Editorial

Comments on the Acquisition of Knowledge

By Carl Helmers

I am sometimes asked by persons new to the field, "What is the best way to approach the problem of learning enough about computers and their intricacies to allow the neophyte to accomplish useful tasks?" Some thoughts on this subject, with an aside on simplicity and system design, provide the theme for this essay on the philosophy of personal computing usage and experimentation. My point of departure for this thought journey is an old but useful principle adapted to a modern context.

The Principle of Simplicity

There is a famous rule of thumb which is well-known to philosophers, logicians, mathematicians and natural scientists, which might be called the "Principle of Simplicity." The familiar name for this principle is the rule of "Occam's Razor" after a medieval logician (William of Occam) who has become identified with the concept. Paraphrased from the typical undergraduate

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philosophy course, the elements of this principle are:

> *Given multiple, equivalent logical formulations of an argument, that argument is best which is both complete and of the simplest structure.*
>
> *Complete means that the argument takes into account all the necessary details of the point being made.*
>
> *Simplest structure means that the argument in some sense is the most compact or easiest to understand.*

The whole point of this principle is that in order to reduce the complexity of long and involved logical constructions, one should choose paths of explanation which are direct and concise rather than long and convoluted. However, the principle says nothing about the need for complicated logical structures to describe complicated concepts. It merely says that for a given level of complexity the simplest argument, which accounts for all features of the point being made, is the best argument to adopt.

Simplicity and Personal Computing

The design of systems and the programming of computers are activities, like many human activities, which benefit from the application of this principle. If I take the liberty of reformulating the principle of simplicity from an engineering or programming point of view, it might read:

> *That system (program) is best which* accomplishes its goals *with minimum complexity.*

This application of an old principle to a modern context is a desirable design goal for the personal computer, or its attendant programming. But understanding and utilization of such constructs can only be simplified within the limits of the function which is the goal of the design. A complex structure is a complex structure, and ceases to be itself when pieces are removed by a simplification which compromises the goals and functions of the structure. Within any given definition of the functions or goals of a computing system or program, the principle of simplicity is most applicable; but if the overall goal is not simple, the available alternatives

of view) within the new system. It can be used when acquiring knowledge about a new area by the technique of slicing up a complicated subject into manageable units. We see the success of this method as design discipline in numerous ways, ranging from the modular low level hardware function boxes called integrated circuits, to the design of finished product personal systems, to the modular design of systems software, to the applications software an intelligent user designs modularly with an eye towards the problems of managing complexity.

Applying the Principle of Simplicity: A Caution

The owner of the personal computing system can use this principle of simplicity in numerous ways. However, it is not possible to accomplish positive goals with a personal computer by ignoring complexity and demanding some form of "absolute" simplicity which amounts to a lack of awareness of the subject matter.

The computer as a servant to mankind cannot be used to its fullest potential without active thought on the part of an interactive user. A "brain amplifier" is less than maximally useful without

for approaching this goal will necessarily reflect this lack of simplicity.

However, all is not lost. One of the greatest contributions of the past half century of systems engineering is what might be called a principle of local simplicity within a larger (ie: system wide or "global") structure. The goal is still complex, but the details are locally simple. This principle is inherited by today's personal computing designs, as well as much of modern technology from aerospace control systems to robotic manufacturing and process control.

The practical application of the concept of keeping designs and structures as simple as possible, consistent with accomplishment of complex goals, is seen in the idea of modularity as implemented in both hardware and software. It is nearly impossible to keep track of a myriad of details about a large and complicated system. But, if the design is approached from a modular and hierarchical point of view, the principle of simplicity is much more easily and usefully applied on a local basis and reflected in the entire system's conception. Local simplicity is used by the designer to minimize complication by choosing and evaluating the best alternatives at each level (or point

brain activities (thoughts) to "amplify." With an understanding of the idea that most complex problems can be organized and presented by applying the principal of simplicity locally, a knowledge of the organization and design of systems and their use can grow and flourish in each active user's understanding of the technology.

I consider it very important to emphasize the point that the user of a computer is an active participant in the technology, that knowledge of the technology and its potential is essential to its full utilization by individuals. When we publish an article on some subject, it helps in this endeavor by providing a local and specific focus on that subject within the global knowledge of computer science. This is a sort of modularization of some aspect of the technology, with various pointers and references to the more general context of computer science practices as necessary. But each such element assumes an active and intelligent reader not willing to turn off input activities at the scanning of the end mark (■) for an article. There is no simple shortcut to knowledge and understanding; we can only provide aids and pointers to help mark the path.

Practical Philosophy for the Neophyte

The osmosis theory of education, coupled with a bit of inspiration from the principle of simplicity, is perhaps the best method of approaching the unknowns of personal computing systems on the part of the beginner. The osmosis theory may be described as a form of directed Brownian motion (in analogy to a well-known physical phenomenon of random motion). It is a directed activity in the sense that there is a particular goal used to judge the relevance of sources of information. It is a random activity in the sense that prior to acquiring an understanding of the field, there is no hard and fast criterion upon which to judge the order and timing of materials to be read and intellectually digested. In its simplest form, it is to simply plunge into the literature of a field and read every scrap of information which is related to the desired goal of understanding the subject. As new points are encountered with this approach, they are integrated into a personal internal structure of knowledge. The strategy is eminently successful when it covers all levels of detail about a subject through various readings, coupled with reflection and a bit of feedback which helps

eliminate the randomness in the direction of future readings.

In one respect, I write about this osmosis method of acquiring knowledge (and its relationship to the principle of simplicity) with some authority; I know that the method is practical because I've personally applied it to gain my present understanding of computer science, such as it is.

This process of acquiring knowledge about a field is prone to an apt computer science analogy: imagine that the person acquiring the knowledge is analogous to a compiler program, that the source text of the compilation is the literature of the field, and that the object text out of the compiler is an internal understanding of the field. The analogy is illuminating with respect to the problems compilers often have with parsing and detecting subtle semantic nuances of a source language, or the problems of forward references to undefined elements of a program, which are analogous to gaps in the knowledge of a person embarking upon a detailed study of a field.

Learning About Mental Amplifiers

I think it can be safely asserted that the raison d'etre for computing is to amplify one's mental powers by automating various processes which can benefit from the effort. There is, of course, the intoxication with technology's details, which affects us all, and a certain degree of speculation on the experimenter's part as to whether an ultimately useful result will ensue when enough hardware and software development has been accumulated. But the pot of gold which attracts a lot of such speculations in the present era is the idea that computers can become amplifiers for mental functions. When both the mental and physical functions are modeled and automated, the result is a robot, hence one of the reasons for the dual fascination with robots and computers.

Mental powers and mental operations are far from simple. The range of activities to which I can turn my conscious attention is wide and varied; the same applies to every reader. In dealing with a complex subject, mental operations and their assistance through automation, the principle of simplicity is by no means to be forgotten, for it gives a criterion for judgment and discrimination among numerous alternatives at all levels.■