IMPACT OF THE TECHNOLOGICAL ENVIRONMENT ON PROGRAMMER AND ANALYST JOB OUTCOMES

Jack J. Baroudi

and

Michael J. Ginzberg

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Center for Research on Information Systems
Computer Applications and Information Systems Area
Graduate School of Business Administration
New York University

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Impact of the Technological Environment on Programmer and Analyst Job Outcomes

Recent research has shown that key IS/DP personnel job outcomes (e.g., turnover, organizational commitment, job satisfaction) are affected by job design, leadership characteristics, and role variables. This study investigates another class of variables, the technological environment faced by IS/DP personnel, which might impact these job outcomes. The technological environment includes (1) development methodologies employed, (2) the hardware environment, (3) project teams and reporting relationships, and (4) work characteristics. Variables from all classes except the hardware environment were found to impact IS/DP job outcomes. As this was an exploratory study, the results should be viewed as hypotheses to be explored in future research.

I. Introduction

The jobs of data processing and information systems (DP/IS) personnel have become an area of substantial research interest in the past few years. That this is so should come as no surprise: large software development backlogs have been reported by researchers (e.g., Alloway & Quillard, 1983); the business press reports that there is a significant shortage of DP/IS personnel and that it is likely to worsen over the next decade; the cost of DP/IS personnel keeps rising while the cost of hardware falls and the demand for application systems grows (Birnbaum, 1982); and, DP/IS personnel continue to exhibit a troublesome turnover rate (Bartol & Martin, 1982). Thus, there is a considerable interest in understanding how to increase DP/IS personnel productivity and satisfaction and to decrease turnover.

Much of the research in this area has focused on motivation. Probably the best known work is Couger & Zawaki's (1978). This research uses Hackman & Oldham's (1976) Job Characteristics Model to investigate the "motivating potential" of DP/IS jobs. Couger & Zawaki's findings for DP/IS personnel are consistent with Hackman & Oldham's findings for other technical and professional employees: DP/IS personnel with jobs high on the five core dimensions -- skill variety, task identity, task significance, autonomy, and feedback from the job -- experience higher levels of satisfaction. Goldstein & Rockart (1984) argue that the Hackman & Oldham model was intended for jobs done independently by individual workers, and that for DP/IS personnel who seldom have this type of independence, there are other factors which impact job outcomes (e.g., satisfaction). Their study added role perceptions (role

conflict and role ambiguity) and leadership behavior of supervisors and peers to the job characteristics previously studied. They found all three sets of variables to be significantly related to job satisfaction. The addition of either of the new sets of variables -- role perceptions or leadership behavior -- provided significantly better explanation of satisfaction than did job characteristics alone.

In another recent study, Baroudi (1984a) examined the relationships among role conflict, role ambiguity, boundary spanning (a characteristic of some DP/IS jobs and a potential antecedent of conflict and ambiguity), and several job outcomes (satisfaction, commitment, and intention to quit). He found that role ambiguity substantially and significantly reduced job satisfaction and commitment, which in turn increased the data processing professional's intention to quit. Role conflict was also found to reduce job satisfaction and indirectly to reduce commitment and increase intention to quit.

One area of obvious potential for explaining DP/IS job outcomes that has so far received very little attention from researchers is the technological environment in which the work is done. Goldstein & Rockart (1984) suggested that job characteristics alone were not enough to explain DP/IS job outcomes, and they added role perceptions and leadership behavior as potential explanators. The technological environment is also likely to be an important determinant of work outcomes, especially in a field where technology is as central as it is in DP/IS. This paper represents a first attempt to explore some aspects of the technological environment and their impacts on DP/IS job outcomes.

II. Technological Environment -- Definition and Prior Literature

The technology we are concerned with is the technology or methodology used for task accomplishment, i.e., the technology of information system development. This is much broader than just the computer technology (e.g., hardware) employed, and includes (1) programming and system development methodologies, (2) the use of project teams, (3) reporting relationships, and (4) the type of work accomplished. There has been limited consideration of these technological variables in the IS research literature, though much has appeared in the practitioner literature. The concern in the bulk of this literature has been the impact on IS/DP personnel productivity, not on satisfaction or other similar work outcome variables.

II.1. Development methodologies

Included in development methodologies are the use of structured methods for system design or programming, the use of fourth generation languages, and the use of alternative development cycle approaches like prototyping.

There is substantial agreement in the literature that the use of structured design methodologies should result in increased productivity as well as higher quality work by IS/DP personnel (see e.g., Goldstein, 1982). There is less agreement, however, about the impact of structured design on IS/DP personnel satisfaction. Both Kraft (1977) and Goldstein (1982) suggest that use of structured design methods will reduce skill variety, task identity, and autonomy, three of the core dimensions in Hackman & Oldham's Job Characteristics Model. Kraft concludes, consistant with the model, that this

will result in reduced satisfaction. Goldstein, however, suggests that use of structured design methods will also reduce role conflict and ambiguity, and will increase task achievement (the ability of DP/IS personnel to accomplish what they are supposed to). The net result, according to Goldstein, should be an increase in satisfaction.

The early writings about structured programming suggested that it too would result in increased productivity of IS/DP personnel. More recently, this assumption has been called into question, as researchers have found inconsistent impacts of structured programming on productivity (see Vessey & Weber, 1984 for a review of research on the impact of structured programming). Some have suggested that maintenance of structured code will be easier than maintenance of typical "spaghetti" code; thus, use of structured programming for system development should increase productivity in system maintenance. We know of no tests of this conjecture which have been performed so far. Very little appears to have been written about the impact of structured programming on job satisfaction, turnover, etc.

Fourth generation languages (4GL) can be divided into applications generators which are tools for use by IS/DP professionals, and information generators for use by end users (Hessinger, 1984). The practitioner press is replete with articles about 4GL. The primary message in these articles is that 4GLs can substantially increase productivity, both through enhancing performance of DP/IS professionals and through off-loading some of the work to end users. A second message in the literature is that use of 4GL enables better communication between IS/DP personnel and users, which will improve relations with users and result in greater user satisfaction (Computer World,

10/31/83). The impact of 4GL use on IS/DP personnel satisfaction is not addressed directly. There is, however, the suggestion that 4GL use will result in "deskilling" of "journeyman COBOL programmers" (Gallant, 1984). And, it has been suggested that 4GLs will wash out the "experience gap" between experienced and novice programmers (Parks, 1983). Either of these effects could impact satisfaction of (at least some) DP/IS personnel.

Prototyping is a development approach which has been gaining many adherents in recent years. Proponents of prototyping suggest that once an initial investment in hardware and software resources is made, prototyping can vastly increase productivity in system development (Naumann & Jenkins, 1982). In perhaps the only published empirical assessment of the impact of prototyping, Alavi (1984) reports that users were more satisfied and there was less perceived conflict between IS/DP and user personnel when prototyping was used compared to a conventional, linear development approach. Unfortunately, Alavi does not report on IS/DP personnel satisfaction.

II.2. Hardware environment

There are numerous ways to characterize the hardware environment faced by IS/DP personnel, very few of which have been considered in the literature as determinants of job outcomes. Among the dimensions which could be considered are:

batch vs. on-line;

system availability and reponse time;

mainframe, mini, micro; and

brand name (hardware vendor).

Technological Environment

In an early study, Sackman (1970) showed that users of on-line systems generally took less human time but more computer time to complete their tasks, but these differences were not as large as those between individuals. He also found a general preference for on-line rather than conventional batch systems. Since the majority of DP/IS personnel now work in an on-line environment, interest has shifted to other dimensions, notably system availability and response. Thadhani (1984) describes several studies which show the impact of availability and response on IS/DP productivity. We are unaware, however, of any studies which look at the impact of hardware environment on IS/DP job satisfaction, commitment, etc.

II.3. Project teams

There is a substantial empirical literature on the use of teams or groups for problem solving in general, and it shows that individual performance is a function of the type of task and the experienced relationship of the individual to the group (see Hackman, 1976 for a review). Group membership sometimes enhances and sometimes reduces individual effectiveness, and this relationship is very complex. The literature about teams in information system development is largely normative: the use of teams is presumed to improve the outcomes of system development (see, e.g., Weinberg, 1974). In a recent article, Miles (1983) recommended the use of Nominal Group Technique to ensure real participation in system development of a wide range of personnel. She suggested that among the results of this participation would be "enthusiasm and sense of commitment."

Despite the general belief that teams are valuable and important to IS development, we know of no empirical literature which tests this proposition. There is no published evidence concerning the impact of project teams on IS/DP personnel satisfaction, commitment, etc.

II.4. Work characteristics

As discussed in the Introduction, several authors have examined the impact of task characteristics on IS/DP personnel satisfaction, and have generally found greater satisfaction with jobs that score high on the Hackman & Oldham Job Characteristics Model. A number of implications can be drawn from these reults. Zawacki (1984) suggests that "high scope" jobs (development rather than maintenance) will be more motivating and more satisfying. Chapin (1984) suggests that more complex projects will be more motivating and satisfying. He is, however, more equivocal concerning productivity: project complexity is likely to have a direct negative effect on productivity and an indirect positive effect (through its impact on motivation). As with a number of the other variables discussed above, the literature which directly addresses the impact of this aspect of the IS/DP environment tends to be conjectural and has not yet been subjected to empirical testing.

III. Research Questions

From the discussion in the previous section it should be apparent that there are a great many factors in the IS/DP technological environment with the potential to impact IS/DP job outcomes, and there has been very little testing of these impacts. For outcomes other than productivity, there has, in fact, been little written at all, be it theoretical, conjectural or empirical. It was our purpose in this research to identify several important areas of potential impact and gather some data which begins to explore those impacts. Since for the most part there were no prior hypotheses to be tested nor were there validated measures for the constructs to be examined, this research should be viewed more as hypothesis generation than as hypothesis testing.

Much of the literature has focused on immediate productivity as the outcome of interest. Our concern is with a different set of outcomes which we would expect to have an important impact on long run productivity. These critical outcomes are satisfaction (with the work, the job in general, and supervision) and organizational commitment. Baroudi (1984a) has shown these to be closely linked to intention to quit (and hence to eventual turnover) for IS/DP personnel. We are also concerned with two variables which Baroudi's study showed to be important precursors of satisfaction and commitment, role conflict and role ambiguity. He found that role conflict was explained significantly by the degree to which IS/DP personnel were involved in boundary spanning roles. However, he found no explanation for the causes of role ambiguity. In this study we are concerned with the extent to which aspects of the technological environment might contribute to role conflict or cause role ambiguity.

III.1. Development methodologies

Three questions in this area were investigated:

Q1: What impact does the use of structured design tools have on Satisfaction, Commitment, role Conflict, or role Ambiguity (SCCA)?

On the basis of prior literature, we would expect the use of structured design methods to reduce conflict and ambiguity. The expected impact on satisfaction and commitment is unclear.

Q2: What impact does the use of structured programming have on SCCA?

Structured programming provides a set of rules to be followed and tools to be used in accomplishing the programming task, and this should reduce role ambiguity. We make no other predictions about the impact of structured programming.

Q3: What impact does the use of 4th generation languages have on SCCA?

There are no direct predictions in the literature about the impact of 4GL use on any of the dependent variables. There are, however, hints about the impact of 4GL use on satisfaction. As a result of better communications with users, IS/DP personnel performance should improve, and this should increase satisfaction. The possible "deskilling" which might result from 4GL use would, however, suggest a reduction in satisfaction. Since these hints suggest opposite effects, we make no a priori predictions about 4GL use.

III.2. Hardware environment

Two questions in this area were investigated:

Q4: What impact does an on-line vs. a batch environment have on SCCA?

Most programmers today operate in an on-line environment; those who do not are likely to feel (probably correctly) that they are working in an

antiquated environment which is likely to stunt their professional growth. We would, therefore, predict that the absence of an on-line environment would lead to lower satisfaction and commitment. There is no basis for predicting any impact on ambiguity or conflict.

Q5: What impact does type of hardware used -- micro, mini, or mainframe -- have on SCCA?

The substantial interest in microcomputers in the population generally would suggest that access to them would be satisfying to DP/IS personnel. On the other hand, the bread and butter of DP/IS operations remains the mainframe computer system. We, thus, would predict a weak positive impact of microcomputer use on satisfaction. There is no basis for predicting an impact on commitment, conflict, or ambiguity.

III.3. Project teams and reporting relationships

Four questions were investigated in this area:

Q6: Does the use of project teams impact SCCA?

The IS practitioner literature suggests that use of project teams enhances performance and satisfaction. We note, however, that the IS practitioner literature is much more positive about the beneficial impact of teams than is the empirical literature on groups. The relationship between project teams and satisfaction, then, is not likely to be large. Arguments can be made to suggest that use of project teams will both increase and decrease role conflict; thus, no prediction will be made. There does not seem to be any basis for predicting an impact on either commitment or role ambiguity.

Q7: For those DP/IS personnel who are assigned to project teams, does the manner in which team assignments are made affect SCCA?

Project team members can stay together and move from project to project as a team, team members can move from assignment to assignment individually, or some other method can be used for team rotation. There is no basis for predicting an impact of the method of team assignment on satisfaction, commitment, or role conflict. Role ambiguity, however, should be lower for those who are assigned to permanent teams, since in such cases the individual's relationship to the group and role within the group are likely to be clearer and better known.

Q8: What impact does reporting to a project leader have on DP/IS personnel SCCA?

There are many possible formal reporting relationships for DP/IS personnel. Among these are (1) reporting to a project leader, (2) reporting to a functional manager in the DP/IS department, and (3) reporting to a manager in a user area. Since so much of the work of DP/IS personnel is project oriented, formally reporting to a project leader might result in lower role conflict and ambiguity. There is no basis for predicting an impact on satisfaction or commitment.

Q9: What impact does reporting to multiple superiors have on SCCA?

The IS literature provides no suggestions about the impact of multiple reporting relationships. The broader organizational literature, however, does. Role conflict occurs when the individual receives conflicting job performance information, while role ambiguity results from a lack of clear and precise information about what is expected of the role incumbent (Van Sell, et al., 1981). As the number of superiors one reports to and receives direction

from increases, so does the potential for role conflict. Number of superiors does not necessarily, however, affect ambiguity, since each superior could provide clear and precise information about tasks, rewards, etc. Thus, we would expect that reporting to multiple superiors will increase role conflict, but we make no predictions about the impact on satisfaction, commitment, or ambiguity.

III.4. Work characteristics

Six characteristics of the work itself were investigated:

Q10: What impact does the number of projects simultaneously worked on by DP/IS personnel have on SCCA?

If concentrated work on a single project implies responsibility for a larger portion of the project, it is likely to increase task identity. Working on a range of projects, on the other hand, is likely to increase task variety. Both are important dimensions in the Hackman & Oldham model, and each should contribute to satisfaction. Thus, there is no reason to expect an impact of the number of simultaneous projects on satisfaction. Likewise, there is no basis for predicting an impact on commitment. Arguments similar to those made above concerning reporting to multiple superiors would suggest that role conflict may be increased by having to deal with a large number of projects (and, hence, project leaders, users, etc.) simultaneously, while there would be no necessary impact on role ambiguity.

Q11 & Q12: To what extent do project size and duration impact SCCA?

No strong arguments can be made concerning the likely impact of project size on satisfaction, commitment, conflict or ambiguity. Similarly, there is no basis for predicting an impact of project duration on commitment, conflict,

or ambiguity. Duration, however, is likely to affect satisfaction. Longer projects will probably result in less frequent feedback (one of Hackman and Oldham's key job dimensions), and this will reduce satisfaction.

Q13: What is the impact of project innovativeness on SCCA?

Innovative projects are inherently more interesting than more commonplace, mundane projects. Further, innovative projects keep DP/IS personnel's skills current, and hence more marketable. We would, then, expect a strong impact on satisfaction. No relationship with commitment, conflict or ambiguity can be predicted.

Q14 & Q15: What is the impact of doing maintenance work and development work on SCCA?

The message in much of the literature is that maintenance is low scope, unmotivating, unsatisfying work while development is just the opposite. There have been numerous articles in the past few years explaining the importance of maintenance, and suggesting that it <u>should be</u> regarded as an important and challenging assignment. The importance of maintenance is unquestionable. However, we would predict that a high relative maintenance work load will lead to reduced satisfaction, while a high relative amount of development work will increase satisfaction. We make no predictions about the impact of maintenance or developement work on commitment, conflict or ambiguity.

The 15 questions investigated and the predicted impacts on satisfaction, commitment, conflict and ambiguity are summarized in Figure 1.

Predicted Impacts of 15 Environmental Factors

	Satis-faction	Commit-ment	Role Conflict	Role Ambiguity
Development methodologies				
1. Structured design	?	?	-	-
2. Structured pro-gramming	?	?	?	-
3. 4th generation language	?	?	?	?
Hardware environment				
4. On-line vs. batch	+	+	?	?
5. Micro, mini, mainframe	-	?	?	?
Project teams & reporting relationships				
6. Use of project teams	+	?	?	?
7. Team assignments	?	?	?	-
8. Report to project leader	?	?	-	-
9. Multiple reporting relationships	?	?	+	?
Work characteristics				
10. No. of simultaneous projects	?	?	+	?
11. Size of team	?	?	?	?
12. Project duration	-	?	?	?
13. Innovativeness	+	?	?	?
14. % maintenance	-	?	?	?
15. % development	+	?	?	?

Figure 1.

IV. Research Methodology

The data for this study were collected as part of a larger project that investigated the antecedents of DP personnel intention to quit. The results of this study are reported in Baroudi (1984b).

IV.1. The Sample and Selection

Nine companies, primarily from the New York/Boston area, participated in the study with data collected from a total of 229 individuals. The 229 subjects represents an overall response rate of 85 percent.

The study participants included applications programmers, programmer/analysts, and systems analysts in centralized DP groups. Additionally, to assure that the study participants were engaged in comparable tasks, only those individuals working on internal systems development projects were included. The participating companies varied in size from approximately 30 programmers and analysts to over one thousand. The different industries represented are listed in Figure 2.

-----Insert Figure 2 here------

Descriptive information about the individual participants is presented in Figure 3.

NUMBER OF COMPANIES	INDUSTRY	NUMBER OF SUBJECTS
1	COMMERCIAL BANKING	24
3	INSURANCE	84
2	BROKERAGE	41
1	PUBLIC ACCOUNTING	27
1	INVESTMENT BANKING	26
1	ELECTRONICS MANUFACTURING	26
9		229

Figure 2

-----Insert Figure 3 here-----

The data were gathered by on-site administration of a questionnaire. The questionnaire took approximately 45 minutes to complete. All subjects were guaranteed anonymity and the participating companies were provided with a summary of the overall findings.

IV.2. Measures

In constructing the instrument to test the research questions, measures with extensive histories of reliability and validity were employed whenever possible. Accordingly, the JDI (Smith et al, 1969) was used to measure general job satisfaction and its various facets. The Rizzo et al. (1970) scales were used to measure role conflict and role ambiguity. The role ambiguity scale was expanded based on the work of Schuler et al. (1982) which recommended the addition of task and reward ambiguity items. Organizational commitment was measured using the Porter and Smith (Mowday et al., 1979) instrument. Descriptive statistics and reliabilities for these scales are presented in Figure 4.

----Insert Figure 4 here----

Unfortunately, no standardized measures of the technology and DP environemnt were available. In most cases however, it was possible to simply ask the subject what category he/she belonged to (e.g., do you report to a project leader? does your department use project teams?) or to what extent they used a particular technology (rated on a 5-point scale). In many cases respondents were asked to list the tools or languages they used and the

DESCRIPTIVE STATISTICS

AGE

RANGE	NUMBER	PERCENT
20-30	96	42%
30-40	98	43%
40-50	30	13%
50-60	5	2%
	229	100%

GENDER

Female	92	40%
Male	137	60%
	229	100%

YEARS EXPERIENCE IN DATA PROCESSING

Mean	6.1 years
Minimum	1.0 years
Maximum	27 years
S.D.	4.5 years

YEARS WITH COMPANY

Mean	4.332 years
Minimum	1.0 years
Maximum	25.0 years
S.D.	4.9 years

EDUCATION

High School Degree	6	3%
Technical School Experience	8	4%
Some College	37	16%
College Degree	99	43%
Some Graduate Work	35	15%
Master's or Higher Degree	44	19%
	229	100%

Figure 3

Variable	Mean	Theoretical Minimum	Minimum	Theoretical Maximum	Maximum	Reliability Cronbach's Alpha
Role Conflict	31.102	8.0	10.0	56.0	52.0	.79
Role Ambiguity	15.1	3.0	8.5	21.0	20.6	.85
General Job Satisfaction	110.9	0.0	31.8	216.0	164.4	.91
Satisfaction with Work	32.4	0.0	6.0	54.0	48.0	.74
Satisfaction with Supervision	41.3	0.0	9.0	54.0	54.0	.86
Organizational Commitment	-51.19	-105.0	-88.0	-15.0	-16.0	.89

Figure 4

percent of time they used them. Subjects were also asked to indicate what percentage of their time was spent in enhancement, development, and maintenance work.

While we have no reliability data for these variables and must depend strongly on the face validity of these measures, it was possible to provide some evidence for the validity of a number of them by building a nomological network (Bagozzi, 1980). Nomological validity is demonstrated by showing that the specific construct relates as expected to a wider theoretical scheme. For example, it was expected that subjects using fourth generation languages would be involved in enhancement and development work and not in maintenance. Additionally, it was expected that people using fourth generation languages would indicate that the projects they worked in were state of the art and innovative. In fact, percentage of time spent in enhancement and development work did indeed correlate positively with 4GL while percentage of time spent in maintenance work correlated negatively. The subjects ratings of how innovative their projects were also correlated positively with use of 4GL.

Innovative projects correlated positively with time spent in enhancement and development and correlated negatively with percent of time spent in maintenance as was expected. The use of structured design tools had, consistent with our expectations, a positive relationship with enhancement and development work and a negative correlation with maintenance work. Structured programming, likewise, correlated positively with enhancement but did not correlate with maintenance work.

While the final demonstration of validity is a complex and time consuming process, the above data provide some evidence for the validity of the measures.

IV.3. Testing

Correlational analysis and analysis of variance were used to test the individual research questions and regression analysis was used to determine the overall amount of variance accounted for in the dependent variables. Where a priori predictions of directionality could be made, one-tailed significance testing was used. Otherwise, all testing of significance was two-tailed.

V. Results

In this section, basic results concerning the 15 research questions discussed above are presented. The relationship between each of the technological environment factors and satisfaction, commitment, role conflict and role ambiguity was examined. Where it seemed relevant, specific other relationships were examined. In the discussion which follows, unless otherwise stated, tests of the relationship with satisfaction include separate tests of general job satisfaction and satisfaction with the work itself. Discussion of the implications of these results is deferred to the following section.

Results

V.1. Impact of development methodologies

The results of the inquiries into Questions 1, 2, and 3 are summarized in Figure 5. Neither the use of structured programming nor structured design methods was significantly related to satisfaction or commitment. The use of structured design was positively related to role conflict, contrary to expectations; i.e., people who used structured design methods experienced more role conflict than did their counterparts who did not use these methods. Use of structured programming resulted in lower role ambiguity, as predicted. The extent of use of 4th generation languages was unrelated to commitment, conflict, or ambiguity. It was, however, positively related to general job satisfaction.

Impact of Development Methodologies

Q	Satis-faction	Commit-ment	Role Conflict	Role Ambiguity
1. Structured design	NS	NS	.128 (p=.03)*	NS
2. Structured pro-gramming	NS	NS	NS	-.106 (p=.057)*
3. 4th generation language	.176 (p=.012)	NS	NS	NS

* one-tailed test

Figure 5.

V.2. Impact of the hardware environment

In general, the variation in hardware environments across respondents was too small to allow a meaningful test of these questions. Only 9 of 229 respondents worked in a batch environment, and only 39 used any computer other than a mainframe.

V.3. Impact of project teams and reporting relationships

Only ten individuals reported working in data processing groups which did not use project teams. Thus, research question 6 could not be tested.

The method of assigning individuals to project teams had an impact on three of the four dependent variables; only conflict was not related to the method of team assignment or rotation. Individuals who rotated to teams with different members (n=126) had the highest satisfaction, followed by those who always worked with the same team members (n=43), followed by those who did neither (n=11) (e.g., they were not assigned to project teams, though their organization used teams). The mean job satisfaction scores for these three groups were 145.40, 138.47, and 119.00, respectively (F significant at .016). Organizational commitment was nearly identical for those who rotate from team to team and those who were permanently assigned to a team (mean commitment scores of - 99.77 and - 100.74, respectively); however, those who did neither showed substantially lower commitment (mean score of -121.00, F significant at .102). Finally, as predicted, those individuals who were permanently assigned to a project team reported less ambiguity than those who rotated or did neither (means of -31.67, -29.97, and -28.13, repectively; F significant at .037).

Results

Whom an individual reported to was found to impact satisfaction, commitment and conflict, but not ambiguity. Reporting to a project leader resulted in lower overall job satisfaction (mean score of 138.80 vs. 146.65, p=.087), lower satisfaction with supervision (mean of 40.3 vs. 42.8, p=.103), and less role conflict (mean of 30.2 vs. 32.5, p=.027 one-tailed test) when compared to all other reporting relationships. Those reporting to a project leader also had significantly lower organizational commitment (mean of - 53.54 vs. -47.19, F significant at .004). Individuals reporting to a functional manager in the DP/IS department had the highest levels of organizational commitment (mean of -47.81 vs. -52.69, F significant at .035).

Having multiple reporting relationships was found to be unrelated to role conflict, role ambiguity, commitment to the organization, and satisfaction with the job, the work itself, or supervision. The results for Research Questions 6 through 9 are summarized in Figure 6.

Impacts of Project Teams and Reporting Relationships

Q	Satis-faction	Commit-ment	Role Conflict	Role Ambiguity
6. Use of project teams	---------- not tested ----------			
7. Team assignments	see text	see text	NS	see text
8. Report to project leader	-	-	-	NS
9. Multiple reporting relationships	NS	NS	NS	NS

Figure 6.

V.4. Impact of work characteristics

Neither the number of projects worked on simultaneously nor the size of project teams was related to any of the dependent variables. Project duration was negatively related to satisfaction with the work itself, as predicted, but was unrelated to commitment, ambiguity or conflict.

The hypothesized relationships between satisfaction and project innovativeness, time spent in maintenance, and time spent in development were all found to be significant. The strongest of these were between project innovativeness and satisfaction with the work itself (r=.485) and general job satisfaction (r=.504). Percent of time spent in development and enhancement was also positively related to both satisfaction with the work (r=.196) and general job satisfaction (r=.176). The percent of time spent doing maintenance was negatively related to work satisfaction, but not significantly

related to general job satisfaction. The percent of time spent in development and enhancement and the percent of time spent in maintenance were unrelated to any of the other three dependent variables. Project innovativeness, however, was associated with higher commitment and lower role ambiguity. Figure 7 summarizes the results for Research Questions 10-15.

Impacts of Work Characteristics

Q	Satis-faction	Commit-ment	Role Conflict	Role Ambiguity
10. No. of simultaneous projects	NS	NS	NS	NS
11. Size of team	NS	NS	NS	NS
12. Project duration	-.123 (p=.053)*	NS	NS	NS
13. Innovativeness	.485 (p<.001)*	.466 (p<.001)	NS	-.292 (p<.001)
14. % maintenance	-.103 (p=.066)*	NS	NS	NS
15. % development	.196 (p=.002)*	NS	NS	NS

* one-tailed test

Figure 7.

V.5. Summary of results

We can summarize these results by comparing those relations that were predicted between the technological environment and the dependent variables with those relationships which were actually found. In the case of satisfaction, four of the independent variables tested were predicted to have an impact. All of these predicted relationships were found to exist. Three unexpected relationships were found, involving the use of fourth generation languages, method of assignment to teams, and reporting to a project leader.

The only predicted relationship with commitment could not be tested. Three other relationships involving method of team assignment, reporting to a project leader, and project innovativeness were found.

Four independent variables were predicted to have an impact on role conflict. Of these, only one, reporting to a project leader, had the predicted impact. One other, use of structured design methods, had an impact opposite from what was expected.

For role ambiguity four variables were predicted to have an impact. Two of these, use of structured programming and method of assignment to project teams, had the predicted impact. In addition, project innovativeness was found to have an impact.

Overall, of 12 predicted relationships tested, 7 were found to exist as predicted, 4 were not significant, and one was significant but in the opposite direction from the prediction. Another 7 relationships between the independent and dependent variables were found in the data. In the next section, we turn to a discussion of these findings.

VI. Discussion

VI.1. Analysis of unexpected findings

Use of structured design methods (Q1) and reporting to a project leader (Q8) were expected to reduce role ambiguity. Neither of these relationships was found. That structured design did not have the expected impact is somewhat suprising. It may be that the measures used to gather the data were not sensitive enough to detect the true relationships and further research is needed. Less suprising was that reporting to a project leader did not reduce role ambiguity when compared to other reporting relationships. While it may be true that a project leader should be able to reduce the ambiguity experienced by his/her subordinates, there is no evidence to suggest that a project leader should be any better at this than other superiors such as a functional DP manager.

While both the number of simultaneous projects (Q10) and having multiple reporting relationships (Q9) were expected to increase role conlfict, neither relationship was found. The lack of a relationship between role conflict and number of projects was quite unexpected and merits further investigation. The lack of a correlation between multiple reporting relationships and role conflict may be an artifact of the measure of multiple reporting relationships. Subjects were asked to indicate to whom they report, and a number of respondents checked both a project leader and the DP manager. This

was coded as reporting to multiple supervisors. It is possible that while some indeed report to both, most report only indirectly to the DP manager through the project leader, thus confounding the measure.

It was expected that use of structured design tools would reduce role conflict. The data show, however, that use of structured design tools was related to greater role conflict. While structured design techniques help by clearly outlining the process to be used in designing a system, the designer must still balance the different and often conflicting requests from the various users, and this could lead to role conflict. That structured design methods increased conflict may be due to the rigid and highly structured nature of the process not allowing the designer adequate flexibility to respond to the total set of user needs.

Seven other relationships were found for which no predictions had been made. For example, it was unclear what impact 4GL use would have on job satisfaction. The literature indicated that there might be both positive (i.e., improved communications with users) and negative (job deskilling) effects. The results of the data analysis revealed that 4GL use enhanced job satisfaction, suggesting either that deskilling was not a problem or that it was outweighed by other positive factors.

No specific relationship was hypothesized between job satisfaction and team assignments. The data indicated, however, that those individuals who rotated to teams with different members were more satisfied than those who were assigned to a permanent team. Rotating to different teams may be more challenging and provide more opportunities, which in turn may enhance job satisfaction. There is evidence in the data to suggest this, as subjects who

rotated indicated that the projects they worked on were more innovative (r=.1083, p=.059) than those who did not rotate. Another possible explanation for this finding is that being assigned to a team with a less than desirable work environment (e.g., there is friction between the team members) may become less critical if the subjects perceive they will eventually rotate out of this group.

Individuals who were neither assigned to permanent teams nor rotated were found to be the least committed to the organization. This finding, however, should be interpreted with caution as there were only 11 respondents in this category. While we do not have empirical evidence, it is possible that these individuals were working on projects independent of the rest of the DP organization, and this created feelings of isolation which impacted their feelings of committment.

Reporting to a project leader was related to reduced job satisfaction and reduced commitment. The available data provide no explanation for these findings. One possibility consistent with the data and prior research (e.g., Couger & Zawaki, 1978) is that the quality of data processing management is poor, with first level management being weaker than higher level management in the DP department. This could result from promoting technicians to managerial positions for which they are unprepared; as they gain managerial experience, they improve their managerial skills.

The last findings for which we had no prior hypotheses were the relationships of project innovativeness to commitment and role ambiguity. The positive relationship between innovativeness and commitment may, in part, be due to the high correlations both of these variables have with satisfaction.

Another possible explanation, though, is that DP personnel generally want to stay near the forefront of their technology. If their employer provides them with this opportunity, they are more likely to value their employment by that organization and to be committed to it. While we have no empirical or theoretical justification for the negative relationship between innovativeness and role ambiguity, it may be that as the projects become more innovative management finds the need to clearly and carefully outline what is expected. With the more routine and ordinary projects management may not consider such elaborate direction necessary, and as a result there is more ambiguity.

VI.2. Regression analysis of dependent variables

The correlational analysis revealed that the independent variables, when considered separately, were generally able to account for 2 to 3 percent of the variance in the dependent variables. To determine how much of the total variance the technological variables were able to explain, a series of regressions was performed. The independent variables entered into each regression were those that correlated significantly (zero-order) with the dependent variable. One independent variable, project innovativeness, was not included in the regressions. The observed relationships between innovativeness and 4GL use, type of activity (i.e., maintenance vs. development), etc., suggested that the project innovativeness measure is a perceptual variable determined by a number of the objective environmental variables, and should be treated as a dependent rather than an independent

variable. As no clear causal ordering of the independent variables existed, simultaneous regressions were used. Figure 8 presents the results of the regressions.

-----Insert Figure 8 here -----

The regressions for general job satisfaction, satisfaction with the work, organizational commitment, role ambiguity and role conflict were able to explain 11.1, 4.6, 6.8, 3.5 and 3.1 percent of the variance in their respective dependent variables. The variance accounted for, particularly in the cases of general job satisfaction (11.1%) and organizational commitment (6.8%) are sizable enough to suggest that technological environment plays an important role in determining these job outcomes for DP personnel. It is important to note that these independent variables are under the direct control of DP management and could be manipulated to effect any needed changes.

VII. Conclusion

The literature on DP/IS personnel has shown that job design (e.g., task autonomy, meaningfulness, and feedback), role variables (e.g., conflict and ambiguity) and leadership (by superiors and peers) are important determinants of job outcomes (e.g., satisfaction and commitment). This study adds certain aspects of the technological environment to the list of factors which impact programmer and analyst job outcomes.

Figure 8

Dependent Variable: General Job Satisfaction
R^2=.111 F=4.491 Sig=.0007

Independent Variables	Beta	Sig.
Report to Project Leader	-.164	.020
% of Dev. & Enhancement work	.148	.039
% of use of 4GL	.130	.077
Permanently assigned to a project team	.281	.033
Rotate to different teams	.352	.008

Dependent Variable: Satisfaction with Work
R^2=.046 F=4.048 Sig=.019

Independent Variables	Beta	Sig.
% of Dev. & Enhancement work	.180	.021
Project Duration	-.167	.032

Dependent Variable: Organizational Commitment
R^2=.068 F=4.882 Sig=.002

Independent Variables	Beta	Sig.
Report to Project Leader	-.238	.0006
Permanently Assigned to project team	.213	.073
Rotate to different teams	.230	.054

Dependent Variable: Role Ambiguity
R^2=.035 F=3.647 Sig=.0278

Independent Variables	Beta	Sig.
Structured Programming	-.110	.113
Permanently Assigned to project team	-.150	.032

Dependent Variable: Role Conflict
R^2=.031 F=3.403 Sig=.035

Independent Variables	Beta	Sig.
Report to Project Leader	-.120	.075
Structured Design Tools	.121	.073

Conclusion

The results of this study suggest that the job satisfaction of IS/DP personnel can be affected by the kind of work they do (development versus maintenance), the tools they employ (4GL usage), whom they report to and how they are assigned to project teams. These results also suggest that IS/DP organizational commitment is impacted by reporting relationship and method of job assignment.

It is important to note that while both "hard" (e.g., hardware, methodologies, and techniques employed) and "soft" (e.g., reporting relationships and project/task characteristics) aspects of the technological environment were considered, the "softer" side of the environment had a more pervasive impact on the job outcomes studied. This might be termed the "managerial environment;" these variables are those most susceptible to management influence, and thus provide leverage points that managers of IS/DP departments can utilize.

The technological and managerial environment in which IS/DP personnel operate appears to be an important factor in determining their job outcomes. This study represents an initial exploration of the impact of these environmental factors. Some clear relationships have been shown, but much work remains to be done. Refined and more sensitive measures need to be developed and validated. In addition, a number of research questions should be retested. For example, the impacts of micro-computers on IS/DP job outcomes went unexamined as IS/DP personnel in the companies included in this study were making little use of this technology at the time of the study. This situation should have changed greatly by now, and we expect micros now are having substantial impacts on IS/DP jobs. One possible impact is on the

percent of time spent in maintenance vs. development. As user developed, micro-based, "prototype" systems become institutionalized, the maintenance of these systems may be shifted to the DP department. As a result, the percentage of maintenance work for IS/DP personnel would increase and the amount of development decline. The results reported in this study suggest that an increase in maintenance will reduce IS/DP job satisfaction. Questions that probe these ongoing changes in the technological environment need to be developed and tested.

Some other questions asked in this study are probably no longer of interest. For instance, questions about the use of batch versus on-line systems or about the use of project teams appear to be moot. Very few individuals report using batch systems and even fewer report not belonging to a project team. We should be examining, rather, what happens to IS/DP personnel as traditional DP jobs are eliminated and positions are transferred to information centers or user departments, in an effort to meet the growing demand for end user computing services.

The technological environment faced by the IS/DP department is undergoing radical and rapid change. Future research must focus attention on how to deliver effective user services as well as the impacts of change on the IS/DP professional. IS/DP management faces the difficult challenge of using technological changes to improve services to their user community while enhancing the quality of working life for the IS/DP professional.

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