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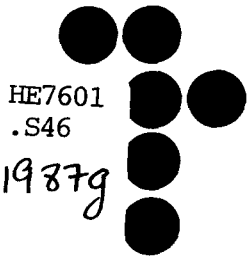

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HUMAN FACTORS IN THE DESIGN OF INTERACTIVE MEDIA

May 7, 1987

Seminar Notes

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Marek Holynski
Center for Advanced Visual Studies, M.I.T.

Elaine Lewis
College of Communication, Boston University

Diana Gagnon
Media Lab/Audience Research Facility, M.I.T.

Gail Kosloff
Rapporteur
MIT

HUMAN FACTORS IN THE DESIGN OF INTERACTIVE MEDIA

Elaine Lewis - College of Communication, Boston University.

Lewis discussed in general terms the work currrently being done in the field of design of interactive media from the perspective of human factors, and more particularly the work being done at the Laboratory for Instructional Technology, Boston University (BU).

The field of human factors, often called ergonomics, is relatively new. Its beginnings, she said, are closely related to work commissioned by the military in the 1940s and 1950s, focussing on people's interaction with technological equipment. Human factors effectively creates a link between a human operator and a machine. She then addressed more specifically human factors related to the design of interactive media - computer based - rather than more common one-way media such as traditional film, video, etc. While human factors in ordinary information media are complex, computer capabilities added to the media mix further complicate the design of interactive media. Lewis categorized three different components of human factors:

- Anthropometric (Physical Capability)
- Sensory (Perceptual System)
- Cognitive (Mental Attributes)

Lewis defined media characteristics as display - screen design, audio, graphics, etc., modality - media use, and interactivity - style of information exchange. She then discussed these media characteristics in terms of the sensory, and cognitive human factors (the anthropometric, she said, would be yet another discussion), using the matrix framework described in Exhibit A. The discussion included work that is being done by different researchers in the various sectors of the matrix.

Color composition & perception - Gerald Murch (Psychologist)
Adaptive graphic interfaces - Marek Holynski
Adaptive input devices for interfaces - Media Lab (MIT)
Audio/natural language prompting - Stewart Card (Xerox)
Psychological software - Ben Schneiderman (Univ. of Maryland)
Cognitive style - Elaine Lewis (BU), Diana Gagnon (MIT)

Lewis then moved on to describe her current work at the BU Laboratory for Instructional Technology (LIT). The LIT, she said, is involved in three different areas of research:

- Menu Studies (Textual, Iconic, Contextual)
- Software Evaluation (Courseware, Public Information)
- Cognitive Style (Taxonomy of Users)

In order to create an understanding of the type of work that was being done, Lewis described two particular studies that she had done in the last few months.

The first study attempted to assess the effects of menu formats in terms of the user's speed, accuracy, and satisfaction while using an interactive program. It investigated the users' response to text and iconic menus while also studying the differences between native and non-native English speakers. The sample had eighty research participants of which fifty were native English speakers while the other thirty were non-native, but fluent, English speakers. The stimuli were two interactive graphic programs that used a touch screen. They were identical except that one used iconic menus while the other used textual menus. The participant had to do six different identification tasks. Exhibit B shows the learning curves for the different groups. As expected, the slowest were the non-native English speakers and the fastest were the native English speakers. Further the text users were faster than the icon users (for all subjects.) As for accuracy, the native English speakers scored better with the textual menus while the non-native English speakers scored better with the iconic menus. Subjects using the iconic version of the program were more likely to say the graphics enhanced the program.

The other group of studies relate to cognitive style dimension and cognitive strategy types. The theoretical framework is represented by the matrix in exhibit C, and the research attempted to study how people use computer systems when they have 'help' options. The study categorized subjects into different cognitive strategy types according to how many times they used help menus and how many mistakes were made. She then showed slides of the test which primarily used text and graphics.

In conclusion, Lewis asserted that they plan to build upon these studies in an effort to understand the different dimensions of cognitive style and to link these with software attributes and different media characteristics.

Marek Holynski - Center for Advanced Visual Studies, M.I.T.

Holynski pointed out that his research is in the area of computer graphics which is now an important component of interactive computer systems. As graphic interactions become more complex the present computer graphics technology for managing this interaction has become increasingly inadequate. Existing computer graphic systems do not provide enough assistance for selecting an appropriate representation of given

data from the large number of all possible representations. They require the user to take full responsibility for object formation and picture composition. The current procedure for picture creation is described in exhibit D.

However, in the future, Holynski envisioned computer packages actively participating in the design process and producing images based on knowledge about image presentation and application domain, user knowledge, and user visual preference. The advantage in such a system, he said, is that it will enable the "layman" to engage in computer graphic design without being a programmer or a graphic artist. Such knowledge based systems are already emerging in labs and will soon be commercially viable. His research, said Holynski, is focused on developing a knowledge based picture composition package - which will take the data, and will perform in the smartest possible way to generate the image that corresponds to this particular set of criteria. Because many researchers try to develop this ability using artificial intelligence (AI), this new emerging field is often called intelligent computer graphics.

He said the development of intelligent graphics systems follows two major directions: First, knowledge based graphics systems that tie the meaning of a picture to its graphic representation; And second, user adaptive computer graphics systems that incorporate the user's personal visual preference into the image generation algorithms.

Under knowledge-based graphics systems Holynski described the systems package used in their experiments. The systems package called the Semantic Network Processing System (SNePS) is not only knowledge based in terms of semantic networks but also does reasoning about the objects, and also allows representation of facts, and rules/user constraints. To display pictures they used GRAFLISP, written entirely in LISP. It is hardware/software independent, uses hierarchical object representation, provides data points and procedural object definitions, and incorporates AI techniques. When linked, the two systems enabled them to enter a knowledge based and rules based on which the whole composition package could function. Once this is done, the system responds to appropriate questions. Holynski showed slides to describe a simple system and its response to questions.

The second area, adaptive graphics interfaces, tells the system to respond in accordance with user preferences or applications. These are called "default display rules" (exhibit E.) However, Holynski stated that often user constraints are not clearly specified, and therefore they have to be developed. This is done by several experiments to determine the relation between pictures and viewer evaluation. Therefore pictures have to be defined/described in a very formal manner using image variables. He said that it took them about three years to develop reasonable

image variables (exhibit F.) He further elaborated on two of the variables - complexity, and regularity, to describe the extremes and width of choice (exhibit G.) However, because the diversity and data were so great they decided instead to use rule acquisition packages. i.e. a package that learns from examples and generates rules from the examples. The package used was "AQ 11", which had been successfully applied for diagnosing soy bean diseases. The basic input data for the rule acquisition package is given in exhibit H. In testing the packages' response, he said, they were surprised at the extent of specificity, and clarity of the results.

The next step was to adjust the system to respond to the preference of a particular viewer by drawing on data that was of interest to him/her. Therefore, the individual's preference was added on top of the earlier described general preference. i.e. "user customized display rules" (exhibit I.) The system was then developed to respond appropriately. The test results showed a significant degree of success with there being a difference between randomly generated images and non-randomly generated images indicating that the system adjusts to the viewer's preference.

Diana Gagnon - Media Laboratory/Audience Research Facility, M.I.T.

Gagnon discussed a range of research projects that her group at the Media Laboratory (MIT) - Audience Research Facility (ARF), were involved in. The ARF's basic research interest centers on the home of the future, and the kind of media that will be present. They are looking at interactivity as possible variable that will be a part of media in the home of the future. Currently there are different interactive media formats, and these, she said, will soon be targetted at home consumers. e.g. interactive toys, CDI, fiber optic services.

While it is not certain which of these media will eventually be successful in the home, there are fundamental questions that could be explored now. e.g. Do consumers want interactive TV in the home? What should it look like? The ARF is involved in a variety of research projects in this area of interactive media studies, some of which involve human factors while others do not:

- Cognitive Interface Studies
- Survey of Active & Passive Media Use
- Prototype Studies :
    - o Interactive Home Shopping

- o Interactive News
- o Interactive Entertainment

Most of the studies, said Gagnon, have a three pronged approach, where they look at characteristics of the media, content, and audience. In the series of studies she described, the media characteristic being explored was interactivity (exhibit J) in relation to a number of content types and user characteristics.

In the first study, people who had a "haptic style of thinking" (i.e. experience as opposed to visual) performed better when exposed to interactive media as opposed to observational media. Another variable related to interactivity was the "locus of control" (internal - feelings and beliefs.) In this study people who had an internal locus of control did better with interactive media. The study also attempted to come up with an interactivity scale, however, the study did not yield any facts and ARF is continuing to work on this.

The second study is still being developed and relates to the modality capability of the individual - how good are they in bringing in information through the ears, eyes, etc. ARF, she said, hopes to run this study during the summer. The third study looks at entertainment - what happens when user control is added. i.e. people's emotional involvement, identification with characters, etc. This study will be conducted in the fall.

The second study looks at the current media user patterns and is clearly described by exhibit K. People use the "passive" end of the spectrum for relaxation and the "active" end for participation. The resultant hypothesis is that people who fall within the active criteria will be more receptive to interactive TV. However, the patterns were not very strong, though there were some relationships. One of the problems was looking at existing media along this scale, since there is no full parallel. Further, people responded differently to different types of interactive control. While viewers liked the idea of being able to control information/news on TV, they were less interested in control over changing the TV program ratings, and even less interested in controlling the action in TV programs. However, Gagnon pointed out that there could be a bias in favor of interactive news because people have seen/experienced some degree of control over news in interactive text or kiosk services whereas interactive entertainment is not as well known/experienced. (i.e. a greater conceptual leap required.)

This problem is being remedied in the current prototype studies where people can experience controlling TV action, etc., in mock focus groups. She said that people seem to universally like interactive news and dislike interactive entertainment.

However, Gagnon asserted, this could be due to the prototype being an already existing TV program where people have got used to non-interactive observation. A way around this problem without having to make new TV programs was to use soap operas giving the viewer the option to interact and select only his/her favorite sub-plot. Still the response, she said, was very negative.

In closing, Gagnon played a brief excerpt from the video of ARF's interactive TV studies which showed viewers' responses to interactive TV news.

EXHIBIT A

	Sensory	Cognitive
Display	composition frequency	menu type
Modality	signal presentation	symbolic representation
Interactivity	input/output devices	cognitive style

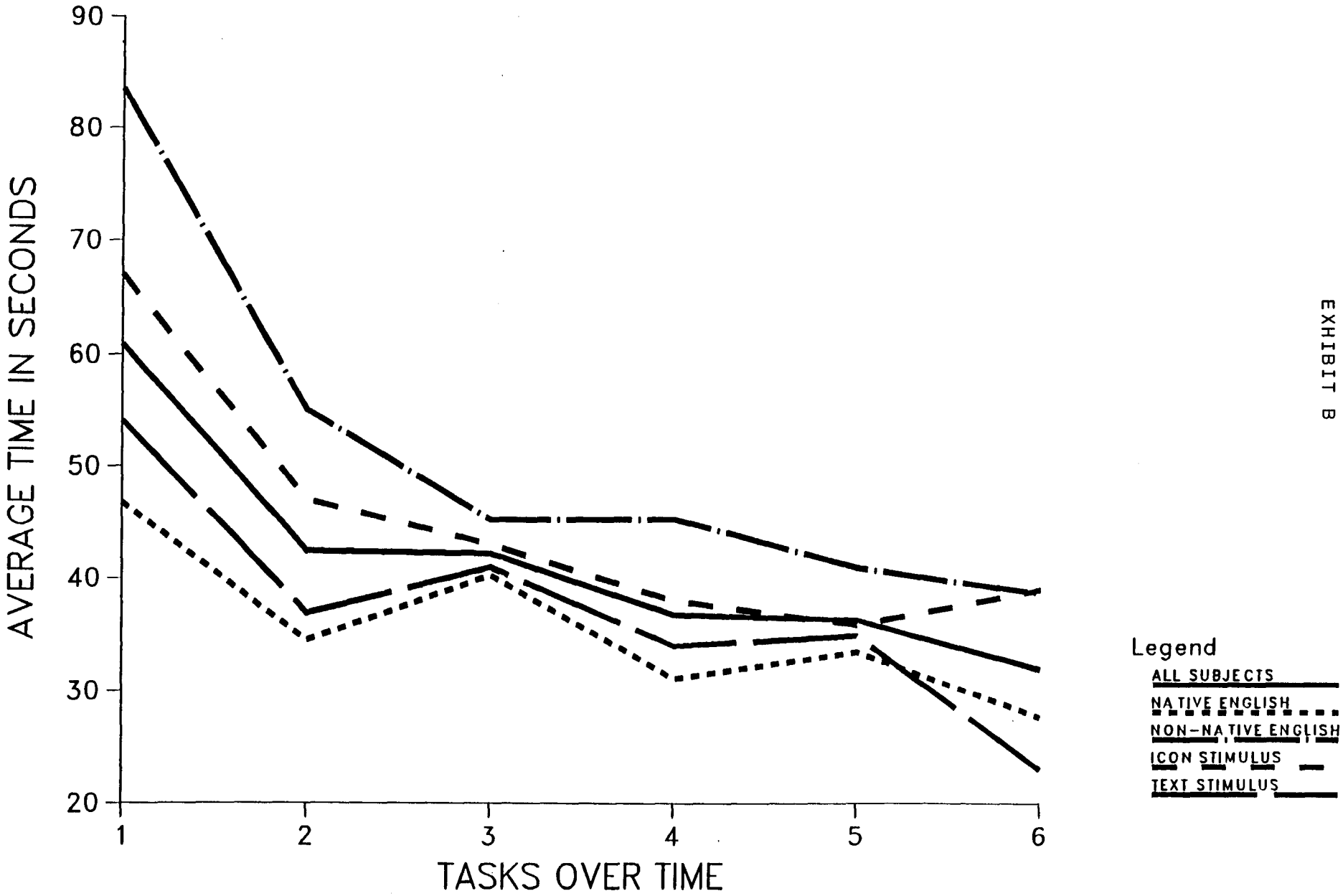

AVERAGE TIME IN SECONDS
90
80
70
60
50
40
30
20
1
2
3
4
5
6
TASKS OVER TIME
Legend
ALL SUBJECTS
NATIVE ENGLISH
NON-NATIVE ENGLISH
ICON STIMULUS
TEXT STIMULUS

EXHIBIT B

Cognitive Style Dimensions and Cognitive Strategy Types

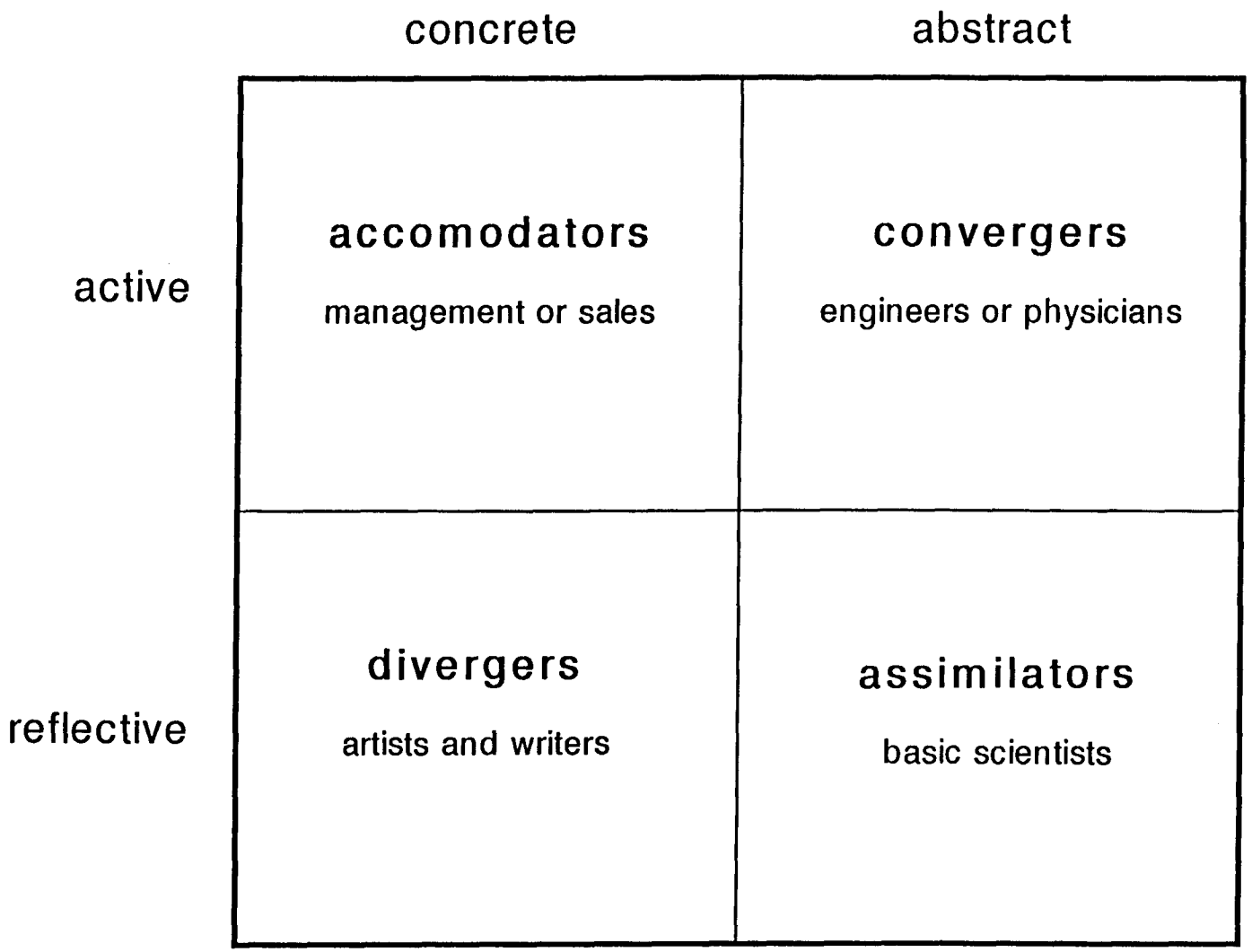


EXHIBIT C

EXHIBIT D

General Structure of Most Graphics Interface Systems

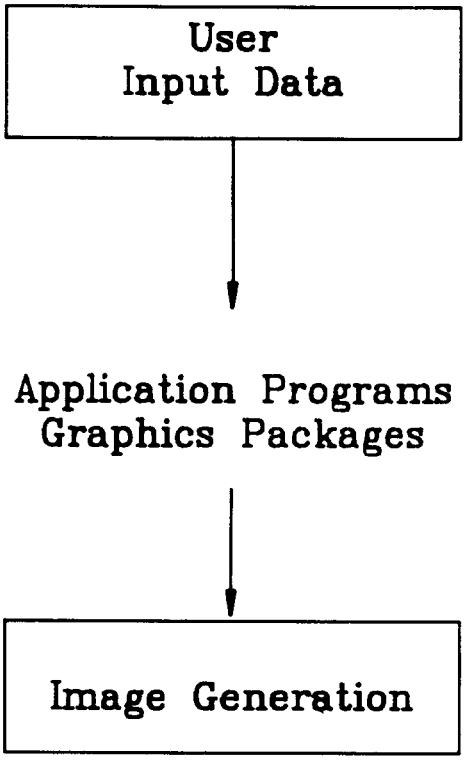


EXHIBIT E

The Adaptive Graphics Analyzer
A Step Closer

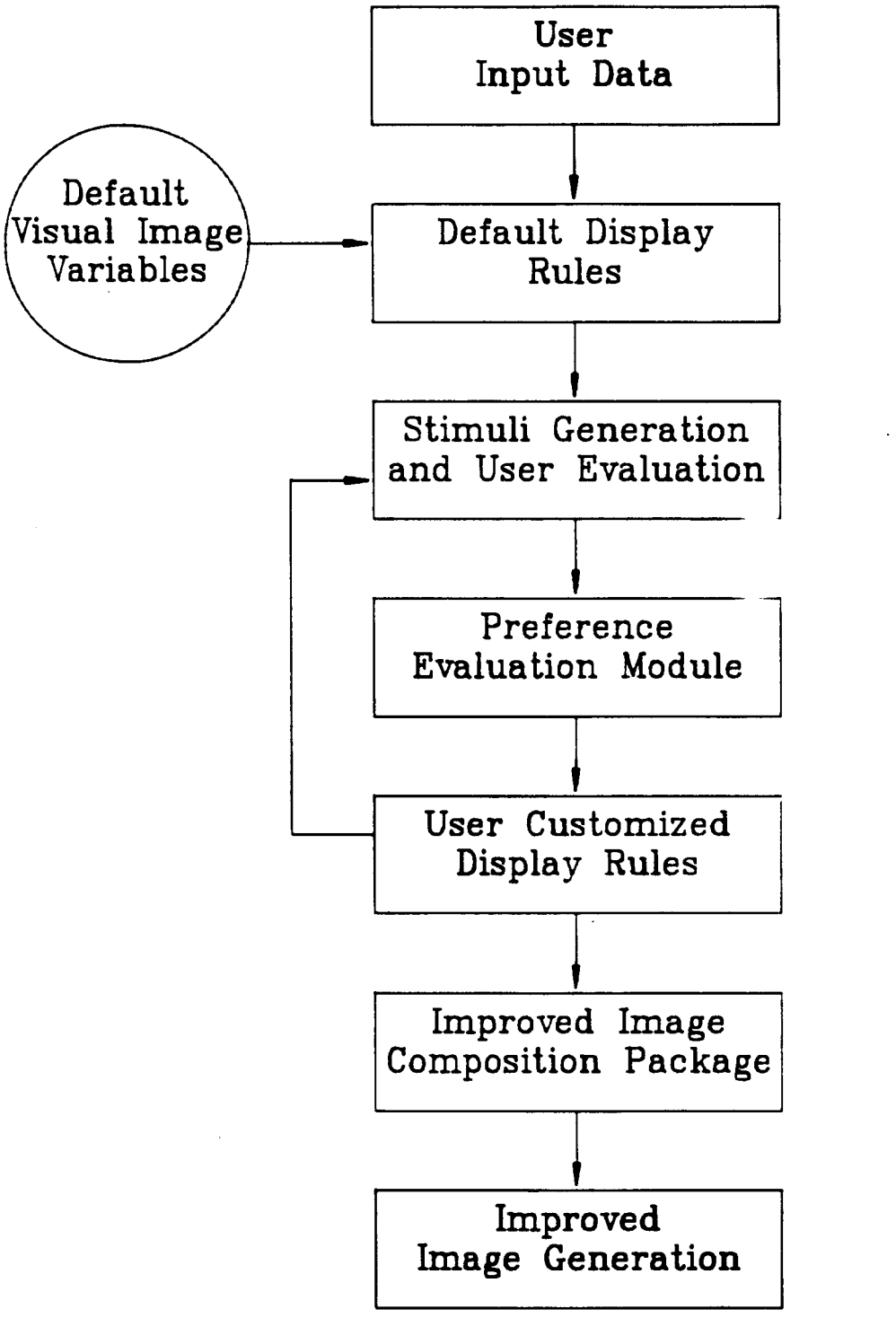


EXHIBIT F

Visual Image Variables

(Expanded Variable Set)

Primitive Element Definition Variables

Local Complexity	**Low, Medium and High**
Local Regularity	**Low, Medium and High**

Quadrant Definition Variables

1.	Busyness	**Low, Medium-low, Medium-high and High**
2.	Complexity	**Low, Medium and High**
3.	Regularity	**Low, Medium and High**
4.	Color Variety	**Low, Medium-low, Medium-high and High**
5.	Shape Variety	**Low, Medium-low, Medium-high and High**
6.	Symmetry	**Low, Medium-low, Medium-high and High**

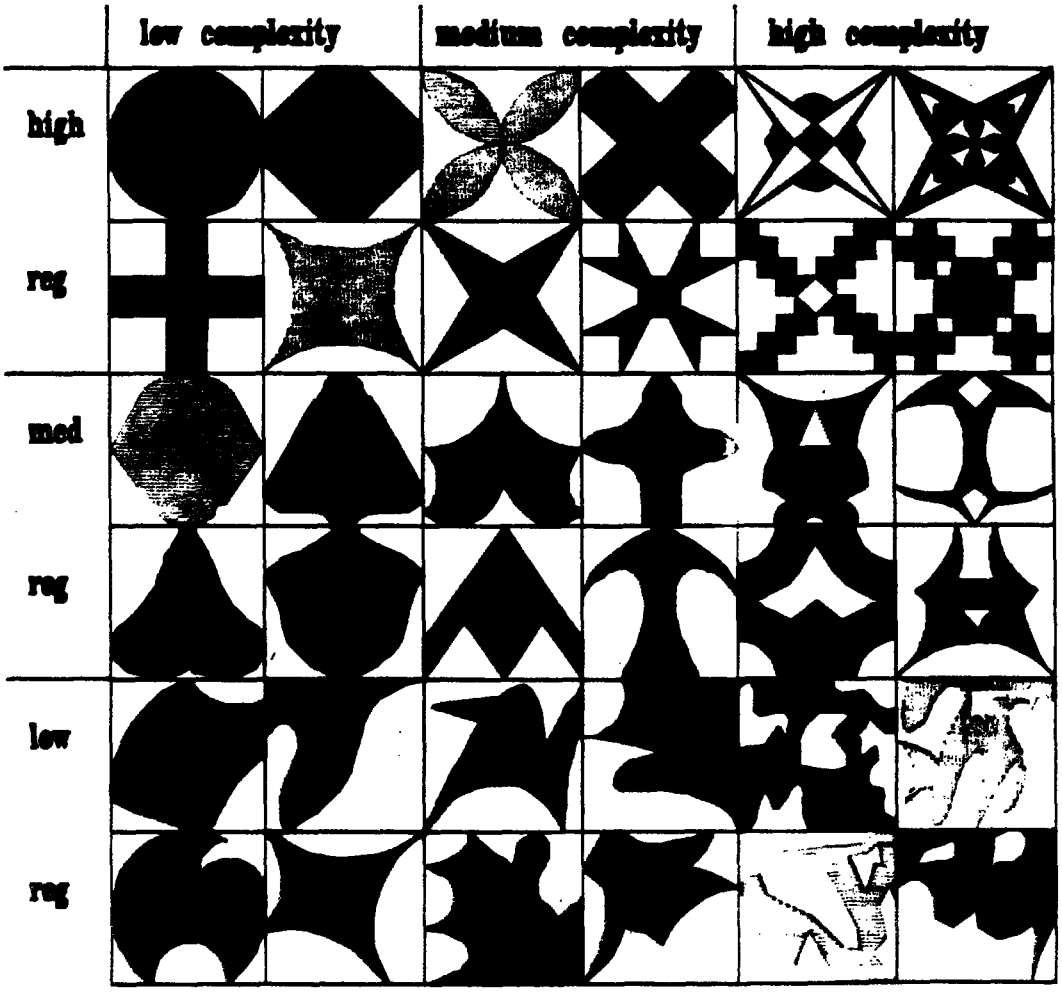
Image Pattern Definition Variables

7.	Balance	**Low, Medium and High**
8.	Grid Size	**Small, Medium and Large**
9.	Colors	**Red, Green, Yellow, Cyan, Magenta, Blue and White**

EXHIBIT G

Visual Image Variables

1. Primitive Element Definition Variables
2. Quadrant Definition Variables
3. Image Pattern Definition Variables



Primitive Element Definition Variables

Local Complexity	Low, Medium and High
Local Regularity	Low, Medium and High

EXHIBIT H

RULE ACQUISITION PACKAGE INPUT DATA :

	Attributes						
	1	2	3	4	5	6	7
Attractiveness							
LOW	m	l	l	m	l	l	w
MEDHIGH	m	l	l	m	l	h	g
HIGH	m	l	h	l	h	h	b
MEDLOW	h	l	m	l	m	l	g
	...						

Attribute code :

1 - balance, 2 - variety, 3 - complexity, 4 - regularity, 5 - symmetry, 6 - busyness (for 1-6 : l = low, m = medium, h = high), 7 - color (w = white, r = red, g = green, b = blue)

EXHIBIT I

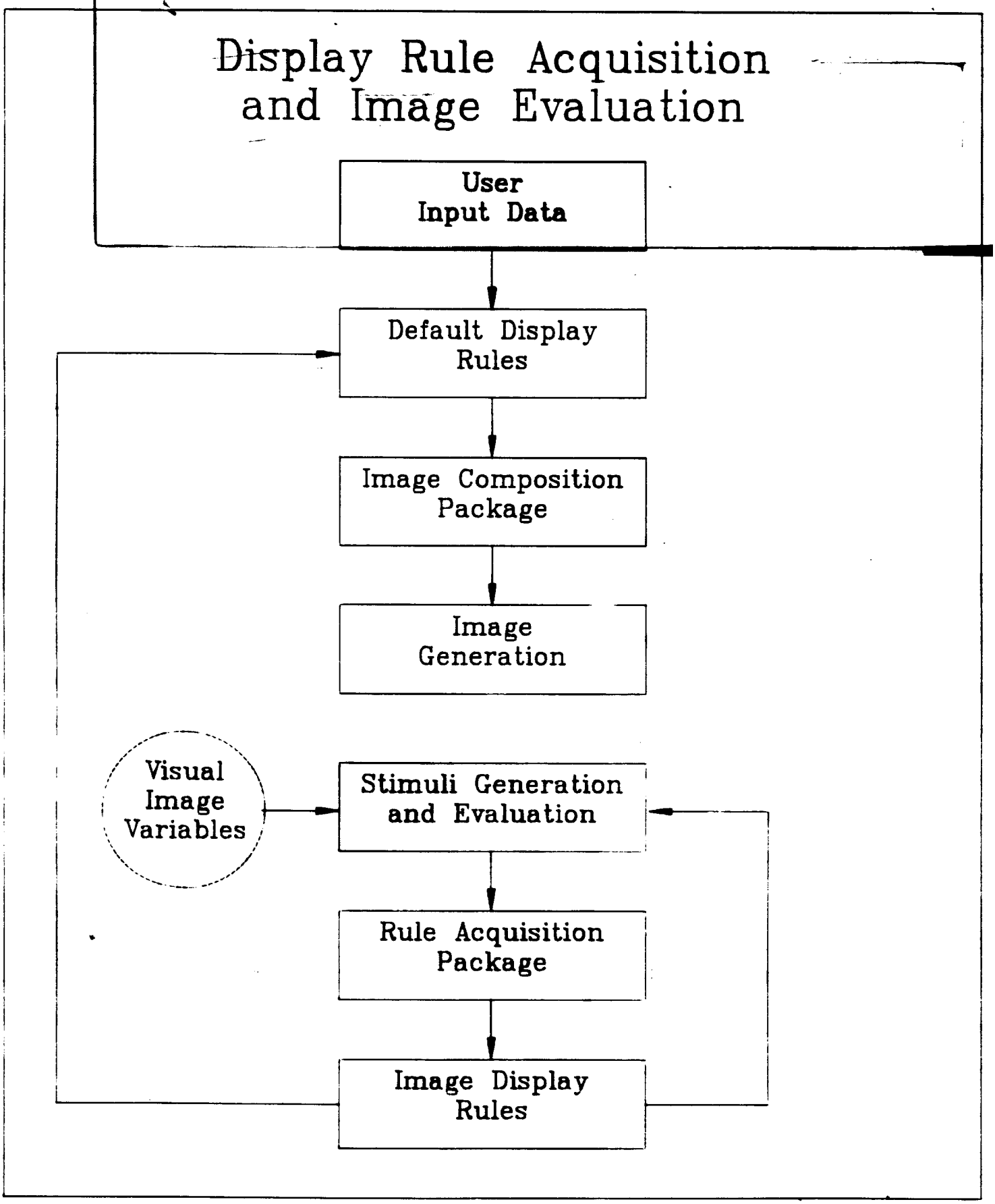

Display Rule Acquisition and Image Evaluation
User Input Data
Default Display Rules
Image Composition Package
Image Generation
Visual Image Variables
Stimuli Generation and Evaluation
Rule Acquisition Package
Image Display Rules

EXHIBIT J

Cognititve Interface Studies

	Media	Content	Audience
Study 1	Interactivity	Spatial Videogame	Haptic style Locus of Control Interactive Scale
Study 2	Interactivity	Information TV News	Modality Prior Knowledge
Study 3	Interactivity	Entertainment	Affective Identification

Active/Passive Media

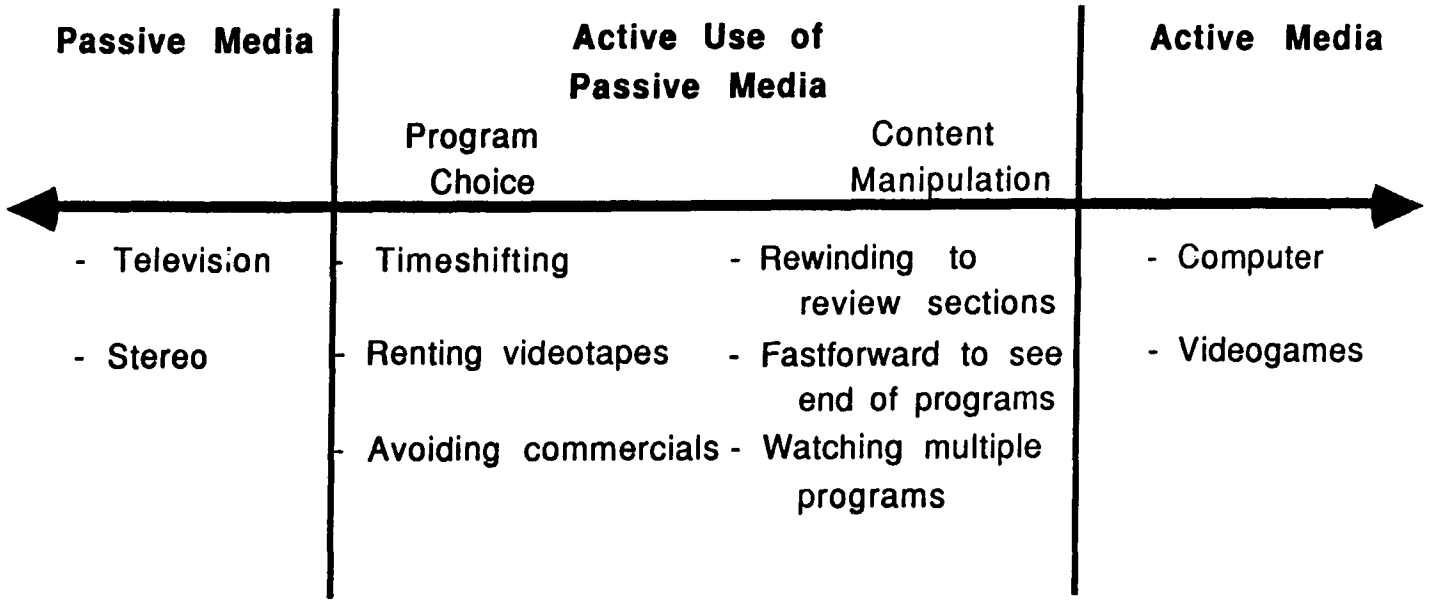


EXHIBIT K