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# THE EMERGING ROLE OF ENGINEERING PSYCHOLOGY

*JULIEN M. CHRISTENSEN, PhD*

## FOREWORD

The report was prepared by Julien M. Christensen, PhD, Chief, Human Engineering Division, Behavioral Sciences Laboratory of the Aerospace Medical Research Laboratories under Project No. 7184, "Human Performance in Advanced Systems." The material was used by the author as his 1963 presidential address for the Society of Engineering Psychologists —— a division of the American Psychological Association.

This technical report has been reviewed and is approved.

WALTER F. GRETHER
Technical Director
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## ABSTRACT

The history of engineering psychology and its relationship to engineering are briefly traced. The emergence of engineering psychology from the "knobs and dials" stage to a full-fledged participating profession in systems planning and development is described. Some of the problems confronting engineering psychology are described, the chief of which is the development of suitable educational programs in a sufficient number of universities to supply the current and anticipated demand for workers in this area.

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# THE EMERGING ROLE OF ENGINEERING PSYCHOLOGY

Julien M. Christensen

## INTRODUCTION

In these days of rapid technological and social changes we look for a maturity in our teenagers that was not expected even a generation ago. Engineering psychology is now in its late "teens" and, in my opinion, is facing problems rather forbidding for a profession so young.

What is the nature of this teenager, engineering psychology? Fitts says it " ... seeks to understand how human performance is related to task variables [especially engineering design variables] and to formulate theory and principles of human performance that can be applied to the <u>design</u> (my underline) of human tasks, human-operated equipment, and man-machine systems (ref. 8)." Later, in the same paper, Fitts reminds us that the engineering psychologist " ... is also interested in parameters that influence the relations between task variables and performance, such as individual differences, motivation, and level of training." In this dawning of the era of automation, I know that Professor Fitts includes also the social consequences of design as an area in which the engineering psychologist shares responsibility with many other professional people.

I would now like to formulate several points. First, unless research results can be expressed in engineering terms, and thus can affect design, the results do not contribute, at least directly, to engineering psychology. Second, engineering psychology is different from experimental psychology in several critical respects. (Fitts (ref. 8) has covered this topic very well and I will not dwell on it here.) Third, engineering psychologists do research and they serve as staff advisers and consultants to design engineers. Fourth, engineering psychologists do occasionally engage in design work themselves. Years ago Frank Taylor termed such engineering psychologists "human engineering technologists." He said that they contribute to systems development at three levels. To quote him, "At the simplest, he designs individual displays, controls, or display-control relationships. At a somewhat more complex level, the human engineering technologist contributes to the design of consoles and instruments panels. At the highest level of complexity, he assists in structuring large systems composed of many mechanical elements and frequently several human beings. In this capacity he helps to determine what information must flow through the system, how it must be processed, how many men are required, what tasks they will perform, and what type of information each one will need. In short, the engineering psychologist helps at this level to determine the configuration of the system (ref. 11)." I really am not too concerned as to what terms are applied as long as we understand that some engineering psychologists have, and others could, make excellent systems planners and designers. I am not willing to accept the design of dials, the design of consoles, and the offering of assistance in structuring larger systems as the ultimate to which a competent engineering psychologist can aspire. I can see no more reason, for example, for keeping an otherwise qualified engineering psychologist out of the business of systems planning, design, and management than I can see in keeping a physician out of the business of designing a steel shaft to replace a broken bone. I do think that sometimes we have become so engrossed in irrelevant theories, unnecessarily fancy experimental designs, filling out forms demanded by certain specifications, etc., that we dilute our effectiveness as engineering psychologists and, consequently, debase our profession. Finally, I feel that generally our universities are failing to prepare engineering psychologists who are capable of providing the kinds of information and services that the design, development, and testing of modern systems require.

## SOME POINTS FROM THE HISTORY OF ENGINEERING AND PSYCHOLOGY

I think it not irrelevant to look for a moment at the history of the chief profession that we support and with which we work; namely, engineering. Just as Boring (ref. 2) reminded us that history can be revised ("As time goes on, there come to be second thoughts about the interpretation of it.") so I remind you that this interpretation you are hearing today is a reflection of the distinctive, perhaps idiosyncratic, interaction between certain facts and me. Another psychologist, and almost certainly any engineer, might interpret them differently.

First, we had better define "engineering." Fitts (ref. 8) reported that as early as 1828 the Institute for Civil Engineering of London considered the practice of their profession as more than the strict application of physical sciences. They defined engineering as "The art of directing the great sources of power in nature to the use and convenience of man." It is of more than incidental interest that they too recognized engineering, in part, as an art — the "gut-feeling" of 1828! One hundred and thirty years later the Institute of Industrial Engineering (ref. 12) stated "Philosophically, he [ the industrial engineer] is devoted to the ideal of helping the nation to use most effectively its physical facilities and human talents for production of goods and services." This is a recasting of the 1828 definition.

It explicitly includes human talents. Perhaps we can all agree that no design engineer should assume the title "systems engineer" or "systems manager" unless he is sensitive to and capable of handling those subsystem and system interactions that involve the organic as well as the inorganic. This nation has thousands of splendid design engineers; there is a critical shortage of systems engineers.

The above definition would appear to include the design and utilization of tools as an enterprise that legitimately falls within the purview of engineering. This being so, we can trace engineering back to earliest man, or (depending upon the particular archeological or anthropological authority to whom you subscribe) even to the man-apes. Australopithecus Prometheus, for example, used pebble tools, employed thigh bones as weapons, and used scoops made from antelope cannon bones. It is interesting to reflect on the possibility that osteodontokeratic tools probably were concurrent with, or may even have preceded, stone implements. Dart (ref. 6) stated, "I am convinced that long before he knew how to fashion weapons and tools from stone, man had discovered another and livelier material for his primitive skill." Thus, we might conclude that engineering and the human factors components thereof, as reflected in the design and use of the first tools, actually determine the dating of the origin of man. This, incidentally, is the position that is subscribed to by many anthropologists; they have despaired of defining meaningful anatomical distinctions and refer instead to cultural achievements.

Aside from serving as a possible source for dignifying engineering and our profession by anointment with antiquity, what possible lesson can be learned from the events of nearly 1,000,000 years ago? I submit that pebble tools and scoops made from antelope bone were specific, intelligent reactions to interactions with the environment and that current principles are no more than that—response to interactions among and between organic and inorganic—responses that have become, as compared with the bone scoop, unbelievably and fascinatingly complex.

I now blithely skip forward a few log units in time (actually almost a million years) in order to consider the impact of the industrial revolution in te ms of interactions and man's response to them. (This neglect of hundreds of thousands of years may be justified when one considers the relatively slow rate of development during the "Age of Tools." The causes for this need not concern us here.) I will rely heavily on a previous report of mine for this information (ref. 5).

## Phase I - The Age of Machines

The first phase of the industrial revolution, which covered a period of approximately 120 years (1750 to 1870), witnessed the emergence from the Age of Tools to the Age of Machines. This period was characterized by brilliant invention in the textile industry and the application of steam power to the operation of machines. In this period Jacquard used punched card techniques (1801) as a programming aid with weaving equipment and Watt designed a self-regulating governor for his steam engine—the beginning of automation and Cybernetics! Engineering, although crude and unrecognized formally, was attempting to relieve the muscles of mankind. The word "psychology" was not even invented, although this should not engender dismay. There were people, as we have seen, who met the fundamental criteria of "engineer" long before there was such a profession.

## Phase II - The Power Revolution

The second phase of the industrial revolution has often been called the "power revolution." This period encompassed the years 1870 to 1945, and was characterized by fantastic developments and increased efficiency in transportation, communications and agriculture. Human factors pioneers from the disciplines of engineering and psychology made their first formally recognized contributions of a psychological nature and one calls to mind such names as Taylor, the Gilbreths, Muensterberg, Binet, and others. Although the primary emphasis was on the adjustment of man to his work by utilization of the techniques of selection, classification, and training, we would be something less than candid if we did not recognize that Taylor and the Gilbreths made certain contributions that now would be considered applications of engineering psychology.

By 1945 engineering psychology had been formally recognized. Thus, it might be well to pause and briefly to summarize its nature at that time. This was our "knobs and dials" era, and those of us who were part of it occasionally view it with nostalgia. In retrospect it may seem to some an era of simplicity; at the time, however, it seemed to be an era of pioneering that required all the insight and mental resources that could be mustered. The major emphasis of behavioral scientists through World War II had been on selection and classification tests and training procedures, or adapting man to job. The few isolated investigations in engineering psychology in the United Kingdom and in the United States contained little evidence that the investigators recognized that they were pioneering a revolutionary enterprise.

As far as the human was concerned, the engineering sciences gave primary attention to the pioneering work of Taylor and the Gilbreths.

## Phase III - Machines for "Minds"

Several events that have occurred during and since World War II have so increased the complexity of cultures (and thus increased the number and complexity of individual and group interactions) that it seems to me that this period should be termed Phase III of the Industrial Revolution. We are living during this period and thus do not have the benefit of hindsight to assist us in interpreting the true nature and extent of its impact on the cultures of the world.

The events of Phase III that are of special interest to us are the development of atomic energy, the development of high-speed computers (a powerful tool for use in communication, industrial, military, economic and perhaps even social systems), automation, and space explorations. We are witnessing the wholesale substitution of machines for many of those functions of man that some have considered his "higher" processes.

## The Response of Engineering Psychology

Elsewhere (refs. 4, 5) I have covered the response of engineering psychology during this period and will only briefly summarize today. We have witnessed a progression from retrofit of original design to design of elements (knobs and dials) to design of components and subsystems to a clear recognition of the requirement to fit machines to men. If we are to meet the challenge, we must now take a fourth step in our profession and recognize that in order to realize maximum efficiency and satisfaction, machines and men can and must be fitted to concepts. We are almost ready to divest ourselves of those preeminently useful lists of the past that explained what men can do best and what machines can do best and, in their stead, these elements of design will be considered only in relation to the conceptual requirements of a particular system as these requirements exist at a particular point in time.

Some will say that this represents a distinction without a difference but I cannot agree. True, the aims of our profession during its first three phases were the same as they are now, i.e., participation in the development of systems that, in terms of specified criteria, are maximally effective. However, even now the nature of complex systems is being considered in some detail at the conceptual level and then, and only then, do the designers determine the components and materials to be used to meet the requirements of the system, and only then do they determine whether these should be organic, inorganic or a combination of both. In the future, systems planners will use simulation more and more as a design tool that will enable them inexpensively and quickly to assess the merits of alternatives without committing substantial resources to any of them. This implies a knowledge and understanding of systems principles (and advancements in simulation) that are not available today.

Why do we need systems research and its companion, research in simulation techniques? Why, in the last decade, have these areas suddenly received increased attention? I hope that the implications from my previous meanderings among anthropology, archeology, engineering, psychology, etc., will support the position I now adopt. Such research is necessary simply because the interactions among our cultural elements (whether organic or inorganic) have become so manifold and so complex that successful and economical design of a system of even modest complexity is impossible without the benefit of sound scientific principles and appropriate supporting tools. Accepting this as a tenet, one then is forced to conclude that professional members of each of the sciences that support the development of systems must assure that their own house is in reasonable order.

The principles of each discipline must be so stated (or, by means of transformations be capable of being so stated) that they can be considered appositively with the principles of other contributing disciplines. Do you feel that engineering psychology is ready to meet this challenge?

For some time to come, this—the appositive consideration of data and principles from what in some cases have been unrelated disciplines—will be the thorniest problem confronting the planners and designers of systems. This is why I suggested earlier that we must plan our experimental work in engineering psychology in such a way that the variables are those that planners and designers can manipulate; and present our findings in such a way that planners and designers can make intelligent decisions regarding the consequences of selected values of the independent variables.

Other areas directly in support of systems planning and design that need particular attention are control dynamics, complex visual perception, decision-making, the proper function of computers, design for motivation, and design for work in unusual environments. (This latter, incidentally, must include assessments of the effects of multiple stressors applied simultaneously or sequentially. Specifically, are the effects on performance additive, logarithmic, or synergistic?)

In a somewhat different vein, we need cross-cultural studies, much like those Hertzberg and his team (ref. 9) have performed in the field of physical anthropology to adequately assess the effects of different cultures, different customs, different educational systems, etc., on systems design and development. Most current engineering psychological data are drawn from studies based on English-speaking people only, and these have been restricted chiefly to Great Britain, Canada, and the United States.

To continue, Chapanis has suggested that we very much need to consider both input and output in the development of better methods of communicating with computers. Someday we will see Kelly's ideas on predictor displays elaborated to include the results of the analysis and synthesis of data from literally hundreds of sources.

In addition, what might be termed "double design" possibilities offer interesting opportunities for engineering psychology. Perhaps I can best illustrate with an example. An engineering psychologist working in the area of remote manipulation should consider the possibilities of redesigning the objects that must be manipulated as well as attempting to improve the remote manipulators.

I suggest also that any branch of science progresses only as its tools and methods improve. While we have one text that might be termed a "methods" book (ref. 2), I think we do far too little work of a methodological nature. We know far too little about the validity of the methods we employ. For example, we frequently employ user opinion as a criterion, but do we really know where and under what conditions it is an effective criterion? We engage in system tests, but we do little to investigate the possibilities of improving our test procedures. We find that traditional laboratory techniques cannot be used, so we seem to despair. Many other examples could be cited.

In systems planning, man is coming more and more to be considered for his cognitive capabilities and his abilities to handle conditions that can't be expressed alpha-numerically. This implies the design of systems in such a manner that man at any moment can effectively exercise his judgment, for this is one of the greatest assets he brings to systems. Bray has termed this the "development of context" in systems design. Finally, let us try, through research, to show systems planners and designers that variability is an outstanding human characteristic that should be used as an asset instead of viewed constantly as a liability. Without variability there would be no learning and no adaptation, two prerequisites for designing into systems one characteristic that distinguishes the mediocre from the outstanding. I speak, of course, of flexibility.

In another publication (ref. 4) I have attempted to trace the history of systems research, to define some of the chief problems in this area, and to forecast future progress. This information is well known to this audience so I will not repeat it here, but will extract some thoughts that are particularly germane to our considerations at present.

The theories of behavior applicable to complex man-machine systems not only must be useful to systems engineers but also should provide a link with existing behavioral knowledge. No new approach can afford to divest itself of the tremendous fund of sound, relevant behavioral knowledge that exists.

Research in mathematical model-building with special emphasis on the solution of complex problems involving higher-order interactions is needed. This (mathematics) will prove to be our common communication medium with engineers, physicists, and other scientists. What are we doing to prepare ourselves to speak this language and use this tool effectively?

I hope finally, however, that our approach to systems research in particular is not in danger of becoming stereotyped too soon, that is, we must not insist on a strict operationalism too early in the game. Bateson's expressions regarding the nature of scientific thought may be worth considering in this respect (ref. 1): "... whenever we pride ourselves upon finding a newer, stricter way of thought or exposition; whenever we start insisting too hard upon operationalism or symbolic logic or any of these very essential systems of analysis, we lose something of the ability to think new thoughts. And, equally, of course, whenever we rebel against the sterile rigidity of formal thought and exposition and let our ideas run wild, we likewise lose. As I see it, the advances in scientific thought come from a <u>combination of loose and strict thinking</u>, and this combination is the most precious tool of science." Engineering psychology, in my opinion, must also support its share of "loose thinkers."

It may be of more than academic interest as to what the exponential increase in interactions referred to earlier means to the individual members of society. Does unit freedom increase or decrease as the number of interactions in which the individual becomes involved increases? While an individual may control more machines, greater computers, more power, perhaps even more people, etc., do not these same elements with which he is interacting also exert greater control over him, essentially reducing individual freedom of choice and action? Such considerations are perhaps beyond the immediate interest or, at least, current responsibilities of the engineering psychologist and the system engineer. Yet to ignore these interactions would patently violate the ultimate intentions of our professions.

### The Response of Engineering

The recent period of the era we are considering has witnessed an interesting shift in perspective for certain branches of engineering. To my knowledge, the industrial engineering profession has most clearly elucidated its position with respect to the design of complex systems. Therefore, I would like to restrict my consideration of the engineering profession to them. I do not say that they are typical; I do say that they have something important to say.

Industrial engineering is changing from a discipline concerned primarily with work methods to a system-oriented discipline. I would like to quote from a recent article in the Journal of Industrial Engineering (ref. 12).

> Industrial engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems....
>
> The Industrial Engineering approach is a unique application of engineering design and analysis techniques. The Industrial Engineer's consideration of people, the design of systems involving people, and the manner by which human performance is analyzed require a fundamental, analytical approach that is essentially different from other engineering disciplines.... The Industrial Engineer is distinguished from other engineers in that he:
>
> 1. Places increased emphasis on the integration of the human being into the system.
>
> 2. Concerns himself with the total problem.
>
> 3. Predicts and interprets the economic results.
>
> 4. Makes greater utilization of the contributions of the social sciences than do other engineers.

The Industrial Engineer differs from other engineers in the degree that his fundamental concern is with operations that result from both physical and human resources, and are measured in both physical and economic terms. Therefore, he is educated not only in the engineering methods of analysis and design which stem from mathematics and the physical sciences, but also is concerned with psychology, physiology, sociology, economics, costs, and human relations.... Philosophically, he is devoted to the ideal of helping the nation to use most effectively its physical facilities and human talents for production of goods and services.

I might observe that we have literally squandered our human talents—even more so than our materiel resources. The authors point out that industrial engineers must have training and knowledge in virtually every physical, biological, and social science.

A few universities have taken direct action to support this revolutionary movement in industrial engineering. Of these, the program at Northwestern University is, in my opinion, outstanding. These educators had the courage to completely restructure their entire program. They divested their curriculum almost completely of the old "techniques" teaching and have concentrated instead on teaching fundamental engineering with more than cursory attention given to all the professions that must support a modern engineering enterprise. They, to quote Lehrer (ref. 10), "... do not rely upon techniques, but rely upon a broad and basic education and upon adequately defining the problem." Further, "Industrial engineering should not be confined just to manufacturing-type activities, but should be truly systems oriented." Again, "... creativity is no problem whatsoever when the educational program has a broad orientation, does not rely upon 'techniques,' and when the faculty inspires and motivates the students to learn for themselves." Techniques, including the use of computers, are worked into the curriculum, and emphasized as being what they truly are, tools for the accomplishment of goals—tools, incidentally, any one of which may soon become obsolete. They emphasize that these techniques must never be allowed to have a restrictive influence upon creative thinking. I reemphasize that they do not limit themselves to a consideration of production systems, but include all systems (e.g., management) associated with modern industrial complexes. I think you may agree with me that these views represent a revolution in industrial engineering.

Some may view such actions as threatening to engineering psychology. I do not, although I think the committee of distinguished industrial engineers who wrote the first article from which I quoted (ref. 12) may have somewhat overestimated the capability and knowledge that one man—even an engineer—can achieve! For example, I would have felt better had they disclosed how their systems engineer (for this is essentially what they are defining, not a traditional industrial engineer) planned to work with, and coordinate the work of, the many specialists on whom he must rely if he is to be successful. What requirements will be placed on them? What will be their responsibilities? However, in general, these appear to be the kind of engineers with whom I would be delighted to associate. I recommend that you read Professor Lehrer's paper.

No, rather than a threat, I feel that this "school" of industrial engineering clearly recognizes that any designer of modern systems can enjoy success only if he incorporates into his work human factors considerations as well as data from the physical sciences. We have much in common with these modern industrial engineers, and in those cases where they are serving also as systems engineers I expect that we will find them to be unusually receptive and understanding customers for our services. I do not hesitate to predict, however, that industrial engineers will have to compete with many other professions for the right to serve as systems planners and systems designers. I know of no formal course of training in these areas (although the Northwestern program tends strongly in this direction), and I suspect that for some time to come systems planners, engineers, and managers will be chosen, among other reasons, with respect to how sensitive they are to, and how well they understand the meaning and implications of interaction. Now in some systems, the primary interactions heavily involve the organic. I hope our engineering colleagues won't be chagrined, then, to occasionally find in at least these instances that an outstanding job of systems planning and management is being done by a biological or behavioral scientist. The current interest in bionics, as Hartmann has suggested to me, might tend to hasten this day, because as selected inorganic subsystems become more and more to be modeled after organic subsystems, the compatibility between organic and inorganic will increase, and, I might add, as perhaps will the number of organic scientists who develop an interest and capability in systems planning and development. (You may object to my term "organic scientists" because it implies that there are inorganic scientists. I mean, of course, scientists who deal with living organisms. On second thought, this is no worse than the term "life scientist," whose opposite, I suppose, is a "lifeless scientist" —as a matter of fact, I am personally acquainted with a number of the latter!)

I wish I could relate to you instances where departments of psychology are taking action, as Northwestern did in industrial engineering, to completely overhaul those portions of their programs that are intended to meet the needs of engineering psychology. But with two or three possible exceptions, I cannot. All department chairmen in psychology would admit that we live in an industrial and technological as well as a scientific age. All would probably agree that man interacts almost constantly and very intimately with the products and the symbols of this age and, further, that these, in no small part, help mold this "behavior" which all claim is of primary interest to the field of psychology. So how can we ever have a truly comprehensive, satisfactory theory of behavior if we ignore these considerations? The findings of engineering psychology may never provide sufficient substance for the formulation of a comprehensive theory of human behavior, but no theory of human behavior can be considered comprehensive if it cannot account for the findings of engineering psychology.

Are we ready for this age with adequately trained psychologists? Why, for example, shouldn't engineering psychologists direct the planning and designing of at least those systems that have a heavy "organic" component? Why should we be satisfied to sit on the sidelines and simply offer advice? Could it be that we are afraid of such responsibilities? When will we become, to quote Lehrer,

" ... truly systems oriented?" How personally bitter it would be and will be to men like Taylor, Williams, Bartlett, Fitts, Chapanis, and others if we drop the heritage which they bequeathed us.

This is the crisis to which I alluded earlier; it can be solved, however, only with the full participation of our educational institutions. A committee of the Society of Engineering Psychologists has already investigated this problem. Their program should be reevaluated and updated. They should consider the dual functions of gaining knowledge and applying knowledge. Competent, progressive engineering authorities might profitably be asked to sit with the new committee.

I am not recommending that we dispense even partially with training in experimental psychology. As one surveys the programs of, for example, modern industrial engineers it is easy to see that even now we complement each other rather effectively. For example, our training in and knowledge of experimental methods, individual differences, probability, reliability, validity, criterion development, and human capabilities meet specific requirements of engineers, systems planners, and systems designers. However, we must gain a better understanding of the fundamentals of engineering and allied supporting sciences, for how else can we truly understand the needs of one of our best customers? We hope to be of service to him; therefore, it is incumbent on us to acquaint ourselves with his needs and to learn his language.

## Program of Action

I submit to you now a program of action. Some of the points are supported by my previous remarks; some are not.

a. The education of engineering psychologists is quite inadequate. The Society of Engineering Psychologists should update the 1961 report on Training in Engineering Psychology (ref. 7) and try diligently through our academic members to get the Chairmen of selected departments of psychology to adopt it. This is fundamental to the development, and very survival, of our profession.

b. We have unique contributions to make to the traditional areas with which industrial engineers deal. We should try harder to acquaint them with our services; it would afford a splendid opportunity to show what we can do. Why, for example, would we not expect to make contributions to production systems similar to those we made to pilot display and control systems, air navigation systems, etc.

c. We should reopen the question of whether a Journal of Engineering Psychology is needed. I am concerned, perhaps, not so much with the matter of a proper repository for our research as I am with the availability of a medium for setting down our beliefs, our policies, our aims—in short—the philosophy of engineering psychology. I would like to see a clear "statement of intent," periodically up-dated for our profession.

d. We should cooperate with other professional organizations, such as the AIIE in exploring the needs for, and possibilities of developing a true systems development curriculum. Skilled systems planners and designers generally recognize immediately the need for information and assistance from such fields as engineering psychology; thus, it would help our profession if there were more of them.

e. Each year the Program Chairman should solicit from the membership their thoughts regarding the critical issues that face our profession and ask leaders in our profession and allied professions to discuss at our annual meeting those deemed most important and timely. If necessary, we should take time for such a symposium from that allotted to the presentation of papers.

f. Because of the shortage of good academic curricula in engineering psychology, we should adopt the practice of the Division of Industrial Psychology of sponsoring a more extensive work shop program at the annual American Psychological Association meeting. This would provide an opportunity for many students and practitioners to learn directly from the outstanding leaders and experts in our field and from leaders in associated disciplines.

In summary, I have suggested that engineering psychology has at least one important choice point confronting it. In addition to researchers, we can remain advisers and designers of little things, or we can, on the applied side, aspire eventually to being systems planners and managers. Dr. Abelson has stated that no psychologist had been asked to comment on the lunar program—probably, I suggest, because none was felt to have sufficient acquaintance with the entire program to judge its implications.

I have given you an example of another profession that took a good hard look at itself, decided it didn't like what it saw, and is doing something about it. I hope we will take such a look. Maybe we will like what this self-examination reveals; maybe we will not. But for Heaven's sake, let's not become complacent at the tender age of 18.

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13 ABSTRACT


The history of engineering psychology and its relationship to engineering are briefly traced. The emergence of engineering psychology from the "knobs and dials" stage to a full-fledged participating profession in systems planning and development is described. Some of the problems confronting engineering psychology are described, the chief of which is the development of suitable educational programs in a sufficient number of universities to supply the current and anticipated demand for workers in this area.


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| Human Engineering, Applications | | | | | | |
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| Military Psychology | | | | | | |
| Engineering | | | | | | |
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