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Obsolescence or Conformity to Expectation? A Study of Technical Obsolescence in One Large Technology-Based Organization

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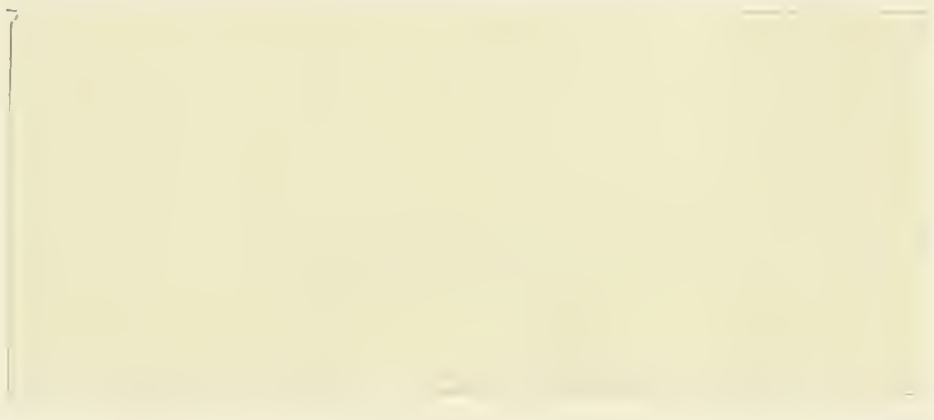

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The authors wish to express their gratitude to the management of the cooperating company for making these data available to us. We also wish to thank all of the engineers, who participated in the original study.

INTRODUCTION

The problem of technological obsolescence among engineers has been a subject of great interest over the past 20 years. Most of the concern over this problem has been based on little more than speculation. The empirical support for the actual existence of an obsolescence phenomenon has been sketchy at best.

Much of the concern can be traced to the well-known work of Lehman (1953), who in his book, Age and Scientific Productivity, showed that most great scientific discoveries had been made by relatively young scientists. Even the exposure of Lehman's fundamental statistical fallacy by Cole (19), has failed to dim the enthusiasm for extrapolating his conclusions from great scientists to very average engineers.

Another source of this concern stems from management observation. Research and development managers often report the difficulty they find in motivating their older engineers to keep abreast of the "state of the art" in their specialties. This may well be true, but in interpreting such observations, we must be careful to separate cause from effect. It could well be that managerial pressures and expectations underlie the observed failure of the older engineer to keep up to date.

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The limited empirical evidence on the subject is hardly any more conclusive. Some researchers maintain that age is an important determinant in learning ability and creative performance and is therefore a strong contributing factor toward obsolescence. Others disagree strongly. Dalton and Thompson (1971), and Pelz and Andrews (1966) report

that people are most productive early in their careers. Upon closer examination of their own data, however, Thompson, et al (1974) found that age in and of itself does not indicate fading ability. Instead, they argue that organizations have too narrow a view and fail to allowengineers to contribute effectively to their organization over their careers. It is these organizational constraints that lead to obsolescence. Supporting this view, Bernstein, in studies of engineers at the General Electric, Research Center, found that no significant relationship between an individual's age and his value to the company. Recent research by Katz (1978), Katz and Allen (1983) and Kozlowski and Hultz (1984) also shows engineers' response to their work environment to be independent of age. Cooper and Jones (1980), in a study of managers, even found an inverse relationship with age. Younger managers, in their case were found to be more obsolete than older ones. They were, however, looking only at high level managers, aggregated across three industry sectors.

Obsolescence and the Organizational Environment

In a review of the literature on aging, Van Atta, et. al. (1970) concluded that intellectual capacity does not decline inevitably with age. Their suggests, instead, that there is considerable evidence in support of the belief that if engineers work in a, "...stimulating environment conducive to productive effort including opportunities for educational renewal and a diversity of work experience, well motivated personnel will remain productive until retirement." Kaufman's (1979) evidence also stands in opposition to the hypothesis that increased obsolescence is directly related to age. While his data show no age relationship, they do support a strong case for the combined impact of work and education.

In this area of education and job experience, Perrucci and Rothman (1969) report that both influence vulnerability to obsolescence. Kaufman's (1974) research indicates that with meaningful work assignments older engineers can stay abreast of their discipline as well as their younger colleagues. While Perrucci and Rothman (1969) and Ansoff (1973) argue for continuing technical education, others (particularly Kaufman, 1975), suggest that continuing education programs, per se, have had little effect on preventing obsolescence, unless the education is directly relevant to the current work assignment. In spite of deficiencies in the research design (sampled engineers were not randomly assigned to treatment groups), the findings to date seriously question the efficacy of continuing education programs especially when they are neither tied to a degree nor to specific work needs.

Many other researchers have focused on the effects of job activities. Margulies and Raia (1967) and Cooper and Jones (1980) find that job-related problem solving is the most important aid in helping professional personnel keep abreast of developments in their fields. Kaufman (1974) contends that if the job is not challenging or stimulating it must be redesigned and enriched in a way that forces the engineer to remain current. Focusing on the first job experience, many studies have found that the challenge and perceived significance of the first work assignment given to newly hired college graduates has far greater influence on eventual performance and career success than does the challenge and demand of succeeding years (Katz, 1980; Berlew & Hall, 19 ; Peres, 1966). Those with limited challenge are likely to become frustrated, reduce their aspirations, and perhaps leave the organization. The feeling of being underutilized has serious consequences not only for

maintaining currency but also leads to a perception of the individual's relationship with the organization that discourages performance. Raudsepp (1964), Ritti (1971), Kornhauser (1962) and Hirsch (1958) all indicate negative outcomes, particularly decreased motivation for keeping up to date, from underutilization of ability. These results are reinforced by Schein (1978), Katz, et. al. (1982) and Katz (1985), who argue that managers need to keep challenging their subordinates with increasingly challenging tasks

Motivation to update has also been studied by Landis (1969) and Glaser (1963). Landis found that when managers do not perceive real advantages in keeping up to date, they will not be stimulated to further learning. Interestingly, Cooper and Jones (1980) also conclude from their literature review that the <u>importance</u> of keeping up to date perhaps the single most important variable affecting obsolescence.

The motivational influence of the work group on obsolescence has also been studied, particularly that portion involving the manager-subordinate relationship. Dubin (1972) suggests that the behavior of the supervisor is one of the chief organizational determinants influencing motivation to update. House and Rizzo (1971) maintain that management practices and policies are critical determinants of engineers' motivation to stay up to date. Locke (1970) argues that supervisors can aid in the motivational process by helping subordinates to specify goals within the context of the job, that will insure the upgrading of technical skills in the realization of these goals. Supervisors can also play the role of coach (Hinrichs, 1966), communicating to subordinates what is expected of them, giving them tasks to help their development, and providing them with feedback on how they are doing.

The use of using continuing education as a strategy to counteract obsolescence, generally fails to recognize the importance of the motivational environment. Continuing education programs were developed as an answer to obsolescence. At the time of their inception (primarily the early 60's) obsolescence had been defined as essentially an individual phenomenon associated with deterioration in the individual's state of knowledge. Given that focus, it follows that strategies for dealing with the problem centered around reeducation (Kaufman, 1975). Even Wheeler's (1968) early study of continuing education courses for engineers and scientists revealed shortcomings in the management of these courses in terms of their organization, their ability to attract the right participants and their relevance to the engineer's immediate work. Landis (1969) suggests that most engineers are not interested in continuing education but rather in performing the current job better. They respond more positively to training than education and demand an almost immediate payoff in terms of recognition or salary. Dalton and Thompson (1971) also argue that courses alone are not an effective remedy to obsolescence. The net conclusion of all of this discussion is that the obsolescence problem, to the extent that it exists has not been ameliorated by continuing education programs, but needs to be addressed from a variety of perspectives. Although earlier works may have stressed reeducation of engineers as the primary method by which obsolescence was to be combatted, the recent evidence strongly suggests that education coupled with career management, and the creation of environments that are demanding and challenging to the engineer are ways that management can influence and prevent obsolescence.

THE STUDY

Based on this review of prior research, the following hypotheses were tested in the present study:

1. Career Goals: Desire for future reward influences present behavior. Therefore, it is expected that the greater the reported desire for advancement, the lower the degree of reported obsolescence.

2. Importance to the Job: If engineers believe that they can satisfactorily perform their work, without investing any effort to stay current technically, they will be less motivated to invest the effort. Conversely, if the performance would be impeded by failure to maintain currency, they will be more motivated to stay current. Therefore, the greater the perceived need to stay current technically, the lower the degree of reported obsolescence.

3. Management Emphasis: Since employees look to management to communicate its expectations with respect to their behavior, it is expected that the greater the perceived managerial emphasis on staying, the lower the degree of reported obsolescence.

4. Nature of the Work: The rate of change of the knowledge base, on which engineers draw, varies with the type of work they perform. Although there is no measure, in this study, of the rate of change of knowledge, it is expected that there will be observable systematic differences in reported obsolescence as a function of the nature of the work being performed.

5. Education: Several studies have shown an inverse relation between level of education and susceptibility to obsolescence. Therefore, it is expected those that engineers who have attained higher degree levels will report lower levels of obsolescence.

6. Group Membership: Many studies have shown the influence that groups have on member behavior. There are strong forces toward similarity in behavior or conformity in groups (Asch, 19 ;Crutchfield, 19). It is predicted that this will be true for the tendency toward obsolescence. Group members will not differ very much in their reported obsolescence. The principal differences in reported obsolescence levels will be between rather within work groups.

In addition, it is predicted that two factors will not have any relationship to reported obsolescence:

1. Age: Contradictory findings have been reported with respect to the relationship between age and obsolescence, although the most recent results call any relationship into question. It is not expected that the current study will find any consistent relationship between age and reported obsolescence.

2. Organizational Level: There is a dearth of information regarding the relationship between organizational status and obsolescence. Certainly managers, as they are drawn further away from technical work by administrative duties, are forced into obsolescence. On the other hand, in an organization, such as the one under study, there are many managers whoare able to overcome this obstacle and maintain their technical competence. As a result, it is expected that there will be no relationship found between management level and reported obsolescence.

METHOD

An anonymous survey was conducted among the R&D personnel of a major U.S. electronics manufacturer. A total of 3036 technical personnel responded to the survey, constituting slightly over 75 percent of the population, covering several types of work (research; product design and development; systems development; software engineering; manufacturing engineering; and sales engineering) and organizational levels (engineer, supervisor and manager) (Tables I & II).

TABLE I

Nature of Work Assignments

work assignment	proportion of respondents
research	8%
product design & development	34
systems development	25
project coordination	15
software engineering	4
sales engineering	1
manufacturing engineering	13

TABLE II

Hierarchical Status of Respondents

position	proportion
engineer	74%
supervisor	15
manager	10

Engineers were generally organized into workgroups of differing size, each reporting to a supervisor. The workgroups define to a very great extent the social context in which the individuals work. It is through the workgroup that the individual gains knowledge about organizational norms, and is made aware of managerial and peer expectations regarding performance and conduct on the job.

Characteristics of the Respondents

Ages are distributed quite symmetrically. Both mean and median fall between 41 and 50, along with more than one-third of the population. The proportion between 51 and 60 is 23 percent, as is the proportion between 31 and 40. Twelve percent are less than 31, while six percent are older than 60.

Educational level ranges from those with less than a bachelor's degree (16%) to six percent who hold a doctoral degree. The bachelor`s is the highest degree for 49 percent and 29 percent have a master of science.

RESULTS

Importance of Staying Current

Since jobs vary in the degree to which their performance requires an engineer to stay abreast of current technology, respondents were asked to evaluate the degree to which this was true with respect to both current and anticipated future jobs (Table III). A clear majority see the importance of currency, both for its present and future potential. This is slightly more true for those with managerial responsibility, perhaps

because they perceive their management placing greater emphasis on it (Table IV). It is a minority of all respondents, however, who believe that their management has emphasized this need.

TABLE III

Importance of Keeping Abreast of New Technology to Current Job and Future Goals

Degree of Importance	Proportion for Current Job	Proportion for Future Goals
high	77%	83%
low	23	17

High = scale rating of "extremely" or "quite" important
Low = scale rating of "somewhat", "slight", or "not important"

TABLE IV

Perceptions of Importance and Management Emphasis on Staying Current as a Function of Position

hierarchical position	proportion perceiving: High importance of currency	proportion perceiving: High management emphasis
engineer	76%	29%
supervisor	80	35
manager	83	41

Respondents were asked to estimate their own levels of obsolescence. This was done by asking each individual to rate his ability, on a percentile basis, to keep abreast of developments in his own field. As might be expected with self-ratings, the distribution is slightly biased toward the high side. Nevertheless, nearly half of the respondents ranked themselves below the 75th percentile in currency in their fields.

A division at this point, will consequently be used to indicate each respondents' degree of obsolescence. Those above the 75th percentile (55% of the respondents) will be aggregated and defined as being lower in obsolescence, whereas those indicating that they are below this point will be considered higher in obsolescence.

Age and Perceived Obsolescence

Given the contradictory evidence concerning a direct relationship between age and technical obsolescence, it is important to see how the self-ratings of the respondents vary with age. The present data fail to support a relationship between perceived obsolescence and age (Table IV). Those engineers over 40 are neither more nor less likely to report obsolescence than their younger colleagues.

When obsolescence is examined as a function of organizational status, some variance across levels is observed (Table V). Supervisors were somewhat less likely to report obsolescence than either engineers or managers.

Obsolescence and Career Goals

Engineers wishing to transfer out of engineering to other functions are more likely to report high obsolescence (Table VI). Causality could

TABLE V

Age and Perceived Obsolescence

Age	Proportion Perceiving Low Obsolescence	N
40 or less	56.2%	1050
Over 40	55.3	1823
Total		2873

$X^2 = 0.15$; N.S.

TABLE VI

Perceived Obsolescence as a Function of Career Goals

Career Goal	Proportion Perceiving Low Obsolescence	N
Continue in present job	50.2%	603
Advance to higher position-technically or managerially	58.8	2123
Move out of engineering	37.4	123
Total		2849

$X^2 = 32.28$; $p < 0.0001$

might result from a desire to change jobs, or that desire could stem from an inability to keep up. Nevertheless, it is interesting to note that while many of the engineers, who perceive themselves as relatively

obsolete, are also motivated to leave engineering, many are not so motivated and would like positions of greater technical or managerial responsibility.

Obsolescence and Management Emphasis on Keeping Abreast of New Technology

A relationship was expected between obsolescence and the extent to which a respondent believed it was important to stay current. The literature suggests that when technical personnel perceive a strong need to remain current they do in fact take steps to do so.

The results support the hypothesis. The perceived importance of staying current is clearly related to level of obsolescence (Table VII). Of those respondents who perceive technical currency to be important, a significantly higher proportion report low obsolescence.

TABLE VII

Perceived Obsolescence as a Function of Importance of Keeping Abreast of New Technology

Importance of Staying Current to Present Job	Proportion	N
High	63.4%	2279
Low	28.3	688
Total		2967

$X^2 = 261.37$; $p < 0.001$

The climate created by management exerts considerable influence on obsolescence. A critical aspect of this climate is the degree to which management emphasizes keeping abreast of new technology. The data certainly support this. Respondents who perceive greater management emphasis on keeping current are far less likely to report high obsolescence (Table VIII).

TABLE VIII

Perceived Obsolescence as a Function of Management Emphasis on Staying Current

Management Emphasis	Proportion Perceiving Low Obsolescence	N
High	76.8%	904
Low	45.4	2053
Total		2957

$X^2 = 263.17$; $p < 0.001$

Obsolescence and the Nature of the Work

Certainly obsolescence is a more serious problem in some types of work than others. The demands of some work (e.g., research) should reduce the chances of obsolescence. In other kinds of work assignment, it may not even be regarded as a problem. As one would expect, obsolescence is proportionately lower in those activities in which engineers perceive the importance of staying current to be high (Table IX). Research and technical support activities have the highest perceived need and the lowest rate of obsolescence. Manufacturing engineering and project work

have the lowest perceived need for currency and the highest proportion of admittedly obsolete engineers.

TABLE IX

Obsolescence and the Importance of Staying Current as a Function of the Nature of the Work

type of work	N	proportion reporting low obsolescence	proportion reporting high importance
Research	218	76.6%	91.3%
Technical Support	991	62.4	82.5
Systems Development	711	56.5	76.9
Projects	419	47.6	66.6
Software Engineering	109	49.5	67.0
Sales Engineering	27	51.9	77.8
Manufacturing Engineering	379	40.6	69.1

Obsolescence and Work Group Membership

Engineers do not work in a social vacuum. Their motivational and situational perspectives are strongly shaped by their work group interactions (Katz, 1980;Katz & Allen, 1982). In fact, work group membership has been linked to performance, innovation, and obsolescence (Katz, 1967; Dubin, 1972; Pelz & Andrews, 1976). Interpersonal and group dynamics generate consistency in norms, attitudes and behavior within groups. One might therefore expect to find norms within groups concerning the need for effort to combat obsolescence. Before looking at the variance in obsolescence across the different workgroups, a test was made of the relationship between obsolescence and group size. Three levels were considered: 1) No workgroup membership; 2) workgroup of size two to

four; 3) workgroup of size five or greater. No variance is observed across size categories in terms of the proportion of respondents who report themselves low in obsolescence. Being a member of a group, either small or large, is not related to obsolescence.

The major hypothesis is that there will be significantly greater variance in obsolescence across groups than within. The assumption is that norms will develop within workgroups around this issue. Greater variance within the groups would imply that obsolescence is more a function of individual or professional factors than group-related factors. The results of an analysis of variance of obsolescence as a function of workgroups (Table X indicate that there is significantly greater variance in obsolescence across groups than within groups. Workgroup membership is very strongly related to obsolescence level. Furthermore, this relationship is unaffected by the age of the individuals involved. In combatting obsolescence, one is not dealing merely with the attitudes, motivation or perceptions of individuals but with the overall climate that results from the history of interactions and experiences of those individuals working together and reinforcing each other.

TABLE X

Source of Variation	df	F	Significance of F
Main effects	109	3.490	0.001
Workgroup	108	3.518	0.001
Age	1	0.511	NS
Two-way interactions			
Workgroups x Age	93	0.968	0.569
Explained	202	2.329	0.001
Residual	1647		
Total	1849		

Major Influences on Obsolescence

The results indicate that neither age nor organizational status, exert major influence on obsolescence. As a whole, respondents in groups do not differ from those working individually. However, membership in a specific group does affect obsolescence. Additionally, educational level, career goals, type of work, management emphasis on staying current, and perceived importance of staying current all impact level of obsolescence significantly. None of these variables exhibit significant linear correlation with each other.

A five way analysis of variance was performed using obsolescence as the dependent variable and independent variables as follows:

1) Management emphasis on staying current
2) Importance to present job of staying current
3) Career goals
4) Educational level
5) Type of work

All five independent variables are significant at $p < 0.001$ (Table XI). The results confirm the cross tabulations presented earlier, showing that type of work has more effect than any of the other variables on obsolescence.

TABLE XI

ANOVA Perceived Obsolescence as a Function of Management Emphasis on Staying Current, Importance of Staying Current, Career Goals, Education and Type of Work

Source of Variance	df	F	P
Main Effects			
Type of work	4	8.86	0.001
Emphasis on keeping current	1	192.92	0.001
Importance to job	1	162.81	0.001
Career goals	2	8.53	0.001
Educational level	3	45.58	0.001
Two-way Interactions			
Work type x Education	12	2.30	0.006
All others	--	----	NS
Three-way Interactions			
Work x Importance x Career goals	8	3.10	0.002
Work x Career goals x Education	24	1.82	0.01
All others	—	----	NS

DISCUSSION

The data lead to some very interesting conclusions. Obsolescence, as reported in this study, is unrelated to the age of engineers. There is nothing in the study to indicate a greater feeling of obsolescence among older engineers. Granted, this is a self perception of obsolescence, but the fact that this self-perception shows a reasonably wide variance (many engineers reporting high obsolescence) coupled with the fact that it relates so strongly to such other factors as nature of the work and the emphasis placed by management on currency certainly bestows some degree of

validity on the measure.

In opposition to age, it is often argued that management practice and attitudes strongly influence motivation, attitude and behavior of technical personnel, and that these external factors are the chief situational determinants of the motivation to update (Dubin, 1971, 1972; Landis, 1969; House and Rizzo, 1971, Dubin and Marlow, 1965).

The results of the present study confirm these earlier findings. A significant relationship is found between obsolescence and the amount of emphasis management places on staying current. Turning this around, one can argue that management have no one but themselves to blame for any obsolescence among their engineering groups.

The emphasis managers attach to keeping up to date, is one of the most important considerations in coping with technological obsolescence.

A significant relationship is found between work group membership and obsolescence. From the early Hawthorne studies (Roethlisberger and Dickson, 1938; Mayo, 1933) the considerable impact that work groups exert has been observed. The results of this study are consistent with this. Groups are relatively homogeneous in reported obsolescence, while strong differences are found between groups. Management emphasis on staying current, varies significantly across groups as well, indicating that management has a major responsibility in establishing the norm that determines the group's propensity to update. Consequently, much of the responsibility for technical obsolescence can be laid at the doorstep of management..

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