

PHILOSOPHY IGNORED: THE ACHILLES HEEL OF THE SOFTWARE INDUSTRY

John N. Warfield
George Mason University
The Institute for Information Technology
Fairfax, Virginia 22030

The computer software industry has foisted upon its clients and sponsors an incredible cost burden, along with a set of products whose characteristics include built in "bugs". This industry also has insisted that software maintenance has to include changes in software, but has provided little guidance to the customers as to how to help assure that such maintenance does not degrade the quality of the software. It is ironic that this situation persists in the face of an analogy in the automobile industry, where the USA almost lost a whole industry due to deliberate rejection of readily available knowledge about how to control quality in design and manufacturing operations.

While much has been published by people in the computer field, this field is probably most notable for ignoring everything philosophers of science have had to say about how to do things right. Thus one can point directly to statements by philosophers which, if taken seriously, would help lead the way out of the current dilemma.

F. S. C. NORTHRUP'S PHILOSOPHY

In 1947, F. S. C. Northrup of the Department of Philosophy of Yale University published a book titled Logic of the Sciences and the Humanities. In this book, he reviewed and correlated the thought of various philosophers of science with his own, and made a number of relatively concise statements that are applicable to today's computer software industry. Appendix I lists 14 quotations from Northrup's book which form most of the basis for the diagnosis of the computer software^{industry} that follows.

THE STATE OF THE SOFTWARE SCIENCE

Software science, which could furnish a sound basis for analyzing and correcting most or all of the difficulties facing the software industry today, is almost non-existent.

Partly because of the youth of the computer field, partly because of the shortage of highly-trained researchers, and partly because there is so much short-term economic incentive to assign people to jobs that relate to immediate product, there has not been developed a proper software science.

Northrup's philosophy explains how the development of such a science would have to pass through three stages. At the present time, computer science or software science is in the middle of the second stage of Northrup's process of development of a science. In this stage, people are dealing always with results of direct observations, and have not formulated the concepts that are required to construct a theory.

As a result, it is not possible to draw on such a theory for a number of potential benefits that are found in more mature disciplines, such as:

- Rendering precise meaning to terms that are important in practice, such meaning coming about from the differentiation of terms that takes place in the third stage of theory development
- Allowing precise definition of experiments that can be carried out (a) initially to demonstrate that the theory is correct and (b) to define new experiments that add to our understanding and ability to make good decisions
- Integrate disconnected contributions coming from scientists whose work has never advanced to the third stage, but instead furnishes useful second stage fragmentary results that provide insights and tests to be applied in the third stage

There is every reason to believe that the industry will suffer indefinitely into the future, until such time as a full theory is available. Such a theory will not be developed until some sponsor shows a willingness to leave the intellectual wasteland that presently characterizes the software theory area, and accepts the importance of millenia of collected scientific thought as being applicable to the computer software area. When and if such a sponsor is found, we will be

permitted to do the necessary conceptualization. Moreover, we will not have to work in a vacuum of methodology, because the necessary methodology for doing the third stage is already available from other fields, who have not suffered the same delaying factors as the computer software industry.

We can now specify precisely how to go about developing such a third-stage theory, based on Three Laws of Design and the method of Options Field/Options Profile development. These Laws and methods have worked in many other fields, but have been ignored by the software establishment. This establishment will continue to ignore these facilitating ideas and methods, as long as large sponsors and clients continue to reward them for the kind of ad hoc performance they have been allowed to perpetuate to this point in time.

But in order for this development to proceed, we cannot start out in a conceptual strait-jacket provided by a potential sponsor. The very terminology that a sponsor might choose may involve so much baggage stemming from accepted elements of the present unsatisfactory theory as to render development of a solution impossible. Instead, the sponsor must be willing to suspend judgment concerning any of the established dogma, and go back to what has served science well for many decades--methods that have been proved, and which cannot be amended or constrained arbitrarily by ideas coming out of a domain where failure to exercise sound practice is commonplace.

QUOTES FROM NORTHRUP

1. "'Inquiry', writes John Dewey in his Logic: The Theory of Inquiry, ' is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole'."
2. "Since inquiry begins with a problematic situation, one must first observe the determinate facts in this problematic situation and allow these facts, together with the indeterminate uncertainties of the situation, to suggest hypotheses respecting the possible resolution of its problematic character, these hypotheses in turn to be pursued to their deductive consequences and thereby checked operationally."
3. [In trying to look at the various expert prescriptions for how to proceed] ...must one arbitrarily choose between these different authorities? Or is there something in the nature of any inquiry at its initial stage which designates one of these authorities rather than the other to be right?"

"We can begin the attempt to answer these questions by asking why all agree on the negative procedure of being skeptical with respect to traditional beliefs. Why should this rule be followed? May not the traditional beliefs be correct? Why should one reject them thus a priori ^{without} ~~that~~ any chance of a hearing?"

"The answer is clear. One must reject them because there is a problem. There would be no problem were the traditional beliefs adequate. It is precisely because there is a problem and because inquiry does not arise or become inescapable unless there is a problem. And the presence of a problem means that traditional answers are inadequate or at the very least that their adequacy is in question. To take them for granted when their very adequacy is at issue would be to beg the question."

"This does not mean that the traditional belief may not turn out to be the scientifically correct one. But if this correctness has once been questioned, and this is what constitutes the problem which starts the inquiry, then the only way in which the traditional belief can save itself is by first losing itself. One must go back behind the traditional belief which is the answer to some problem to the problem for which it is the answer. This is the justification for the negative rule that at the

initiation of inquiry one must question every traditional belief.

4. "John Dewey has the correct answer to our question concerning the positive method to be used in initiating inquiry. His prescription is correct because it affirms a tautology, the tautology, namely, that one must begin inquiry with what one has at the beginning, namely, the problem. It is the problem and its characteristics as revealed by analysis which guides one first to the relevant facts and then, once the relevant facts are known, to the relevant hypotheses."
5. "The rule governing the first stage of inquiry may be stated as follows:
The problematic situation must be reduced to the relevant factual situation."
6. "Pure fact is much less than most people, including even many scientists, suppose it to be....To confuse pure fact with pure fact plus inferred knowledge is a serious error....Pure fact may be defined as that which is known by immediate apprehension alone."
7. [Once we have determined the facts inherent in the situation, we are ready for the second stage of inquiry] As a rule, [the second stage] "involves not one method but three; namely, the method of observation, the method of description, and the method of classification."

"The second stage of inquiry begins with immediately apprehended fact and ends with described fact...Only fact in the former sense is fact independent of all concepts and theory. Described fact is fact brought under concepts and to this extent theory. Furthermore, described fact is not a mere aggregate of atomic data. One inspects relations as well as sense data. Consequently described fact takes on the form of propositions. Propositions are expressions of which it is significant to say that they are true or false. The importance of propositions is that they possess formal properties and thereby provide the type of material to which the formal methods of formal logic and mathematical calculation can be applied."
8. "In fact, if one proceeds immediately to the deductively formulated type of scientific theory which is appropriate to the third stage of inquiry, before one has passed through the natural history type of science... appropriate to the second stage, the result inevitably is immature, half-baked, dogmatic and for the most part worthless theory."

9. [In the third stage of inquiry, we depart from strict observation and introduce into the developing theory concepts that are arrived at by postulation.] "They derive their meaning from and refer to entities and relations which are known to exist by means of postulation rather than by immediate apprehension. [This requires, for validation, that such concepts] "involve the construction of a deductively formulated system. The basic assumptions or postulates of this system designate unambiguously what is proposed to exist. To this proposal or hypothesis, formal logic is then applied to deduce theorems or consequences. Among these consequences one seeks for certain theorems which define experiments that can be performed...If in all instances the experiment gives the result called for by the theorems, then the hypothesis is said to be confirmed and the entities and relations designated by it are said to exist. If the experimental result is negative, the hypothesis or postulate set is known to be false and some alternative hypothesis suggested by the data of the second stage of inquiry, is put in its place and subjected to the same procedure."
10. "We are now in a position to provide a definition of the concepts by postulation which enter at this third stage of inquiry. A concept by postulation is one the meaning of which in whole or part is designated by the postulates of some specific deductively formulated theory in which it occurs."
11. "...a scientifically significant operation is one in which the theoretical concept defines the operation, rather than one in which the...given operation defines the scientific concept...If one surreptitiously smuggles words into the deductive theory which have only an intuitively or empirically given meaning and no postulationally prescribed meaning...the theory never works."
12. "It is the theoretically designated concept, not the empirically given operation which designates objectivity in science. Empirically given operations become a criterion of objectivity in science only by way of the epistemic correlations which join them to the objective entities and relations designated by concepts by postulation."
13. "Nothing will exhibit the weakness of a given theory more quickly than a relentless generalization of it for all possible evidence."

14. "One of the major difficulties which confront any scientist when he first constructs a deductively formulated theory for the natural history data of a fresh subject matter is to give postulational meanings for every one of the concepts in his deductive theory. ...Until one has carefully distinguished concepts by postulation from concepts by intuition and noted that one can never make up for the absence of concepts by postulation as correlates for all one's intuitively given data by substituting the attendant concepts by intuition--until one recognizes this, one's attempts at deductively formulated theories strike an impasse, the cause of which one does not understand."

"This means that a deductively formulated scientific theory must be constructed quite independently of one's operational definitions. Every concept must be postulationally prescribed as to its meaning, with all other concepts in the theorems derived from the primitive ones in the postulates by the method of definition."

"...It is the independence of the concepts by postulation from the operational definitions of which they are the epistemic correlates which permits the theoretical scientist, by means of his concepts by postulation, to designate novel and previously undreamed of operations and experiments."