoff, "The Uses of Faces to Represent Points in k-Dimensional Space Graphically." Journal of the American Statistical Association 68:361-368 (June 1973).

[19]Lewandowski and Spence, "The Perception of Statistical Graphs."

[20]See Mary Ann Chick Whiteside, "Resources for Computer-Assisted Journalism," Editor & Publisher, November 2, 1991, pp. 3PC-4PC; Mary Ann Chick Whiteside, "Getting Started in Computer-Assisted Journalism," Editor & Publisher, November 2, 1991, pp. 5PC-6PC; and Elliot G. Jaspin and Sandra Davidson Scott, "Should Government-Developed Software be Copyrighted?" Editor & Publisher, November 2, 1991, pp. 14PC-15PC, 20PC.

Figure 1. Two-way visual crosstab showing the relationship between gender and sleeping in the nude. Source: USA Today, Jan. 3, 1992, p. 1D.

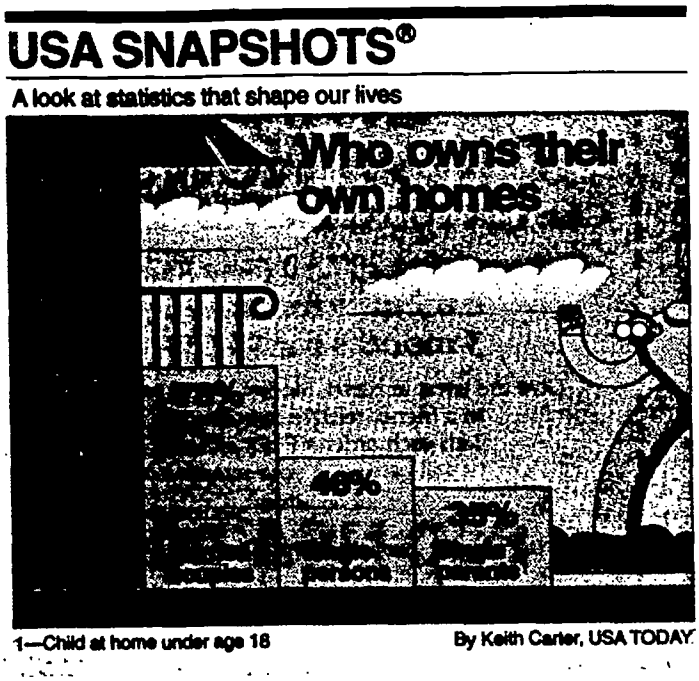


Figure 2. Two-way visual crosstab showing the relationship between marital and parental status and home ownership. Source: USA Today, Dec. 30, 1991, p. 1D.

Figure 3. Two-way visual crosstab showing the relationship between marital and parental status and home ownership. Source: USA Today, Jan. 17, 1992, p. 1D.

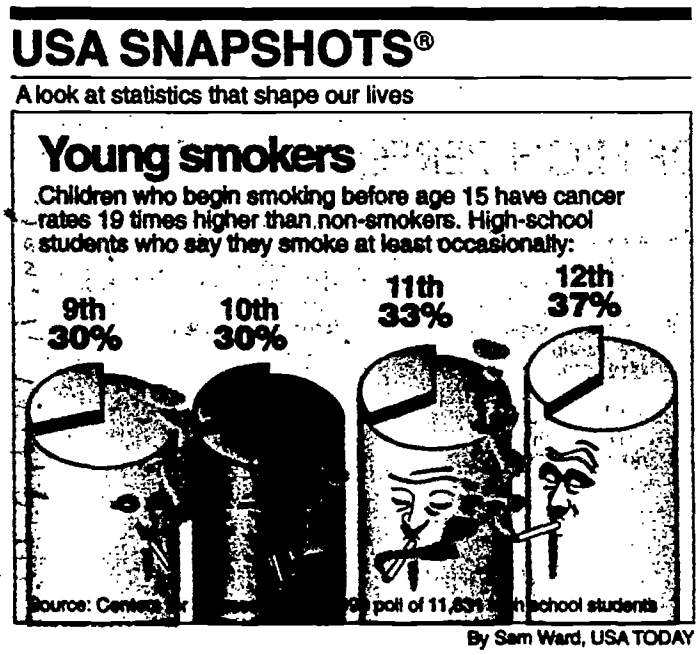


Figure 4. Two-way visual crosstab showing the relationship between grade level of teenagers and smoking behavior. Source: USA Today, Jan. 7, 1992, p. 1D.

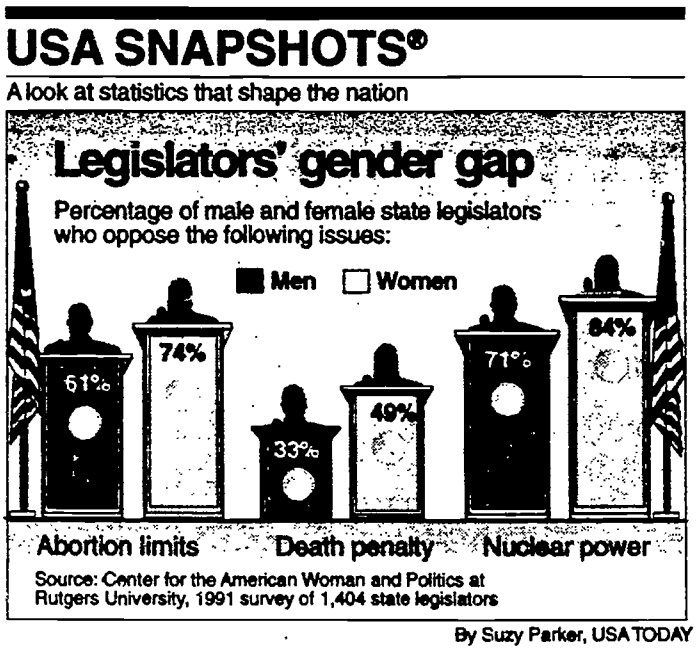


Figure 5. Two-way visual crosstab showing the relationship between state legislators' gender and their support for various policies. Source: USA Today, Jan. 24, 1992, p. 1A.

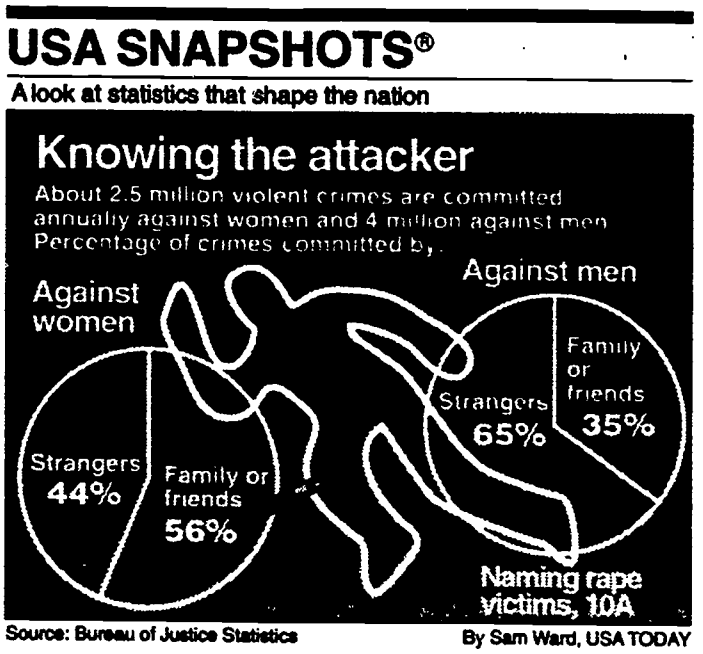


Figure 6. Two-way visual crosstab showing the relationship between men and women as victims of violent crime and familiarity with the aggressor. Source: USA Today, May 9, 1991, p. 1A.

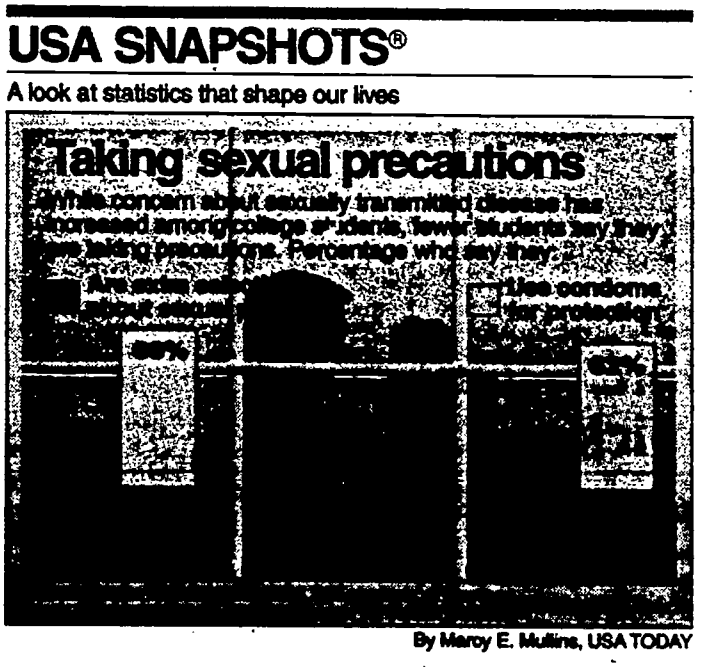


Figure 7. Two-way visual crosstab showing the relationship between year (1990 vs. 1991) and taking of sexual precautions. Source: USA Today, May 6, 1991, p. 1D.

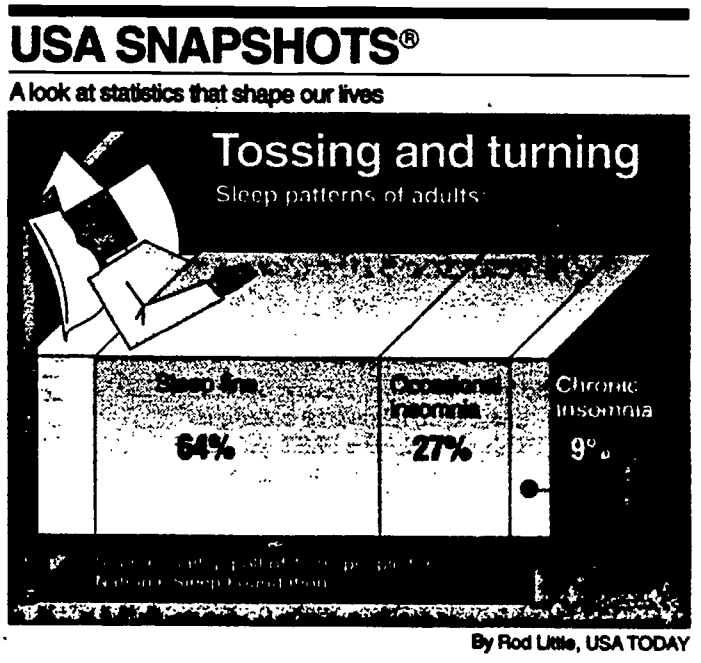


Figure 8. Typical USA Today chart showing distribution of responses for one variable only — how well people sleep. Source: USA Today, Jan. 9, 1992, p. 1D.

Figure 9

Percent of Population with High Blood Pressure

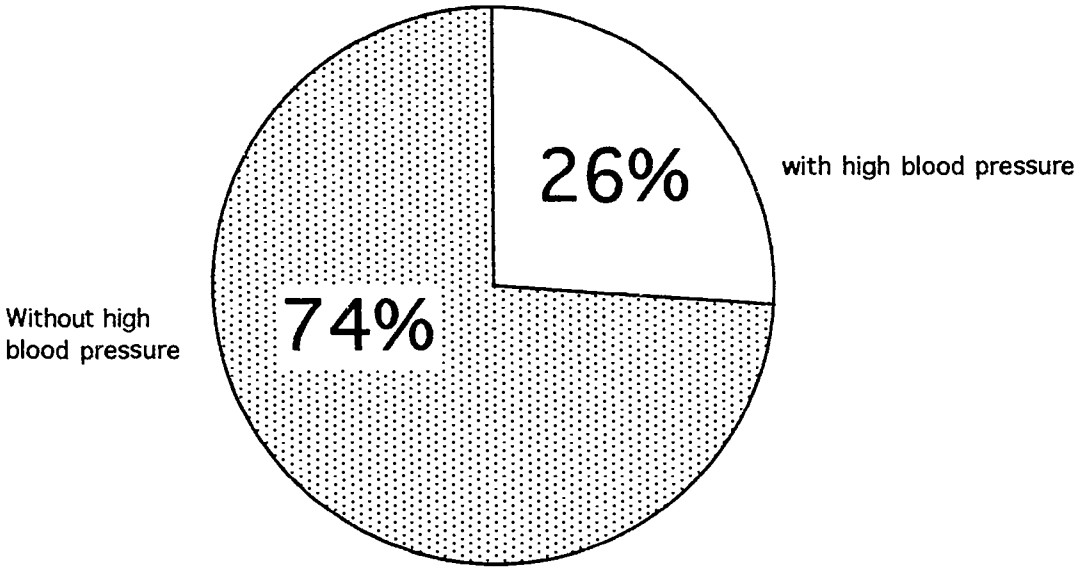


Figure 10

Percent of Population with High Blood Pressure by Sex

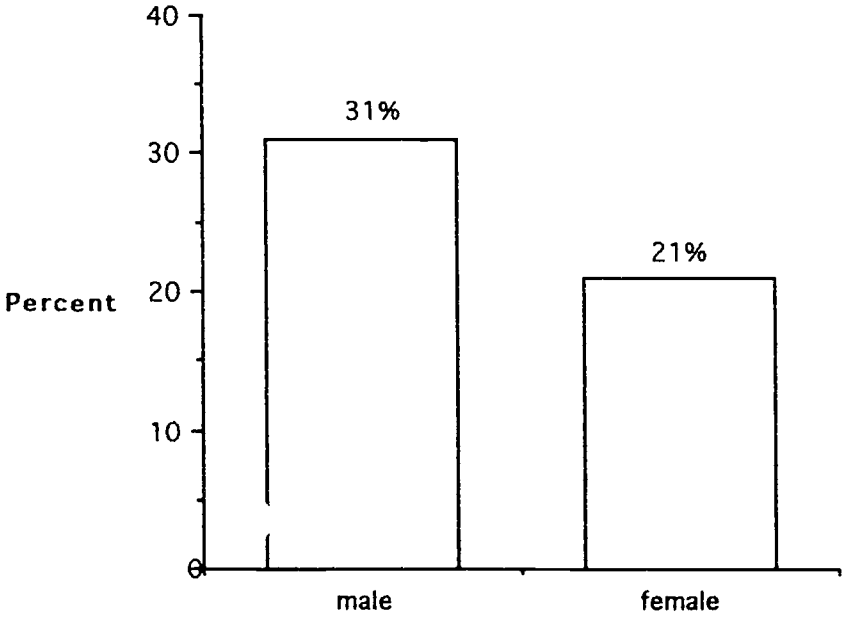


Figure 11

Percent of Population with High Blood Pressure by Age

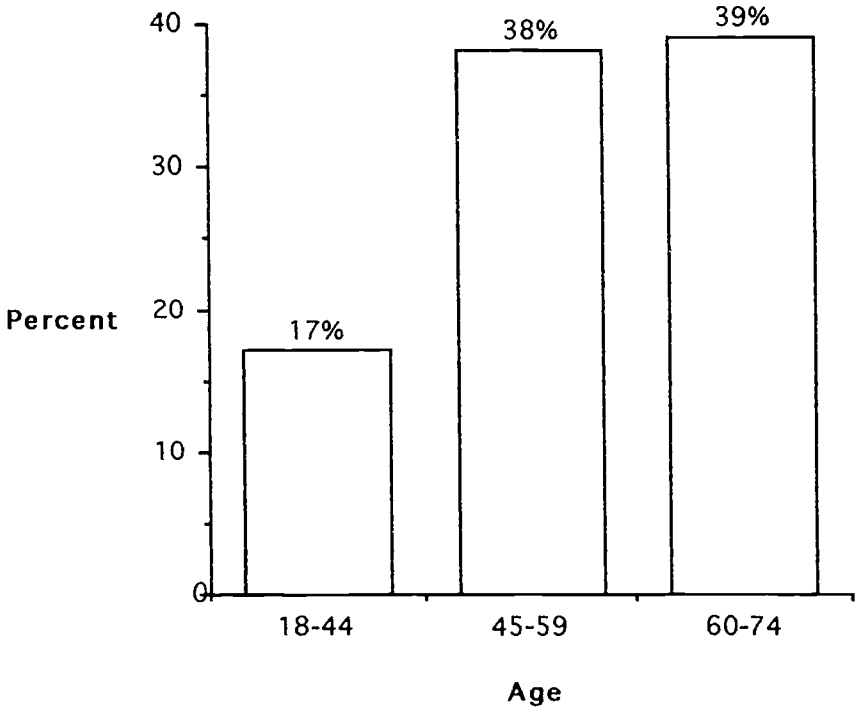


Figure 12

Percent of Population with High Blood Pressure by Race

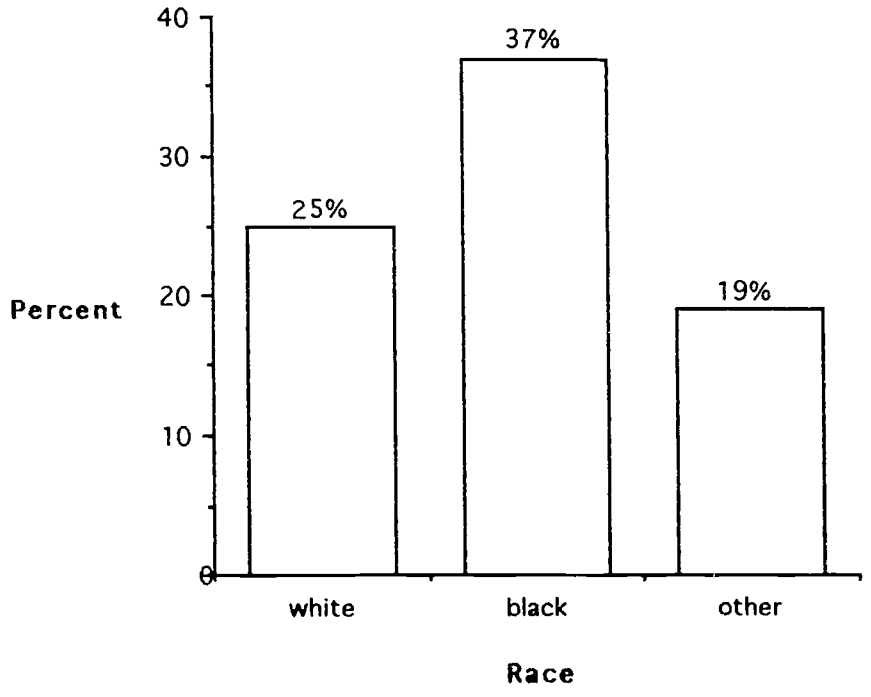


Figure 13
Percent of Population with High Blood Pressure by Sex and Age

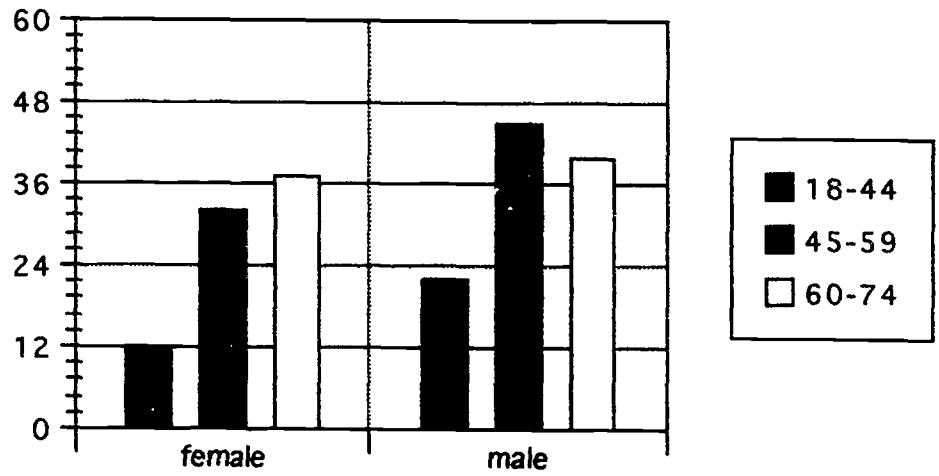


Figure 14
Percent of Population with High Blood Pressure by Sex and Age

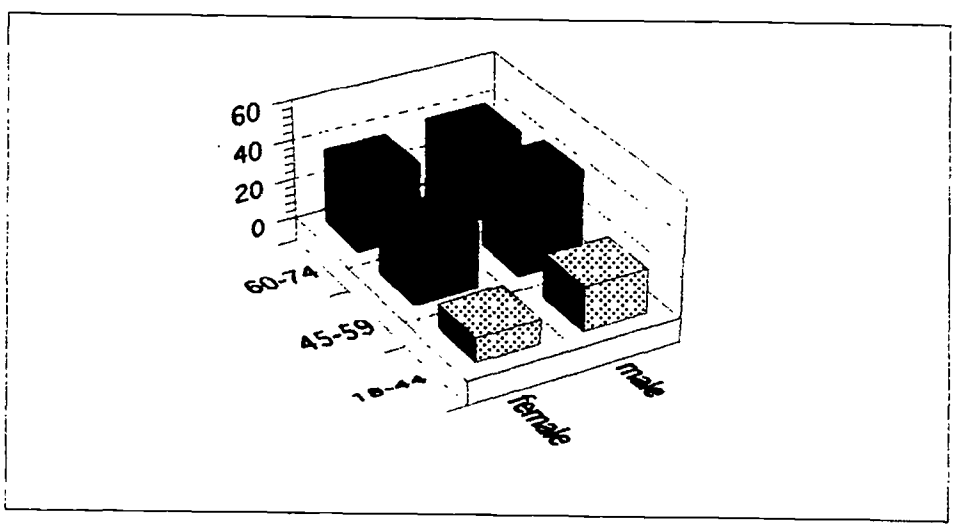
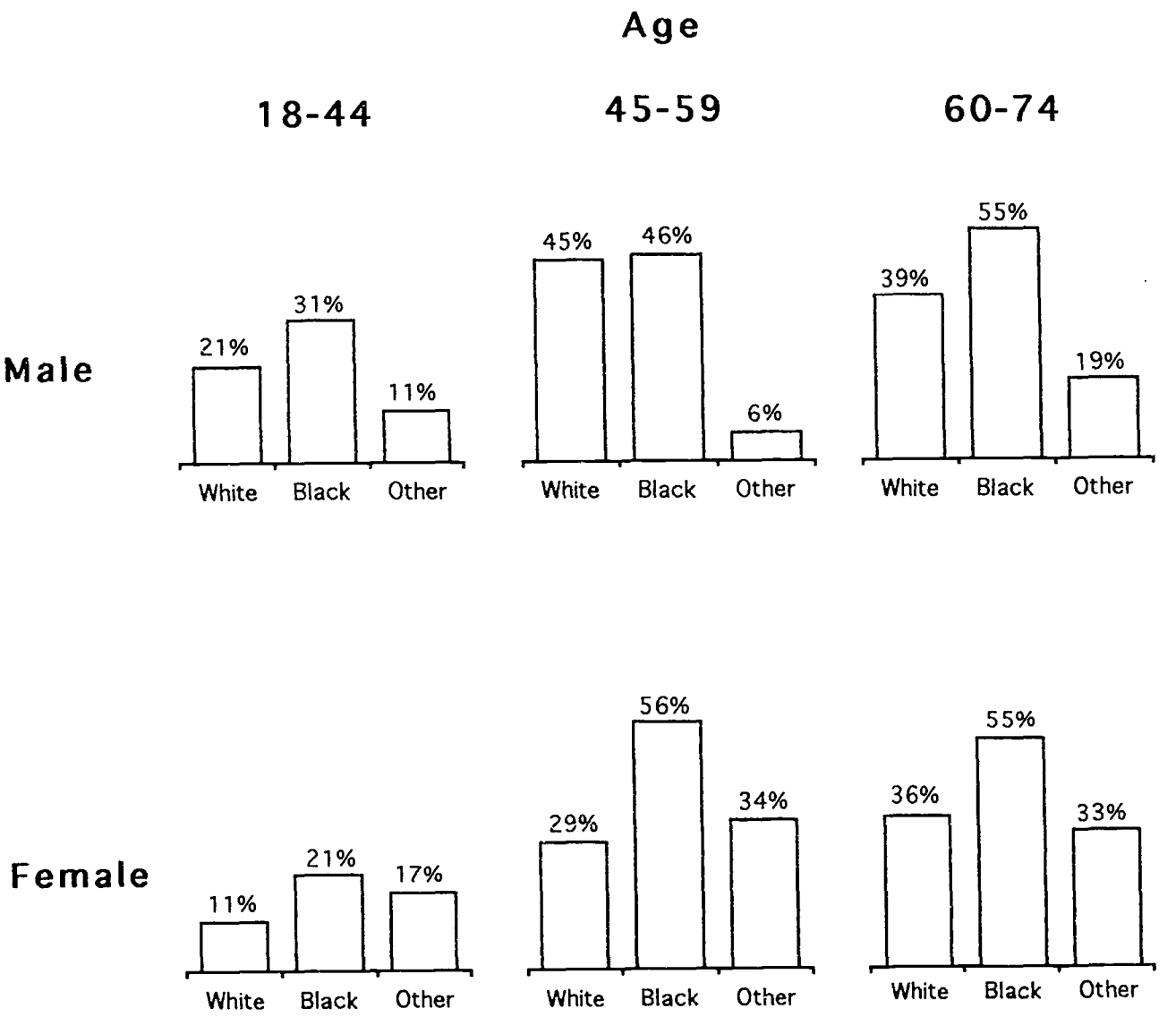


Figure 15

Percent of Population with High Blood Pressure by Sex, Age and Race



THE INFLUENCE OF STATISTICAL GRAPHICS ON NEWSPAPER READER KNOWLEDGE GAIN

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Presented to the Newspaper Division,
Association for Education in Journalism and Mass Communication,
Montreal, Canada, August, 1992.

ABSTRACT

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Newspapers stories often contain statistical information aimed at helping the reader grasp the event or understand the context in which the event occurs. This study considered the effectiveness of two methods of presenting statistical information to enhance reader understanding of news events -- the traditional method of blending it into the body of the story and the increasingly used method of putting it in an information graphic that accompanies the text. A 2x2 randomized group, posttest-only experiment was conducted to measure the effect of four conditions: statistical information in the text only, statistical information in the text and in a graphic, statistical information in the graphic only, and no statistical information in either place.

Results indicated that newspaper readers' knowledge of a news event can be increased when statistical information is part of the story, whether in the text or in a graphic. The redundant technique of putting it both places leads to more knowledge gain from a news story than does either of the other techniques alone, but an analysis of variance indicates that the interaction of the two factors is not significant.

This experiment suggests that by adding statistical information to the text of a story or putting it in an accompanying information graphic -- or by doing both -- newspapers can significantly increase reader knowledge of a complex news event.

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THE INFLUENCE OF STATISTICAL GRAPHICS ON NEWSPAPER READER KNOWLEDGE GAIN

INTRODUCTION

Numbers may be an anathema to a lot of journalists -- and readers -- but percentages and fractions and tallies of one thing or another go into most stories. The numbers are used to quantify the world of news, whether they specify exactly how many or what percentage or whether they give an estimate. These numbers may highlight a story detail or provide a macroscopic overview that puts things into perspective. The explosion of information that is a hallmark of the late 20th century has unleashed an ever more torrid stream of data that not only is available to journalists, but that they are expected to harness in telling the story. But along with the exponential growth in the numbers in the news has come a challenge: how to present them in a way that informs, rather than overwhelms, readers. More and more, newspapers are responding by turning to graphs and charts.

The use of graphic devices has mushroomed at newspapers not only as a design element, but also as a way to convey information to readers. This study looks at the effectiveness of simple

graphics such as pie charts and line graphs in conveying basic statistical information in a newspaper story. Two methods of presenting a story's statistical information-- the traditional method of presenting the information in the text and the increasingly common one of accompanying a story with simple graphics that present the data -- are experimentally manipulated to see which method is more effective.

BACKGROUND

Colorful, boldly designed *USA Today* caught readers' eyes and grabbed newspaper editors' attention when it first hit the newsstands in 1982. The innovative newspaper made its mark by approaching the business of information in a fresh way. *USA Today's* splash and dash formula -- lots of color, shorter stories, more entertainment and lifestyle stories -- included revolutionary use of graphic elements not only to make the newspaper attractive, but also to present information in new ways. *USA Today* unlocked the potential of information graphics, known in the industry as infographics, peppering its pages with dressed-up pie charts, bar graphs and line graphs, locator maps, cartoon-like graphs, and more-visually complex graphics that explained a process or chronicled the unfolding of a news event. Now the nation's second-biggest selling newspaper[1], *USA Today* has had a ripple effect on a newspaper industry trying to counter steadily declining readership.

As the 1980s progressed, the graphics revolution started by *USA Today* swept through the industry, and more and more newspapers experimented with various types of graphics and gradually embraced them. At first, editors were split on the utility of graphics. A 1983 survey of editors indicated that half thought readers didn't pay much attention to graphics.[2] Much of the skepticism has faded, and now graphics are accepted as valuable tools that contribute to the overall goal of informing the reader and that are more than window-dressing. Survival factors into the equation. Newspapers are trying retain busy readers who have great demands on their time and bring into the fold young people weaned on television and video games. Graphics are a key element in the battle for readers, *Editor & Publisher* reporter George Garneau wrote in an article on newspaper redesign. "They [newspapers] are trying to be more useful and more accessible in the way they package information, to convey more information faster using graphics, to satisfy browsers who are pressed for time as well as traditional readers."[3]

Another reason for the graphics boom is that technological advances have made the creation and distribution of graphics relatively easy. Graphic artists can use a Macintosh desktop computer and illustration software such as MacDraw II, Aldus FreeHand or Adobe Illustrator 88 to create attractive infographics in a fairly short time. Newspapers can also draw on infographics distributed by major news services for a subscriber fee. The Associated Press, Knight-Ridder/Tribune News Information Services (KRTN), Reuters and The New York *Times* are

among the news services that produce and distribute infographics electronically. Many newspapers receive the graphics directly on a Macintosh via satellite, instead of having to download graphics files using dial-up databases.[4] As a result, the newspaper graphic artist can use the Macintosh to print or revise the graphics or store them for later use. Modems make possible the direct transfer of graphics files. Facsimile machines are another useful tool, making it easier for newspaper graphic artists to communicate visual needs to freelance illustrators.

The 1991 Persian Gulf War was a watershed event in the use of graphics by newspapers. With newspaper demand high, the news services moved a barrage of graphics on troop sizes, weapons and military movements, as well as locator maps, Gulf weather graphics and historical graphics.[5] "No other news event in recent memory has generated so many maps, charts, diagrams and symbols," wrote a *Dayton Daily News* reporter who surveyed graphics editors on their use of graphics during the war.[6] In his story -- which appropriately was accompanied by a "how" graphic showing how news organizations transmit infographics on the war -- the reporter quoted editors whose reasons for relying on graphics ranged from the need to explain how things happen in such a highly technological conflict to trying to compete with television by giving the reader a wider perspective.

The boom in newspaper use of graphics has greatly outpaced social science research into their effectiveness in that medium. The first wave of research, during the mid-1980s, focused on how widespread the use of graphics was becoming and how they were

being used.

Smith and Hajash,[7] who looked at infographic use in 30 newspapers over seven days in October 1986, found an average of 4.5 per edition. Nearly three-fourths of the information graphics were used with a story. They found that graphic use was more widespread in general news sections, where 58.4 percent appeared, and in business sections, which accounted for 27.6 percent of the graphics. The largest percentage of graphics topically dealt with business/economics (29.5%), followed by weather (23%) and public affairs (23.7%), with the remainder being categorized as general. Maps, which accounted for almost 46 percent of graphics, were the most frequently used, followed by bar charts (17.1%), tables (11.1%), line or fever charts (10.6%) lists (10.5%), how graphics (3.3%), various other (1%), pie charts (0.8%), and scatterplots (0.1%).

A November 1987 survey by Utt and Pasternack[8] of daily newspapers with circulations of at least 25,000 found that infographics had become common front-page elements. Nearly 57 percent of the 93 newspapers responding to the survey said infographics regularly appeared on the front page.

Tankard[9] analyzed what he termed "chartoons" -- the sort of graphs popularized by *USA Today* combining traditional graph elements with cartoonlike features -- and came up with 10 design pitfalls that should be avoided with newspaper graphics used to display quantitative information.

In a subsequent study, Tankard[10] compared the effects on viewers of chartoons and plain graphs and three-dimensional

graphs and plain graphs and found that both chartoons and three-dimensional graphs were more appealing to viewers than plain graphs. Tankard's experiment also indicated that chartoons and three-dimensional graphs do not lead to less information gain than plain graphs, the opposite of what theory had predicted. Tankard's hypothesis that chartoons and three-dimensional graphs would lead to less retention of information than plain graphs had derived from three theoretical bases: (1) Tufte's concept of data-ink ratio[11], a measure of graph complexity that holds that added and unnecessary ink will distract the viewer from the ink carrying data information and could force the viewer to work harder to determine what is meaningful; (2) the figure-ground relationship, a basic principle of Gestalt psychology, which would suggest that when chartoons incorporate a line illustrating a change in data into a drawing of a person or object, the viewer who sees the person or object will tend not to see the lines portraying data; and (3) schema theory, which holds that people process information in terms of schemas or scripts, but by providing cartoonish illustrations along with data, chartoons give rise to conflicting schemas, which could confuse the reader and lead to less information gain. In reconciling his experimental findings of no difference in information gain between chartoons and plain graphs or between three-dimensional graphs and plain graphs to the theoretical predictions, Tankard concluded that the non-data ink in a graph may make little difference to the average newspaper reader, that basic schemas for processing bar graphs and pie charts might not be

incompatible with chartoons or three-dimensional graphs, and that switches back and forth between the pictorial elements of a chartoon and the lines representing changes in data might not be as extreme as switches in examples used in Gestalt psychology.

An experiment by Kelly[12] offered further evidence that the data-ink ratio may not be crucial in reader understanding of newspaper graphics. Subject recall for 10 graphs was tested using a chartoon version and a simple version, and no significant differences were found.

David[13] proposed a theoretical framework for graphic representation of quantitative information based on findings in psychophysics and cognitive psychology. David's framework consisted of three independent variables: accuracy of perception, speed of processing and memorability of a quantitative graphic. In a followup experiment, David[14] compared mass media graphics that violated various theoretical principles of accuracy of perception to simplified representations of the same data and found evidence that some mass media graphics distort the data. The absolute error of the size estimate associated with eight test graphs was greater than the absolute error of the size estimate for the simplified control graph with which it was compared, although this was only statistically significant for five of the eight pairs. David concluded that although the findings indicate that mass media graphics possibly distort data, some violations of common graph-making principles may not actually hurt accuracy. Findings from visual psychophysics and visual processing cannot be applied directly to the study of

graphs in the absence of experimental validation, David said.

Scant attention, thus far, has been given to how information graphics and text work together.

Pasternack and Utt[15] looked at reader use of infographics included as part of a story package and found that readers turn to infographics primarily for content-related reasons, with appearance of the graphics being secondary. They concluded that the "info" in infographics should be emphasized. Another finding indicated that size of the graphic affects reader use. Subjects in the experiment were presented with two story packages -- one accompanied by a dominant graphic device containing its own headline and a chartoon incorporating two bar graphs and a pie chart and another accompanied by a small, unadorned ledger chart. For the story package featuring the dominant graphic, 70 percent of the subjects read the graphic first. For the story package featuring the non-dominant graphic, 81.4 percent read the story first. Because some readers read the infographic before the article and headline to prepare for the story and others read the infographic after the article and headline as supplementary material, Pasternack and Utt advised editors to avoid repeating the content of the article in the infographic. Instead, they recommended using infographics as "icing on the cake" to provide additional detail that would, in the absence of a graphic, appear in the latter part of the story.

In an experiment of dubious methodological rigor, Ward[16] found no evidence that sidebar graphics more effectively convey numerical information or aid in comprehension of a main story

than a sidebar story would. Subjects received one of five versions of a story package -- the story alone, the story accompanied by a bar graph, the story accompanied by the same bar graph with adornment, the story and a table, and the story accompanied by a sidebar story verbally presenting the information presented in the graph or table in other versions. Analyzing subject responses to a questionnaire on information found in the story and/or in the various graphics or sidebar, Ward found no significant differences between accuracy scores of subjects whose story was accompanied by sidebar bar graphs and those with a sidebar story. Ward also found no evidence that a bar graph accompanying a news story is more effective than a table in providing numerical information and in aiding comprehension of a main story. A subject rating of the understandability of the various versions found no significant differences.

Stark and Hollander[17] found that a "how" graphic enhances readers' accurate recall of the facts of a news story. In their experimental study, subjects received one of four versions of a simulated front page whose lead story about a plane crash was either offered without visuals, with a "how" infographic, with a aftermath photo, or with both the infographic and photo. The graphic did not contain information that was unavailable in the text. Responses to a questionnaire about the crash showed that subjects with more visuals were able to answer more questions about the crash and to answer them more accurately. Ability to answer and accuracy were highest for the group with the story

plus infographic plus photo, followed by the group with the story plus infographic, the group with story plus photo, and the group with story only.

Two experiments by Griffin and Stevenson also indicate that a story accompanied by a graphic will lead to more knowledge gain than the story alone would. In the first experiment,[18] subjects receiving background information in both a foreign news story and in an accompanying graphic that contained written background information on the country's history, geography, government and people and a locator map fared better on a questionnaire focusing on contextual background information than did those who had the background just in the text or not in the text, but only in the graphic. In another experiment,[19] Stevenson and Griffin found that reader knowledge of the geographical setting of a foreign news story could be improved by accompanying the story with a locator map. Subjects who received geographical information in the story as well as via a locator map performed better on a questionnaire about the story's geographical setting than did subjects who received the geographical information only in the text or who received in only via a locator map and not in the text.

The studies by Stark and Hollander and Griffin and Stevenson indicate that graphics may effectively complement text in conveying information. However these studies focused on special categories of graphics -- the Stark and Hollander study looked at a "how" graphic, one of the least commonly used types of graphics, and the Griffin and Stevenson studies focused on the

background box and the locator map. A rigorously controlled experimental study is needed that looks at the commonly used graphics that provide statistical information.

THE RESEARCH QUESTION

The research question addressed by this study is whether reader understanding of the statistical information that fleshes out a news story can be increased by providing this information via a graphic, as opposed to the traditional method of presenting it just in the text. Can a graphic effectively complement or even supplant text in communicating statistical information to newspaper readers?

METHOD

To test the influence of two techniques of presenting the statistical information associated with a news event, a simple 2x2 randomized group, posttest-only experiment was designed. The two factors were "text," referring to whether statistical information was woven into the story, and "graphic," referring to whether the story was accompanied by a graphic. For both factors, the values were "present" and "absent." They were crossed to produce four conditions: text and graphic, text only, graphic only and neither. The dependent variable was subject response to a set of eight multiple-choice questions about U.S.-Japanese trade relations. Examples include:

_The U.S. trade deficit with Japan through the first nine months of 1991 was about: A) $5 billion B) $15 billion C) $30 billion D) $50 billion;

_After the USA, the next biggest market for Japanese exports is: A) Europe B) Asia C) Africa D) South America.

Correct answers were summed to produce a single scale with a potential range of 0 to 8. For use as covariates, self-assessments of interest in world affairs and knowledge of world affairs were included, with response choices of very, fairly, not very and not at all interested/informed. Also for use as covariates, measures of recent newspaper, network television and newsmagazine use were included, with response being the number of days in the previous week the subject read a daily paper and watched the evening network news and number of weeks in the previous four that he or she read a newsmagazine.

The stimulus was a Jan. 7, 1992, news story from *USA Today* that described President Bush's arrival in Tokyo with a delegation of American business leaders in a trip aimed at breaking down Japanese trade barriers. The day's cover story, it ran about 30 column inches, jumping from the front page to page 2. It was accompanied by a graphic, which ran on the jump page, containing two line graphs -- one showing Japan's share of the U.S. passenger car market over the past decade and the other comparing the level of U.S. imports from and exports to Japan over the past decade --and two pie charts -- one showing the sources of Japanese imports and the other showing the destination

of Japanese exports. The graphic had its own headline, under which was a cartoon drawing of two cars -- one whose hood was festooned with a Japanese flag slightly outpacing one whose hood was decorated with a U.S. flag. Between the graphic headline and the four charts was a short, 47-word, verbal summary of the trends indicated by the graphic.

In the "graphic" version, the answers to the eight questions on the U.S.-Japanese trade that were posed in the quiz sheet were clearly available from the two line graphs and two pie charts contained in the graphic. In the "text" version, this information was woven into the story. The headline, byline and outtake quote from the original story were retained so that the stimulus looked very much like a photocopy of a clipping from *USA Today*. For the same reason, the graphic was lifted straight from the story, but the verbal summary was deleted as a control measure. An example of the stimulus material is provided in an appendix.

Subjects were undergraduates in communication/journalism classes at the University of Dayton (Ohio) and the University of North Carolina at Chapel Hill. They were given copies of the stimulus with the quiz sheet folded and told to read the story, taking as much time as they wanted, then to put the story out of sight before opening the quiz sheet. They were told the quiz sheet contained questions about the story, but nothing beyond that.

RESULTS

Table 1 shows the mean knowledge scores, which have a possible range of 0 to 8, for each of the experimental combinations as well as for individual factors and the overall total. Results are clear-cut, dramatic and consistent with the aforementioned Griffin and Stevenson experiments examining the effect of text and other types of graphic elements on reader understanding of the context of international news. Including information either in the text or in an accompanying graphic increases knowledge, and the redundant condition of including information in both forms more than doubles the average knowledge over the control condition.

Table 1 about here

The marginal means, which show the effect of each factor independently, suggest that presenting statistical information in the text increases reader knowledge more than presenting it in a separate graphic. Furthermore, a comparison of the marginal means for the presence and absence of each factor indicates that the presence or absence of the information in the text affects reader knowledge more than the presence or absence of a graphic. To test the relative contribution of the two independent variables as well as that of the non-experimental factors of media use and self-assessed interest in foreign affairs and awareness of world affairs, we used a simple analysis of variance

(ANOVA) with the two experimental factors as independent variables and the three media-use items -- frequency of readership of a daily newspaper and weekly newsmagazine and viewership of network TV news -- and the two cognitive measures -- interest in and awareness of world affairs -- as covariates. The dependent variable is the cumulative score on the eight-item multiple-choice test of statistical information about U.S.-Japanese trade, which is presented in Table 1. ANOVA allows us to sort out the unique contribution of each component to the total variance of the dependent variable and to assess its relative influence on knowledge. Results are shown in Table 2.

Table 2 about here

The ANOVA confirms part of what an inspection of the table of means hinted at and discounts another part. While either technique of presentation of statistical information significantly increased knowledge, presentation in the text had a greater effect. The simple correlation between presence or absence of the statistical information in the text and knowledge (eta) is .54 and drops to .49 (beta) when controlled for covariates and the other independent variable. In contrast, the eta between the presence or absence of a graphic and knowledge is considerably less -- .29 -- but does not change at all when the influence of the other independent variable is controlled. The betas indicate that each of the techniques tested makes an independent contribution to reader knowledge -- even when

controlling for other factors, both presence of the statistical information in the text and presence of a graphic add significantly to knowledge gained.

Although the redundancy of including the information in both text and graphic raises the level of knowledge beyond that of either factor separately, the interaction is statistically non-significant. While it is not possible to convert an ANOVA interaction term into a correlational measure of the strength of the relationship, we can infer from the non-significant F that the redundancy contributes little to the level of knowledge.

It probably comes as no surprise that student subjects who claimed to be interested in and knowledgeable about world affairs scored higher on the knowledge test than those who did not. However, it may be surprising that real exposure to news media in their daily lives had relatively little influence on their knowledge of the statistical information about U.S.-Japanese trade that was assessed in the experiment. One problem is that all of these factors are confounded with one another. When the unique contribution of each covariate to knowledge is assessed -- the partial correlation, controlling for all other covariates -- part of the puzzle is clarified and part remains.

The last column of partial correlations shows that the influence of interest and self-assessed level of information remains relatively strong, while the influence of news media exposure diminishes, but with a puzzling anomaly. The puzzle is that while exposure to network TV news and newspapers has no independent influence on knowledge about the U.S.--Japanese trade

situation, the correlation between readership of newsmagazines and knowledge moves from zero to a negative .17. Does knowledge of the world decrease as readership of newsmagazines increases? Probably not, and one can argue that the single partial correlation, reflecting the small unique covariance between the two variables after most of the common variance has been removed, represents the kind of perverse relationship that is not uncommon when one tries to untangle a set of tightly interrelated measures.

The important findings are (1) the two techniques of presenting complex statistical information -- the traditional one of presenting it in the text and the more recent one of doing so in an accompanying graphic -- both increase reader knowledge; (2) the ability to learn from the news is also a function of the interest and knowledge that the news consumers bring to it; and (3) on the whole, use of news media in daily life has relatively little influence on knowledge gained from a specific story. What are we to make of the results of this experiment?

DISCUSSION

"Innumeracy" adds to the problem of the public's well-documented "illiteracy" of world affairs. If people cannot distinguish among thousands, millions, billions and trillions -- regardless whether referring to trade deficits, unemployment or populations -- then prospects for understanding the complexities of global economics and politics are diminished. Economics has

increasingly become the raw material of politics and, of course, of news. If economics is now the basis of international relations, rather than political ideology or war, then citizens have a responsibility to understand basic economic information, which is conveyed through statistics as often as not. What is an editor to do?

As noted earlier, the arrival of graphics technologies and *USA Today*'s infectious enthusiasm for graphic presentation of almost everything point toward a single solution. News graphics now encompass everything from traditional pie charts to chartoons and how-to cartoons. In a visual age, it seems, newspapers can mimic TV's unique visual power. The question, of course, is whether understanding of complex material, which is the heart of serious news, is facilitated by graphic presentation. The answer seems to be "yes, but. . ."

In this case, the "yes" includes the key finding of the experiment: graphic presentation of statistical information does increase understanding of the material. The experiment does support the current emphasis on statistical material as an element of news and graphic presentation of that material. The graph-makers are on the right track.

However, the "buts" loom large. First is the obvious one that a single experiment involving available undergraduate subjects, while strong in internal or design validity, is weak on external validity or generalizability. Subjects were instructed to read the story, knowing that some kind of test on the content followed. In real life, newspapers compete with all sorts of

other stimuli, including time. Attending to the news is casual, often passive behavior that usually accompanies something else. The counter-argument is that real life includes daily repetition of news consumption over years. The specific effect may be tiny but accumulates over time. The single experiment may approximate what happens in real life over an extended period.

Beyond the methodological limitations, the results indicate that putting the statistical information directly into the text of a news story has a greater effect on knowledge than graphic presentation. As was indicated in other studies of mass media influence, graphic presentation seems relatively less effective in adding information to people's understanding than the traditional method of having them read it. Does that mean that editors would be advised to stick with words and junk the graphs?

Probably not. At a minimum, graphic displays improve the looks of the page and showcase the story. They may lead readers to the story and entice them to read. And, of course, graphics themselves convey information that can supplement or reinforce the text. Either way, the result is greater reader understanding of complex material.

No one would suggest that the *USA Today* technique of a graph on Page 1 of every section will overcome public innumeracy or apathy toward the complex world of economics, science and opinion polls. But as a technique for presentation of complex material that complements or reinforces text, the trend toward use of graphs is commendable. Evidence from this experiment is that it works. As a technique for increasing readership as well, the use

of graphs is popular but unproven. If it improves both readership and reader understanding, it will be doubly important as a component of newspapers of the future.

Table 1. Mean Statistical Knowledge Scores by Presence or Absence of Information in Graphic and Text.

		Graphic		
		Present	Absent	Total
Text				
	Present	6.09 n=32	5.27 n=31	5.69 n=63
	Absent	4.13 n=30	2.58 n=33	3.33 n=63
Total		5.13 n=62	3.86 n=64	4.49 n=126

Table 2. Analysis of Variance Summary Table on Influence of Text and Graphic, Self-Assessed Knowledge and Interest and Media Exposure on Knowledge.

Source of variation	SS	DF	MS	F	P	Corr*	Part.corr
Covariates	92.01	5	18.40	6.83	.00		
Interest	13.70	1	13.70	5.09	.03	r= .31	r= .16
Informed	16.17	1	16.17	6.09	.00	r= .32	r= .18
TV news	1.02	1	1.02	.38	.54	r= .12	r= .04
Newspaper	5.54	1	5.54	2.06	.15	r= .20	r= .10
Newsmagazine	15.38	1	15.38	5.71	.02	r= .01	r= -.17
Main effects	183.63	2	91.81	34.12	.00		
Graphic	47.89	1	47.89	17.80	.00	η= .29	ß= .29
Text	133.22	1	133.22	49.50	.00	η= .54	ß= .49
2-way interaction	2.99	1	2.99	1.11	.29		
Graph x text	2.99	1	2.99	1.11	.29		
Explained	278.63	8	34.83	12.94	.00		
Residual	314.86	117	2.69				
Total	593.49	125	4.75			R = .68	

*Correlations are simple Pearson correlations between covariates and measure of knowledge, simple etas between independent variables and measure of knowledge, and multiple R for the entire model. The partial correlations control for all other covariates; the betas control for the other independent variable and covariates.

[1]*Editor & Publisher International Yearbook, 1991.* [New York: Editor & Publisher], p. I-338.

[2]Sandra H. Utt and Steve Pasternack, "Front Pages of U.S. Daily Newspapers," *Journalism Quarterly* (Winter 1984), pp. 879-884.

[3]George Garneau, "Modernizing Through Redesign: More Newspapers Feel it's a Critical Step to Reach More Readers," *Editor & Publisher* (Dec. 2, 1989), p. 15.

[4]Stuart Silverstone, "Newsroom Graphics," *Macworld* (February 1987), pp. 131-135.

[5] Mark Fitzgerald, "Graphics on the Gulf," *Editor & Publisher,* March 9, 1991, pp. 12-13.

[6]Jim Dillon, "Newspapers' Depiction of Gulf War Has Been Quite Graphic," *Dayton Daily News,* Feb. 17, 1991, p. E1.

[7]Edward J. Smith and Donna J. Hajash, "Informational Graphics in 30 Daily Newspapers," *Journalism Quarterly* (Fall 1988), pp. 714-718.

[8]Sandra H. Utt and Steve Pasternack, "How They Look: An Updated Study of American Newspaper Front Pages," *Journalism Quarterly* (Autumn 1989), pp. 621-627.

[9]James W. Tankard, Jr., "Quantitative Graphics in Newspapers," *Journalism Quarterly* (Summer/Autumn 1987), pp. 406-415.

[10]James W. Tankard, "Effects of Chartoons & Three-Dimensional Graphs on Interest & Information Gain," *Newspaper Research Journal* (Spring 1989), pp. 91-102.

[11]Edward R. Tufte, *The Visual Display of Quantitative Data* (Cheshire, Conn.: Graphics Press, 1983), pp. 93, 107, 116.

[12]James D. Kelly, "The Data-Ink Ratio and Accuracy of Information Derived from Newspaper Graphs: An Experimental Test of the Theory," a paper presented to the Association for Education in Journalism and Mass Communication meeting in Portland, Ore., in July 1988.

[13]Prabu David, "Criteria for Evaluating Quantitative Graphics in the Mass Media: A Theoretical Framework for Research," paper presented at the Association for Education in Journalism and Mass Communication annual convention in August 1991 in Boston.

[14]Prabu David, "Accuracy of Visual Perception of Quantitative Graphics: An Exploratory Study," 1992, paper in progress.

[15]Steve Pasternack and Sandra H. Utt, "Reader Use & Understanding of Newspaper Infographics," *Newspaper Research Journal* (Spring 1990), pp. 28-41.

[16]Douglas B. Ward, "The Effectiveness of Sidebar Graphics," a paper presented to the Association for Education in Journalism and Mass Communication meeting in Boston, Mass., in Aug. 1991.

[17]Pegie M. Stark and Barry A. Hollander, "Information Graphics: Do They Help Readers Understand News Events," a paper presented at the Association for Education in Journalism and Mass Communication meeting in August 1990.

[18]Jeffrey L. Griffin and Robert L. Stevenson, "The Influence of Text and Graphics in Increasing Understanding of the Context of Foreign News," in press, *Newspaper Research Journal* (tentatively October 1992).

[19]Robert L. Stevenson and Jeffrey L. Griffin, "The Effectiveness of Locator Maps in Increasing Reader Understanding of the Geography of Foreign News," to be presented at the International Communication Association meeting in Miami in May 1992.

APPENDIX

One of the four versions of the experiment stimulus is printed on the next two pages to provide an indication of the form that the stimulus took. The version presented, the redundant condition, contains statistical information in both the text and in the accompanying graphic. The other conditions were: to have the statistical information in the text, but provide no graphic; to have the statistical information in a graphic only, but not in the text; and to have the statistical information in neither the text nor in an accompanying graphic. The stimulus versions are manipulations of the cover story of USA Today on Jan. 7, 1992, and a graphic that accompanied it on an inside page.

COVER STORY

Pressure on Tokyo could 'backfire'

'Taking GM over there to complain . . . is a joke.' **last leg, 2A; Debate, 6A**

By James R. Healey
and Mark Memmott
USA TODAY

TOKYO -- President Bush arrived in Japan today with an entourage of 21 business executives and a planeload of promises to revive the U.S. economy by breaking down Japan's trade barriers.

But most observers say his trip -- which marks an abrupt reversal of the administration's traditional free-trade, quiet-negotiations approach -- won't do much to pry open Japan's markets or boost the U.S. economy in 1992.

"It's extremely unlikely, given Japan's trade history, to expect a big improvement," says Seth Cropsey, director of the conservative Heritage Foundation's Asian Studies Center. "God bless the president for trying, but it's unreasonable to expect a sea change."

What the trip will produce, observers agree, are plenty of promises. Already, carmakers in Japan say they'll increase imports of U.S.-made parts and want to boost imports of U.S.-made cars. And it appears Bush will leave with a "Tokyo Declaration" that includes the Japanese government's promise to

Please See COVER STORY next page

COVER STORY

U.S. can't 'badger'

Continued from 1A

continue efforts to narrow the trade gap between the two nations.

Japanese business leaders, mindful of the upcoming U.S. election, want to do what they can to help Bush -- who they prefer to more protectionist-minded Democrats.

But experts say their pledges will do little more than trim a few billion dollars from the trade gap with Japan, which exceeded $30 billion last year in the first nine months alone. The trade gap peaked at about $60 billion in 1985, when the USA imported just over $80 billion of Japanese goods and exported just over $20 billion of American goods to Japan.

"Our problems with Japan are long-term, structural problems," says Michael Penzer of Bank of America.

Among the most basic difficulties: The goods Japan exports to the USA -- which account for 33.9% of all Japanese exports -- are mostly high-value, manufactured products that form the backbone of its economy. In fact, the USA is Japan's top export market, followed by Asia, destination of 32.7% of Japanese exports, and Europe, where 23.8% of Japanese goods are exported.

Meanwhile, Japan imports a short list of U.S.-made products, many relatively inexpensive goods that support relatively few jobs.

The USA is the source of just 22.9% of Japanese imports. Other Asian countries are Japan's biggest suppliers, accounting for 41.5% of Japanese imports.

So why is Bush raising expectations by declaring "my highest priority is jobs" and "one way to get this economy going again is to open up markets abroad for American goods and services"?

Observers say the answer is simple: It's "an election-year conversion" to a more protectionist trade approach that might appeal to voters, says Jeff Faux, president of the liberal Economic Policy Institute in Washington.

Bush's visit to Japan turned into his first campaign swing of '92 when it became apparent the U.S. economy wasn't shaking the recession and voters were unhappy about the president's perceived preoccupation with foreign affairs.

The man most responsible for shifting the trip's focus and inviting the 21 CEOs is Commerce Secretary Robert Mosbacher -- who next week leaves the Cabinet to oversee Bush's re-election campaign.

Mosbacher has been an advocate of using the administration's political clout to champion U.S. business overseas.

At Commerce, he has often taken groups of business executives when visiting foreign capitals, including Tokyo.

But it's one thing for a Cabinet secretary to tout the interests of specific U.S. companies, experts say.

It's quite another for the president to arrive in Japan with Lee Iacocca of Chrysler, Harold Poling of Ford, Robert Stempel of General Motors and 18 other CEOs.

"The president of the United States has never put himself even implicitly behind the interests of a major American industry" the way Bush is on this trip, says Clyde Prestowitz, a former U.S. trade negotiator.

The problem, say many experienced Japan hands, is that by putting so much public pressure on Japan, the president increases the chances "this could all backfire," says Prestowitz.

Japanese politicians may decide to be even less accommodating to U.S. interests.

"The Big Three (automakers) want to bang down the door and that's the wrong approach," says Peter Woods, president of Tokyo-based Rover Japan Ltd., an importer of British and French vehicles.

Japanese officials agree. "You cannot sell products and services if you treat your customer as your enemies," says Hiroshi Harabayashi, a spokesman at Japan's U.S. Embassy.

And if the trip does backfire, some experts worry U.S. and Japanese trade barriers might actually be raised -- which would hurt U.S. consumers.

Japanese VCRs and TVs might become "luxury items available only to the rich," says Edward Hudgins, deputy director of economic policy studies at the Heritage Foundation.

In Bush's defense, experts say, other approaches haven't worked very well in the decade-long effort to narrow the U.S. trade deficit with Japan. The United States has:

■Arm-twisted Japan into accepting voluntary restraints on exports of cars to the USA. The first such agreement went into effect in 1981.

But the effort didn't slow Japanese passenger car sales in the USA. Japanese car sales in the USA have steadily climbed. Japan's share of the U.S. car market stood at 30.2% last year, up from 19.8% in 1981.

Japanese makers coped with the restraints. They built U.S. factories, whose cars aren't subject to export restraints. And they started exporting more profitable, higher-priced cars such as the Lexus and Acura models.

■Tried negotiations aimed at boosting Japanese purchases of specific U.S. goods. In 1986, the two countries signed an agreement to boost foreigners' share of Japan's semiconductor chips, but foreigners' share has not reached the agreed-upon level.

■Tried, with some help from Japan, big reductions in the value of the dollar to make U.S. goods less expensive and Japanese goods more costly.

But Japanese companies more than compensated for what they feared might be an *endaka fukyo* -- a slump in sales caused by a strong yen and weak dollar.

To keep prices from rising, they slashed costs and shifted production to countries such as Taiwan and Singapore.

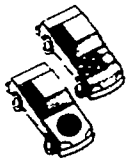
After all those efforts, the deficit with Japan still accounted for two-thirds of the U.S. trade gap in 1991.

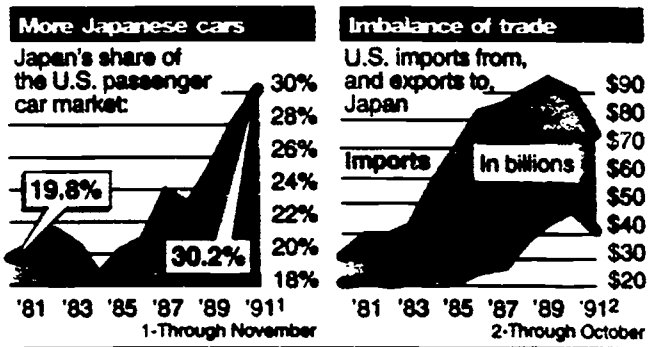
"The idea of taking GM over there to complain about Japanese trade is a joke," says Hudgins at the Heritage Foundation. "The problem is that GM doesn't make good cars, and is as bureaucratic as the federal government."

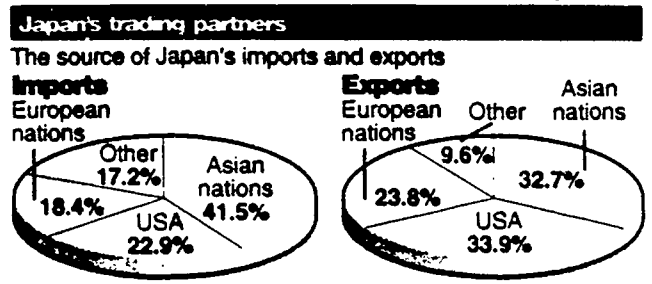
So what should be done? "We can't badger the Japanese into being more like us -- less organized and less efficient," says Faux at the Economic Policy Institute.

"But what we can do is offer trades. ... We should be prepared, for example, to offer Japan political gains -- our support for them getting a seat on the U.N. Security Council, for example -- in exchange for Japan opening its market a little more. What we can't expect to do is solve our trade deficit with Japan by turning the White House into a mobile car showroom."

U.S.-Japanese trade







Source: Motor Vehicles Manufacturers Association; International Trade Administration; Census Bureau; Britannica World Data

By Ron Coddington, USA TODAY

TRADITION, CONFUSION AND MULTIMEDIA: BALANCING STABILITY WITH CHANGE IN SETTING STANDARDS

Presented to the *Communication Technologies and Policy Interest Group*, Association for Education in Journalism and Mass Communication,Montreal, PQ, Canada, August, 1992

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Abstract

This paper contends that the complexity of multimedia represents a difficult challenge to established industries responsible for this new medium: computers, consumer electronics, traditional content industries (print, broadcast and film), and telecommunications. Currently, the result has been partial standards, shifting industrial alliances and a confused consumer base. As well, the vague and changing definitions of multimedia invite problems. The main challenge, however, is forging unity in standards policies from diverse industrial cultures.

The importance of standards are described generally and for each industrial sector involved with multimedia. The inconsistencies among them are noted and serve as the basis of policy recommendations to stabilize and encourage growth of this nascent media form. Recommendations focus largely on government and consumer actions that can shape industrial standards.

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Introduction:

From the mainstream press announcements to specialized trade and industry magazine reviews, *multimedia* has entered the marketplace as a promising, if confusing, new form of mass communication.[1] Faced with an increasingly saturated marketplace in commonplace media gear, consumer electronics manufacturers search for that ultimate home information appliance combining the features of traditional media with the power of computers and telecommunications networks in a new amalgam of technologies.[2] With this comes a reluctant marriage of diverse manufacturing, regulatory and policy history that make for considerable confusion. Our interest is not so much in a definitive answer to what multimedia standards will be — this perhaps is impossible to achieve in this formative time — but to examine the forces at play, signal their importance to the reader and isolate actions that will forge stable standards. Particularly, our focus is on the dissimilar industrial cultures multimedia force together in search of common ground.

Just as it has with many other twentieth century technologies, the subject of standards has proven to be a high hurdle that multimedia computing must clear before it can effectively move out of the research setting to gain widespread acceptance among potential business users and home consumers. Even so, the topic is one that the average observer commonly finds intimidating.

This confusion results partly because standards discussions center on engineering matters that can be difficult for lay persons to understand. Additionally, there are so many industrial and governmental forces at work in the process (or struggle) to determine coherent standards that it is sometimes difficult to sort through the activities of the various, often competing, organizations that are at work shaping multimedia technology. Then, too, with announcements about breakthroughs in computing making headlines on practically a daily basis, the volume of material announcing changes in the multimedia scene can be overwhelming.

The goal of this article is to offer the reader a broad vista on standards for multimedia in the hope that it will provide a grounding for basic issues involved. In keeping with that objective, this article will touch on four concerns: (1) the leading reasons that drive the

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[1]Hawkins, Trip. "Why Multimedia is Multiconfusing." *Personal Computing* 13: 10, (October, 1989) p. 220.

[2]Shao, Maria and Richard Brandt, "It's a PC, It's a TV — It's Multimedia: Add a CD here, a VCR there, and you have a computer revolution," *Business Week*, October 9, 1989, pp 152-162; See also "When Worlds Collide: Demystifying Multimedia" *PC Today*, 6:5 (June, 1991), p. 6.

establishment of standards; (2) the processes through which standards are determined and the contrasts in doing so among component industries; (3) the main elements of multimedia that have to be standardized before that industry can move forward in the consumer marketplace; and (4) ways to bring about these standards.

The Need for Standards:

Although to some the topic of standards might seem dry and highly technical, it is important to recognize political and social impacts that certain standards can have. The setting of standards represents one way that society gives shape to innovations that, in turn, influence the social milieu in which they operate. In other words, standards must be thought of as more than simple factory specifications. Admittedly, the consequences of standards are often limited to the industrial parameters they set; nevertheless, it must be recongized that standards can also serve as a reflection of dominant social values and as a tool for promoting those values, whether or not they are commonly acknowledged.[3]

This social impact especially important to remember when considering standards for communications technologies. For what may seem like a technical detail to some may actually be a feature that has a powerful impact in determining such things as who will have access to the technology, or the extent to which the technology will affect established channels of communications. Keeping in mind the social and political dimensions of standards--and communications standards, in particular (such as those for multimedia)--can add a new level of richness to discussions that formerly might only have been engineering debates over technical features.

A general discussion of the potential advantages and disadvantages of standards could, by itself, be the subject of an entire article.[4] The intent here, however, is to point out some of the major incentives and disincentives in the promulgation of standards for multimedia. Complicating the matter is for every positive point in favor of standards, a negative effect can be found, depending on one's perspective. In other words, the "goodness" or "badness" of standards is often relative, arising from the impact they will have on the different parties involved. Additionally, since no one is blessed with a crystal ball, the determination of *when* to formalize a standard excites a debate that is often as troublesome as the choice of standard itself.

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[3]For a discussion of the social and political nature of technological innovation, see: Langdon, Winner, *The Whale and the Reactor* (Chicago, IL: U. of Chicago Press), 1986; and Jennifer Slack, *Communication Technologies and Society: Conceptions of Causality and the Politics of Technological Intervention*, (Norwood, NJ: Ablex), 1984.

[4]Hack, David. "Sci-Tech Alert: Telecommunications and Information-Systems Standardization — Is America Ready?" *CRS Report for Congress #87-458 SPR*, (Washington, DC: Congressional Research Service, The Library of Congress), May 21, 1987. See also, Carl F. Cargill, *Information Technology Standardization: Theory, Process and Organizations*, (Bedford, MA: Digital Press), 1989.

Economic benefit is frequently given as a major virtue of standards-setting for new technologies.[5] As these analyses explain, common agreement on standards has the effect of broadening the market for the sales. Instead of fragmented national or regional sales areas, a consensus on standards creates a mass market offering greater efficiencies of scale. The expense of research and development, assembly and marketing of merchandise can be spread out over a larger number of customers, making it less costly to manufacture and, consequently, cheaper for consumers.

A concept that goes hand-in-hand with such efficiencies of scale is that of manufacturing learning curves. As firms have the opportunity for increased sales, they will gain experience in production of a new product — faster, better and on a larger scale. Smaller markets offering more limited sales potential, on the other hand, are more likely to lengthen the learning curve because they do not provide the depth of experience in developing finished products.

In sum, economies of scale and shortened learning curves are two of the most frequently cited advantages to widespread agreement on standards. Bigger is better, in other words, and standards play an important role by shaping the commercial environment to support greater efficiencies and cost savings along every stage of a product's life cycle.

Standards also heighten competition in the marketplace. With competition focused on products sharing the same standards, arguably each firm is highly motivated to improve the performance of its own product through added features, better performance or lower cost to differentiate it from competing products. Without standards, this argument continues, those same firms would more likely seek a competition-free market through use of unique, proprietary configurations. Standards, consequently, may harness competitive forces to spur improvement of a specific technology — forces that might otherwise be dissipated in their impact and, as a result, of less benefit to consumers.

A related idea is that standards created by an entire industry strengthen market competition by reducing chances of one firm dictating its own successful product design to other interested manufacturers. One might say that democratizing the standards-setting process counteracts the likelihood of any one member company dominating the specifications for a given product line. As a result, adversarial business forces promote the industry as a whole — not just the interests of any one corporation over another — and the diversity of manufacturers which results leads to greater competition and lower-cost goods.

A fifth advantage is that they provide to consumers who might otherwise be confused if a range of technologies based on incompatible standards were to develop. This effect of *simplifying* the marketplace is especially pertinent to communications technologies that exhibit a "lock-and-key" characteristic. Computer software can only work in a machine

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[5]Cerni, D.M. *Standards in Process: Foundations and Profiles of ISDN and OSI Studies*, NTIA Report 84-170 (Washington, DC: US Department of Commerce), December, 1984 [NTIA Report #84-170].

designed for it; that is, the encoded information and the display equipment fit together like lock and key. Thus, a confusion of technologies have broad implications. Software, peripheral equipment, and operating systems form pieces of an interdependent matrix that have impact far beyond the purchase.

Beyond primarily economic advantages are social benefits from standards. Standards promote large, mass markets for software products. Volume means often lower costs that, in turn, allow access for a greater number of consumers. Further, standardized products often have exacting industry-wide specifications assuring reliable and safe performance. Joint standards usually result in public availability of specifications. Consumer groups, inventors, and new firms entering the market can join in to enhance product design, effectiveness and safety.[6]

Standards are not without important drawbacks. Fundamentally, standards define a technical path with wide implications for products dependent upon it. Maverick companies with innovative ideas face tremendous obstacles in gaining market attention for what otherwise might be exceptional advances in the cost/performance of products. As was well demonstrated in the "color TV wars" of the early 1960s, adoption of a single world color TV standard was stymied by national interests, industrial investments and cultural identity. Crane commented in her book on the color TV standard that:

> In sum, each nation [or you could say, each corporation] approaches the issue of compatible standards with a parochial point-of-view. The determination of whether it is necessary as well as desirable to adopt standards compatible with other nations will be based upon an evaluation of several factors involving the national interest. These include national political strategy, national technical needs, public opinion, estimates of the value of services, economic status, . . the costs of not agreeing, history, and experience. Once standards have been adopted, it is virtually impossible to change them.[7]

Multimedia represent not only technologies but *content software* as well. These materials contain cultural bias, favor certain interests and reinforce points-of-view on matters of public debate. Merely the choice of what documents to render into multimedia form constitutes a decision that has wide cultural and social implications. Standards favor particular nations and companies, and, in turn, the contents they render into multimedia form.

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[6]*Ibid.*, p. 12. and William Stallings, *Handbook of Computer-Communications Standards: The Open Systems Interconnection (OSI) Model and OSI-Related Standards* [Volume One; Second Edition], (Carmel, IN: SAMS/MacMillan), 1990.

[7]Crane, Rhonda, *The Politics of International Standards: France and the Color TV War* (Norwood, NJ: Ablex) 1979.

What is Multimedia?

In speaking of *multimedia*, we refer to the computer-based technology that makes possible the integration of what were formerly considered separate methods and traditions of communications (text, graphics, motion video, still video, animation and sound), and allows for participation or interaction by users. Increasingly, too, this term implies interconnection in a hierarchy of information resources, beginning with the user's terminal device and extending, as does the voice telephone system, into international networks where a vast information base may be accessed. The advantage of multimedia over traditional forms of communications, then, can be seen in the freedom it allows for the creative, varied expression of ideas through a single channel of transmission, and the opportunity it provides for individual response. Of course, how well multimedia is able to fulfill its potential depends on the standards ultimately adopted.

It should be mentioned strongly that *multimedia* is far from being an agreed-upon term, with clear implications and limits. To an industry leader, Microsoft, Inc., multimedia is a set of capabilities that serve to extend the power of today's personal computer into sound, animation, pictures and color to "create a more impactful *[sic]* and engaging computing experience."[8] Tandy, Inc., the parent company of the *Radio Shack* electronics stores, describes multimedia similarly " . . .[a personal computer that] combines text, impressive graphics, high quality sound, animation and interactivity in a powerful yet affordable system."[9]

More complex definitions, ones *not* tied to consumer electronics or personal computers, develop from the industrial forerunners of multimedia: computers, television, publishing and telecommunications.[10] This view is *industry* centered, based in the manufacturing groups that must merge to make workable multimedia systems. It is, as well, *capability* centered, in the sense that computers contribute interaction and digital storage, television adds visual communication and motivation, publishing yields standard formats permitting indexing and browsing, and, finally, telecommunications adds the ability to communicate or publish over long distances. An essential part of this discussion is that standards-making entities are needed to determine how these contributing industries fit with each other and present the consumer with a "consistent" interface. Lack of consistency and common focus is voiced as the major barrier to wide consumer adoption of multimedia.

Finally, some conclude that *multimedia* eludes definition, both for the numerous forms it takes and its swift rate of evolution.[11] These critics argue that the lack of standards

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[8]Microsoft. "Multimedia Personal Computing: The Microsoft View, May 1991" A background report of Microsoft, Corp. Redmond, WA , May 1991., pp 1-2.

[9]Tandy Corporation. *Multimedia: More than You Imagined.* Promotional brochure, 1991.

[10]Arnett, Nick "The Four-Layer Multimedia Model" in *Multimedia Computing and Presentations.* Santa Clara (CA): Multimedia Computing Corp., Jan. 15, 1990.

[11]O'Malley, Christopher, "Multimedia Update: The Technology is Still Too Expensive for Widespread Business Use" *Lotus* , 7:7 (July, 1991) p. 13; also, John Dvorak and Jim Seymour. "Just What is this Multimedia Thing Good For, Anyway?" *PC Computing* 4:4 (April, 1991) p. 54.

caused in this confusion spreads rapidly to the mass consumer and businesses who hold back, fearing to make choices which may so easily go wrong. These critics frequently maintain that agreement on technologies is the first task of stabilizing the marketplace. Were we to have solid agreement on microprocessors to be used and CD-ROM capabilities, or include writable optical disks into the standard mix, it is argued, the key roadblocks to adoption would be solved.

However, as William Comcowich, chairperson of the Interactive Multimedia Association stated, the situation isn't a straight-forward matter of agreement on multi-sensory computer technology to be used. Multimedia depends on the integration of " . . different industries with *vastly different business cultures*."[12] In tabular form, we can summarize contributing industries:

Table 1: Contributing industries to multimedia development, showing their focus, key products and exemplar organizations.

Industry	***Focus*/Products**	**Exemplar Organizations**
Computer and Software	*Tools* - Personal computers, storage and retrieval devices, software	IBM, Apple, Microsoft, Software Toolworks
Consumer Electronics	*Volume Equipment* - Video display, audio reproduction	Zenith, Sony, Philips, Commodore, Kodak
Traditional Content: Publishing	*Content* - Textual and graphic, indexes, archival information	McGraw-Hill, Mead Data, Microsoft, TCI
Traditional Content: Broadcast/Film	*Content* - Music, films, instruction	CBS, Warner-AMEX, PBS
Telecommunications	*Interconnect* - Networks, gateways, information utilities	AT&T, Bellcore, Compuserve, Minitel, Internet/Usenet

These varied industrial cultures drive diverse consumer expectations and utilization. Traditional broadcasters, for example, anticipate a largely passive consumer of information who views or listens mainly for leisure. Contrary, the computer manufacturer anticipates an active user, one who manipulates contents and its storage for specific purposes. Print media may anticipate a consumer more inclined to browse, acquire and search contents repeatedly. It is the medium of scholarship and the archive.

It should by now be clear that *standards* have multiple implications that are as much indicative of the society and industrial culture that develop them as they are of particular technical criteria. It should also be evident that multimedia represents a unique cross-

[12]Comcowich, William, cited in James E. Strothman (ed.) "Interactive Multimedia White Paper: Promises and Pitfalls" prepared for the attendees of the 1991 Comdex conference, Knowledge Industry Publications, 1991. [emphasis added].

industry circumstance that is without precedent in terms of the complexity it could entail for traditional communications industries and the public who will eventually use their products. Accordingly, we must revise what is commonly meant by the term "standard" to reflect these broad social implications. A suitable definition is provided by the American Society for Testing and Materials (ASTM), which defines a standard as:

> . . . a technical specification or other document, available to the public, drawn-up with the cooperation and consensus or general approval of all interests affected by it, based on the consolidated results of science, technology and experience, aimed at the promotion of optimum community benefits, and approved by a body recognized in the national, regional or international level.[13]

The attractiveness of this definition is that it does not focus exclusively on the concept of a standard as a physical measurement or code of conduct. Instead, it provides a more encompassing view of a standard as the product of dynamic interactions between social groups with the intent of maximizing the benefit that a technology provides. It is a definition that more fully captures the idea of standards as a reflection of social values and social goals.

Our task now is to examine in some detail the standards-setting practices of multimedia's foundation industries. The goal is to better specify conflicts and problems they have in achieving workable standards.

Who Sets Standards?

There are several different ways that standards can be categorized, but for the purposes of this article we will identify standards according to how they come into existence. The three types of standards that will be discussed include: *house, de facto* and *de jure* standards.

House, which are sometimes called *user* standards, arise when an organization is influential enough to dictate to its suppliers what standards it wants them to follow in providing requested equipment. These house standards are determined by a host organization to meet unique internal needs that are not being met by any standards available previously elsewhere.

James Martin, in discussing house standards, uses the examples of organizations like General Motors, which established its Manufacturing Automation Protocol (MAP), or Boeing, which was able to create and promote its own Technical and Office Protocols (TOP).[14] In the area of multimedia, the National Institute of Standards and Technology is

[13]Kemmler, E. L. "Codes, Standards, Accreditation and Certification," *ASTM Standardization News,* 11 (1983), pp. 28-31.

[14]Martin, James. *Telecommunications and the Computer.* 3rd ed. Englewood Cliffs (NJ): Prentice, 1990.

evaluating Federal Information Processing Standards (FIPS) for the deployment of multimedia systems throughout the federal government.[15] In each of these situations, these organizations have both the stature and the size to decide their own standards priorities for internal use; sometimes the standards they develop gain broader acceptance among other public and private groups, too.

Another class of standards, called *de facto* (or informal standards), come about when a corporation beats out the competition in such a decisive manner that it is able to establish the design of its own equipment as the dominant standard in the field. Although such a standard has not been approved by any standard-setting organization, it nevertheless becomes the accepted technological approach on the basis of its wide-spread use. The dominance of IBM Corporation fostered a decade of personal computers adhering to its BIOS standard.[16] By making this standard "open" or public, lively competition ensued in these machines driving price down and features up.

Apple Corporation, contrary, blocked open use of its BIOS through copyright protection, foreclosing competition. Thus Apple remained the exclusive provider of Macintosh-standard personal computers. Both corporate strategies illustrate the strengths and weaknesses of the *de facto* standard. By opening its standard, IBM permitted competition all while offering the industry its corporate prestige and stability. Unfortunately for IBM, the price competition that ensued from "clone" manufacturers forced it to take increasingly smaller market shares. Apple maintained control over its proprietary system. With the lack of price competitiveness and competing suppliers, the Macintosh holds a minority share of the personal computer market in contrast to the hundreds of PC clone models available. Thus the use of *de facto* standards can lead to serious trade-offs of tight corporate control *v.* unpredictable competitive outcomes.

A third class of standards are called *de jure* (also *formal* or *consensus* standards). These refer to product specifications that are developed through common agreement among firms that each have a say in their development. As one might expect, the benefit of such standards, in comparison with *de facto* standards, is that any of a variety of manufacturers can suggest changes to the initial product details. This can give the standard more flexibility and increase chances for a longer, more productive life.

Such standards are characteristic of long-established industrial negotiation or governmental oversight. Both broadcasting and telecommunications abide largely by *de jure* standards. The need for technological orderliness in both industries fostered government controls early in the century in the belief that stability would help "universal service" and thus maximize social utility. Supplementing government efforts is a host of industrial organizations such as the Electronic Industries Association, The International Telecommunications Union, the Consultative Committee on International Telephones

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[15]Reilly, Lucy. "Federal Government Multimedia Standards Effort is Underway," *Multimedia Computing and Presentations*, 15 December 1990, p. 2.

[16]A *BIOS* or *Basic Input-Output System* standard sets established control points or programming calls in a personal computer's microprocessor. Software written to the standard has assurance that keyboard, screen display, printers and disk storage and other peripherals will operate properly

and Telegraph, and more particular to the subject at hand, the *Multimedia PC Marketing Council* or *MPC*.

Like any other "decision by committee," *de jure* standards are not without their own pitfalls, since they usually take more time to produce and create some impatience with the process. In the delays that result, a precarious race sometimes ensues between struggling *de jure* standards and those potential *de facto* standards that some companies can't wait to launch into the fray.

Standards for Multimedia:

The standards considered for multimedia represent only partial fusion from its varied foundation industries. Consequently, a full range of standards-setting methods is being used, often with little inter-industry co-ordination.

Table 2: Standards, sponsoring organizations and utilization of standards by multimedia attribute for US computer industry.

Attribute	Standards /Group	Sponsors	Stage/Scope
Textual, Typographic	ASCII - American Standard Code for Information Interexchange; Postscript; Truetype	American Standards Institute; Adobe Inc.; Apple, Microsoft.	Widely shared *de jure* standards (ASCII) and *de facto* standards (Postscript, etc.)
Still Images	JPEG - Joint Photographic Expert's Group	Joint International Standards Org. (ISO) and International Electrotechnical Committee (IEC)	Draft standard; 3 review stages remain
Moving Images	Px64 Standard; MPEG - Motion Pictures Experts Group; DVI - Digital Video Interactive	CCITT - Conference Committee on Int'l. Telephone and Telegraphs; Joint ISO and IEC; Intel Corp.	Some end use of Px64; proprietary DVI in final form; MPEG in approvals process.
Audio	CD-ROM XA ADC PM - Philips (CD-ROM); Red Book (CD-Digital); Other standards: Sun, Apple, Natural Microsystems; *de jure* standards from JPEG and MPEG	Various manufacturers; Joint ISO and IEC	No industry-wide accepted standards; many contending

Table 2, Con't.

Attribute	Standards /Group	Sponsors	Stage/Scope
Animation	*De facto* standards for each computer platform, market forces decide	Various software firms with popular products, e.g. Paracomps' *Macromind Director;* Apple's *Quicktime;* IBM's *Linkway, OS-2* operating system extensions	No industry-wide accepted standards; left to market forces
Peripherals Interface (API)	MCI - Media Control Interfaces for IBM/PCs, MacIntosh Hypercard Extensions and others; Various operating system standards	Microsoft, Apple, etc. Proprietary systems	Single platform *de facto* standards, multiple market forces
Telecommunications; file exchange	MVIP (Multi-Vendor Integration Protocol); Metamail, UNIX-MIME, etc.	Natural Microsystems; Bellcore and others	Experimentation

The Computer Industry: Easily the most complex standards activity has developed in the computer industry, where, given the long tradition of *de facto* standards, industry leaders are trying for accord to stabilize the market and encourage both end product consumers as well as software developers who need a stable standard as the "platform" for their content product. In so doing, a host of industrial standards have been reviewed and proposed, each representing a major attribute of multimedia:

Perhaps the safest comment is that computer industry standards are in flux. For all its complexity, Table 2 does not convey well the layers of activity needed before universal multimedia standards can be developed. To take one example, telecommunications, multimedia transmission will rely on not only hardware and software standards developed for a particular computer, but also it must accommodate telephone/data network standards for electrical characteristics, signalling, routing, traffic management, and so on. As one article claims, this is difficult task since data networks presently are not well designed to carry real time *digital* information essential to motion and audio reproduction.[17]

What is clear from Table 2 is that standards-setting is a mix of *house*, *de facto* and *de jure* standards, a situation reflected in the computer industry generally. Communities of users (and the standards that apply) can be distinguished in terms of *platforms* (the actual computing gear and the operating systems basic to their functioning, such as Apple's MacIntosh), *environments* (the software that defines the visual and auditory limits of what can be done, such as Microsoft's *Windows 3.1*), *peripherals* (the hardware that allows various audio-visual functions, such as CD-ROM drives), *networks* (the standards

[17]Arnett, Nick. "Networked Multimedia: Building Communities Through Computing," *Mind Over Media*, Aug. 20, 1991 (a publication of Multimedia Computing Corp., Santa Clara, CA).

for information exchange among users or to central databases) and *authoring software* (the client application software that allows users to manipulate multimedia products and presents contents, such as Assymetrix Corporation's *Toolbook*). Each enables various multimedia attributes.

However, contrary to traditional media environments such as broadcast, there is not a simple, consistent, *de jure* base for information products — programs — that work in most transmission environments. Information products for multimedia depend tenuously on a host of home and *de facto* standards that are themselves changing and frequently inconsistent. The Multimedia PC Marketing Council (MPC), formed largely by Microsoft to wring consistency from what was becoming a chaotic standards environment, *itself* has changed basic standards a year after original criteria were adopted and published.[18] To add to confusion, the MPC does not enjoy universal participation. In competition, an IBM–originated consortium with Apple, Intel, Sony and Eastman Kodak have started the Interactive Multimedia Association (IMA) to promulgate different, higher standards. These would permit handling of broadcast television images in addition to computer-based graphics.[19] While the IBM standard (as expressed in its "Ultimedia" PC) has everything needed for MPC certification, " . . IBM would not guarantee that MPC-approved software would run on its system."[20]

Industry analysts reckon hardware manufacturers such as IBM and Apple so fear software dominance by Microsoft, that they have banded together to ward off this threat. The authoritative *Seybold Report* argues that:

> Microsoft's main sin is that it recognized — long before IBM, Apple and other vendors — that the future belonged to whoever owned the software that ran on the boxes sitting on everyone's desktop or lap, regardless of who made the box. Accordingly, Microsoft since day one has set about becoming the dominant player on all those desktops.[21]

In this context, it is no surprise that arch-competitors Apple and IBM have jointly formed two organizations to develop an advanced operating system (Taligent) and multimedia standards (Kaleida).[22] In the hotly competitve computer industry, moves toward standardization swiftly imply a concentration of power that generates powerful marketplace adversaries.

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[18]Sultan, Kristina. "MPC Group to Set 2nd Standard: Higher-Level Multimedia Spec Due Within a Year, *PC Week*, 8:43 (October 28, 1991) p. 12. See also: _____. "Multimedia PC Council Comes Under Fire, *PC Week*,. 8: 48 (December 2, 1991), p. 19.

[19]Xenakis, John. "Multistandards for Multimedia: Major Vendors Join Fray Over Huge Potential Market. *Information Week*, 342 (October 14, 1991) p. 22.

[20]Ross, Matthew. "IBM Chooses Different Course with its Ultimedia PC," *PC Magazine*, 10:1 (December 17, 1991) p. 36.

[21]Cline, Craig E. and Jonathan Seybold. "Apple, Microsoft, IBM and Consumer Electronics." *The Seybold Report on Desktop Publishing*, 5 (11) July 22, 1991, p. 6.

[22]"IBM, Apple Seal Promise-laden Pact, Taligent: To be formed by IBM & Apple Computer to develop an advanced operating system." *Computerworld*, October 7, 1991, p. 7.

To this competitive battle of technology standards and basic operating systems add a host of software preconditions for successful operation. Graphics platforms, such as Microsoft's *Windows*, competes with the Apple MacIntosh *Finder* and its audio-visual extensions. Upon this layer, we can add various authoring platforms as diverse as Assymetrix Corporation's *Toolbook,* Microsoft's *Multimedia Viewer,* Authorware's *Authorware Professional* — all with different mixes of features and hardware/platform demands.[23] Given the multiple and mutually exclusive choices of the computer industry, the consumer is presently faced with dauntingly complex decisions in purchasing a full multimedia environment. As an Apple executive lamented when questioned about industry-wide standards, "We have a Balkanization of media technology today."[24]

The Consumer Electronics Industry: Perhaps to simplify choices (and to lower costs), the consumer electronics industry is marketing "partial" multimedia solutions having limited functionality for display on home television sets. Consumer electronics is a high-volume mass market industry accustomed to appliance electronics such as televisions, "packaged" stereo systems and electronic learning aids (e.g., Texas Instrument's "Speak and Spell;" Franklin's Bible concordance). Philips CD-I technology, for example, offers "interactive" games, travelogues, atlases, encyclopedias, etc.[25] Commodore, Inc., is marketing CDTV (compact disk television), a system presumably so simple for the end user that it " . . is the porthole into the magic of computing for people who are afraid of computing."[26] A two-way technology, using an over-the-air radio frequency with a modified home TV receiver has been announced by *TV Answer*, Inc. and Hewlett-Packard. Using a digital transmission standard similar to cellular telephones, it will offer consumers " . . . the ability to access, organize, create and communicate information anytime, anywhere. " This will be accomplished with about a $700 hardware investment and " . . . unlike many personal computers . . . [the system] is easy to set up and requires no special training to use."[27] Finally, Eastman Kodak is hinting at market entry with "Photo CD," a technology to store home photos on a compact disk.[28] These are *home* standards, captive of a given manufacturer, each with its stable of software applications.

Few such standards have attracted adoption from other firms. Each is attempting to gather wide support from consumers, and from other manufacturers working under license arrangements. Simultaneously, each must attract cooperative software publishers

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[23]Kaliczac, Anne (ed.) "Multimedia Authoring Tools," *Infoworld*, March 9, 1992, pp. 76-96.

[24]Spindler, Michael [Presideent, Apple Computer], quoted in: Seybold, Inc, "The Apple-IBM Deal: What it means in the words of key players" *The Seybold Report on Desktop Publishing*. 6 (3), November 1, 1991 p. 3.

[25]North American Philips Corp., "Introducing a Whole New Way of Looking at Television." Seattle *Times*, October 16, 1991, page A-8. (advertisement)

[26]Shapiro, Eban. "Now, CD's Emit Sights as Well as Sounds: But Competing Formats, High Prices May Limit Appeal." New York *Times*, Sunday, May 12, 1991, p. F-5.

[27]TV Answer. "TV Answer and HP to Speed Development of First, National Interactive TV System," press release, February 27, 1992. [TV Answer, Inc., 1941 Roland Clarke Place, Reston, VA 22091].

[28]Shapiro *Op. Cit.* p. F-5.

who can make or break these systems through the availability of wide content variety. Most of these nascent systems are not being embraced by consumer electronics manufacturers and software publishers who are holding back to see which survives in the marketplace.[29]

This leads to a vicious circle well-known to the consumer electronics industry: as manufacturers hold back waiting to see which standards survive, all are denied a wide level of support. Software publishers, new equipment manufacturers, retailers and consumers stay away, fearing what has occurred in this industry many times before: abandoned, orphaned equipment, bereft of suppliers, dealers and, especially, software. The attics of America are littered with 8-track tape drives, 4 channel LP audio recordings, Betamax® videotape machines, and computers with peculiar standards having few if any software providers. Consumer electronics survives on wide distribution, low mark-up and high volumes. Equipment and software must be durable, simple and not require extensive support, since sales outlets can range from department stores to discount malls. The complexity and uncertainties of multimedia seem to contradict these essential growth conditions. Manufacturers of exceptional influence and staying power in the marketplace will be needed to see these home standards through into wide, *de facto* adoption.

Traditional Content Providers: The publishing and broadcast/film industries have both embraced the electronic future and defended traditional turf against new media outsiders. The commercial publishing of content-based software has in the past few years included dictionaries, marketing information, video libraries and Hollywood film clips, text databases (such as phone directories), academic journals and novels. These have appeared in a variety of machine-readable form: magnetic tapes, CD-ROMs, magnetic disks and laser video disks. Some observers contend that this market " . . could be as big or bigger that the application software industry we know today"[30]

Indeed, some of the big guns of publishing have entered the electronic market. A listing of the "top 10" CD-ROM titles (March 1991) shows Microsoft, TMI-Grolier, Ziff-Davis, McGraw-Hill, Britannica, Inc., and Quanta Press — all traditional print-on-paper publishers — with products listed.[31] Indeed, "electronic publishing" has an active history for the past decade, with a host of problems to be inherited by multimedia applications. But the standards problems are less those of technology (since text and images can be converted or adapted to a wide array of electronic or platform standards). Rather, they largely center on choosing the "client" software[32] that allows manipulation of the

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[29]*Ibid.*

[30]Pane, Patricia. "Data on Demand: The Market for 'Content-Based Software' Will Ride the Wave of Multimedia," *Infoworld*, March 11, 1991, pp. 47-51.

[31]*Ibid.*, p. 51

[32]*Client Software* refers to local software that manages connection and transactions between the individual user and a remote data source linked through telecommunications networks. As well, the term covers software that manages access to the vast information contained in locally used CD-ROMs. When a remote computer is used, it frequently called the *server* or *host*. The client software typically resides on the user's personal computer; hence, *client*..

contents. For a publisher, the choice is critical, since to choose client software limits users to those having the necessary hardware and software support. Some publishers have hedged bets by issuing their materials in several forms, notably for the IBM and Apple MacIntosh platforms. The enabling software within these environments can vary greatly, from the simple (a basic key word retrieval system and plain text display in an early CD-ROM version of *Webster's Dictionary)* to the complex (a hypertext[33], color, audio motion picture in National Geographic's *Mammals).*[34] Equipment requirements for full implementation of *Mammals* are several times in cost over that needed for *Webster's Dictionary*.

"Client" software limits the ways in which the user can manipulate or access multimedia content software. There are no accepted, agreed upon standards for capabilities offered or user behavior demanded. What does exist as commonalities have generally evolved from hardware/platform capabilities. If a mouse is supported, the product may employ "point and click" screen buttons to manipulate the contents in a way familiar to those having experience with a Macintosh or PC with *Windows*. If the system has a CD-ROM with a sufficiently high data transfer rate, it may support motion or animation standards. An audio board in the computer may allow polyphonic music or text-to-speech encoding. Because sound, motion and color can add heavily to the cost of user equipment, most titles are kept simple: basic text, some color (which can remain distinguishable in less costly gray-scale displays), and sometimes, still images.

Organization and search strategies borrow heavily from computer traditions of flat file databases[35] Others use the organizing principles of various author clients described above, particularly hypercard/hypertext structures. Many simple multimedia structures try to resemble their print-on-paper ancestors, capitalizing on one's knowledge of how traditional publications are used. Indexes, chapters, sections, tables of contents, summaries and bibliographies all can be found as navigational aids through an electronic publication. For visual resources, the user can be presented with on-screen VCR-like controls for *play, pause, rewind,* etc.[36]

The point is that metaphor or the electronic embodiment of a familiar media form is the perhaps the most often attempted informal "standard" to bridge the user to multimedia content. Yet there are novel efforts to exploit the speed and agility of electronic interfaces. Hypermedia organization, manipulation of visual (not textual) symbols,

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[33]*Hypertext* describes a way of organizing information much like a simple file of index cards. However, cards are not merely ordered alphabetically by a key term, but are *cross indexed* by multiple terms in the body text. This allows one to pursue individual paths for exploring a topic. See: Sueann Ambron and Kristina Hooper, *Learning with Interactive Multimedia: Developing and Using Multimedia Tools in Education*. Redmond, WA: Microsoft Press, 1990. pp. 6-25.

[34]*Microsoft Bookshelf,* Redmond, WA: Microsoft Press, 1988 (CD-ROM); *Mammals,* Washington,DC: The National Geographic Society, 1990 (CD-ROM).

[35]*Flat file databases* are typically simple keyword retrieval systems. Few employ Boolean operators that allow the efficiencies of multiple search keys. None use relational linking that allow diverse databases to focus on a single query.

[36]Rosenthal, Steve, "Quicktime Steals the Spotlight: Apple's multimedia architecture transforms business presentations into Oscar contenders," *Infoworld*, March 9, 1992, pp. S65-S66.

systems that "learn" user preferences and needs represent departures from the routine of earlier media forms.[37] No real standards exist in this innovative climate, and perhaps properly so since standards can "freeze" out emerging possibilities in the interest of stability. Yet, those who control the intellectual property of traditional media need this stable climate to develop their multimedia publications. Glenn Morrissey, multimedia product manager of Assymetrix, Inc., argues,

> You want a common conceptual model, because if people are going to buy different software — that's what made the Mac[Intosh] competitive . . . that by putting a common interface on things, you bring everyone up to a standard. The interface has to be simple and universal . . . [38]

Vying standards are holding-up the content-based software industry as they are the other sectors of multimedia development. One software publisher, restless with this contention, asserts:

> No one wants to be first. Software people out there are pushing: 'This is going to be a standard; you've got to do it my way, and pay me for the privilege of doing it.' Well, that's not the way computers were developed. It was a whole bunch of people doing a whole bunch of different things, and the market chose which ones were right.[39]

So the dilemma is posed: how does one accomplish stability yet allow innovation? Add to this basic problem the quickly expanding capabilities of new computing hardware, content software must follow a rapidly moving technological target.

Telecommunications: The earliest efforts of electronic publishing relied on distant databases and foreshadowed problems in multimedia standards as this earlier generation searched for *its* best standards mix. It is not in the scope of this paper to detail the contortions of the electronic publishing industry (primarily videotex and teletext) in the US during the 1980s.[40] It is reasonable to conclude that successes here were at best mixed and well below initial projections.[41] The two best-funded ventures, *Viewtron* in Coral Gables, FL and *Galaxy* in the Los Angeles area, failed in the mid-1980s having hemorrhaged millions of corporate dollars. Low speed telephone lines slow to deliver

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[37]See Sueann Ambron and Kristina Hooper (Eds.), *Interactive Multimedia: Visions of Multimedia for Developers, Educators, and Information Providers,* Redmond, WA: Microsoft Press, 1988, pp. 215-251..

[38]Pane, *Op. Cit.* p. 51.

[39]*Ibid.*

[40]For a review, see: Ralph Lowenstein and Helen Aller. "The Inevitable March of Videotex" *Technology Review.* October, 1985, pp. 22-29; Durand, Philippe. "The Public Service Potential of Videotex and Teletext. *Telecommunications Policy,* June, 1983, pp. 149-162.

[41]Harris, Catherine. "For Videotex, The Big Time is Still a Long Way Off," *Business Week,* January 14, 1985, pp. 128-133.

text and pictures, expensive special-purpose decoders costing consumers over $600 apiece, contents that failed to take advantage of the essentially transactional nature of these technologies, and costly phone charges were fatal flaws in the designs. They *did* adhere to technical standards, a special compression scheme for text and images developed by AT&T known as NAPLPS (North American Presentation Level Protocol Standard). Software, since it was developed by a single provider at a central source, was untroubled by the needs of multiple providers that exist today. However, an essential failure at the contents level was to not adequately recognize the kind of activity best done through an interactive, real-time communications link (*transactions* such as banking, catalog purchasing, ticket booking), and to take advantage of the large user base of modem equipped personal computers (obviating the need for $600 phone line decoders). Consequently, videotex's use as an electronic delivery medium for newspaper content was not cost-advantageous over its print-on-paper, hand delivered ancestor.[42]

Though electronic publishing has been redirected in recent years to removable, permanent media (such as CD-ROMs), the potential of networked services has not been forgotten. The French success with a simple videotex system (*Minitel)* distributed to over 10 million households by government telephone authorities, shows in its wide use and profitability the virtue of *de jure* standards widely promulgated at low user cost.[43] Use is largely transactional, involving purchases, catalog sales, electronic mail, banking and so on. In the US, use of networks, particularly *digital* networks, offering high speed information transfer, represent an attractive alternate means of diffusing multimedia information that is unsuited to the static, archival nature of CD-ROM disks and other removable, recorded storage media. One multimedia expert optimistically speculates: "As soon as high speed networking is in place — so all types of data can be transmitted in real time, i.e. digital media and sound — multimedia will become a consumer product."[44]

In anticipation, there has been some standards development in this area. Bellcore, the research organization of the seven regional Bell operating companies, for example, has released *Metamail*, a standard for multimedia mail.[45] In addition to the standard text carried in simple electronic mail, multiple fonts, foreign characters, still images, binary data and audio can be transferred. *Slate*, an experimental product in use on the Rensselaer Polytechnic Institute campus, allows intermixing voice, images, supporting notes as components of messages. Real-time document "blackboard" conferencing is supported as well.[46] While these are enticing technical feats, their focus is largely mail — intentional point-to-point communication. The daunting challenge to networked

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[42]Current videotex efforts, such as the Sears and IBM-sponsored *Prodigy*, have tried to address earlier deficiencies, but have an unclear records so far. See: Jeffrey Rothfeder and Mark Lewyn, "How Long Will Prodigy be a Problem Child," *Business Week*, September 10, 1990, p. 75.

[43]"L'informatisation de la société française" *Le Monde*, 7 janvier 1986, pp. 35-37.

[44]Pane, *Op. Cit.* p. 51.

[45]Borenstein, Nathanial. "Metamail Announcement" distributed by *Internet* newsgroup comp.multimedia. Bellcore, 7 February 1992. Further information at <nsb@bellcore.com>.

[46]Dern, Daniel. "E-Mail Integration: Taking on New Roles," *Infoworld*, February 24, 1992, p.

multimedia is *navigation*. With thousands of databases totalling millions of entries, the unaided task of finding specific information is considerable.[47]

Considerable discussion, thus, is directed to standards for locating and accessing networked information. Most work has developed on *Internet,* a world-wide network[48] connecting major universities, libraries, and research institutions, both public and private. With the need to exchange images, audio tracks, drawings in addition to simple text, multimedia offers important capabilities. One system available on this network to search for documents is WAIS or *Wide Area Information System.* Experimentation currently with this standard involves use of Metamail to provide multisensory capabilities. A French university has adapted this standard to its archive of recorded music. Sections of music audio may be fetched and auditioned using modified WAIS search software.[49] Underlying Metamail is *MIME* or *Multipurpose Internet Mail Extensions*, developed by the Internet Engineering Task Force to allow transfer of *Postscript* (a typeface and graphic description language), voice messages, binary data files, and video.[50]

Finally, there is a problem of standards in overcoming diverse addressing protocols in networks. Within the vast reaches of *Internet,* for example, five subsumed addressing styles can be found. The obvious need is to allow one "standard" to transfer mail to another, since accessing the widest number of electronically linked individuals is the central point of networking. The 1988 CCITT standard, X.400, for inter network mail addressing is rapidly spreading as a world addressing standard. While not really intended as a multimedia vehicle, the X.400 standard provides for some variant text forms (spreadsheets and binary files).[51] As is the case with Internet, we may expect the growth in network transmission capability to create a demand for a wider standard like *MIME.*

Can Standards be Reconciled?

The root industries of multimedia are dissimilar in many ways. They are uncomfortable fellows in the bed of multimedia, with their diverse business traditions, records of industrial cooperation and presence of governmental, professional and international bodies giving force to the standards forged. The situation of multimedia is further confused by an innovation rate that is swift and a definition that (seemingly) keeps taking

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[47]*Archie*, an automatic cataloging system for the contents of Internet servers and databases, has about 195 billion bytes of storage devoted to this task, a formidable data base by any measure. See: Emtage, Alan and Peter Deutsch, "Archie: An Electronic Directory Service for the Internet" McGill University, Montreal, Canada, 1991 [document available through anonymous FTP on *Internet* to <quiche.mcgill.edu>].

[48]More correctly, *Internet* is a backbone network into which many smaller, primary wide area networks connect.

[49]*Base Multimedia des CDs de l'Agos*. This WAIS source contains audio CD "documents." Together with descriptive text are 20 second audio samples of each. It is located via *Internet* at <zenon.inria.fr>.

[50]Dern. *Op. Cit.*, p. 41.

[51]*Ibid.*

on capabilities and functions. Too, there appears to be a market for multimedia technology that is enthusiastic without full realization of just what it is. Consequently, the task of coherent, planned standards covering the breadth of multimedia capabilities will likely prove difficult. Each comes to the multimedia planning table with differing needs, consumer expectations, innovation rate, and financial circumstances. In short, each is a particular industrial culture, evolved over decades of separate development. To summarize:

Table 3: Showing root industries of multimedia, contrasted by typical rates of change and usual standards-setting methods.

Industry	Rate of Change	Traditional Standards
Computer, Software	Fast; Innovation, hardware driven.	Proprietary house and *de facto* standards.
Consumer Electronics	Moderate; market driven; high volume output.	House, *de facto* and *de jure* standards.
Traditional Content: Publishing	Slow; content driven.	Stable, industry-wide traditions. *De facto and de jure* standards.
Traditional Content: Broadcast	Slow; content & Policy driven.	National gov't. regulated industrial standards. Primarily *de jure*.
Telecommunications	Very slow; national and international policy driven.	National and international standards. Primarily *de jure*.

The computer industry views media qualities of sound, motion, and color as variations of digitized information. They are " . . . the ones largely responsible for seeing to it that all these different cultures work together to deliver effective multimedia applications for business, education and the home."[52] In doing so, it is perhaps the most turbulent industry, with an extremely fast rate of change driven by technical advances. What standards exist are mostly the result of *de facto* corporate dominance and some non-binding industry agreement.

Consumer electronics, the home use audio-visual equipment industry, concentrates on delivery technologies for the broadcast, video and music publishing industry. Characteristically, sales volumes are high, profit margins low and standards are often driven by industry-wide agreement to reduce confusion in the marketplace. The tragedy of shifting or divisive video disk and tape standards in the past decades are fresh reminders of the chaos and consumer disgruntlement from ill-advised change and poorly shared standards.

The traditional mass media abide by long-established industrial standards and processes for producing their content products. Transitions such as digital audio broadcasting and high definition television are approached slowly and often with government supervision

[52]Pane, *Op. Cit.*, p. 51

lest the consuming public be abused by rapid and inconsistent shifts in technology. Developments such as HDTV (high definition television), have received extensive debate both by industry and by government for their social and economic consequences.

Telecommunications, with its mandate of universal service, and the network *dictum* that consistent standards are necessary for reliability and universality, make this industry the slowest and most stringent in terms of change and standards adoption. International, federal and state concurrence with change slows the process of evolution to a glacial rate, necessitating that most changes be transparent to the basic phone service user. Massive changes such as ISDN (integrated service digital networks) have provoked a decade-long debate not only with the standard itself, but with the social consequences of its costs.[53] But other standards requiring little change in technology, such as X.400 for electronic mail, enjoy rather fast adoption.[54]

In forging agreement among this diverse group, unique problems have to be considered that raise multimedia from the commonplace of standards-setting:

- The industries have very different rates-of-change. Their needs are in part embodied in the speed of their response to change. Standards-setting must respond to these traditions, a tough requirement when rates of change vary so much across foundation industries. An inability of content software, reflecting the conservative change rate of the publishing industry, to meet new computer technologies can doom innovations to a fatal software lag. Too fast a pace confronts content software providers with a frustrating moving technical target that denies them economies of scale and market stability.

- There are few companies with sufficient expertise to cover all major sectors of multimedia development. Some, by merger or new venture, are gaining expertise. Microsoft, for example, operates a traditional publications affiliate, Microsoft Press. Packard-Bell and DAK Corporation, have made successes of selling multimedia-equipped computers through volume outlets like discount stores or through catalog mail order in a way that imitates the market strategies of the consumer electronics industry.[55]

- The core of multimedia is *content* software. This is a departure for the computing industries whose concern in the past has largely been *applications* software given to the performance of certain functions like word processing. There are different needs in this new software domain, some of which can be ascertained from traditional content industries of publishing, broadcast and film.

- Cooperative efforts to bring standards to multimedia, such as the MPC, do not enjoy full cooperation within the computing industry and do not include many of the related industries needed to support standards. Consumer electronics, for example, seems diverted to appliance-like, special-purpose

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[53]Hafner, Catherine and Daniel Cook. "The Rewiring of America: Making Phone Lines the Transportation System for the Information Age, *Business Week*, September 15, 1986, pp. 188-196.

[54]Nittiskie, Leslie. "X.400 Tops List of Developments at NIST Meeting" *Communications Week*, November 25, 1991; Korzeniowski, Paul. "X.400 Faces New Challenge," *Electronic Message News*, Wednesday, October 30, 1991.

[55]"PC Economics 101: Welcome to the wonderful world of commodity computers" *Computer Letter*, 7: 38 (November 18, 1991), p. 1; Ron Wolf. "Computers Move to the Corner Store," *San Jose Mercury News*, July 22, 1991, p. 1E; See also DAK Industries, Inc., *Early Spring Catalog*, 1992, pp. 52-59.

forms of multimedia that adhere only to limited proprietary standards. Further, cooperation among several firms can pose a threat to competitors who, in turn, seek partners for *their* standard.

- There seems little cooperation across operating platforms to bring consistency to user interfaces. The issue of standards in how contents are accessed is at best mixed (see earlier discussion, above), since differing content needs, arguably, differing strategies. But techniques of display and information access are often constrained in their use by considerations of license and the intellectual property rights of authors and developers.[56] The result may be an exaggerated difference amongst content software to satisfy copyright restrictions, not to provide the best interface to the user.

These issues signal the immaturity of a growing industry, but they also show one very much at risk of fragmentation and consumer confusion if it is not stabilized. Industries accustomed to stability, such as publishing and telecommunications, will perhaps hold back participation until stabilizing standards come, or will wager their own industrial clout to make *de facto* standards that may not be in the best interest of all.

By one estimate, it can take between 4 and 8 years for an international body to develop standards.[57] Some fear that standards, approached at this glacial rate, may be obsolete before they are established.[58] The question, then, is how to provide standards swiftly enough, with enough flexibility to allow orderly growth of capabilities and the market. Reflecting on problems of achieving "interoperability" in advanced communication systems, the Congressional Office of Technology Assessment made several recommendations:[59]

- *Provide better data and a more analytic rationale for standards discussions:* A dilemma is that government is often not able to keep pace with technical and economic considerations of the marketplace. Conversely, it could be argued that industry is not sufficiently aware of the broad social consequences of standards decisions. Research on the *process* of standards-setting is recommended with a view toward improving cross flow of information. Agencies such as the FCC might initiate fact-finding proceeding or, alternatively, set-up inter industry panels to trade information and work-out solutions.

- *Allow for the emergence of market solutions.* Government-imposed standards have not always allowed for the best decisions. *Voluntary* or *consensus* standards seem preferred since the participants must abide by the market consequences of their decisions. The government, clearly, is rarely obliged to do so. Thus a *minimalist* role for the government is suggested. Recent government actions concerning HDTV standards suggest how this might be done. In this case, the government has provided a neutral forum for the testing and evaluation of competing standards. It assures the testing is thorough, fair and the results are public while industries develop competing "standards" and sample systems for evaluation.[60]

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[56]Pane, *Op. Cit.*, p. 47; Paul Karon, "Electronic Publishing Faces Legal Traps over Copyrights" *Infoworld*, March 9, 1992, p. S70.

[57]Gilhooly, Denis. "Expanding the Scope for the CCITT," *CommunicationsWeek*, January 16, 1989.

[58]Office of Technology Assessment, US Congress, *Critical Connections: Communications for the Future*, (Washington, DC: US Printing Office) January, 1990. [document OTA-CIT-407]

[59]*Ibid.*, pp. 300-306.

[60]Naegele, Tobias, "When Will We See HDTV? Don't Hold Your Breath," *Electronics*, March 1989, pp. 72-73.

- *Encourage particular standards with sanctions or incentives.* Government procurement power can force standards through its weight in the marketplace. Already, proposed federal "guidelines" for multimedia are being written by The National Institutes of Standards and Technology. The US Armed Forces have perhaps been most aggressive in seeking standards for their many training and documentation needs.[61] The market potential of multimedia applications for the Federal Government is estimated at about $1 billion.[62] Short of explicit standards setting, the government could withhold support for contending standards, letting it be known that all were considered immature. This would hopefully motivate industry to revise and improve their offerings.

- *Mandate industry-wide standards.* Though current policy is to avoid mandating standards in appreciation of marketplace forces, the globalization of networking and communications generally may constrain this open approach. If other nations mandate standards for such key technologies as ISDN or HDTV, the lack of US participation may be ruinous for trade and security. Industry, though,would likely find such an approach loathsome, particularly if their proprietary technologies were at stake.[63]

Beyond possible government efforts, there are industrial and consumer forces that may be useful in pressing for multimedia standards development:

- *Home standards may evolve to de facto and consensus standards.* The path is perilous, but the evolution of videotex standards a decade ago shows some promise in this process. The *NAPLPS* standard evolved from Canadian and Bell/AT&T research. Backed by the prestige of AT&T and the sponsorship of two key newspaper groups (Knight-Ridder and Times-Mirror Corporations), the *home* AT&T standard became a *de facto* standard by virtue of the AT&T monopoly. It fell short of a consensus standard as deficiencies and financial problems in the test systems blossomed.

- *Consumer testing and involvement:* The role of consumer testing has been limited in the specialized domain of high technology. But organizations such as Consumers' Union have a long history of involvement in testing the products of the consumer electronics industry. Hobbyist and trade publications in the consumer and corporate computer information industries have a long record of product and software evaluation. Publications such as *Infoworld* offer its testing facility to manufacturers seeking independent assessment of their wares, awarding favorable cases a seal of buyer assurance reminiscent of home and garden publications several decades ago.

- *Joint development:* Consumer electronics and computer manufacturers have long known the problem of inadequate standards. Recent fusions, such as the liaison between Apple and IBM, may seem reassuring in their cooperativeness. The disquieting element is that they are often a response to the power of other marketplace groups seeking backing for *their* standards. Several large, contending industrial groups can keep standards divided for years as was the case in home VCRs.

- *Changed economics and saturation of traditional markets.* Consumer electronics and computer manufacturers both have experienced "plateaus" in their sales histories. Saturation occurs as products, such as VCRs, move from household novelty to commonplace appliance. After an initial saturation, one is left with a replacement market based on wear and obsolescence. A household computing appliance has long been sought by computer and consumer electronics manufacturers, but

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[61]"Market Drivers for Multimedia World: Market for multimedia products developed, driven by a number of factors." *Computer-Graphics-World*, January, 1992, p. 14.

[62]Reilly, Lucy. "Federal Government Multimedia Standards Effort is Underway," *Multimedia Computing & Presentations*, December 15, 1990.

[63]Office of Technology Assessment, *Op. Cit.*, p. 306, footnote 60.

> has proven elusive.[64] A large, new market may exist for *home* multimedia, if the product can be made simple, stable and enjoy a wide acceptance of its content software standard. An attraction of multimedia, unlike traditional computers, is that *content software* provides a continuing sales potential that could parallel that of the recording industry. In short, there are strong incentives to achieve the stability a mass information appliance market will require.

It would be comforting to have a clear view of how multimedia will develop. The lack of standards apparent and the divided efforts to establish them promise confusion for both the consumer and industry. It is a stiff challenge to create stability within a fractured industrial base having diverse cultures and standards-setting customs. And it will take wisdom among the participants to know when and where to hold off strict standards to allow for growth and innovation. The multimedia standards effort is worth engaging, however. The difficulties here are a visible signal of future challenges facing industrialized nations as they construct new information-based economies from old industrial roots. Our experience in making effective multimedia standards will be instructive in meeting this challenge.

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[64]Depke, Deidre. "Home Computers: Will They Sell This Time? IBM, Tandy, and Others Say Yes" *Business Week*, September 10, 1990, pp. 64-70

Regulating the Kaleidoscope

An analysis of policy in the information age

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狄文

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The kaleidoscope produces dramatically different images from scraps of red, blue and green paper, just as "telecomputing" products result from the synergistic combination of computers, telephone and mass media. But while all the paper in the kaleidoscope is basically the same, telecomputing's parent industries have disparate purposive, economic and regulatory foundations. Society is now facing the fusion of the relatively unregulated/competitive computer industry, the structured/monopolistic telephone industry and the mixed regulatory/economic environment of the mass media. Merging technologies is easy compared to merging the related industries.

This paper is designed to stimulate discussion among readers of different viewpoints and to outline the diversity of concerns in the creation of policy. Policy is defined in the widest possible terms including court decision, agency rules, laws, contracts, private corporate policies and instances of intentional non-regulation. More important than advocating any one specific solution is the necessity that we understand our choices and the effects of those decisions.

Regulating the Kaleidoscope
An analysis of policy in the information age[1]

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Like patterns in a kaleidoscope, technologies intermingle – merging and separating to produce new and yet unrealized communication services. The kaleidoscope produces dramatically different images from scraps of red, blue and green paper, just as "telecomputing"[2] products[3] result from the synergistic combination of computers, telephone and mass media. But while all the paper in the kaleidoscope is basically the same, telecomputing's parent industries have disparate purposive, economic and regulatory foundations. Merging technologies is easy compared to merging the related industries.

In this paper, the author hopes to stimulate all readers to consider the diversity of viewpoints in the creation of policy. Policy is defined in the widest possible terms including court decision, agency rules, laws, contracts, private corporate policies and instances of intentional non-regulation. More important than advocating any one specific solution is to understand the possible effects of policy choices. After the introduction, the first part will look at telecomputing – what it is and what it may do. The second section examines the types of problems that

[1]The "Information Age" refers to the economic and social changes predicted as society moves from an industrial based economy to one more dependent on information services as discussed by (Dizard, 1989; Dordick, 1986).

[2]"Telecomputing" includes any synergistic combination of computer, telephone and mass media technology.

[3]Telecomputing can perform a number of functions from simple alarm systems (a service) to online magazines (a product). Although neither the word "product" or "service" is completely accurate, for simplicity's sake this paper will use "product" as a general term.

telecomputing facilitates and the policy decisions that have resulted. Finally, the last section will critique current policy and recommend changes.

Introduction

Despite all efforts to the contrary, telecomputing systems remain in a state of political ambiguity. Current users often describe the telecomputing environment as the "electronic frontier" or "cyberspace"[4] (Branscomb, 1991; Electronic Frontier Foundation, 1990a; Electronic Frontier Foundation, 1990b; Kapor & Barlow, 1990). Barlow (1990) described it most colorfully, if not correctly, when he said:

> Cyberspace, in its present condition, has a lot in common with the 19th Century West. It is vast, unmapped, culturally and legally ambiguous, ... hard to get around in, and up for grabs. Large institutions already claim to own the place, but most of the actual natives are solitary and independent, sometimes to the point of sociopathy. It is, of course, a perfect breeding ground for both outlaws and new ideas about liberty.

Barlow's analogy may seem rather dramatic but it expresses in simple terms the virtual quagmire of policy that has been echoed in more academic sources (Branscomb, 1990; Brown & Helland, 1985; Chen, 1990; Clarke, 1988; Cousins, 1980; Forester, 1990; Grimm, 1989; Hammod, 1984; Jordan, 1984; Katz & Graveman, 1991; Parker, Levy, Spafford, Hawthorn, Rotenberg, BloomBecker, et al., 1991; Shapiro, 1991; Silverman, 1989; van Dam, 1990).

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[4] "Cyberspace" was coined by the science fiction writer William Gibson (Gibson, 1984) and is a popular term for the sum total of all electronic messaging and information systems, including BBS's, commercial data services, research data networks, electronic publishing, networks and network nodes, e-mail systems, electronic data interchange systems, and electronic funds transfer systems (Rose, 1991). See also (Barlow, 1990; Barlow, 1991; Branscomb, 1991; 1990; Kapor, 1991; Kapor & Barlow, 1990).

The frustration expressed by Barlow is not unique to any one particular group. The players involved in telecomputing controversies are normally well intention and fair from their viewpoint. Problems arise as people from different backgrounds find their expectations and fears competing. Telecomputing forces the fusion of the relatively unregulated/competitive computer industry, the structured/monopolistic telephone industry and the mixed regulatory/economic environment of the mass media. The result is a myriad of new products and services with an equal number of new challenges. As disputes inevitably develop, old regulatory schemes are imposed on the new technology. Policymakers react to specific problems with well-intentioned but poorly informed choices. The result is a patchwork of rules and rights that often fails to serve either the technology or society and leads to a imprecision in defining issues which may include:

- The cultivation of an open communication marketplace.
- Threats to the First Amendment rights of emerging public forums.
- The integrity of our public communication network and protection of defense, business and emergency services.
- The protection and encouragement of the potentially vital telecommunication and computer industries.
- Threats to privacy and property.
- Lost revenues to creators of intellectual property.

Since telecomputing is the result of merging technologies, it has not been created by a single group or even a single industry. As each industry creates its vision of the future, it becomes too easy to overlook the competing visions of others. Too often, computer, telephone and media industry analysts take an "us-versus-them" approach to challenges. They remain blind to legitimate concerns that are not normally germane to the technology that they know best. Unfortunately, it is these same analysts who will educate/lobby the policymakers as to the issues and possible solution.

The kaleidoscope analogy is used to emphasize two main observation about the telecomputing industry. First, telecomputing products and services are *not* the

result of any one industry's efforts. Just as the kaleidoscope combines colors to create its beautiful patterns, telecomputing results from the synergistic conversion of industries – each distinct but necessary. Looking at any product from the viewpoint of a single industry is like look at only one color in the kaleidoscope. It is impractical and incomplete. Second, just as kaleidoscope images are constantly evolving, so are telecomputing products. The combination of technologies produces not one but an infinite variety of products. These products are distinctly different from each other and distinctly different over time. Trying to apply a single policy or theory to all products is as practical as trying to regulate a kaleidoscope.

WorldofTelecomputing

The combined advantages of the three parent technologies creates an extremely flexible variety of products. First, the telephone network gives users the ability to bridge space by providing nearly unlimited access. Users can replace transportation (travel to see one another) with telecommunication (visit via telephone). But the telephone network is structured to favor point-to-point interpersonal communication. It lacks a strong ability to provide real point-to-multipoint communication.

Second, the computer offers users the ability to manage, manipulate and produce information. The system works (e.g., filing, sorting, adding) for users by bridging intelligence. The user is able to access the intelligence of the programmer through the computer (i.e., ability to ability to file, sort, add, ect.). But the computer has traditionally been a more isolated tool with a limited audience for each product. Until computers are connected to a network, their ability to distribute information is limited to disk exchange.

Although mass media provide neither the interactivity nor the installed intelligence of the other parent industries, they can provide what the media do best. Not only do mass media provide information and entertainment, but, due to their traditional reliance on advertising, they have a unique ability to identify markets.[5] In this way, the media provide bridges between groups of people – information producers and consumers.[6]

Product Classification

A synergistic combination is accomplished when the ability of one technology supplants an original limitation of another. The result is not a single product but rather, like the kaleidoscopic images, a group of loosely related products spread across three dimensions: social presence, distribution and intelligence.

Social Presence

Short, Williams and Christie (1976) conceptualized communication media as falling along a continuum of "social presence." Social presence is defined as the degree to which the medium facilitates the awareness of the other person and interpersonal relationships during the interaction. Under their theory of social presence, face-to-face communication has the greatest presence, followed by teleconferencing, then written communication.

Telecomputing can extend many levels of social presence from simple access to remote computers (e.g., providing access to a database of citations) with little or no

[5]Unlike most other industries, the mass media must not only sell its own products (programs, stories, ect.) but, in order to sell advertising, must find buyers for the products of other people.

[6]Telecomputing may cause the distinction be between these two groups to diminish through multipoint-to-multipoint communication, discussed below.

social presence to online chats.[7] The amount of social presence is effectively the level of interaction allowed by the system. For example, individual computer games have become very popular but usually only one person can play at a time (or at least take turns playing). Telecomputing enhances gaming by allowing people to do more than to sit in a single location and race or battle each other (or the computer). In games such as GEnie's *Federation II*, a true cyberspace is created. These games provide an alternative universe for users to interact, explore together or in competition. Users are no longer limited to the assigned adversaries and structured duties. The character that is encountered is not computer generated but another users with all of the possibilities of such a relationship. The computer game is was a tool for entertainment but the cyberspace game is a medium of communication.

Distribution

The traditional model of communication implies a rather simple relationship of communication from sender through a medium to the receiver. Mass communication is accomplished when there are multiple receivers to a single message. The result in a rather simplistic understanding of information distribution with two possible choices – point-to-point and point-to-multipoint communication. Telecomputing creates practical alternatives to traditional communication distribution including multipoint-to-point and multipoint-to-multipoint. Multipoint-to-point communication takes place as one receiver is the target of communication from many senders. For example, telecomputing facilitates the growing trend towards reverse advertising – where consumers communicate their desires to product manufactures. Multipoint-to-multipoint

[7]The "online chat" creates a direct connection between telecomputing users for real-time conversations.

communication takes place as work groups and online forums[8] communicate in a relatively open area. It is impractical to think of these distribution systems as either point-to-point or point-to-multipoint communication because the senders'/receivers' expectation of the message is not the same. The level of distribution is therefore defined by the number of possible participants for a medium.

Intelligence

The amount of installed intelligence gives the system the ability to modify, create or add value to a product. For example, database services add intelligence to the original paper volumes by allowing automated searching of information. Clipping services[9] and expert systems[10] are an additional advancement over database services with even more installed intelligence. As the systems advance, they take more work away from the users and must get more intelligent to accomplish their tasks. Intelligence adds value to the relatively unintelligent distribution systems of the telephone and mass media.[11]

Mapping Products

If each product were plotted along the dimensions described above, the result would be a true (three dimensional) world of products. It is inevitable that this "world of products" will come about but, to date, telecomputing rarely makes use of

[8] A "forum" computer messaging system which exchanges public messages and files between users.

[9] "Clipping services" automatically scan incoming files from news or other information services and forward files to users which meet a search criteria set by the users.

[10] "Expert systems" are programs that attempt to endow computers with the ability to imitate the thought processes of humans or act as an intelligent assistant, providing advice and making judgments in a specialized area of expertise (Rosenberg, 1987, p.221).

[11] See discussion below of value-added services.

intelligence needed to add value and capabilities. Though computers are low-cost facilitators for many telecomputing products, it is not yet possible to distribute truly intelligent services such as virtual reality,[12] hypermedia[13], and artificial intelligence[14]. For now, the two-axis model, in Figure One, provides a good description of current products.

The horizontal axis accounts for the level of distribution and the vertical axis the level of social presence. In point-to-point telecomputing, the service acts very much like a common carrier by delivering little more than a simple channel of communication such as electronic mail or and interactive link to another computer. At the other extreme are mass delivery services such as online publications and electronic auditoriums.[15] In the midrange of this continuum, telecomputing functions as an enhanced communication or distribution channel for a product with a limited audience.

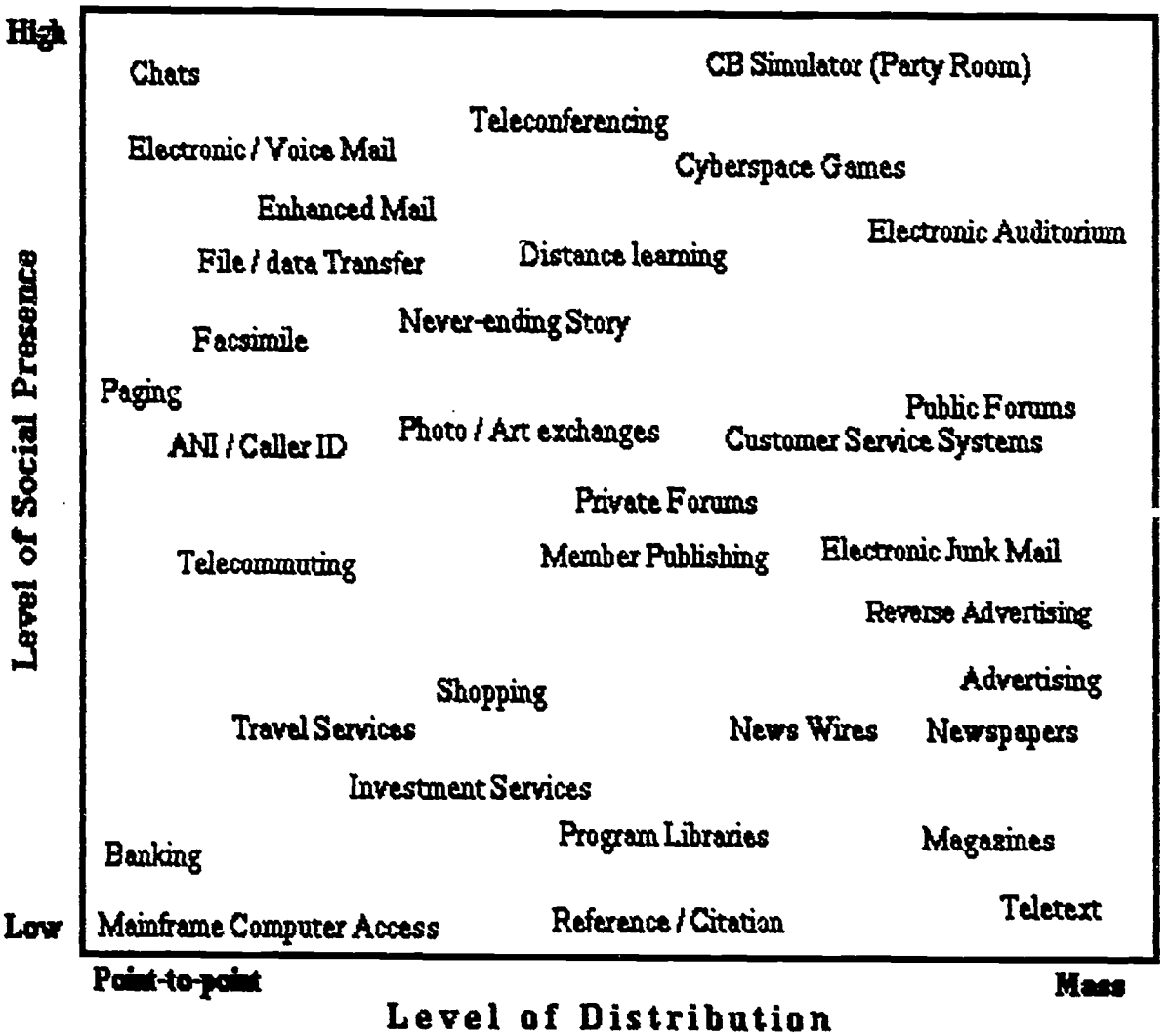
[12] "Virtual reality" is a functional simulation of a environment (real or computer-generated) which allows users to enter and interact with that environment without physically traveling to it.

[13] "Hypermedia" is a general class of programs or instruction sets which allows users to access multichannel information in a non-linear manner.

[14] "Artificial intelligence" is the capability of a device to perform functions that are normally associated with human intelligence, such as reasoning, learning and learning (Rosenberg, 1987, p.28). Note that artificial intelligence technology is often necessary in "expert systems" but is not necessarily used in expert systems.

[15] The "Electronic Auditorium" is similar to a teleconference but enforces a virtual stage where certain participants are allowed to talk freely while others must ask permission to talk or send questions/comments through a moderator.

Figure One
World of Telecomputing Products[16]



The vertical axis charts telecomputing's social presence. At one extreme (high social presence), there are "live' services such as teleconferencing and online chatting. At the other extreme (low social presence), telecomputing provides a means to access remote systems such as banking, information retrieval or mainframe computer services. At the midrange, telecomputing allows time-

[16]Figure One is intended to show a snapshot of current telecomputing products. Please read the next section for a discussion of individual products.

shifting or asynchronous communication. The vertical axis therefore becomes a continuum from no access with another person to direct (real-time) interaction.

The World of Products

By now, it should come as no surprise that there is no "typical" telecomputing product. Products have evolved through the efforts of many people working independently. The result is the myriad of products that are continually changing. What follows is a discussion of the current products pictured in Figure One. Since telecomputing is continually changing, any description would be out of date. This section is intended to illustrate the diversity of products. It is not intended to act as a definitive categorization and definition of products.

The first temptation is to classify products by their parent industies. For certain products such a classification system makes sence but the synergistic convergence of the technologies has moved most products far from their parent industies. Although there are many other possible categories for products (all of which would be somewhat inaccurate), the products pictured in Figure One will be discussed as five basic categories: 1.) Real-time products; 2.) Data-transfer; 3.) Time-shifted interaction; 4.) Computer products; and 5.) Online publications.

Real-time Products

Real-time products provide just what the name implies -- real-time or live communication including: online chats; teleconferencing; distance learning; electronic auditoriums; cyberspace games; and CB simulators. The technology for these services are basically the same, the main difference are the number of participants and the resulting structure of the interaction.

Chat lines allow conversation between two or three people – usually text-only.[17] Close cousins to the online chat are data teleconferences and CB simulators (sometimes called party rooms). The teleconference has a planned, stated, discussion topic or reason for being. CB Simulators, the name coined from citizen band radio, are completely open, free-form discussion areas where any number of people can participate. In both cases, multiple people can interact at once but the structure of the conversation is slightly altered by their different purposes.

Very similar to teleconferencing are electronic auditoriums and distant learning systems. The simple link is enhanced with system software[18] that enforces additional structure to the conversation by creating different classes of users with differing freedom to send messages.[19] Distant learning systems allow for education through telecomputing so act like a highly structured teleconference. A popular use for the electronic auditorium is the "game show." Game show participants will assemble at a pre-arranged time for a contest of some sort (e.g., trivia contest, bad joke contest, ect.). In both cases, there are identified discussion leaders and audience members.

The most advanced real-time technology is the cyberspace game. Not only must there be a link between individuals but the host software must function as an extended-time game. The games may last anywhere from several hours to several months. Also, there is a near necessity that most cyberspace games comprise several rooms so that interaction with the entire group is not necessary. The

[17]America Online currently allows a limited amount of sound to be transmitted. A main use for the chat is for the sysop to talk directly to visitors.

[18]The telecomputing host software will simply not accept messages from unauthorized users or transmit the messages to a moderator only.

[19]Often sysops will move a popular teleconference from a normal meeting room to an electronic auditorium. This is either done for by host software (as described above) or enforce rules of behavior on participants.

exploring nature of these game provides close interaction with many people but not all at once.

Data Transfer

Probably the technology most identified as telecomputing are those where data is managed or transmitted including: electronic or voice mail; enhanced mail; file/data transfer; facsimile; paging; and ANI/caller ID. The popularity of these products is understandable since they are basically delivery services with clear analogies outside telecomputing.

Electronic/voice mail, file/data transfer, paging and facsimile the simplest of these products. The computer must simply forward the message to the correct person and possibly store it until they can receive it. The level of social presence on these products are relatively high because the receiver usually knows the sender.[20] As systems advance, social presence may be better felt to a greater extent by other products (e.g., video mail) and these products will not have the same high level on the continuum.

Enhanced electronic mail provides an additional service over normal electronic mail. Frequently, the recipient of the enhanced mail is not a subscriber to electronic mail system. Enhanced mail may deliver the message to a post office close to the recipient. It may customize artwork or other information for the recipient (such as a nice Valentines' Day message) or based on the sender (and current needs of the sender). It has also been used effectively to facilitate political support for telecomputing information utilities. The enhanced mail system took user's messages, determined the correct congressional representative or senator, and mailed the user's sentiments to that person (or people).

[20]See also electronic junk mail.

ANI[21]/caller ID is the most unusual of the data delivery services because it does not deliver an isolated message. ANI/caller ID allows the receiver to know something about the person calling,[22] via a normal voice phone call, before the call is answered. As such, it acts only in conjunction with another message.

Time-Shifted Interaction

Time-shifted interaction is probably one of the most innovative uses of telecomputing. These products – including public/private forums, never-ending stories, photo/art exchanges, member publishing, customer service systems, electronic junk mail, and reverse advertising – open the possibility of publishing to everyone. They allow users to exchanges messages, ideas, art and expression with groups that would not be practical otherwise .

Any discussion of time-shifted interaction must start with the forum – one of the most universal telecomputing products. The purpose of the forum is to create a low cost communication center for people of similar interests. Users participate in time-shifted discussion groups or send large files and messages through forum libraries. The result is an organization that is half-way between a publication and a club. Sysops must garner the support of volunteers[23] in order to create an ongoing message exchange. This frequently means creating or editing discussion areas and finding new information for discussion.

Forums are frequently used to facilitate contact between businesses and clients. Customer services systems not only allow communication among product users but will also take orders, track billing and distribute sales information to clients. These systems can become a source for reverse advertising. Users discuss problems with

[21] Automatic Number Identification

[22] Caller ID systems usually only display the phone number of the person calling but systems can (and ANI frequently does) display the name or other identifying information.

[23] In commercial services, "volunteers" must actually pay for participation.

products and desires for new products. The manager of the customer service system gains valuable knowledge through clients' discussion. The system can also automatically track clients orders to suggest future needs or alternatives for the client.

Participation in forums necessarily reveal valuable information about users. The person that spends times in a genealogy forum may be interested in purchasing genealogy products and information. Participation in any kind of forum suggests a person's economic status because they are able to buy the necessary equipment. Armed with this kind of information, electronic junk mail is growing. The junk mail can be sent to a large group of people yet still be personalized.

For people who desire more than simply being a part of a forum, users may choose to create and distribute their own works online. Denise Caruso is an excellent example of member publishing with her weekly column and forum on America Online. For those with a more artistic flair, many telecomputing services offer the opportunity to exchange artwork or digitalized photographs.

Writers' forums have come up with an interesting variation on the typical forum conversation in the never-ending story. Participants take turns at writing a small section of a story and then read how others build on their work. While this may not produce great literature, it apparently makes for an interesting and active forum.

Computer Products

A great deal of work can be accomplished via telecomputing without direct interaction with another person. For example, when a person access a mainframe computer, human interaction is not necessary – sometimes not even desirable. The same is true for reference/citation databases and online banking. In this way,

telecomputing is supplying access to computers with special ability and/or information rather than access to other people.

Telecommuting allows users to work (at least partially) at home rather than commuting to the office. As such, it is likely to require a mixture of products including file/data transfer, electronic mail, access to remote computers, and voice telephony. The main purposes, at least for now, has been to allow users to receive raw data at home and send completed work back to the office.

Three products, which are very similar, require a mixture of advertising, information distribution and data processing: 1.) online shopping; 2.) travel services; and 3.) investment services. In all three cases, service providers are attempting to sell products and services to people in the comfort of their home.

Online Publications

For the most part, this category contains telecomputing extensions of the mass media. Online advertising, program (software) libraries[24], magazines, news wires, and newspapers often simply redistribute products published in their traditional counterparts. Advertising products can take advantage of telecomputing's two-way link by allowing consumers the immediate opportunity to respond. Magazines and newspapers may accept letters to the editor through online services. Pure online publication (those with no traditional mass media counterpart) are going in popularity as well.

Teletext is left in the lower corner of Figure One because of the nature of its delivery system. By definition, teletext systems are broadcast to receivers through television signals. While this method of distribution makes them one of them one of the most widely available, interaction is not possible because the broadcast

[24]Software libraries are included in this group because it is assumed that they replace a similar bookstore style delivery of software.

signal is strictly one-way. Therefore, social presence must be less than other services.

Origins of the Technology

Each industry developed its own form of telecomputing in its own vision of the future. Even though similar products were being created, each creator had a unique perspective on the product's use and possible misuse. For example, computer networks and computers connected to the telephone network seem very similar – as if they are one technology. But the concerns of the computer developer, trying to network computers, do not necessarily match those of the telephone engineer, connecting a network to the computer.[25]

Historically, both creators and policy-makers have seen telecomputing in one of three lights: (a) a utility of business, (b) an ancillary product to another publication or (c) a band of thieves. These first uses of telecomputing have resulted in a patchwork of legislation but little true policy. While not all authors (even those cited) are as narrowly focused as described below, telecomputing policy tends to break down into these three distinctive camps. None of the three views are necessarily wrong but each view is incomplete.

A Business Utility

Some of the original telecomputing systems were the public and private databases, electronic funds transfer and business/government data communication systems. These systems were a telephonic extension of an in-house computer system. For example, *CompuServe*, the nation's largest telecomputing firm, grew

[25] A reasonable guess at the difference between these two people is that the former would want to protect the computer from damage and the latter would want to protect the network.

out of the excess computing power of H&R Block and still enjoys business customers as a high percentage of its users.[26] These systems were created as the telephone technology began to merge with computers. Clearly, government and business users were the most profitable so they were the first to be served. As a result, the systems managed a great deal of money and sensitive data.

The resulting policy goals were designed to protect the security of these systems, such as preventing unauthorized access and protecting data integrity. Adopted legislation was designed to protect the data as a possible source of fraud or crime against property. For example, West Virginia's Computer Crime and Abuse Act[27] directly follows its section on Crimes Against Property,[28] and Louisiana regulates computer related crime[29] following statues against bribery and forgery.[30] The tenor of these Acts are such that they provided a level of protection equal to if the information were in a vault. This type of regulation climaxed with the Electronic Communication Privacy Act (ECPA) of 1986.[31] Although the word "privacy" was used in the title, the intent of the Act was to define system *security*. This act did almost nothing to regulate the use of private information within a system.[32] Instead, the ECPA concentrated on defining what was a breach of the system – specifically a legal breach of the system.[33]

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[26] From CompuServe promotional material.
[27] WVA §61-3c
[28] WVA §61-3
[29] 9 LSA § 73.1
[30] 9 LSA § 72-73
[31] Pub.L.No. 99-508, 1986 U.S. Code Cong. & Admin. News (100 Stat.) 1848 (codified at 18 U.S.C. §§ 2510-2521, 2701-2710, 3117, 3121-3126).
[32] 18 U.S.C. §§ 2520 does make provision for recovery of civil damages in case were communication is intercepted, disclosed, or intentionally used.
[33] The EPCA was built on a solid foundation of previous acts which accomplished basically the same thing. See *Omnibus Crime Control and Safe Streets Act of 1968*, Pub.L. No.90-351, §§ 801-804,82 Stat. 197,211-25; The *Electronic Fund Transfer Act*, Pub. L. No. 95-630, Sec.2001, §§701-707, 88 Stat. 1500, 1521-25 (1974); and The *Cable Communication Policy Act of 1986*, Pub.L. No. 98-549, 98 Stat 2779. See also (Burnside, 1987; Johnsom, 1989)

The problem with these laws is that they did a poor job of defining the difference between information of different qualities. Penalties were not strong enough to deter the hacker intent on entering systems with truly sensitive data and too high for the teenager who takes a childish romp through a system with less sensitive data. At the same time, penalties which are sensitive to the value of the data, define "value" as monetary value (value of the information and the system time).[34] Monetary value is easily overestimated by the system owners and too difficult for the guilty hacker dispute.[35]

The telecomputing analysts from this viewpoint (Bigelow, 1989; Chess, 1989; Congress of the U.S., 1987; Denning, 1990; Grimm, 1989; Katz, 1990b; Katz & Graveman, 1991; Parker, 1989; Pujals, 1989; Salamone, 1991) will be more concerned with system security than anything else. The focus will be to identify what could be stolen or damaged as security is breached.

Ancillary Publications

The early videotex and teletext systems led to a second view of telecomputing. As ancillary services to newspapers, broadcast stations and cable companies, they imitated the parent product rather than providing something distinctly different (Conhaim, 1991; Dick, 1986). Large-scale attempts at this early form of telecomputing (commonly called videotext), such as Knight-Ridder's Viewtron met with an ambivalent public and a lack of videotex standards. This resulted in some spectacular failures. In other countries, moderate success has been achieved through a mandated videotex monopoly – as in French Minitel videotex and British Prestel teletext.[36]

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[34] *E.g.*, S.D.Code.Laws 43-43B-3-6, IA Code Ann. 716A.
[35] See discussion of Bell South case below.
[36] In these cases, the government mandated a universal standard protocol and billing cooperation.

Surprisingly, these new media ventures did not usually spark First Amendment arguments – normally associated with media policy. In general, the policy arguments concerned market structure and anti-trust policy. Typical issues surrounding these services included: (a) should telcos be allowed to offer data communication services,[37] or (b) what is the power or a company to control the distribution of its product?[38]

The unique position of the FCC, as a regulator of both telephone and mass media companies, allowed them to come as close as anyone to truly considering the views of more than one industry. Throughout what became known as the Computer Inquires (I, II and III)[39], they tried to define a market structure which would separate telephone companies' monopoly services and competitive services. Since 1982, the market structure argument has been complicated by the break-up of AT&T through the Modified Final Judgment[40] and the continued jurisdiction of Judge Harold Green. Although these arguments began with utility-like cases, such as Hush-A-Phone[41] and Carterfone[42], the generally strong market prediction for information services kept regulators thinking about enhanced services as potential mass media (Cawkell, 1986; Cronin, 1985; Hiltz, 1984; Hiltz & Turoff, 1978; Noll, 1979; Rice & Paisley, 1982; Schiller, 1986; Vitalari & Venkatesh, 1987).

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[37] 60 Radio Regulation 2d Cases

[38] These were generally copyright-like issues as in *WGN v. United Video*, 685 F.2d 218

[39] First Computer Inquiry 28 F.C.C.2d 267, 21 R.R.2d 1591 (1970), *aff'd in part on sub nom.* GTE Service Corp. v. FCC 474F.2d 724 (2d Cir. 1973), *decision on rmand* 40 F.C.C.2d293, 26 R.R.2d 1727 (1973). Second Computer Inquiry, 77 F.C.C.2d 384, 47 R.R.2d 669 (1980), *on reconsideration* F.C.C. No. 80-628 (released Dec. 30, 1980). Third Computer Inquiry 104 F.C.C.2d 958, 60 R.R.2d 603, Third Computer Inquiry (Phase II) 62 R.R.2d Cases 1662, Third Computer Inquiry (Reconsideration) 62 R.R.2d Cases 1594.

[40] *United States v. American Tel. and Tel. CO.*, 552 F.Supp. 131 (D.D.C. 1982) *aff'd mem. sub nom. Maryland v. United States*, 460 U.S. 1001 (1983).

[41] *Hush-A-Phone v. United States*, 238 F.2d 266 (1956), *on remand sub nom. Hush-A-Phone v. AT&T*, 27 F.C.C. 112 (1957)

[42] Use of the Carterfone Device in Message Toll Service, 13 F.C.C.2d 420, 13 R.R.2d 597 (1968).

Mass media analysis tends to view telecomputing from the perspective of a publication. Naturally First Amendment rights are important but even more important are issues of monopolization and copyright. From these authors' perspective (Aumente, 1989; Branscomb, 1987; Cambell, 1990; Compaine, 1984; de Miramon, 1990; Dertouzos, 1991; Dick & Greenwood, 1989; Durlak, 1987; Ellis, 1989; McQuail, 1987; McQuail & Siune, 1986; Michael, 1987; Rogers, 1990; Snow, 1986; Tigar, 1984; Weber, 1990), overall market structure and payment systems seemed to be as important as protecting any one individual's rights.

The Band of Thieves

Finally, a fair amount of telecomputing policy can trace its roots to a respectable beginning which was adulterated through irresponsible action. The real explorers of computer technology were the computer hackers -- students of the universities which pioneered the technology (Branscomb, 1990; Denning, 1990). Hacking began as students explored computer technology in the early 60's (Levy, 1984). Seymour Papert, former co-head of MIT's Artificial Language Lab described hackers as creators of the front line of computer science (Brand, 1987, p.56). These early hackers were not criminal or even unethical (for the most part). Hacking activity included original programming and computer development as often as unauthorized system use (Brand, 1987; Denning, 1990; Levy, 1984; Meyer, 1989).

As hacking became more popular and possible, the number of hackers increased but societal forces for ethical behavior decreased (Forester & Morrison, 1990; Kurzban, 1986). Previously hackers were peers that played with the university systems late at night and work with them in daytime (Associated Press, 1991; BloomBecker, 1990; McAfee & Haynes, 1989; Taff, 1991). As the center for hacking

activity moved from the university to the BBS[43], hackers became a loose collection of people that barely knew each other and the invaded systems were even more distant. Hacking techniques were transferred to the general public but not the hackers' ethic.

Some BBS became a harbor and information center for a wide variety of illegal or undesirable activity. These systems caused the definition of "hacking" to change. It now referred to entering computer systems or using software without proper authorization (Dick, 1986). The early to mid-1980s saw an explosive growth of hacker groups. Some BBS promoted themselves with such things as broken software[44] or promises of hacking information. The images were complete with system names such as *Adventurer's Tavern, Midwest Pirates Guild* or *The Cave*[45]

As the unfortunate image of the hacker/thief reached its worst point in the mass media and through online discussions, law enforcement stepped in. The most notable raid against hackers was a Secret Service operation to retrieve a document taken from a Bell South computer. Armed with a ridiculously exaggerated case of electronic theft, the Secret Service raided the homes of a couple dozen geographically dispersed teenagers who called themselves "The Legion of Doom." What was meant to be a landmark case for telecomputing security became a comedy of errors.

Sometime in December of 1988, a member of the Legion broke into a Bell South Computer. While there he downloaded a document on 911 management.. The

[43] "BBS" or electronic bulletin board system is a small scale telecomputing system which offers a variety of services on a relatively small scale, local or limited-interest system.

[44] "Broken software" is legitimate software with copy protection schemes removed without authorization.

[45] The author ***does not*** suggest that any particular BBS is guilty of illegal activity, only that these BBS names are typical of the hacker image.

document served as a trophy and was distributed across the country via BBS. It made its way to a Chicago area BBS and later to the publisher an electronic magazine called *Phrack*. The BBS sysop forwarded the document to AT&T. The publisher published it. Bell South determined that the three-page document's value was $79,449 and hinted that it contained proprietary information which threatened 911 security (Barlow, 1990). After two years of investigation, the Secret Service conducted raid where over forty computers and 22,000 disks were confiscated -- including those that belonged to the publisher and the sysop. Bell South later admitted that they sold the document for less than $20 and that it posed no threat to the company or the 911 system.

Despite the corrupted image of the hacker, telecomputing users did not completely abandon the "hacker" concept. The Legion of Doom/Bell South incident (among others) was used as a rallying point for two disparate groups: 1.) BBS sysops who felt the need to defend their rights as electronic publishers and 2.) hackers of both the old definition of hacking and the new. In quickly formed discussion groups, such as "The Awakened Eye" on *America Online,* and the telecommunications forums on *CompuServe* and *The Well,* this eclectic group began to defend hacking, hackers and the rights of telecomputing systems. Formalized groups such as the Electronic Frontier Foundation and Computer Professionals for Social Responsibility began to provide everything from the discussion of issues to legal defense funds for accused hackers. The resulting discussions represent many points of view but they are almost always in opposition to the image of telecomputing as a business utility. Some in the group defended hacking as a means to insure the free flow of information or a harmless investigation which can benefit invaded systems by exposing faults (Kapor, 1991). Others claim First Amendment protection or privacy consideration for seized BBS (Electronic Frontier Foundation, 1990a; Ellis, 1989; Samuelson, 1991). A final group

support reasonable legislation but warns against criminalizing bad manners or childish exploits (Weingarten, 1986).

Personal Observation

The growth of telecomputing is comparable to the early days of other industries which capitalized on new technologies. As in broadcasting, there is a mixture of corporate investment and amateur experimentation. Telecomputing, like telephones, has been slow in entering the residential market. Matters of telecomputing funding, programming and channels of distribution have not yet been settled, and it is likely that future practices will bear little resemblance to those of today. Somewhere between the visions outlined above, lies a middle ground that will be the market structure of the future. Anticipating that market structure too soon is like removing color from the kaleidoscope. It abandons certain uses in favor of others. But problems are developing and ignoring them is simply not an acceptable solution. The next section will look at threats posed and some of the policy responses to those threats.

Issues in Telecomputing Policy

As telecomputing products enjoy the advantages of more than one technology, they also suffer the disadvantages of more than one technology. For example, if someone used a fax machine to transfer stolen credit card numbers from one place to another, the telephone company would not be held accountable. But if the same list was transferred through a file library of a BBS the system operator (sysop) may be held responsible as a publisher of the list (Branscomb, 1991; Cangialosi, 1989; Electronic Frontier Foundation, 1990a; Johnsom, 1989; Parker, 1989; Rose, 1991). This point is not made to debate the proper level of responsibility (that debate is

paper of its own) but rather to point out that the same activity in different media creates a different level of responsibility for the system owner.

The problem lies in the nature of the products that are created. The images produced by a kaleidoscope are almost indescribable – infinite in their variety and unpredictable in motion. The same can be said for telecomputing products. Telecomputing can already take the form of a publication (teletext[46]), highway (ISDN[47]), file cabinet (database[48]), common carrier (electronic mail[49]), clubhouse (forum[50]) or vault (EFT[51], ATM[52]) (Electronic Frontier Foundation, 1990b). Possible offending uses of these range from slander to terrorism.

How best then to deal with the challenges posed by telecomputing? The product of telecomputing is inherently intangible; online activity lies somewhere between speech and action; and property lines are poorly drawn. In all, telecomputing seems to lie somewhere between previously defined aspects of property, speech, inherent rights and actions. A quick fix is to expand is to expand current notions of rights and laws to cover telecomputing activity (Hearnden, 1989; Parker, 1989; Pujals, 1989) but the practice of trying to extend or adapt existing law to telecomputing would be just successful as trying to describe kaleidoscopic images. The effort is bound to be imprecise and often too late. A reasonable law

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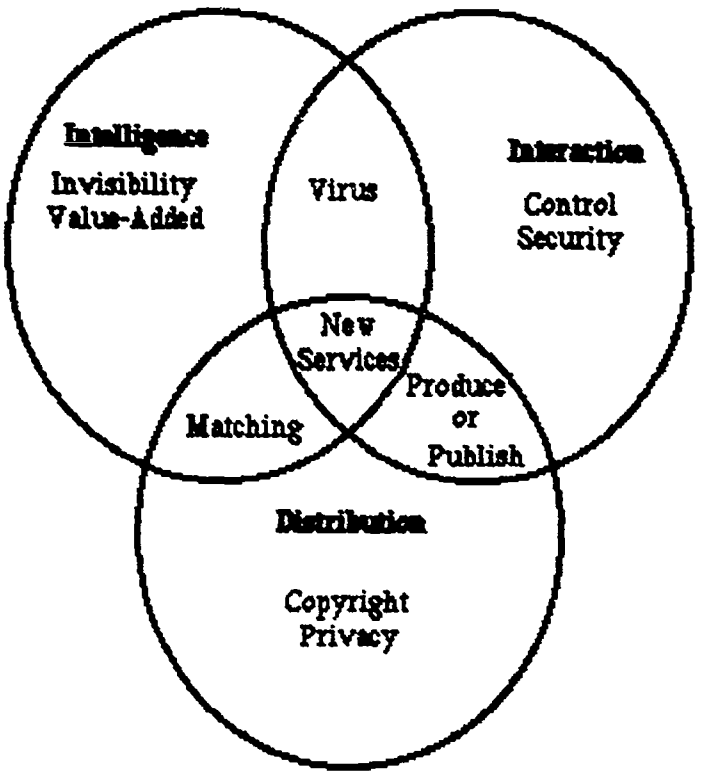
[46] "Teletext" is an information system delivered to homes via a television signal.
[47] "ISDN" or Integrated Services Digital Network is a developing telecommunication standard for the digital transmission of voice, data and video over a common telephone line.
[48] A "database" is a collection of interrelated or independent data items stored together without unnecessary redundancy to serve as an information source or serve applications.
[49] "Electronic mail" is a computer system which stores and forwards messages and computer files from any one system user to another.
[50] A "forum" computer messaging system which exchanges public messages and files between users.
[51] "EFT" or Electronic Funds Transfer is a computer system that processes financial transactions and/or transmits information necessary to complete financial transactions.
[52] "ATM" or Automated Teller Machine is a telecomputing device which allows users to conduct routine bank business without human interaction.

designed to protect a vault becomes unreasonable when it is later applied to a clubhouse or highway.

The purpose of this section is to map telecomputing issues, examine competing interests and cite sources of misunderstanding. It is tempting at this point to attempt to solve all possible problems that may occur through telecomputing but that is the same as solving all of society's problems. Since telecomputing can facilitate a wide variety of activity, it may also be used for all forms offenses and offending activity. If I hit someone with a modem, it is not a telecomputing crime. It is also worthwhile to note that not all unethical or offending behavior is necessarily criminal. Telecomputing policy, as all policy, defines relationships between people. The goal of reasonable policy is to keep those relationships fair not to legislate good manners. So as not to get this paper overbroad, it will limit itself to challenges unique to telecomputing, but to remain reasonable, not all solutions will be legal.

As in the discussion above, there are three dimensions to telecomputing – intelligence, social presence and distribution. Each dimension is a source of controversy (See Figure Two). Like the possibilities, the problems only predominate in one category or another. The following discussion looks at individual dimensions separately for the sake of clarity but eventual policy decisions will have look at all dimensions.

Figure Two
Classes of Telecomputing Offenses



Intelligence

Hard disk space is used by many computer programs on a temporary basis to hold currently needed information. Since it takes time to actually erase disk space, frequently the space is simply marked as available and information is left behind. Old data files are normally treated in the same manner. When the software required to access the telecomputing service *Prodigy* is used, the program claims a certain portion of the subscriber's available hard disk space for its own use. Any information previously stored in that space is still there. As a result, *Prodigy* has access to any information left behind on its subscribers' hard disk – information that subscribers may not wish to divulge (Ziegler, 1991). Even though it is common for software to act in this manner, *Prodigy's* link with distant computers raises the possibility that information could be taken without the subscriber's knowledge. If in the course of this

normal operation, some information was transferred, was there a theft? Was *Prodigy's* software (and thereby the company) exceeding its authority?

If the answers to the questions above were yes, then *Prodigy* may be guilty of breaking federal and state laws.[53] In reality, it is unlikely that *Prodigy* even thought that the programming technique would cause concern and they are not alone in overlooking potential problems.[54] The problem with *Prodigy's* software is a classic problem associated with the trend toward more intelligent telecomputing systems. As systems become more intelligent there are two sources of controversy associated with that growing intelligence: invisibility and use of value-added services.

Invisibility is the ability of a technology to act without a conscious thought process by consumers of the technology. When you walk into a room and turn on the lights, most switches act are set so "up" is "on." You don't have to think about switch so the switch becomes technically invisible.[55] To widen their market appeal, telecomputing products are developing better human interfaces. As the interface improves, more of the systems' actions become invisible to users. If the users were properly informed of the way the software operates, *Prodigy* might not have (even technically) exceeded its authority. Here, the challenge is to make things simpler

[53] *E.g.*, 18 U.S.C. 2511(1)(a); AL 13A-8-100; AZ 13-3004; FL. Stat. Ann. 934.02; IA.Code.Ann. 716A.9.; KY Rev. Stat. 434.840; MN Stat. Ann. 609.91; Ann. MO Stat. 569.099; MS Code Ann. 97-45-1; NVRev. Stat. 205.477; SC 16-16-20; SD 43-43B-1; VI 19.2-61; Rev. Code WA 9A.52.130; WI Stat. Ann. 943.70; and WV Code 61-3C-12.

[54] "Invisibility" does not necessarily mean that you can not see the technology, just that you do not have to give it much thought to use it. For example, an alarm system may be "invisible" to thieves, but if it were equally invisible to authorized users (i.e. police, homeowners), it would not have much value.

[55] The light switch is a defacto standard established by tradition but many telecomputing standards, such as the Hayese compatible modem or ISDN (when established), must be established through market power or "official" policy. The creation of a standard causes problems of its own but is not considered by this author to be problem unique to telecomputing.

for potential users yet to have users understand the extent to which the service is entering their computers.[56]

The second source of controversy is the creation and use of value-added services. Value-added services do not initiate or carry communications but rather create value by adding additional ability to established links (Rosenberg, 1987).[57] This process usually runs into problems when the added value comes from information available via the telecommunication itself.[58] For example, ANI/Caller ID[59] adds value to a standard voice conversation by allowing the receiver to know who is calling prior to receiving the phone call. Value-added services cause problems in the assignment of relative rights to the added value. In the case of Caller ID, two rights are in opposition – the privacy rights of the receiver versus those of the caller (Katz, 1990a). Caller ID changes the relationship between the caller and receiver by giving the receiver the same knowledge that the caller has traditionally possessed – the identity of the person likely to be on the other end of the telephone line.

The intelligence creates a conflict in rights by allowing one person to create or collect information which may have been too difficult previously. Ownership rights in that information determines rights to control resulting interaction and distribution of the information. Arguments over property right to that new

[56] Other services are able gain a surprising amount of access into a subscriber's computer. AppleLink, by Apple Computer, is able to determine the software and hardware configuration of a subscriber's computer. American Online regularly updates software without asking users.

[57] For example, packetnets – low cost long-distance networks for computer-to-computer communication – add value to established phone lines by allowing multiple telecomputing users to share lines and reduce cost.

[58] Added value may also include such things as error detection and correction, network creation and management, or other products which do not necessarily cause a problem.

[59] "ANI" or Automatic Number Identification is similar to caller ID. Both products provide identification of calling party before called party answers the phone.

information are more a matter of defining rights (as in the ANI/Caller ID argument above) than of real monetary value.

Social Presence

> IBM, in an attempt to improve its internal communication system, created a telecomputing system – complete with forums for open discussion. Unfortunately, the forums were used to criticize company policy and its management. Naturally, IBM became dissatisfied and ended these open discussions but not before employees had already created copies of the offending discussions. One nearly complete copy made its way to *The Wall Street Journal* and resulted in an embarrassing news story. (Carroll, 1991)

> Southern Illinois University-Carbondale's (SIU-C) Computer Services Department recycled used computer paper by sending it to local nursery schools and kindergartens for drawing paper. The public relations value of this effort turned sour when children began bringing home their drawings on the back of paper where racist jokes were printed. The offending jokes were blamed on a small group of students who printed the jokes then discarded the paper. (Associated Press, 1989)

The growing ability of telecomputing to facilitate interaction creates some of the most direct clashes for the technology. Since telecomputing results in communication unlike those previously defined, people are able to interact in ways not anticipated. The new communication patterns allow people to have their presence felt in surprising ways. Social presence issues can be divided into two general classes: control of the interaction and security of the interaction.

In the IBM example, the host became unhappy with the actions of its guests and therefore ended the opportunity for interaction – just as a party host who sends guests home. The IBM example adds employer/employee rights to complicate the relationship but there is still the basic problem of controlling the interaction. Other situations are more like SIU-C, where users offend each other or outside people are offended by users. In either case, the sysop is put into a difficult situation. While

these situations are similar to those that occur outside telecomputing, some have tried to impose policies on telecomputing in particular which will correct the perceived problem. In systems where there was a contractual relationship between user and server, some subscribers have sued for breach of contract and to regain access to private messages (Gaffin, 1990). *Prodigy,* which considers itself a family-oriented publication, has imposed a confusing and poorly defined editorial policy on public forum messages.[60]

Not only may online controversies cost telecomputing services subscribers, sysops face a poorly defined level of liability for the actions of users. There have been frequent instances when an entire BBS is confiscated due to the presence of a relatively small number of offensive messages.[61] Anticipating civil cases, authors have compared BBS to a tavern, grocery store and telephone company (Cangialosi, 1989; Johnsom, 1989; Kapor & Godwin, 1991). Since the level of automation (intelligence) varies tremendously across products, the definition of interaction rights may be just as difficult as any in telecomputing because the sysops have different levels of control.

Closely related to issues of control are issues of security. This paper treats separately two issues which are often treated as one – privacy and security. Security is the ability to deny access to interaction, while privacy involves issues where a person is trying to control the *distribution* of information (Katz, 1990b;

[60] *Prodigy's* policy openly discourages online controversy and anything that might offend users or shopping service providers. *Prodigy* reserves all rights to disallow forum messages but seems to enforce its policy inconsistently. For example, the word "bitch" is not allowed in a dog-breeders forum while another *Prodigy* forum specializes in homosexual issue – complete with discussion of sexual practices (Associated Press, 1990). *Prodigy* will not allow messages in a public forums that respond to or mention a particular person and will not allow private messages to service providers that concern anything but business with that provider.

[61] At present, confiscated computers have not led to many resolved cases but reports are increasing. *See* Kapor & Godwin (1991), Levy (1991).

Roger, 1988).[62] Although there is clearly a relationship between these two issues, arguments are weakened when these issues are confused. A person's privacy can be threatened even when their home and property are secure.[63] On the other hand, there is more to system security than matters of privacy.

When a computer virus or worm[64] invades a system, no personal information may be in danger but system users may feel the loss of security. Someone has managed to invade there area and make their unwelcome presence felt. Some people have argued that the responsible hacker can actually help system security by pointing out flaws (Harpers Magazine, 1990; Branscomb, 1991; Denning, 1990). The problem in this line of reasoning is that the cost of improved security is a breach of security by the hacker. The system itself loses value through the intrusion of others. But added security carries some costs itself. For example, a random digit password is more secure than those assigned by users.[65] The system that is more difficult to use (or slower for security reason) will be less valuable to users.

To sum, interaction issues revolve around the need for system control. Without this control the system may become problematic for both the users and the sysop. With too much control, or improper controls, the system becomes at the least inhospitable.

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[62] Privacy will be discussed in the next section

[63] Through the normal course of business – writing a check, buying property, getting married, ect – a person releases private information that they may wish to control. See next section "Distribution" for more information.

[64] "Viruses" and "worms" are self replicating programs that, under a pre-programmed condition, perform a secondary task designed by the program writer. These programs are normally written for their ability to enter computer systems without authorization.

[65] Too often, system users choose poor passwords that are not only easy to remember but also easy to guess. When Robert Morris released his worm program on Internet, it contained a surprisingly short list of password which proved successful in entering most systems. *See* (Spafford, 1989).

Distribution

A friend called me [Craig Neidorf] up and said, "Hey did you know I can get your MCI Friends & Family calling list?" I asked him what he was talking about and he explained by use of a demonstration. He proceeded to three-way us to the 800-[number omitted]. We were greeted by an automatic electronic messaging system:

"Welcome to MCI Friends & Family Circle Update line!"
"Please enter your telephone number beginning with your area code." (He did)
"Thank you."
"One moment please while we access your account."
"To verify your MCI account, Please enter your 5-digit zip code." (He did)
"Congratulations and thank you for being one of our valued friends and family customers."
"Your calling circle consists of 5 members."
"If you would like to inquire about a specific member or nominee to your circle press one (1)."
"To hear the status of each person in your calling circle press two (2)." (He choose 2)
"The following people are active members of your calling circle. You will receive a 20% discount every time you place a call to them.
"Your friend at (XXX)YYY-ZZZZ"
"The person at (XXX)YYY-ZZZZ"
"Your sister at (XXX)YYY-ZZZZ"
"Your mother at (XXX)YYY-ZZZZ"
"Your friend at (XXX)YYY-ZZZZ" (Neidorf, 1991)

Telecomputing creates new opportunities to distribute information but distribution comes at a price. Distribution implies that there is a product to be distributed and very likely that product is owned by someone.[66] The new ability to distribute information challenges current thinking in intellectual property and privacy. Whether it is intellectual policy or personal information, people are claiming convincing property rights in information. The difference between these two groups is the point at which they claim rights to the information. In general, property rights, if they exist, tend to endow the owner with three particular rights: possession, use, and disposition (Epstein, 1990).[67] While the copyright owner tends

[66] In this case, "product" has been carefully chosen and does not imply "service." It is only when a product is available that there is something to distribute.
[67] See also 12 *Oxford English Dictionary* 639 (2d. ed. 1989)

to enforce their rights at the point of disposition, the privacy rights proponent will attempt to regulate the very possession of the information.

In the situation above, while it is necessary for MCI to possess the list of a subscriber's "circle of friends," it is offending to know that others may easily gain possession of the same information. It is not necessary for a person to distribute private information in order that person to feel the breach of privacy. For example, the ECPA controls police possession of information not what they do with information once they receive it. In situations where private information must be distributed (e.g., credit information), laws carefully regulate the possession of inaccurate information.[68]

On the other hand, copyright owners are compensated at the point of distribution so disposition becomes more important than who possesses the product or how it is used. It is assumed that the copyright holder has invested (work, resources, money) in the production of a product. The copyright holder can not profit from their products if they can not control the distribution.

To suggest that a person has a property right in a piece of information is not enough. Different product have different needs. Copyright policy, while it endows certain rights to the creator, encourages the free flow of information by refusing to grant such rights to pure facts and by granting compulsory license in certain situations.[69] Privacy policy generally discourages the distribution of information while giving owners broad rights to update that information.[70]

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[68] *E.g.*, Consumer Credit Reporting Act 15 U.S.C.A. 1681-1681t.

[69] In general works of pure facts represents special problems for copyright protection. *E.g.*, Donald v. Zack Meyer's T.V. Sales and Service, 426 F.2d. 1027, *cert. denied* 400 U.S. 992. *See also* Gorman, Copyright Protection and Representation of Facts, 76 Hard.L.Rev. 1569 (1963). Compulsory license is the right to use copyrighted works in certain situations upon payment of a flat fee. *E.g.*, 17 U.S.C.A. 111, 115, 116, and 118. *See also* [Porter, 1989 *284].

[70] *See* Consumer Credit Reporting Act 15 U.S.C.A. 1681-1681t.

The two policies come into opposition in situations where a product is created from private information. For example, when Lotus began to create a low-cost CD-ROM database of marketing information called *Marketplace* (names, addresses and other personal information), it invested a great deal of money in collecting what it thought was public domain information and putting into a useful form (Levy, 1991). When the general public exerted privacy rights to the information, the product became too expensive. Proponents of the product claimed that Lotus was simply redistributing information that was already available to large corporations while opponents argued that the general availability of the product would result in its misuse.

An Information Age economy will naturally depend on relative rights in information. The cost of possessing information and the right to distribute information will determine, in a large part, the ability to profit from that information. Relative right to information are not as simple as who owns what but also use and distribution right to that information. The added intelligence of telecomputing systems (better ability to create and collect information) combined with new opportunities for interaction (and opportunities to distribute) will create new demands on policymakers to determine distribution rights.

Assessing Telecomputing Policy

Admittedly, the discussion above does not begin to include all of today's telecomputing issues and the future is bound to create even more complex issues. Future polices should be cast in such a way as to achieve their goals without creating undue problems in enforcement and without unnecessarily restricting other services.

The goal is to create a system by which policies can be assessed so that they do not create more problems than they solve. By starting with the nature of the technology, a policy can be assessed systematically. Since each technology has its own level of intelligence, social presence and distribution, resulting policies should be carefully crafted so as not to be overbroad in any of the three dimensions. The following are examples of policies that fail to consider at least one possible dimension.

Intelligence

The New Jersey State Assembly is currently considering a bill that will create a professional level of programmers (Levy, 1992). According to Assembly Bill 4414, "No person shall practice, or present himself [sic] able to practice, software designing unless he [sic] possesses a valid license as a software designer in accordance with the provisions of this act." While it is admirable that the New Jersey Assembly wishes to protect consumers from poorly written software, the bill only considers one type of computer software. The need for this bill may be somewhat justified if you define "software" as highly intelligent processing tools that most consumers are poorly equipped to judge. But if software is given a more broad definition – which may include hypermedia and custom databases – the bill creates a licensing of publishers and writers that can not be tolerated.

Social Presence

When the Secret Service was attempting to collect evidence in the Bell South case (discussed above), they suspected the employee of an Austin-based game writer.[71] Under court order, they confiscated all computers, computer equipment

[71]The game writer was not a computer game writer but did compose on a computer and used a telecomputing system to communicate with business associates and possible buyers.

and supplies of in the game writer's company. Along with any possible evidence, the law enforcement officers seized business records, the work product of the company, a public forum and a private electronic mail system. The current trend in policy relating the seizure of computer equipment favors the seizure of all computers, supplies and peripheral equipment, including all backup copies of the system.[72]

As a tools to commit crime, computers are forfeited in much the same way as the tools of a burglary or the airplane of a drug dealer – both of which may have other legitimate uses. But telecomputing systems are more than simple tools. Because of the added work done by the computer system (filing, publishing, mail services), the seizure of the company's computers are more analogous to seizing the company's building than a tool. Putting aside the First Amendment rights of the publication (the BBS[73]) and the privacy rights of noninvolved people using the public mail system[74], the seizure of all company records is rarely tolerated. The computer is not a tool of crime but rather a location for possible evidence. As such, the computer deserves the care required in any search including, including specification of what should be searched and a requirement that the search me as non-intrusive as possible. The generalized assumption that a computer can be seized overlooks the variety of activities that the computer could be performing.

[72] A computer is certainly "property" and hence theoretically might be subject to seizure if it is forfeitable pursuant to a specific statute authorizing such forfeiture, e.g., the Racketeer Influenced and Corrupt Organizations Act, 18 U.S.C. § 1913. .

[73] There is growing recognition that BBS are a form of press. See, e.g., An Electronic Soapbox: Computer Bulletin Boards and the First Amendment, 39 Fed. Com. L. J. 217, 240 (1988), citing Legi-Tech, Inc. v. Keiper, 766 F.2d 728, 734-36 (2d Cir. 1985).

[74] If electronic communications are maintained on the computer, such as with computers operating electronic bulletin boards, reference must be made to the Electronic Communications Privacy Act, 18 U.S.C. 2701-2711

Distribution

The Electronic Communication Privacy Act[75] protected the privacy of electronic mail much to the same degree as postal mail or telephone conversation. The level of distribution considered worthy of privacy protection is strictly point-to-point communication. While it is reasonable that public comments should not be afforded privacy protection, the Act does not protect the privacy of small, closed groups. In order to have enforceable privacy, these groups must communicate through mailing lists rather than more efficient public forums.

What am I advocating?

It seems logical at this time to call for policy change. But the kind of policy change that I **could** advocate in the space left is exactly the kind of policy change that I am **not** advocating. It has become far too simple to call for quick fixes through laws, rules and corporate policy. What is needed instead is understanding, education and cooperation. More than anything else, understanding and cooperation is needed between industries. Decision makers must actively seek out interested parties beyond their normal circle of consultants. If reasonable policy is going to be created, it must come from active consultation between groups such as the National Association of Regulatory Utility Commissioners, Electronic Fronteir Foundations, Computer Professionals for Social Responsibility, Society for Professional Journalist, Association of Educators in Journalism and Mass Communication, International Communication Association and other industry/user representatives.

The analyst trying to make sense of this developing technology must resist the temptation to over-generalize. Telecomputing is not a single product nor should it

[75] 18 U.S.C. 2510 et seq.

be treated as such. Rather than considering telecomputing products en masse, regulators should concentrate on specific activities and products. But defining a single product is more difficult that it seems. Regulators and analysts must expand there traditional regulatory view to include all dimensions of the telecomputing products. To protect the public welfare without unnecessarily infringing upon the rights of product providers, all interested parties should participate actively and cooperatively in developing meaningful and fair regulatory structures.

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