C4B

Comments on the Paper

ON KILLING THE BUGS

by

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The preliminary notes to the above paper invite criticism and citation. I apply my reader's license liberally and include the following comments as well.

Several months ago (DATAMATION, Feb '62) an article was published entitled "How to Make A Computer Appear Intelligent," by Weizenbaum. This was an effort to strip away the veil of mysticism that separates the Carnegie-RAND crew from the real world. The things that are being tried experimentally in our research laboratories were at one time laudable merely due to their divorce from current technology. Cliches are perhaps the best way to describe the laudable nature of these past performances. They were "basic" research, blue-sky, way-out, impractical, etc. In short, the researchers were probing the frontiers of the art and providing foundations for tools which the next generation would place into active use. I submit

that the lead time between research performed and practical application is rapidly decreasing. In some not too rare cases research has actually lagged practical developments in the field.

Before I proceed much further, I must hasten to admit that the purpose of this commentary is basically positive. I submit that the researchers must drive forward more rapidly in the face of an active technology or they will suddenly find that they are historians.

I have in the past lamented the above facts and even moved myself to write gristly memoranda on the subject (RAND IN A CHANGING WORLD, 8/14/62 and Research Can Be Managed, 8/29/62). Furthermore, I have set out to demonstrate that these two memoranda are eminently practical. I cite the Command and Control venture with J.P. Haverty, and my soon to be published "The Scientific Management of a Computer Shop" as examples of directed research which are useful, salable, note-worthy and topical.

To further clarify my comments, I wish to point out that subterfuge, esoteric terminology, and pedantic writing in the third person (which renders text so dull and boring that it is unreadable) are poor substitutes for

profound accomplishment.

Perhaps some examples will serve to drive home my thesis and accelerate the research effort a measure. "Bugs" makes a strong case for adaptability and flexibility. N.Z. would have his readers believe that these are wonderful, profound, human traits universally enjoyed by mankind. Nothing is further from the truth.

In my sojourns into the real world (where schedules, due dates, and unsimplified problems exist) I find a complete spectrum of people. A frequency histogram of this population would have two very apparent lobes on it. One lobe is characterized by the man who is, in every sense, a stupid sub-routine. He takes his instructions, interprets them in the light of his vocabulary and experience, and proceeds to do precisely what he thinks you wish him to do.

True, he has some likes and dislikes, but these are generally subverted to purpose, the same way a trained animal manages, through self-discipline and fear of correction, to concentrate his attention on a specific task. Frequently these people get so enmeshed in their specific task that they lose most of their human faculties and become, for all intents and purposes, a mechanical

device. The secretary whose mind wanders and who knowingly submits letters for signature with obvious typographical errors is such a case.

An employee of mine once worked as a line foreman for Pontiac Motor in Flint, Michigan. The line jammed up one day because a trundle cart had become disconnected from the chain which provided its motive power. When the auto worker responsible for the error was accosted, he replied, "Boss, you tole me to check and see them carts was dogged. You didn't tole me what I should do if they wasn't." Thus, the undogged cart caused the jam, the entire line ground to a halt, and several thousand dollars were wasted.

One can say that industry, or in the famous words of N.Z. the organization caused this basically intelligent, creative, thinking, dynamic, loyal human being to be turned into a robot, but I violently disagree. This man was working to the limit of his mental capacity! True, he may have had latent native ability which, through sympathy, education, and assistance, could have been developed more highly. But the point still remains: this man was a sub-routine.

Freeway traffic is one of my current investigations

and serves as a magnificent laboratory for the proof of my "two classes of thinkers" premise. Many people, through distraction, inability, stupidity, or lack of education allow themselves to be so closely associated with the automobile they are driving that the automobile and its driver can be represented by a very simple transfer function. They are almost as stupid as the trundle cart which could not re-dog itself to the power chain.

There are also the other class of drivers which are creative and adaptive. We find these weaving in traffic (you may question their judgement but not their adaptiveness); studying the town well enough to take and know alternate routes in case of trouble or turmoil; or in many other ways taking minor advantage of their more stupid brethren. In industry we find these two classes exist in great profusion. The duller or less creative increase their value to their organization through adding memory capacity, not ability.

This is typified by the secretary who types, learns to proofread carefully, and finally manages to make travel arrangements properly. All of these tasks are approximately the same intellectual level. She merely has grown to

where she has sufficient memory capacity to hold three sub-routines rather than one.

Furthermore, we find the secretary or clerk who is potentially creative (or perhaps occasionally creative) and finds that she cannot discipline this new-found ability. Therefore, she makes errors in judgement which reduce her value to the organization. Examples of this phenomena are the secretary who changes the wording in a letter or technical document and also changes the meaning since she did not "improve it." Or the secretary who changes a shipping order from Air Express to Best Way since it will save the firm money, not realizing that the time differential involved may overwhelm the saving by several thousand percent.

To conclude this portion of the commentary, one must appreciate that two kinds of people are desirable. We might call these the sub-routine and the adaptive routine. In the real world the balance between these two personnel classes is a very tenuous and important constituent of any productive operation.

I at one time had the "pleasure" of running a crew of prima donnas. It was thought that by gathering together

the best people possible that material would be produced whose quality, quantity, and worth would be disproportionately high. This experiment was an utter failure. Rather than run the crew, I herded it. The net output was approximately zero. We suffered from an interest span approximately equal that of a five year old child. Nobody would leave anything alone. Everything had to be improved. Every improvement led to a new area of investigation. Half-digested work was laid down to come to light again later when the interest and motivation had waned.

To get this crew going again and to get the required output produced, a large portion of the crew had to be changed. The classical balance between the adaptive routines and the sub-routines was restored. This allowed a steady course to be held for a sufficiently long period to implement and complement the ideas of one man. We then altered our tack and pursued a new course.

One might compare this action to N.Z.'s Spider. Each node cried for some attention and, if the attention was not immediately forthcoming, the cries escalated 10 db in noise. The process continued until all of the avail-

able time was spent polling and determining which node had the most urgent need. Before that need could be satisfied, the hue and cry from an adjacent node caused the polling process to be reinitiated.

This is similar to the man who has ten problems and concentrates for 15 milliseconds on each one of them. At the end of a hard and fruitless day finds he solved none of them. Clearly if the periodicity of his polling was increased to some optimum level, the list of outstanding problems would be decreased, the day would be fruitful, and progress could be depended upon.

This latter is very similar to the falacious reasoning brought about by the time sharing adherents which chant the philosophy of the "arbitrary time slice." Clearly this is not only inefficient; it is unnatural. The "natural" time slice would be a better way to schedule (yes, scheduling is what we're talking about) since a task would be continued until it reached a natural breakpoint before the list was interrogated for a higher priority task.

Back to an earlier theme which indicates that the real world and the researchers are not far enough apart.

Some of the current multi-computer load sharing systems are being constructed which will allow two scheduling algorithms. When the load is light, a minimum turnaround time algorithm will be in effect which trades off some excess computer capacity to achieve lessened turnaround time and greater customer satisfaction. When the computing load is high and queues of more than momentary length exist, an alternate scheduling algorithm will be employed which calls for maximum efficiency operation so as to exploit the ultimate capacity of the computer facility. It is interesting to note that under these conditions this too results in lessened turnaround time and greater customer satisfaction!

Several years ago (in 1956, to be exact) I was faced with a gas turbine data reduction program some of whose input data might or might not be present. The variability was due to the unreliability of certain test instrumentation in the test cell. Just because a thermocouple burns in two, we did not wish to shut down the test engine or lose the other results of the test run. The data reduction computer program was constructed so that the input data was edited for missing data and, standard data was dubbed

in so that the thermodynamic equations would still produce meaningful results and not get "hung up." This, I maintain, was an example of the two level organization structure referred to before. The adaptive program recognized the trouble and made selective replacements so that the stupid sub-routines could operate as before.

E.L. Jacks of General Motors Research Laboratory improved this one step further and caused the original editing program to output a bit string where ones indicated that a data field existed and was acceptable. Zeros indicated that a data field was not acceptable or unavailable. Each sub-routine then took this key and compared it against a lock which was unique to the specific sub-routine. If the key fit the lock (the key had at least as many ones as the sub-routine required), the sub-routine would operate. Otherwise, zeros would be inserted in the cells allocated to computed results. Was this not an instance of delegated authority?

The subject of file descriptions is treated in "Bugs" at some length. This particular area is most pungent to my thesis. In 1954 the SPEEDCODE System was made available on the IBM 701. In its later developments the concept of the filed, physical record, logical record, and logical

file were incorporated in the card input statement. This is probably the first instance of a self-describing file. Out of my experience with this system, I designed some self-describing files for a three phase monitor system jointly produced by General Motors and North American in 1956. In 1959, Roy Nutt and I were faced with the problem of file design, description, and specification for the FACT Compiler. An extension of my previous experience came up with the non-redundant file. Our mutual experience brought together a very flexible form of data description at the source language level.

We had one other thought which was original (to us, at least). This was to place the file design on the front of the file so that the files were self-describing and could be manipulated by a generalized program. We discarded this latter idea due to the press of time although we felt then that it was an excellent scheme. Later I found that Jerry Peterka of SDC had, in 1959, implemented such a scheme and called it VIOC. Unfortunately the scheme never got into general use at SDC and has not yet won major acceptance. The work done by the FACT crew has since been adopted and extended by the COBOL implementers and

is now running in many computer shops all over the United States. It seems that some of this work, done by line programmers in the performance of their task, is worth study by our researchers of today.

In closing, a comment must be made on Aldeberans. Several years ago, some associates of Tom Cheatham developed a scheme called the "task list drive" for use in allocating storage and firing routines as a function of the input data. It was published in the Communications October '61. Again, this work was done by practicing professional programmers in the performance of their day-to-day activities. It appears that its external behavior could be described (if esoteric descriptions are desirable) by page 35 of "Bugs."