THE ELECTRONIC NOTEBOOK: An Artist's Expert System

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One of the most exciting developments in programming today has been the development of expert systems, or intelligent assistants. For a good description of exactly what an expert system is, I keep in mind this definition, written by Edward Feigenbaum (originator of the first expert system) and Pamela McCorduck in their book, THE FIFTH GENERATION:

> Just what is an expert system? It is a computer program that has built into it the knowledge and capability that will allow it to operate at the expert's level. Expert performance means, for example, the level of performance of MD's doing diagnosis and therapeutics, or PhD's or very experienced people doing engineering, scientific, or managerial tasks. The expert system is a high-level intellectual support for the human expert, which explains its other name, intelligent assistant.

An expert system for instance, accepts input in the form of symptoms of a patient's condition. Then, by comparing the list of symptoms to rules of thumb through an inference system which has been built into its knowledge base by the programmer, it arrives at a diagnosis. Often, such a computerized, intelligent assistant will preface its diagnosis with statements such as, "There is a 75 percent certainty that the patient suffers from..." and then deliver the name of the disease or condition.

Like many people interested in computers and programming, I had been hearing about expert systems for a number of years, and had read about their development in the popular magazines. But because I am an artist, and not an M.D. or an engineer, I felt the field of expert systems was passing me by. What, I wondered, would an intelligent art assistant be like?

I began to think about an intelligent art assistant in the form of an electronic notebook. Like many other artists, I have kept, more or less regularly, a series of notebooks; they are familiar to me and are a part of my working habits. But, the medium of the computer, I felt, would allow me to build a notebook in which I would engineer out the faults I found in the way I used the traditional paper notebook.

The emphasis here is on "the way I used," because, truthfully, what I was trying to do was engineer-out my own shortcomings. It is a fact that human beings can typically hold only three or four things in mind at one time. We are frequently tired or bored or otherwise inattentive. We are forgetful. I wanted my electronic notebook to power me through those low points with which I am beset, and help me on toward the high times of art making.

Here is a list of qualities and capabilities I wanted my electronic notebook to possess:

1)It should remember everything I tell it to. It should check the idea or ideas currently under consideration against all other ideas I have told it to remember, to see if such an idea, or a similar one, has been considered before.

It should deal equally well with verbal or visual ideas. It should store all ideas that I originate, visual or verbal, in ordered collections with as little conscious effort on my part, to order the ideas, as possible.

Besides pointing out repeated ideas, another benefit of such a mindful notebook would be that it recognizes patterns in my thinking that I have, so far, failed to see and bring them to my attention.

2) If two ideas are under consideration at the same time, it should compare those ideas for similarities and differences, and should make

separate lists of these qualities.

3) Under certain circumstances, it should forge a dynamic link between words and images connected with an idea, so if that particular word is under consideration, the image will appear automatically. Yet, it should still be possible to work with words only, or images only when desired.

4) It should be able to synthesize two verbal ideas and/or two visual objects at a time, while having under active consideration 20 different ideas, each idea having from 4 to 7 different elements. This excludes all ideas and images in the ordered collections mentioned above. (These limitations are valid for a Macintosh Plus with one megabyte of memory. A Macintosh with more Random Access Memory (RAM) could contemplate much larger ideas).

5) My electronic notebook should have a search tool allowing independent examination of its active memory and the ordered collections.

6) It should have the ability to automatically generate a program so that the results of the syntheses mentioned above can be repeated without the user going through the entire process, step by step. These programs can then be saved and used in different projects.

Comparing the description of my electronic notebook to that of an expert system, as defined by Feigenbaum and McCorduck at the beginning of this article, a critical difference can be perceived. The difference is that in the traditional expert system, the expertise is contained in the rules of thumb (or inference system) and the knowledge base the programmer builds in the program. In contrast, the rules of thumb in the electronic notebook are replaced by a process of analysis and systhesis, and the knowledge base is the user's own creation. It is, in effect, just like the blank pages of an artist's new notebook.

How would an artist use such an electronic notebook?

To answer this question, a few conventions about the expression of ideas in the electronic notebook need to be defined.

First, each idea needs to have two parts, and each part should be one word long. It is possible to cheat a little, however, and connect words with dashes (-) or underscores for a more complete expression of an idea. Following are three examples of ideas that might be written in the notebook:

(red boat)
(fast plane_with_scalloped_wings)
(yellow taxi-with-black-checkers)

Second, each major statement of a thought should contain from four to seven ideas. In the examples above, each idea is held together by parentheses; in the example below, the major statement of a thought is held together by additional parentheses which group the seven separate ideas:

((ob mickey) (eyes pie_slice) (ears 2-d_circle) (nose ovoid) (gloves 3-fingered_wrist_button) (shorts red_with_buttons_front_&_back) (shoes large_yellow))

In this statement of a thought, seven ideas are expressed concerning a stereotypical cartoon mouse named Mickey. The "ob" in the first idea, (ob mickey), is an abbreviation I use for the word "object."

Finally, though the statement in the electronic notebook may be entered exactly as given above, the program will probably print the statement back in a much different form, such as:

(((((((() ob mickey) eyes pie_slice) ears 2-d_circle) nose ovoid) gloves 3-fingered_wrist_button) shorts red_with_buttons_front_&_back) shoes

large_yellow)

This occurs because during the electronic notebook's ruminations, it tears the statement of thought completely apart in order to analyze it, and then reassembles it in a form more to its liking, enabling it to effect a synthesis and storage later on.

In effect, these conventions for entering ideas, while far from natural English processing, are much like the conventions of poetry, where certain rules of process pertain. This is particularly true of poetic forms such as syllabic poetry, in which the number of syllables per line is of utmost significance. Like these rules of poetic discourse, the simple conventions outlined above force me, as user, to focus and concentrate my thought. The major difference between the poetic process and the electronic notebook is that the images described do not remain in the mind only, but spring to life on the computer terminal screen.

Let us see how this works. After calling up the main processing part of the program, you are prompted:

Please enter the thesis:

and you enter, as shown above:

((ob mickey) (eyes pie_slice) (ears 2-D_circle) (nose ovoid) (gloves 3-fingered_wrist_button) (shorts red_with_buttons_front_&_back) (shoes large_yellow))

The notebook then asks for an opposing idea:

Please enter the antithesis:
((ob minnie) (ears hair_bow) (shoes slippers_with_style) (eyes pie_slice_with_lashes) (skirt plain_or_fancy_always_feminine) (voice amusing_singing) (purse large_usually_present))

and you respond by entering a major statement with seven parts concerning Mickey's stereotypical female cartoon mouse companion as shown.

After searching the ordered collections, the notebook reminds you that you have used this idea before:

```
Previous theses and antitheses:
(((((()))) (() (mickey) minnie) (((((((() ob
mickey) eyes pie_slice) ears 2-d_circle) nose
ovoid) gloves 3-fingered_wrist_button) shorts
red_with_buttons_front_&_back) shoes
large_yellow) (((((((() ob minnie) eyes
pie_slice_with_lashes) ears hair_bow) shoes
slippers_with_style) voice amusing_singing)
purse large_&_usually_present) skirt
plain_or_fancy_always_feminine)
```

But that's all right, if you only want to review your ideas. Without any command from you, the picture of Mickey appears automatically.

Of course, you had to originally draw the picture, but its appearance and subsequent analysis will be done by the electronic notebook. The program asks you if you want to see the image of the opposite idea. When the required input has been given, a picture of Minnie appears.

What would happen if you synthesized Mickey and Minnie and created the Platonic Ideal Mouse, with a combination of both sexes? First, you type:

```
(synthesize thesis antithesis)
```

The electronic notebook responds with this output:

```
The property list synthesis:
(((eyes pie_slice) (ears 2-d_circle) (nose
ovoid) (gloves 3-fingered_wrist_button) (shorts
red_with_buttons_front_&_back) (shoes
large_yellow)) (ears hair_bow) (shoes
slippers_with_style) (eyes
pie_slice_with_lashes) (skirt
plain_or_fancy_always_feminine) (voice
```

amusing_singing) (purse large_usually_present))

In this response, the notebook has made one very large list of all the ideas you entered, except the first of each statement:

(ob mickey)
and
(ob minnie)

The notebook refers to these as properties, small ideas that describe qualities of the overall ideas under consideration. But the notebook is not finished with its analysis. It continues:

Duplicate classes, same or different properties, potential for coincidence: ((((((((((() eyes pie_slice) eyes pie_slice_with_lashes) ears 2-d_circle) ears hair_bow)))) shoes large_yellow) shoes slippers_with_style)

This output is really a RE-ORDERING of the original entry. The notebook is listing ideas that are the same, or the "duplicate classes," in the two major statements you originally entered. For example, Mickey's eyes were described as:

(eyes pie_slice)

and Minnie's eyes were listed as:

(eyes pie_slice_with_lashes)

The classes -- eyes -- are the same, but in this case, the properties -- pie_slice and pie_slice_with_lashes -- are different. The above example demonstrates the kind of synthesis the notebook will make, described by "potential for coincidence," or things that can exist as one in the same time and the same space. This kind of synthesis can be made between (eyes pie_slice) and (eyes pie_slice_with_lashes). As proof of this, the notebook displays only those parts of Mickey and Minnie that are coincident, as described by your two major statements -- the

eyes, the ears, and the shoes, with their slight differences.

This particular image is useful as a check to insure that you have included in your major statements all elements in the two ideas and images being considered that you are especially interested in.

Next, the notebook lists all those properties or ideas that Mickey and Minnie do not have in common, at least as far as your major statements are concerned:

```
Divergent classes for contrast:
((((() nose ovoid) gloves 3-
fingered_wrist_button) shorts
red_with_buttons_front_&_back)
((((() skirt plain_or_fancy_always_feminine)
voice amusing_singing) purse
large_usually_present)
```

Now, the notebook is ready to display the complete synthesis. It has done this by first combining Mickey and Minnie, then translating the abbreviation "ob" into "object," then listing the classes that are duplicates, and concluding with the classes that are contrasting. Then, the synthesized graphic is displayed:

```
Synthesis of object or concept or action:
(((mickey) minnie) (ob object) ((((((((((() eyes
pie_slice) eyes pie_slice_with_lashes) ears 2-
d_circle) ears hair_bow)))) shoes large_yellow)
shoes slippers_with_style) ((((() nose ovoid)
gloves 3-fingered_wrist_button) shorts
red_with_buttons_front_&_back)
((((() skirt plain_or_fancy_always_feminine)
voice amusing_singing) purse
large_usually_present)(#t #t #t #t #t #t)
```

Using the electronic notebook as a tool, you have just made a new object from two objects based on a few shared traits. These two objects, Mickey and Minnie, happen to be very similar. But you can

make new objects from dissimilar ones with shared traits, or even new objects from those having only contrasting characteristics. You can also synthesize actions and ideas.

The electronic notebook described here exists today in the form of a program I have written called The ArtEngine (so named because it is traditional to name the rules of thumb or inferencing portions of expert systems Inference Engines). It will perform all the functions described, plus many more, whose full disclosure demands more space than this brief article allows.