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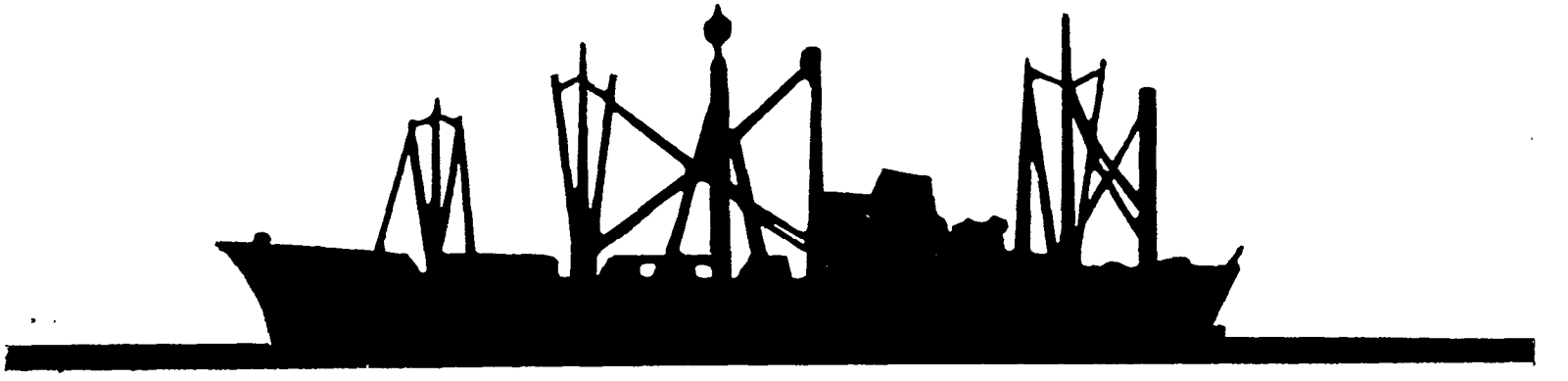

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

HUMAN PERFORMANCE ENGINEERING: A TECHNOLOGY FOR DEVELOPING THE HUMAN RESOURCE

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ABSTRACT

Human performance engineering is a behavioral technology that rests on the proposition that increases or decreases in productivity always are the byproduct of human action. The key to increased productivity thus begins with location of those actions that must be changed. This is followed by the introduction of variables known to be effective in bringing about alterations in human behavior. By this approach, managers are envisioned as major sources of such variables. Increasing productivity thus is tantamount to engaging managers in an appropriate application of these causal agents. Following a careful enumeration of the procedures and results of this approach in a manufacturing setting, a detailed proposal outlining, application to the shipbuilding setting is presented.

INTRODUCTION

Last year in my invited address to you, I listed many of the factors that likely have contributed to the current productivity slowdown in the U. S. This listing underscored that this slowdown is multi-determined, and suggested that certain of these determinants more readily could be addressed by each of us than others. For example, the resource-draining influence of federal regulations that seemingly has increased logarithmically in number since the middle 1960s probably only slowly can be reversed, and then not without involvement of complex political "machinery." Moreover, there is little that can be done about the loss of work excellence formerly supplied by the now-ended migration of farm workers into our labor marketplaces. Further, the enormously complex problems and uniformly nonbeneficial influences wrought by inflation, combined with near-unchecked federal spending, are not easily addressed by any single industry, let alone single groups and/or individuals. Indeed, current high interest rates coupled with this spiralling inflation appear to have prompted many of our organizations to become mini-banks rather than to fulfill their original committments to manufacturing, service, and sales activities. These current economic conditions thus reinforce nonproductivity and corresponding unemployment that, in turn, beget further of these ailments in a sort of endless vicious circle. Noteworthy also has been the continued influx of the young and inexperienced as well as an increased proportion of female workers, estimated by some to have contributed 18% of the current slowdown in productivity, again exemplifying difficulties that probably only gradually and complexly can be surmounted. Finally, sociologists have expressed concern about the counter-productive pressures within organizations toward upward mobility within management heirarchies. The contention here is that such pressures reinforce unusual conservativeness and a tendency tendency holding the status quo rather than fostering the bold, creative, imaginative, and innovative actions by young and/or aspiring managers that are needed to deal with productivity problems.

while many of these ingredients thus likely will require remedies that each of us as individuals only indirectly can influence, I noted last year certain other problems that impact productivity that each of us more clearly and directly could address. In part, some of these "addressable" problems are highlighted by the results of polls that have been conducted over the past 15 years, the exact period that characterizes the time frame of the current slowdown. Pollsters tell of pervasive changes in the attitudes, work ethics, committments, and of the declining respect that our workforce

currently holds for its employers. For example, polls show that about 70% of the workforce "trusted" their employers at the end of the 196Os, but that less than 30% have a similar trust today. Further, although well over 65% during the late 1960s reported that they "respected" their supervisors, most now apparently feel that they openly can disagree with their managers. Finally, well over 70% of our workforce in 1968 conceded that individual effort and hard work paid off, but by the mid-1970s the percentage fell to about 30% that expressed the belief that their individual efforts were noticed and rewarded. In addition, pollsters tell us that rather than quit work, a significant percentage of our workforce has learned to withdraw in other ways. In effect, efforts to camouflague sagging work habits seem to have increased markedly, a significant proportion of our workers now "push" the rules, and often show indifference if not outright hostility when confronted with these seeming inproprieties. These findings prepare us for understanding the polls on the subject of job satisfaction. The evidence is unanimous that satisfaction in work is near an all-time low, regardless of vocation, position, sex, age, and so forth. And, for those that believe that job satisfaction and productivity are directly related, this indeed is an ominous sign.

Other factors impact against full committment to increased work by our human resource as well. Pollsters speak of a precipitous rise in middle-aged crises. More divorces, more problems with children, **more** alcoholism and related addictions, and less self-esteem have conspired to distract our middle-aged work population away from productive output. we also are informed that the changing social security and other laws have increased the proportion of older workers that populate the workforce. If the stereotype is correct that older workers are less productive, then we have yet another human-resource problem that must be addressed.

An interesting recent study regarding our human resource compared the number of minutes actually worked per hour of pay by the average U. S. and Japanese worker. Allowing for the possibility of an indirect calculation procedure, these data are nonetheless to be regarded with considerable concern. The average Japanese worker was found to return 58+ minutes of work for every hour of pay. In contrast, the averages U. S. worker purportedly yields only 45 minutes of work per hour. While, a 130minute difference may seem relatively trivial when considered for a single hour, when summed over a typical 8-hour work day, it is anything but insignificant. The differential adds up to 104 minutes, or almost two full hours per day of lost labor!1 And, when totaled for an 40-hour work week, the result is aver a full day's work that is paid for but not received Now, while caution doubtlessly is adviseable in the interpretation of this statistic, certainly this difference across countries in work output must account for some of the reason why many U. s. industries have serious survival problems at present. Indeed, consider how a single day's work could help one of the manufacturering concerns wherein **we** now are installing a Human-Performance-Engineering (HPE) program to increase work output. This company makes, among other things, a product that sells for

slightly over **$20.00** per 1000 pieces. The exact duplicate (identical quality) manufactured in Taiwan sells for slightly over $9.00 per 1000, a price for the finished product that is well below the cost of the steel to our U. S. company. If we could obtain 13 more minutes per hour of work from each plant employee in this organization, we would be able to produce the same product for about $6500.00 less per week, or about a 22% savings. **Now,** while $16.00 per 1000 still is a long way from the $9.00 amount for the Taiwan product, can there be any doubt that such is a step in the right direction. And, when coupled with better and quicker service, greater product versatility, and so forth, there should be little question that this U. S. company could be more competitive than they presently are! Please note that while only in the beginning phases of this application, we already ***are*** over a third of the way to our goal of a 22% increase in work output.

Pollsters contend that the major factor needed for addressing most of the current problems with our human resource is that of a..."management style that managers have not learned yet." Of course, this invective suggests that we have knowledge of such a "style," that there is only one and not several styles and, finally, that managers can master and implement "it." Last year, I proposed that such a "style" indeed was available, and presented data on "its" effectiveness from three markedly different applications to show that managers with different backgrounds, experiences, persuasions, sexes, ages, temperaments, and so forth could indeed not only learn "it," but also maintain its implementation for prolonged periods. One of these applications was within a large metropolitan hotel that, in order to reverse a sagging reputation and increase clientele, required massive deep cleaning of virtually the entire property. while I summarized only that portion of our program that involved the maids and the room areas, we now have published our data in connection with cleaning and, then maintaining the public areas as well (including all lobbies, hallways, seven restaurants, and the back of the house), and with bellmen in order to increase both the quality and quantity of customer service. These programmatic applications since have been extended to other properties, including hotels in Scottsdale, Az., Chicago, Ill., Detroit, Mi., Danvers, Nass., Nashville, Tn. and, most recently, Rochester, Mn. Different managers, employee population, property configurations, and program applications were involved across these sites, yet all have been remarkably and perduringly successful in increasing both the quality and quantity of service, cleaning, food preparation, and so forth in each instance.

Time did not permit detailed coverage of program application in a sales setting (real estate) last year and, unfortunately, this program also was not well summarized in my 1981 IREAPS paper. For those wishing a more detailed summary, please write or consult the upcoming November issue of TEE JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT (1982). Again, increased productivity from the salesforce, indisputably attributable to the program ingredients that I outlined last year, resulted in a remarkable increase in profitability and an change in company competitiveness from seventh

for proportion of business in the area to first by a wide margin. Moreover, this was accomplished with managers and a workforce that were quite different from those involved in our hotel programs.

In addition, please recall the rather extensive program application within a furniture manufacturing organization wherein was displayed, among other things, systematic and lasting changes in worker efficiency due to program ingredients on a department-by-department basis (well summarized in the 1981 IREAPS PROCEEDINGS). Overall efficiency increases in some departments exceeded 15%, and no department failed to show significant gains on this measure of impressive magnitude. These program-produced changes were displayed as of the late Spring, 1981, and were the culmination of efforts initiated in late 1977. To achieve the reported outcomes, managers of very different backgrounds, ages, training and experience, and of both sexes were involved at all organizational levels. And, the same individual differences characterized the work population as well. Also noted in last year's presentation were extensions of program ingredients to the white-collar workforce in the corporate offices of this company, and to the delivery division. This year heralded an extension to the sales division that, in spite of having no direct salesforce, has been quite successful both in offsetting any decline in orders due to the current recession and, for about half of our applications, rendering remarkable increases in sales volume. During this period of evolving program application, the company has prospered, growing from 35 millions in gross volume to just less than 70 millions. This is a remarkeable achievement in a climate wherein an excess of 540 businesses have been failing each week! And, there is good evidence that this correlation between program application and company growth is a causal one.

Finally, not mentioned in last year's presentation have been systematic program applications in a region of a large insurance company, to a branch of a major pest-control firm, to a large and prestigious CPA firm in Detroit, to one of the five largest book binderies in the U. S., to a small distributing company in Chicago, to a plant of one of the country's largest food-processing corporations, to a small parts manufacturer in Indiana, to a large Indiana banking operation, and so forth. Again, these applications have entailed different managers, work samples, operational procedures, environmental challenges, and many other variations, yet all have been accompanied by from solid to spectacular increases in worker productivity. we believe that these data, some of which now are published in solid, reputable, edited journals, go a long way to supplying an answer to questions regarding (1) whether or not management "style" can serve as an effective combatant against the current productivity slowdown, (2) whether such a "style" indeed exists, (3) whether "it" can be learned by ALL managers, and (4) whether is can be applied within a wide variety of settings to different work populations. We believe that these data supply an optimistic albeit yet tentative answer of "YES" to all of these concerns.

Since the IREAPS presentation of last year, I have been blessed with

numerous "eye-opening", industry-relevant experiences regarding the manufacture of ships that, while extraordinarily illuminating, also were somewhat overwhelming in terms of both the amount and complexity of information input. This input resulted from (1) an opportunity to present our work to top Naval Personnel of the Materials Handling Division of the U. S. Navy, (2) participation on the ad hoc Human-Resources IREAPS task force where I was exposed to truly outstanding experts, and (3) was given opportunity to visit two compact shipyards for purposes of proposing a Human-Performance-Engineerings (HPE) application. In addition, I was privileged to sit in and present to the summer SNAME, SPC-9 panel meeting in Seattle, and was invited as an addressee by Mike Gaffney of the NRC to represent our work to a symposium devoted to contrasting approaches to human resource development. While I learned much from these opportunities, I also learned that there was much more yet to master, thereby still leaving me relatively uneducated about shipbuilding procedures and practices. Indeed, the confusion that I sometimes felt from these experiences surely supplies justification for retitling my paper from its present, rather grandiose moniker to... "AI'? EXPERIMENTAL PSYCHOLOGIST'S VIEW OF ALICE'S WONDERLAND, OR THE SNARK REMAINS A BOOJAM."

In fairness, however, I believe that I did learn some important things about the shipbuilding industry that bear importantly upon any potential contributions that might be made through an application of HPE to reversing sagging productivity therein:

1. At the end of World-War II the U. S. was building approximately 50% of the world's ships. Currently, our country is building less that 2% of the ships, and even this figure might be lower were it not law that the Navy employ national resources in this connection.

2. While it may be law to build Navy ships with U.S. resources, it apparently is not necessarily the case that the private sector be involved. The navy currently does much of its own repair work, and purportedly has conceived of the possibility to even build them (again?) were conditions "appropriate." Clearly, one such condition has to do with whether the private sector can be at least nominally competitive with current non-American manufacturers. This is an especially acute problem at present since the U. S. government recenly has committed to rebuilding the Maval fleet. It thus is imperative that our private sector respond in such a way as to guarantee its full involvement in this committment.

3. The private sector apparently recently has begun to respond to certain of these challenges with truly advanced technological alterations. For example, some yards have experimented with innovations in production control procedures. These include numerically controlled, automated cutting, computer aided design, and numerous variations on zone outfitting. However, much variability across and within yards presently exists in terms of inclusion of these and other new procedures.

A The preceding is complicated by the fact that, unlike most U.S.

manufacturing undertakings, shipbuilding more closely resembles building-construction rather than well-developed assembly-line operations. And, building-construction undertakings long have been known to defy easy changes to accomodate automation procedures, modern production control innovations, or efficient material-handling processes. These factors complicate the development of sound work-measurement procedures. This latter especially is problematic since,...

5. shipbuilding remains a very labor-intensive undertaking likely in part because of the aforenoted problems.

6. In spite of the current, intensive efforts to develop and deploy advanced technologies in this industry, there surprisingly only recently has been much attention given to the systematic development of the so-called "human resource." In this connection, only recently has there developed an awareness from other labor-intensive industries of the numerous undertakings that have been tried in this connection as well as of the corresponding direct and indirect potential gains in productivity that can result.

By "indirect effects" is meant that certain changes wrought through human-resource development typically are not immediately and directly reflected as graded increases in measures of work rate by individual workers. Instead, more work output is achieved through programs that reduce absenteeism, tardyism, turnover, accidents, and increase work quality. There now are numerous illustrations of the beneficial effects of such programs from the automobile, food-processing, and "hard" manufacturing industries.

By "direct effects" is meant that human-resource development directly has resulted in increases in actual work rate, i.e., more output per unit time per worker. Judging from my aforemention committee involvements this last year, the shipbuilding industry only recently has become more aware of programs employed by others that result in such direct changes. Certain of these programs have focused on improvements in the so-called ENVIROMENT-WORKER interface, capitalizing upon current knowledge on how to tailor features of the work situation so as to capitalize on the sensory and motor capabilities of the worker. The general intent of these programs has been to remove obstacles that encourage unnecessary complication, behavioral reduncancy, competing actions, and/or that minimize "drain" on worker sensory systems to accomplish their assigned tasks. Another way to accomplish much the same effects have been through programs that attend to problems of material supply, flow, and quality. These programmatic approaches thus also increase work rate through environmental alterations. In effect, all such programs that are concerned primarily with environmental-worker interfaces conform to what Hackman (1978) terms *'environmental tailoring" to capitalize upon apparent worker capabilities and/or needs. Appropriately, these have been categorized as human-factors programs, and those that in general have proven most effective incorporate many of the well-known principles of sensory and motor

function researched some time ago by human-factors psychologists.

Yet another and perhaps even more recent development in connection with direct approaches to increased productivity through human-resource development in your industry has been an increasing concern regarding the possible utility of various WORK-IMPROVEMENT PROGRANS. Here, rather than "environmental tailoring," focus instead is upon "worker tailoring" (Hackman, 1978). The general idea is to institute means to counter the purported decline in work wrought by what pollsters claim has been a negative shift in worker attitudes and the so-called "work ethic." However, this general approach has been accompanied by considerable skepticism as well as controversy within your industry (as well as others). The major reason for skepticism has been because of the widely-voiced contention by some that work-improvement programs are, at worst, unproven or, at best, likely to exert only short-term beneficial effects (cf., Kendrick, 1980).

Certain of the more authoritative recent surveys at least **partly** attest to these skepticisms. For example, Woodman and Sherwood (1981), in a summary of reports on the effectiveness of group and/or team approaches to work improvement, concluded that none provided convincing proof of effectiveness in increasing work output. Illustratively, they showed that many of the projects reported upon were flawed because they did not employ procedures needed to rule out alternative, plausible explanations of purported effects. Even more serious was the fact that almost none of the reports included provisions to show effects in other than single work situations. Finally, even had some group approaches proven convincingly effective, carefully documented figures that reflected cost-benefit relationships were even more rarely available.

While it is not clear that quality-circle procedures qualify as a "group" approach to work improvement, it is important to note that thus far there is only a single published report that incorporated the safeguards necessary to a convincing conclusion regarding the possible effectiveness of this strategy (Hendrix & Ovalle, 1982). Regretfully, these authors were unable to show that their application of quality circles had any effect on work output, let alone any of the other effects currently claimed by those that champion this work-improvement approach.

An even more wide-ranging set of surveys by Cummings and Molloy (1977; 1978) of work improvement programs, sponsored by The National Science Foundation, recently were released. These authors concluded much the same regarding the effectiveness of group, job restructuring, objectives-setting, flexitime, Scanlon-Plan, and various other approaches as did Woodman and Sherwood (1981) did about group and/or team approaches to work-improvement. Cummings and Molloy (1977) noted one exception, however, an so-called "new kid on the block;" namely, Organizational Behavior Modification (OBM, after Luthans & Kreitner, 1975). (N. B., Organizational Behavior Modification is but a subset of what is termed herein the Human-Performance-Engineering, HPE, approach. Also note that there

is another perhaps even "newer kid on the block" that, while not unlike certain of the approaches analyzed by Cummings and Nolloy, nonetheless is seen by some as also holding great promise as a work-improvement tool. This approach, the so-called Quality-of-Work-Life or OWL philosophy, while not the focus of this paper, will be touched upon later.)

Our data, partly summarized last year and some of which is "In Press" (Anderson, Crowell and colleagues, five articles, 1981), buttresses the optimistic view of Cummings and Molloy (1977) that, at last, it may be possible to directly alter and then maintain indefinitely any work behavior of any worker in any setting. As noted earlier, much of the research with the HPE technology has incorporated all of the safeguards needed to (1) rule out alternative interpretations, and upon which to (2) base the contention that the techniques involved can work in any setting and/or set of circumstances. Moreover, careful documentation of program costs and benefits invariantly (3) has permitted the conclusion that out-of-pocket organizational costs (but not of efforts) are miniscule and (4) bottom-line benefits of a minimum of 10% increases are standard outcomes. Moreover, most of our applications have been in effect at least four years (Emory Air Freight successfully have maintained a primitive version of an HPE program for 11 years), thus (5) directly countering the view that all work-improvement programs are short-term in effect.

In the latter connection, please recall the furniture manufacturing project presented last year in which a 14% increase in overall plant efficiency was directly traceable to department-by-department applications of HPE ingredients over *a* four-year time frame. As noted, another year has passed, and the program has continued to be refined, refreshed, and maintained. It thus is possible to employ the data collected over this latter period to evaluate concerns regarding program longevity.

MEAN DEPARTMENT EFFICIENCIES

	Preprogram 1977-	Spring 1981	Summer 1982
Indiv. Appl.			
Fbrgls	94%	104%	109.1%
Uph	85.2%	87%	101.8%
Pch Prs.	88.5%	98%	98%
Weld	70.3%	79.5%	92.5%
Vrtbra	----	85%	95.7%
Group Appl.			

Pol & Buff	86.3%	99%	98.2%
Pltng	84.3%	89.9%	92.9%
Mn. Ln.	94%	99.4%	99.5%
PLANT	84%	96%	97.1%

Table 1: Mean department efficiency changes prior to and following HPE program application and maintenance. The first five departments entailed program application on an individual basis and the remaining departments entailed group application

And, even more important, the earned ratio has continued to increase. Earned ratio is calculated as the number of hours it would have taken at standard to turn out the product for a given week divided by the number of actual hours expended. This index thus takes into account both direct (product relevant) and indirect (nonproduct relevant) labor hours. The ratio had been a steady .54 at project outset, rose to .66 when presented to you last fall, and presently is .672. Indeed, the earned ratio for every department has continued to increase!

PROPOSITIONS THAT FOUND HPE APPLICATIONS

The technology of Human Performance Engineering is predicated upon certain propositions. These include:

1. People do not change, behavior does.

The primary message here is that any work-improvement program will be successful the degree to which it is directed at the actual actions of employees, not at such inferrables as personality traits, motives, attitudes, or other so-called internal or "mental" characteristics. Indeed, there is considerable scientific evidence that the latter, by whatever definition, more likely will change as a result of behavior changes rather than serve as the cause(s) of human action.

2. All human behavior is lawful.

By lawful is meant the same as any scientist means by laws. It means simply that human behavior is controlled by events, circumstances, and/or conditions in the world, and that these "controlling" relationships can be objectively specified. As for any science, knowledge of these laws permits accurate prediction, understanding, and even systematic alteration of the behavior subsumed by them. Indeed, we know of no behavior that is not lawful, predictable, or that cannot be understood in terms of the operation of said laws.

3. Behavior is docile.

There appears to be no behavior that cannot be changed by use of what we presently know of the aforementioned laws. Human action seems eminently malleable. It putatively is readily molded through the so-called "processes" of acculturation and other environmental determinants.

4. We now know enough about the laws of human behavior to apply them to obtain and then maintain any human performance needed in the world of work.

Clearly, there is much left to be discovered about human behavior. However, major strides have been made in this connection during the past century. At present, it seems a safe conclusion that enough progress has been made to achieve **almost** any reasonable change desired of human work behavior.

5. Increases or decreases in productivity always can be traced to and thus are the byproduct of the nature, quality, and quantity of human action.

We believe that the "bottom line" of any organization depends upon what both front-line operatives and managers alike do or do not do. As such, productivity problems can be viewed in terms of too much or **too little** of those actions critical to missions of the groups that make up respective departments, departments that form divisions, and divisions that give rise to the organization as a whole (cf., Crowell & Anderson, 1982).

One major deduction from this proposition is that reversing the productivity slowdown is a matter of altering those various critical human actions within organizations that currently impede innovation, development, and efficient performance.

6. These propositions, if correct, permit the deduction that the degree to which any work-improvement approach is effective is the degree to which the laws of behavior are operative therein, either by design or serendipitously. By this deduction, Quality-of-Work-Life and/or Quality-Circles approaches, to be successful, must capitalize on the presence and the efficient operation of these laws. However,...

7. Some work-improvement programs better provide for the efficient operation of a broad spectrum of what currently is known about behavior than others. On this view, programs that do not explicitly provide for the use of such laws are not likely to be either as efficient and/or as effective as those that do.

These propositions and the relevant associated research permit, in our view, relevation of theso-called "management style that managers (purportedly) have not learned yet," as called for by pollsters. To extract maximum work from our large workforces, it accordingly is our belief that...

8. Managers must become' Human Performance Engineers. This means that they arrange their work situations so that they systematically can introduce, alter, and then maintain the operation of those variables, factors, and conditions that we now know to be effective in work settings. And, while we know of perhaps 100 or more such variables, there are a few that are so seemingly universally potent that they qualify as fundamental to any program of effective HPE. These can be enunciated in terms of the Steps to HPE that should be followed in ANY program application. In other words, the following steps are recommended in order to maximize the efficient utilization of the greatest number of laws presently known to be relevant to behavior change.

In specifying these steps, it is possible to "kill two birds....," so to speak. In the NRC-sponsored debate on HPE versus QWL, an attempt was made to minimize the importance of the former approach on the grounds that it was little more than traditional Industrial Engineering with a little psychology thrown in. Admittedly, there are certain similarities between these characterizations since both rely heavily upon measurement procedures. But, there are pivotal differences in techniques, and in the reasons for their presence in work settings across these "paradigms." Thus, an attempt will be made to highlight some of these critical differences in the following "steps to Human Performance Engineering."

STEPS TO SUCCESSFUL APPLICATIONS OF THE HPE APPROACH

STEP I: We recommend that considerable time be spent in locating where best to begin an application of an HPE program within an organization. Several considerations are involved in this choice. One of these is where (1) there is a heavy labor concentration. On the view that human behavior forms the cornerstone of success (or failure) for organizations, a second consideration derives from an examination of existing measurement systems that might reflect upon (2) large "disparities" between company expectations and current employee performance levels. The larger this disparity, the more compelling the site for program application. A third issue has to do with (3) ease of program development. Complicated tasks, large and "rambling" work areas, a history of workers and/or manager resistance, and so forth all represent concerns here. A final consideration is that of "representativeness." If, for example, program development in a portion of the organization does not provide the foundation for extension to remaining portions because of marked idiosyncracies between settings, much wasted time and effort can be the result.

These criteria of (1) labor concentration, (2) evidence of pronounced disparity between expectation and obtained performance levels, (3) ease of program institution, and (4) idiosyncratic program-development demands should be considerered with the axiom... "begin with the smallest unit likely to show effectsc.

perfect procedures, **systematically** extend to the next unit, and so on." These considerations guided us in, for example, choosing housekeeping to initiate an HPE application rather than food, sales, building maintainance, or front desk operations in hotel: in choosing the fiberglass rather than upholstery department of a plant and the plant per se rather than the corporate white-collar workers or delivery or sales in our manufacturing example; of attending to teller service rather than selling or other branch functions; why we chose service rather than sales to "upright" a failing branch of a large pest-control organization (see Figure 1), and so on. In each case, the presence of all of these criteria dictated where to initiate HPE procedures. And, it should be clear that these considerations and corresponding decisions represent quite a different collection of issues than those that typically guide standard industrial engineering applications.

STEP II. This step entails development of a mission-relevant measurement procedure that, if at all possible...(l) Reflects individual work performance, **(2)** Can be collected on a daily (or as frequencly as possible) basis, and (3) Is behaviorally relevant.

By "mission-relevant" is meant that, whatever the measurement system, changes should directly impinge upon the goal(s), purpose(s), and/or outcome(s) of the organizational component where HPE is applied. The reason for INDIVIDUAL MEASUREMENT is that, although sometimes not possible because of preeminent work arrangements and task requirements that appear to defy nongroup approaches, such is the only way to ensure maximum contribution from every employee. Much the same rationale underlies the reason for FREQUENT COLLECTION OF MEASURES. For example, the more frequently it is possible to objectively sample (monitor) the work of every employee, the less the delay in introducing behaviorally potent variables. And, there is considerable scientific evidence that DELAY can result in pronounced attenuation of said potency.

The stipulation of BEHAVIORAL RELEVANCE is perhaps the most important ingredient of those listed for this step. Any HPE application simply cannot be effective in the absence of this criterion. Behavioral relevance is achieved by the presence of three quite different conditions. First, a measure is behaviorally relevant only if each worker UNDERSTANDS, i.e., can verbalize, explicitly what actions (behaviors) s(he) must change in order to alter the value of the measure. Second, increases on this index of work output will be attenuated the degree to which the worker's actions do not fully CONTROL the values of the measure. Only the individual-worker's and not the actions of others must be able to produce changes in the measure. Finally, the laws of behavior can be invoked more efficiently and effectively when little delay occurs

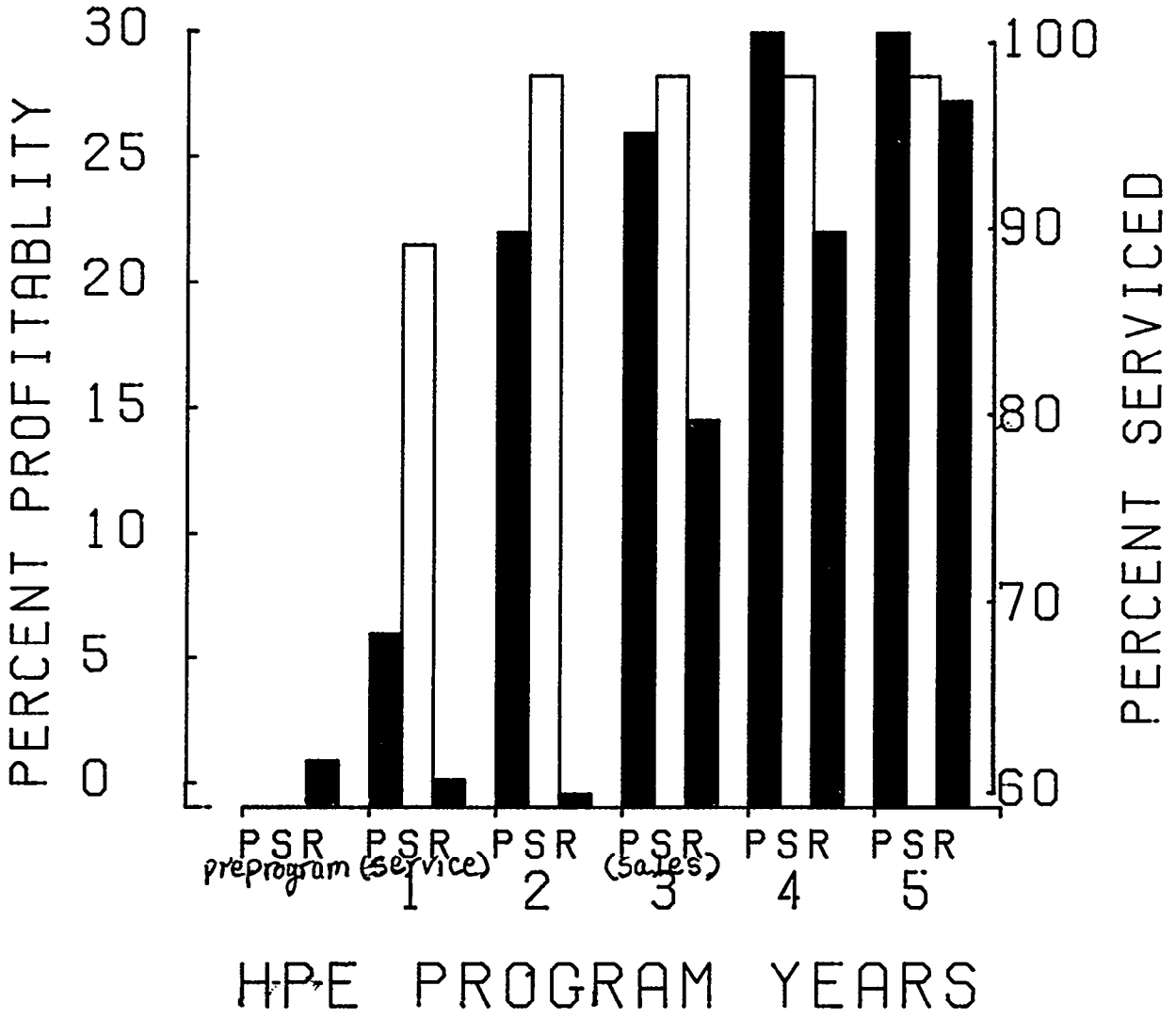

Figure **1:** Correlated changes in profitability (P), percent customers serviced (S), and revenue (R) with the temporally-staggared introduction of respective H-P-E applications to the service (service) and sales (sales) operations of a "failing" branch of a major pest-control company

between worker performance and collection of the measure.

We have a large amount of data that reflect on each of the preceding stipulations listed for this step. Probably little further embellishment is required regarding the issue of MISSION RELEVANCE. Suffice it to say here that whatever measure is used to index worker performance, it must reflect the occurrance or nonoccurrance of those key employee actions that are essential to fulfillment of their contribution to the mission to the organization. This can be assessed by calculating correlations between changes on this measure and the standard indices of productivity/profitability used by the company. In one of our sales programs, for example, we measured number of personal, face-to-face initial and followup contacts with prospective customers (see Figure 6 below). If increases on these measures had not been highly correlated with increases in new and pending sales and property listings, they would have been discarded for other behavioral evaluations. In an ongoing bank program, we developed an elaborate measure of the "first-class treatment" that a teller may/may not dispense to customers. If changes in this measure proved not to correlate highly with productivity measures such as customer-account retention, increases in the latter, a reduction in complaints, etc., we would have to discard it and begin again. Fortunately, it often has been possible to use extant measurement systems, thereby automatically providing a guarantee of mission relevance.

A good example of what can happen when INDIVIDUAL MEASUREMENT is not possible comes from the preceding furniture-manufacturing example. Table 1 shows that where individual measurement is in effect, both larger productivity gains that more easily can be maintained are more likely than for our "groups" applications wherein production-control procedures and task requirements defied individual assessments. As regards BEHAVIORAL RELEVANCE, consider first the issue of employee UNDERSTANDING. In our manufacturing example, we used the extant measurement system in effect, namely, daily efficiency. This was transduced by each worker completing a daily form that designated part number, time taken to perform the work, and number of pieces. These data were entered into the computer, efficiencies calculated for work on each part, all then being averaged to provide an overall index of daily work efficiency. Simple public display of this information for each individual on an daily basis resulted in across-board efficiency increases over an 8-week period of 5%, 8%, 3%, 5%, 6%, and 13%, respectively for the fiberglass, punch press, welding, main line, plating, and polishing and buffing departments. These departments were both supervised and staffed by all-male work populations. In contrast, the all-female upholstery department showed a meagre 0.5% efficiency gain over a similar 8-week period of simple public display. The explanation for this difference in effect was that none of the members of the upholstery department, including the manager, understood what the measure meant in terms of their daily activities. But, each showed steady increases thereafter once they and the manager were COACHED to "understand" this index in terms of the behavior changes each needed to make. The very same problem occured in our hotel HPE

applications. Virtually every hotel has some form of a checklist measurement system for assessing the quality and quantity of cleaning performed by their housekeeping staffs. Yet, one of the major and chronic complaints of hotel management has been over unusual difficulty in getting and maintaining clean rooms. A careful comparison of these standard checklists with the one(s) that we developed provides one clear reason for the general lack of success with standard measurement procedures. Virtually all checklists that we examined were so vaguely worded, globally formulated, and incomplete that is was virtually impossible for maids to UNDERSTAND exactly what actions they needed to change in order to obtain checkmarks. Moreover, supervisors found it impossible to be objective, accurate, or consistent in their use of the instrument for the same reasons. (These two factors probably accounted for the fact that we could find no hotel that routinely employed their checklists after an initial trial period of usage.) However, with development of a checklist that was behaviorally explicit and comprehensive, maids, housemen, and others, along with their supervisors, were able to make and then sustain the necessary behavioral adjustments needed to increase the overall quality and quantity of cleaning activities. It is worth adding that one major difference between ours and other checklists is the unusual detail that we include. This can be appreciated from the fact that most lists require few more than eight to 12 checkmarks while ours, for example, often involve 70 or more. Figure.2 is the list that we used in the hotel project that was summarized at last years' IREAPS presentation.

As regards the issue of CONTROLLABILITY, there are numerous examples of behavioral variables that have little or no effect on measures over which the actions of individual workers have little influence. The measure of number of "sales" is an excellent example. Sales managers historically have lamented over their inability to obtain marked and/or lasting changes on this measure. One clear reason for this is that number of "sales" is not exclusively determined by the behaviors of their sales staffs. We again can draw from our furniture-manufacturing HPE application to exemplify this problem. Although all sales are implemented by an indirect sales force, certain of the latter work individually and certain others are employed by distributor organizations. In the former case, it was possible to develop behavioral measures over which sales reps have full control, but we were prevented this opportunity where large distributor organizations were involved. We thus were forced in these latter cases to focus our HPE efforts on the standard measurement of sales output. By using behavioral measures that were "controllable" by the individual sales reps, we were able to increase their 1981-2 sales volume anywhere from 5% to a whopping 231%! In contrast, volume decreased modestly during our HPE

LOBBY CHECKLIST

Houseman_____ Supervisor_____ Date_____

yes	no	
		Front Doors
		1. Glass
		2. Stainless door frames
		3. Thresholds
		4. Mirrors clean
		5. Grating clean
		6. Red quarry clean
		Arcade
		7. Walk-off mats vacuumed
		8. Baseboards at optical shop
		9. Arcade pillars-base
		10. Phone booth floors
		11. Phone booth walls
		12. Phone booth doors
		13. Phone booth vents
		14. Telephones
		15. Hanging ash trays
		16. coffee-shop wrought iron
		17. Exterior coffee shop brick
		18. Art display base board
		19. Arcade doors- stainless
		20. Above door jams
		21. Lettering above door jams
		22. Shutters- 6 panels
		23. Flame room exterior windows
		24. Danish Room door
		25. Danish Room vestibule
		26. Floor-Smoke Shop entrys
		27. Exterior Smoke Shop windows
		Lobby
		28. Wash mosaic wall
		29. Smokey mirror
		30. Dust all display boards
		31. Fill & clean standing urns
		32. Polish vertical Brass insets
		33. Return air vents clean
		34. Viking Club doors dusted
		35. Viking Room doors dusted
		36. Cigarette machine
		37. Fireplace glass (both sides)
		38. Fireplace ledge washed
		39. Fireplace brass front polished
		40. Mirror columns
		41. Furniture clear of del
		42. Carpeting as good as possible
		43. Glass ash trays clean
		Front Desk
		44. White partition wall
		45. Black marble
		46. White base board marb
		47. Plexiglass guard
		48. Display counter
		49. Telephone counter (sc
		50. Bonnie Bell case
		51. Plastic plants
		52. Stairwell fixture & signs
		53. Announcement board
		54. Railings & glass inse to Mezz
		55. Mezz stairs
		56. Escalator stainless
		57. Escalator Panel
		58. Under astro-turf
		59. Custodial closet
		Elevator Foyers
		60. Corners all around
		61. Radisson Hotel displa
		62. HAB display case
		63. Ledge over HAB entry
		64. Size shop windows
		65. Elevator door frames
		66. Inside elevator carpe
		67. Inside elevator walls
		68. Sweep & mop red quarr. tile
		69. Sweep & mop lobby ter
		70. Clean reservation off
		4 X per year
		71. Liquid gold Viking rm. entry
		72. Dust Viking ship over door
		73. Clean central lobby fixture
		74. Mirrors over escalator

Figure 2: The checklist measurement instrument for one of the H-P-E applications to the public accomodations industry reported by Anderson et al., 1982

applications to the sales measures supplied by the larger distributor firms. (Even the latter may be viewed as a success when compared to the much larger decline in volume of a noncomparable control group, cf., Cook & Campbell, 1978, that was not exposed to the HPE program.)

As regards differences between the above HPE concepts and those of the industrial engineer, both admittedly rely heavily upon measurement. However, such systems usually are developed by the IE without explicit concern for changing individual worker behavior. Instead, such measurements, along with being used to develop standards, primarily are used for developing new or trouble-shooting old production-control procedures, constructing work schedules, projecting future labor needs and/or costs, and so forth, all of which are both laudable and desireable purposes. The difference, however, from an HPE application is that such systems typically are not developed for the explicit purpose of altering human work activity in terms of what is known about the laws of human behavior.

STEP III. We are in accord with the IE regarding the importance of standards. However, the reasons for our agreement again appear to differ somewhat. Standards, when appropriately developed and introduced, capitalize upon several important behavioral possibilities one of which is that the more explicit and objective the statement to workers regarding exactly what is expected in behavioral terms, the easier and more quickly are those expectations achieved. This "postulate" is not simply a restatement of the standard view of goal setting. We now know, for example, that goal setting per se only will have marked and perduring influence in changing human performance the degree to which these goals are expressed in highly explicit, well articulated behavioral expectations. Illustratively, a goal for sales is much less useful as a prerequisite for changing behavior than is one expressed in terms of number of appropriate client contacts. The former is an OUTCOME measures that, in part, is dependant for increases upon the latter, which is a behavioral measure. Moreover, maintenance of these changes is not likely unless a means is developed by which both the behavioral expectations and how to achieve them are made chronically conspicuous to all concerned.

Thus, this step consists of the arrangement of a complex of ingredients and variables, including (1) development of work expectations, (2) formulation of the latter in behavioral terms that both designate exactly what actions are required along with their required rate and pattern (e.g., a given number of calls within a carefully-defined customer population), and (3) a procedure wherein this information can be kept chronically conspicuous. Again, there are considerable data on the potency of this step and/or the variables involved. In connection with the need for behavioral explicitness, consider the effects of the simple introduction of expectations, expressed in behavioral terms, for student employees that worked for the UND Senior Bar during the 1981-2 academic year. Historically, student attention to cleaning in both serving; eating, recreational, and the lavatory areas has been so bad as to defy

description. The result has been a chronic struggle over the years between this facility, state health officials, and its constituents to achieve a safe margin of cleanliness. General managers chronically have appealed to their student-employee colleagues to clean their respective areas better or risk losing their place of work. No visible changes ever seemed to occur, however. We thus developed a behaviorally-relevant measurement procedure that, among other things, included the development of checklists of exactly what actions were needed to achieve a clean station for each of the 11 different areas (different checklists for each!). Then, after covertly (secretly) recording on these lists how each of the 30 student-employees cleaned their respective areas, we simply displayed the checklists at each station and called them to the attention of each student. The average percent of items cleaned prior to posting these expectations was 49.9% for the 30 employees, but rose to 55.2% upon display and explanation of the lists. Moreover, because display was possible at each work station, these expectations were kept "in front" of workers, a factor that likely was partly responsible for maintenance of this gain over several months. These data are shown in the left portion of Figure 3.

A similar result was obtained from our aforenoted HPW bank project. Following development of our behaviorally-explicit definition and measurement procedure of "first-class service" (involving placement of microphones at each teller station to record, and a reliable scoring system to measure the quality of teller transactions), we simply introduced the scoring system and associated behavioral expectations in the form of a memo and group meeting with the tellers. Prior to introduction, tellers averaged 62% of the behaviors that defined "first-class service," this in spite of having chosen a branch acknowledged to be the best of the 19 for this particular organization. Introduction of behavioral expectations resulted in an immediate 15% average increase in teller courtesy, thereby raising their service from third- to at least second-class quality by our definition. However, since we were unable to discover a means to maintain the conspicuousness of these expectations, average courtesy showed a decline within about 7-8 days following introduction of the memo. But, as soon as expectations again were mentioned by the branch manager, courtesy picked up again. Some of these data are shown in Figure 4.

A final illustration comes from a recent HPE application within the manufacturing concern noted above that currently is experiencing harsh competition with the Tiawanese. While an IE-type measurement system has been in place for several years in the plants of this company, it unfortunately proved insufficiently behavioral to be of

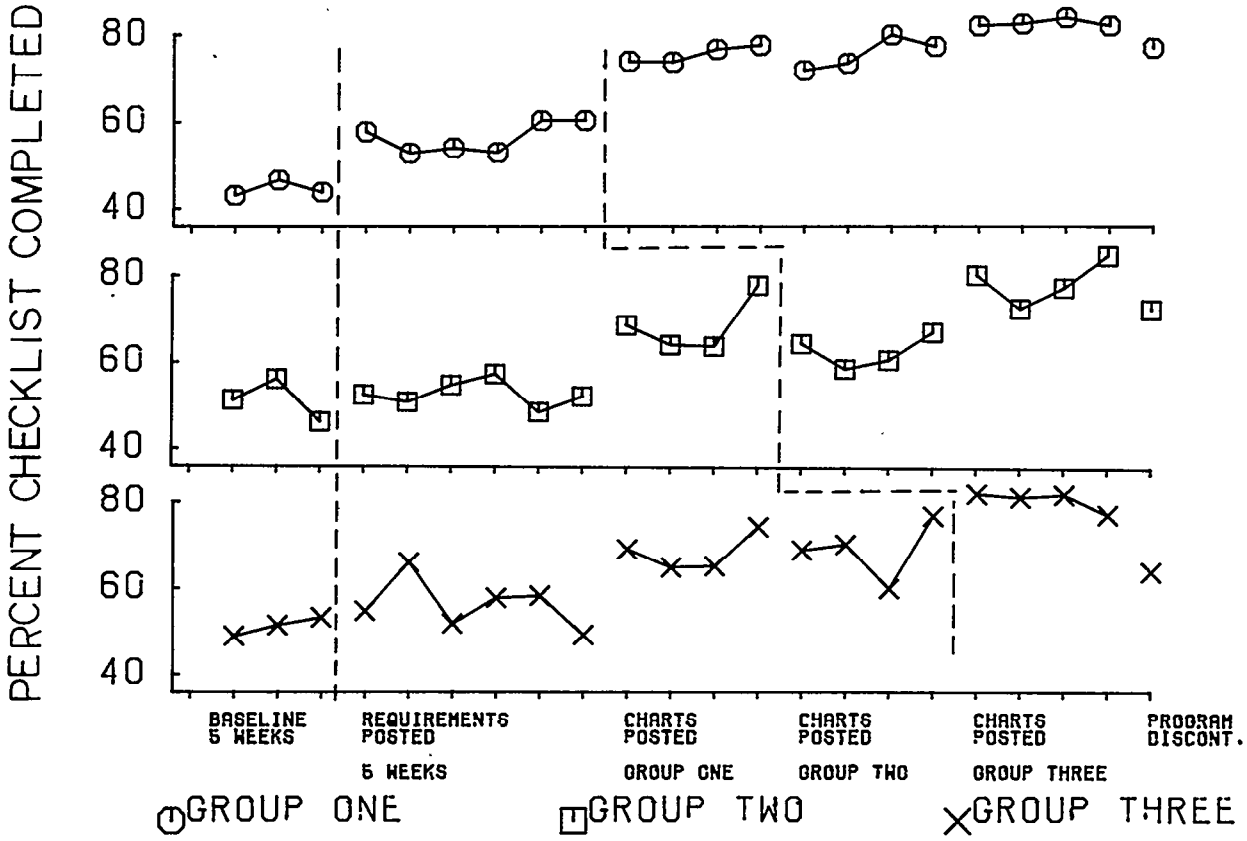

Figure 3: Mean percent items checkmarked for each of three, randomly-formed groups of student employees of the University of Notre Dame Senior Bar. Each checkmark represents acceptable performance on one aspect of a total cleaning assignment. The first three points are preprogram checklist averages. The ensuing six points are for average scores achieved following public display of the checklists at appropriate work stations. Thereafter, the data reflect average changes in percent checkmarks upon public posting of scores for Groups 1 (upper graph), **2** (middle graph), and 3 (lower graph), respectively. Note that the procedure of public charting was introduced on a time - staggared basis. The final point was collected following the last day of employment for each student.

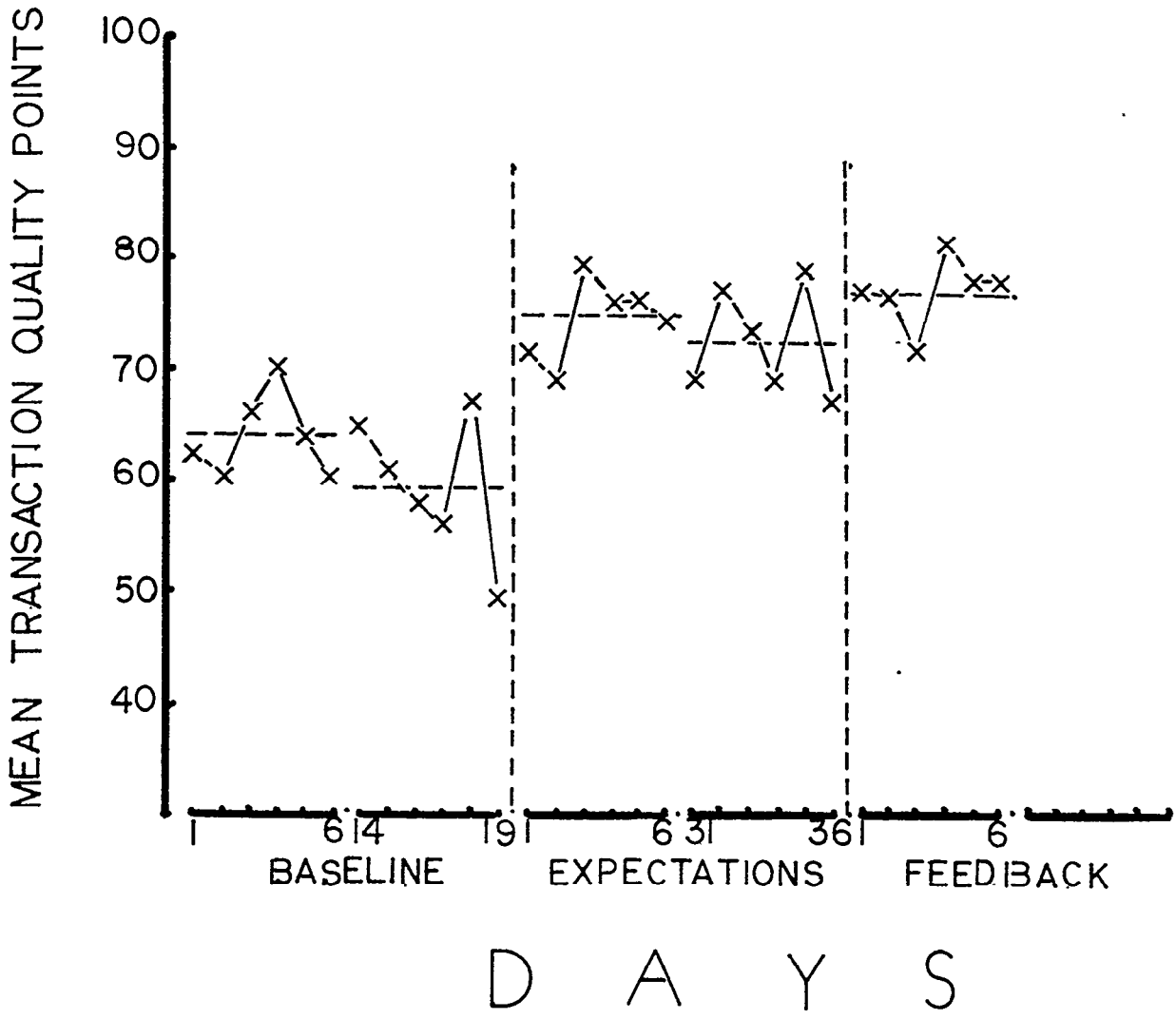

Figure 4: Mean service-quality scores, averaged across the tellers of a large branch of a major bank. The initial scores (scores for the first and last six baseline recording days) were obtained prior to informing tellers about how transactions were scored. The intermediate 12 points (first and last six recording days of this phase) were collected following discussion and dissemination of information about the scoring system to all tellers. The last six scores are for the first six recording days following public posting of scores for each teller.

as much use as we require to implement changes in worker performances. At these plants, workers operate up to five machines concurrently. Their prime responsibility (ies) is to maintain as much 'up time" as possible for each by minimizing break- and shut-downs. Unfortunately, we discovered through a laborious investigation over 100 reasons for machine "down time," and that there existed no way to discern which of these was involved for any given machine for any given "down" period. Moreover, because of this inexplicitness, no standards had been developed in behavioral terms in order to learn whether "down time" was being minimized. We reasoned that without a measurement system that "sensitized" individual workers in these connections, it would be easy for each employee to develop their own, unbuttressed expectations. We thus devised a scheme by which each worker easily could designate the exact reason(s) for down time for each machine, and then introduced it. Note well that this introduction did NOT include a statement concerning expected durations for each reason. Prior to this introduction, average daily machine "up time" ranged from about 6.0 to 6.8 hr. Since introduction of the new measurement system (sans expectations), "up time" has averaged in excess of 7 hr. daily. This amounts to a whopping 5+% increase!

Again, we believe the differences in emphasis and utility of this step for HPE and for the prototypical IE are self evident.

STEP IV. Probably there is no easier and more potent way to increase work behaviors than through the proper introduction of feedback. The key term here is "proper." While there remains much research to be done regarding all of the many conditions that define this term, there are some guidelines in this connection that have nominal empirical validity. First, (1) we believe feedback should be conspicuous, (2) ever-present, and (3) freely available for scrutiny by the individual worker and his/her "boss." Our findings are that improvements thus likely will be greatest if feedback is given in the form of individual charts that are posted in a conspicuous place where the manager and worker alike routinely can see them. Moreover, (4) these charts should be kept updated with the same frequency as measurements are collected, e.g., daily. Further, (5) the effects on work improvement of visual display can be enhanced by daily, neutrally-worded manager statements to each worker regarding their prior scores. There also is mounting evidence that (6) feedback accompanied by promises of no retaliation... neither personal nor job status... will result in more robust, across-board long-run gains than by any other procedure.

While public posting likely will prove the best procedure, there also is evidence that (7) public anonymity also is important. Here, the idea is to provide for each worker a context about how others are doing with respect to her/himself, but to do so in a noncompetitive and nonthreatening manner. Personal "threat" and competitiveness with colleagues can breed unwanted discomforts, counterproductive actions, and low esprit de corps. What is wanted instead is self-competitiveness within a context of fairness

(objectivity) and balance. By being able to visualize how one is doing compared to others without embarrassment or unusual conspicuousness, workers feel emotionally more able to make the work adjustments appropriate to organizational expectations. Moreover, by encouraging self-competition, it is possible to "spice" otherwise monotonous and/or uncomfortable working circumstances.

While space does not permit citation of all of the direct and circumstantial evidence regarding these directives for feedback of (1) conspicuousness, (2) everpresence, (3) individual availability, (4) current, (5) multimodal, (6) nonaversive, and (7) anonymous, we have collected an enormous amount of data regarding the effectiveness of the feedback step when most or all of these variables are in place. Please be referred to last year's presentation, for example, wherein across departments of the manufacturing illustration, feedback dispensed in accord with these stipulations (Figure 5, Anderson, 1981) resulted in an across-board increase of 5.8% in over plant efficiency. Similarly, indirect evidence from our real-estate sales project was that a like feedback procedure alone resulted in an over 266% average increase in number of initial "cold-turkey" contacts and in an 175% average increase in personal followup contacts. Further, during this feedback-only period, this firm rose from seventh in percent-business for their area (a position that they had occupied for several years) to, by a large margin, first place!

Feedback per se in the hotel project presented last year resulted in nearly 300% increase in quality of cleaning, as measured by average changes in checklist scores. Moreover, this magnitude of change has not been unusual for numberous HPE extensions to our other hotel projects (some noted above). For example, feedback-only reduced by a whopping 4800% the food-delivery latency of waitresses in one of our targeted restaurants, an increase in average restaurant charge of 17% and in room rate of 7.2%. In our pest control operation, simple daily posting of number of customers serviced resulted in an across-board increase from about 69% of customers served each month to 90%, or a 21% increase. In the case of the Senior Bar project noted above, posting was done on a time-staggared basis for 10 employees at a time. Figure 3 shows two outcomes in connection with feedback introduction. First, the group of 10 that were exposed to the feedback procedure first showed an immediate and sustained average increase in cleaning performance of 19.1%. Second, not surprising was a near-comparable increase in the cleaning performances of the two groups not yet exposed to this procedure. The reason that this change was not surprising is that all groups concurrently were made aware that one-third of their colleagues were being measured and charted. It is probably that those not posted "put two-and-two together" in this connection and changed their behavior accordintly...and behaved thereafter as if they too were receiving feedback even though such was not actually the case!

At the risk of gilding the proverbial lily, consider the 'results of an HPE application to the UND hockey team. Although heralded as

innately talented, this team performed poorly over the 1979-80 and 1980-81 seasons and into the one (1981-2) wherein we applied HPE procedures. We targeted for change the number of "legal hits" per minute that each player made, this requiring an elaborate and laborious scoring system. (We are aware that debate is possible over whether this measure is "mission-relevant." However, the team captains nonetheless decided that an increase in "hits" was essential to reversing their team fortunes.) Once a baseline has been determined, each team member's game scores were publicly and anonymously posted. These data, averaged for the six seniors separately from the remaining 13 juniors and underclassmen are shown in Figure 5.

These data show that, for the 13 juniors and underclassmen (all of which exhibited baseline "hit-rate" performances decidedly below their senior fellows), posting had the immediate and beneficial effect of markedly increasing the percentage of "legal hits." (The effect was not as pronounced for seniors because they already were at a high "hit-rate.") Moreover, there was coincident, instant reversal in team fortunes. The team, among many other accomplishments, launched a home-ice winning streak that went unbroken the remainder of the season!

Again, differences between an IE and an HPE approach can be discerned from the foregoing. Whereas both as noted entail work measurements, concern over how such measures integrally can be employed to alter the individual work performances of employees through the development of appropriate feedback procedures rarely is of concern by the former. Accordingly, it is unlikely that an IE would show much interest in the many variables outlined above that seem to characterize the most effective use of feedback.

STEP V. Display of performance expectations, as part of the feedback procedure, represents yet another human performance variable of documented effectiveness. Unfortunately, we only rarely have analyzed this feature separately from the feedback procedure, and thus have minimal data that directly addresses the value of this step. Fortunately, we can use the data from the hockey project to at least illustrate the potential of this factor. After simple posting for a period of four weeks, we developed performance expectations through individual goal-setting sessions. Each player individually was asked to set a realistic "hit-rate" goal that subsequently was displayed as a straight line on his chart. While only a few actually achieved, let alone were able to maintain, their expectations, all 13 of the juniors and underclassmen (as shown in Figure 5) again showed a marked increase over previous performances. Setting fair, realistic standards and then displaying them as part of the feedback procedure thus is, we believe, yet another behavioral variable of considerable importance. Locke (1968) believes that this activity

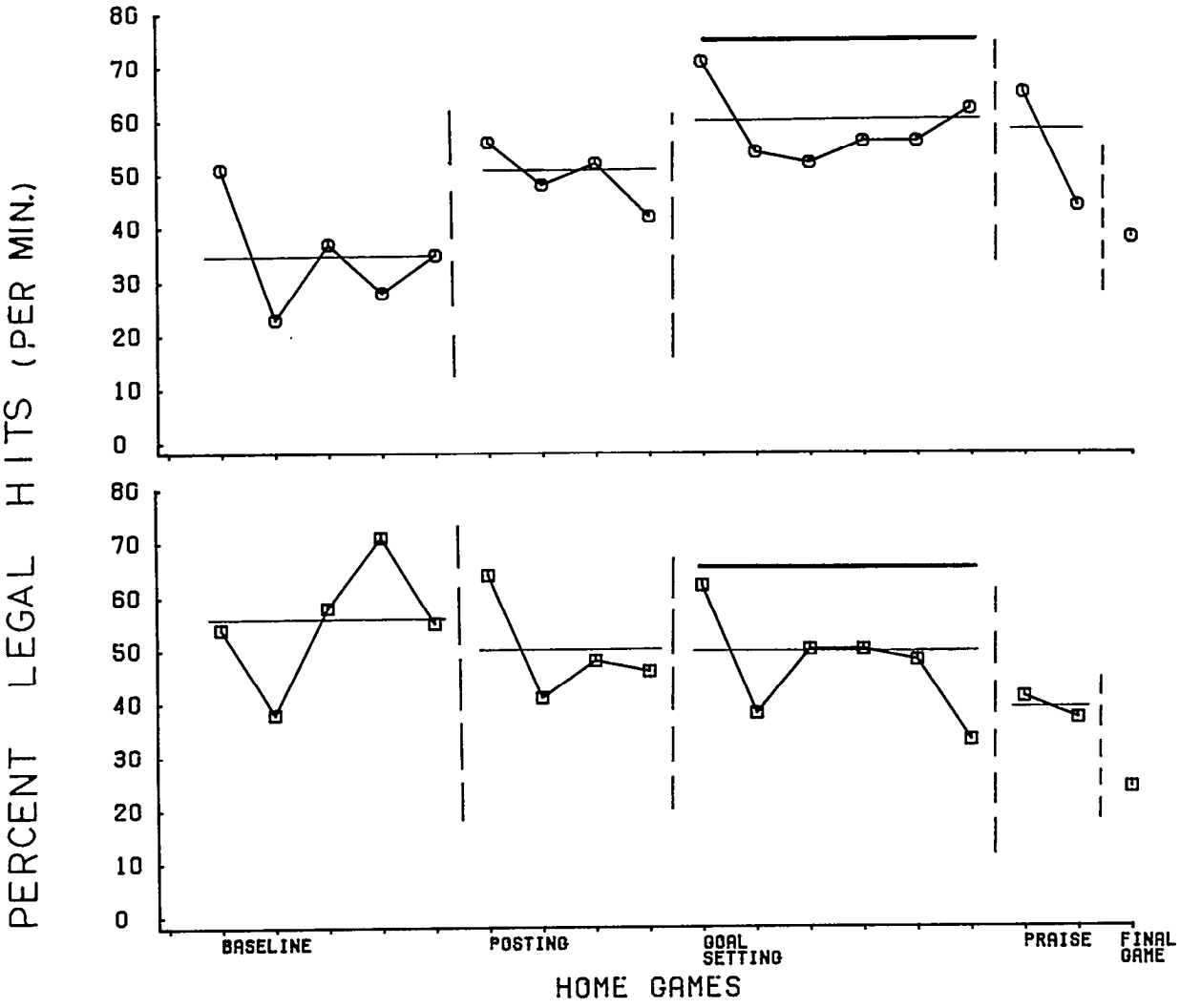

Figure 5: Mean number of legal "hits," by home game, expressed as hits-per-minute, displayed separately for (1) the 13 University of Notre Dame junior and underclassmen (upper graph) and (2) 5 senior varsity hockey (lower graph). The initial points represent average hit-rates prior to individual public display of the data. The ensuing four points show the effects of the latter. The third set of points represent "hit rate" following individual goal setting. The next two points were derived following individual recognition from the coach. The last points display performance during the final home game.

will be most effective if, perhaps in addition to the above, (1) the goal is modestly difficult to achieve, and yet (2) is "committed to" by the individual worker.

STEP VI. This step permits invocation of some of the most well-established of all of the known behavioral variables. These have to do the the known effects of behavioral consequences; namely, (1) if a positive or "satisfying" event follows a behavior, that behavior subsequently will increase in rate and vigor of occurrance, (2) if a negative or "annoying" circumstance follows a behavior, the reverse will occur, and (3) if nothing follows behavior, behavior rate also subsequently will diminish but more slowly than if a negative is involved. ACTUALLY, IT IS THE FIRST AND LAST OF THESE LAWS THAT APPEAR TO HAVE THE GREATEST UTILITY IN THE WORK SETTING. Although NEGATIVE CONSEQUENCES can be quite effective in determining the course of work behaviors, their usage also has been associated with numerous undesireable effects as well. Some of these include EXCESSIVE ABSENTEEISM, TURNOVER, TARDISM, SABOTAGE, UNION CONFLICT AND GRIEVANCES, LOWERED ESPRIT DE CORPS, AND GENERAL EMPLOYEE UNCOOPERATIVENESS. Indeed, recent surveys suggest that excessive use of negatives engenders considerable loss of employee respect for their managers.[1]

Importantly, rather remarkable work increases have been achieved through the exclusive dispensation or withholding of positive outcomes respectively for appropriate or inappropriate behaviors. And, fortunately, there are perhaps an infinite number of ways in which these variables can be implemented, many of which are likely to prove effective in almost any work situation. For example, we have had considerable success in the use of FOREMAN PRAISE AND SUPPORTIVENESS as a positive outcome for work improvement. While considerable training and follow-through is required with foremen to teach them to become the equivalent of a "social cookie," the associated gains in work improvement can be well worth it. Consider Figure 5 of last year's IREAPS presentation (Anderson, 1981) wherein the efficiencies for the worst three, the best three, and the remaining employees for four departments of the furniture-manufacturing example are averaged (1) prior to feedback, (2) as a result of feedback, and (3) when praise by foremen is added to the feedback condition. The overall gain to date from the addition of praise is 11.8% even though praise is dispensed to the three best of each department for maintaining, not increasing, their performances at 100% efficiency.

We recently added a tangible reward system in the form of specially-made, gold-colored coins that can be inserted in all of the vending machines in the employee lunch area. These coins are the equivalent of quarters and can only be earned if (1) an entire department achieves a preestablished performance goal the previous month, and (2) individuals within that department exceed by specified percentages that performance goal on any given day during the succeeding month. For example, 5-9% above the goal earns one coin, 10-14% earns two coins, and 15% or more garners three coins.

And, in addition to regular vending services and games, the company installed a "mystery" machine, insertion of five coins into which earns a (1) certificate of award, a (2) certain number of instant winners whose number corresponds to various gift-certificate amounts, and (3) and opportunity for a monthly lottery for such items as a color TV with remote control, etc.

Figure 6 shows the effects of the use of a tangible reward for performance increase in our real-estate sales project. **As** seen, across-board behavior increases were both immediate and lasting as long as this system was in place. The rewards were in the form of credits exchangeable for a wide variety of goods, the credits being earnable in terms of a complicated system that involved changes in both of the client-contact behaviors noted above.

Of course, if charted behavior changes either do not change in the desired direction or are not maintained at appropriate levels, they do not qualify for pleasant consequences. This does not mean, however, that they thereby qualify for unpleasant outcomes. Indeed, we have found that such exactly is what should NOT happen! Instead, less than appropriate activity levels should be fully ignored for best, long-run effects. As long as managers invariantly follow appropriate behaviors with consequences that are satisfying to their employees, ignoring inappropriate behavior frequently is all that is needed to achieve productivity increases that are as impressive as those cited above.

We have found that A FEW RULES OF THUMB are helpful in the use of positive consequences. First, (1) satisfying consequences should be contingent in that they should be dispensed so that the employee connects it with the targeted behavior change. Giving rewards immediately after response changes occur can be quite important in this regard, although there are others ways to make the connection if the latter opportunity does not present itself. Second, (2) it is much better to give smaller, more frequent rewards than a few large ones. Third, (3) we believe that behavioral approximations should be occasionally rewarded. This means that reward should be given once in awhile for visible (objective) evidence of "trying" even in the absence of full success. Fourth, (4) once a desired behavioral level has been achieved, that level should be followed by reward every time it occurs for awhile. Eventually, however, (5) reward frequency can be gradually reduced with no loss of rates of performance. Eventually, rewards can be given "every now and then" with good success. This latter is part of what a good MAINTENANCE PROCEDURE should entail.

When social rewards are used, we train managers to develop characteristics that parallel what we term "the four Vs." The first V stands for VULNERABILITY. By this is meant that the more sincere the praise, the more effective it will be. The second V stands for

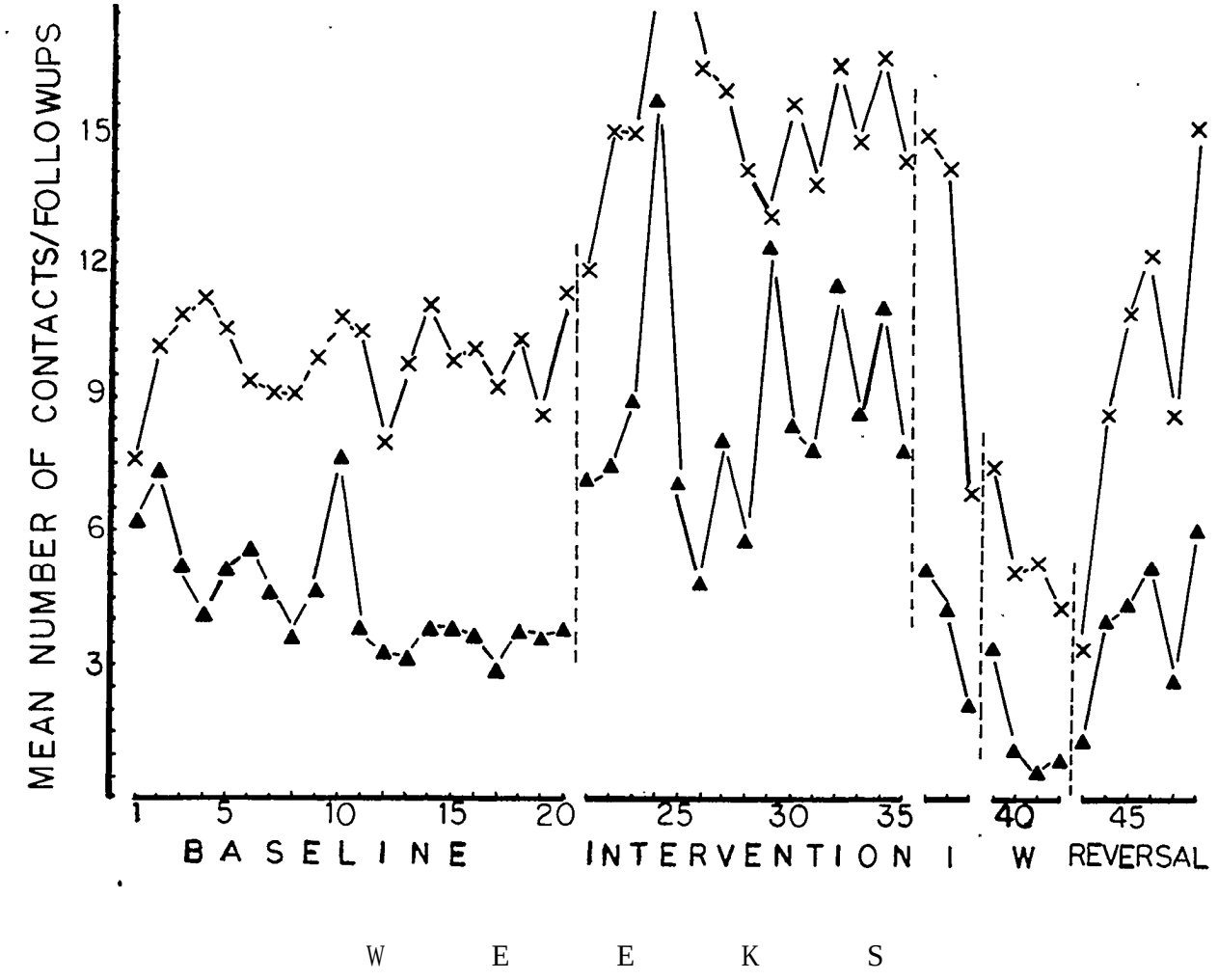

Figure 6: Average number of initial (~) and followup (X) contacts made by real-estate agents, arranged by week, for (1) 20 baseline, (2) 15 reward, (3) 3 pre-program withdrawal, (4) actual program withdrawal (W), and (5) an additional six program-reinitiation weeks.

VARIABILITY. Since humans habituate to nearly everything, it is important to vary how and what is done to socially reward any given employee. The third V is for VERSATILITY. Different persons like different things. Managers must learn these preferences and dispense accordingly. This V is based on the axiom... "different strokes for diffent folks." Translated, some people prefer their praise in the form of a "pat" on the back, others in terms of "a good word," still others in a handshake, smile, or combination of these salutations. The fourth is for VISIBILITY. Social "strokes" can be made most effective when dispensed publicly for all to see. In that way, those that haven't earned such have an opportunity to experience and correspondingly learn to discriminate between their receipt and nonreceipt.

A final word of caution here. Training and then ensuring that managers (1) cease and desist from the use of negatives in connection with the charts and (2) accordingly increase the use of positives is no small chore. We have found that achievement of these outcomes require that we be every bit as systematic, programmatic, and alert as is required to achieve behavior changes from front-line operatives. It is no less a Human-Performance-Engineering task to change and then maintain key manager behaviors than it is to increase productivity-relevant operative behaviors (cf., Crowell & Anderson, 1982).

CONCLUDING REMARKS

In fairness, the preceding has been a highly abbreviated overview of the number of steps and corresponding behavioral variables that should be involved in an effective HPE program. Indeed, in a recent paper presented to the American Institute for Kitchen Dealers (anderson, 1982), I outlined a 13-step HPE program that if followed likely would increase the chances for survival of small Kitchen and Bath dealerships. Embedded within these 13 steps were considerably more variables to be implemented than discussed in this paper. Nonetheless, those steps outlined in the body of this paper represent the major ingredients (prototype?) of any successful HPE application and, if appropriately adapted to a shipbuilding undertaking, doubtlessly would have a visible and lasting influence in increasing work output. As regards reliable and objective individual measurement, my brief experiences in a single shipyard suggest that numerous obstacles likely will have to be surmounted before such is possible across all of the crafts. Moreover, systematic involvement of leadermen in both the feedback, coaching, and reward phases present numerous challenges at present. Suffice it to say, however, that if such challenges can be met in hotels, food-processing organizations, insurance and real-estate companies, pest-control corporations, a diversity of manufacturing settings, and student work settings, I feel confident that the challenges posed by the shipbuilding industry also can be met with at least equal successes.

And, as regards precise estimates of the effects that can be achieved, an extrapolation from the present data suggests that we

can expect a minimum of a 7% increase in work output simply from development of an behaviorally-relevant measurement system coupled with a statement of its ingredients to employees and supervisors; a minimum of an additional 10% from development and deployment of appropriate feedback programs; and at least another 6-7% (and possibly considerably more) from institution of a relevant reward system. All told, then, it should be possible to achieve and sustain from 20-25% more work output from our front-line operatives as a result of an appropriate application of the HPE approach. And, with the measurement systems and safeguards in place that undergird this approach, there can be no question that convincing proof can be obtained as to whether this claim does or does not achieve fruition. Finally, I can see no reason why some of the other fringes that have been associated with HPE applications also cannot be achieved, including reduced absenteeism and turnover, fewer grievances and conflict, and a generally elevated esprit de corps. All of these effects are traceable to the systematically greater concern and congeniality that leaderman and managers are bound to develop in the process. I know of no other extant work-improvement program that (1) can make such explicit claims, (2) has the means to assess them, (3) the evidence to back them, and (4) the explicit means to achieve them. Please, nonetheless wish me some luck as well just in case!

References

Anderson, D. C. Human performance engineering: On reversing the productivity slowdown. PROCEEDINGS IREAPS TECHNICAL SYMPOSIUM, 1981, 9, 335-358.

Anderson, D. C., Crowell, C.R., Sponsel, S. S., Clarke, M., & Brence, J. Behavior management in the public accomodations industry: A three-project demonstration. JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT, 1982, In Press.

Anderson, D. C., Crowell, C. R., Sucec, J., Gilligan, K. D., & Wikoff, M. Behavior management of client contacts in a real estate brokerage: Getting agents, to sell more. JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT, 1982, In Press.

Cook, T., & Campbell, D. T. QUASI EXPERIMENTATION: DESIGN AND ANALYSIS ISSUES FOR FIELD SETTINGS. Chicago, Rand-McNally, 1978.

Crowell, C. R., & Anderson, D. C. The scientific and methodological basis of a systematic approach to human behavior management. JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT, 1982, In Press.

Crowell, C. R., & Anderson, D. C. Systematic behavior management: General program considerations. JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT, 1982, In Press.

Cummings, T. G., & Molloy, E. S. IMPROVING PRODUCTIVITY AND THE QUALITY OF WORK LIFE. New York: Praeger Publishers, 1977.

Cummings, T. G., & Molloy, E. S, & Glen, R. A methodological critique of 58 selected work experiments. HUMAN RELATIONS, 1978.

Hackman, J. R. The design of work in the 1980s. ORGANIZATIONAL DYNAMICS, 1978, Summer, 3-17.

Kendrick, J. W. UNDERSTANDING PRODUCTIVITY: AN INTRODUCTION TO THE DYNAMICS OF PRODUCTIVITY CHANGE. Baltimore, Johns Hopkins University Press, 1977.

Locke, E. A. Toward a theory of task motivation and incentives. ORGANIZATIONAL BEHAVIOR AND HUMAN PERFORMANCE, 1968, 3, 157-189.

Luthans, F., & Kreitner, P. ORGANIZATIONAL BEHAVIOR MODIFICATION. Glenview, Ill., Scott-Foresman, 1975.

Wikoff, M., Anderson, D. C., & Crowell, C. R. Behavior management in a factory setting: Increasing work efficiency. JOURNAL OF ORGANIZATIONAL BEHAVIOR MANAGEMENT, 1982, In Press.

Woodman, R. W., & Sherwood, J. J. The role of team development in organizational effectiveness: A critical review. PSYCHOLOGICAL BULLETIN, 1980, 88, 166-186.

Steel, R. P., Lloyd, R. F., Ovalle, N. K., & Hendrix, W. H. Designing quality circles research. THE QUALITY CIRCLES JOURNAL, 1982, 1, 40-43.