Differences Between Third and Fourth Generation Programmers: A Human Factor Analysis

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The use of nonprocedural (fourth generation) languages created a revolution in the manner in which computer-based information systems are being constructed. These languages are being used extensively by end-users and by programmers in end-user departments. They are being also used, to a less extent, by traditional programmers whose major computing environment is the mainframe. Programmers’ performance is a function of two major groups of variables: those that are related to the person (his/her attributes) and those related to the environment. This paper reports the results of a study that compared the attributes of programmers in a large centralized third generation mainframe environment to the attributes of fourth generation programmers in the same company. Significant differences were detected. Based on this finding, this paper suggests a procedure for matching an individual’s attributes with the characteristics of different software environments.

The purpose of computer languages is to enhance communication between people and computers. The complexity of the programming task is determined, in part, by the gap between the languages of the computer and the language of the person (Klerer, 1987). Computer languages are evolving in order to reduce this gap.

The third generation languages (3GLs), also known as high level languages, emerged in the late 1950’s. These languages are designed for use by a trained information systems professional, who develops well-defined applications in a structured environment. Third generation languages require a large number of lines of detailed code with sequential, procedural logic (Martin, 1985).

The fourth generation languages (4GLs) are nonprocedural since they specify what is to be accomplished, but not how it is to be done. Thus, the 4GL programs are less detailed and shorter (Williamson and Maginnis, 1990). Enhancements and maintenance are easily performed (Case and Manley, 1986; Matos and Jalics, 1989), allowing for rapid development and customization (Miller, 1990). However, the 4GLs lack standardization (Lehman and Wetherbe, 1989) and require more machine running time and over-
head (Matos and Jalics, 1989). The types of skills needed for proficient programming with the 3GLs and the 4GLs differ. The 3GLs require more programming skills while 4GLs, which are used by end-users, require less programming skills.

A recent survey identified the most important traits for programming jobs in general (Licker and Miller, 1989): 1) ability to solve logical problems, 2) ability to work with precision and details, 3) team work, 4) empathy, 5) understanding the business environment, 6) working with others, and 7) concentration. The importance of these traits may vary from one language environment to another. Precision, details and concentration seem to be important attributes for the 3GL environment, while team work and working with others are the perceived traits associated with the 4GL environment. Thus, it seemed likely that the types of programmers attracted to the 4GL environment would be different than the programmers attracted to the 3GL environment.

The first purpose of this study is to investigate whether the educational background is the same for programmers working in different environments (i.e., 3GL and 4GL). The second purpose is to investigate whether certain personality modalities are the same for programmers working in different environments. Finally, with the trend of increased use of the 4GL tools in the mainframe environment and with the increased trend for distributed systems, many MIS managers must hire both 3GL and 4GL programmers. Thus, the third purpose of the study is to determine if there is enough evidence which will allow employers to best match programmers with jobs in 3GL and 4GL environments.

The above objectives are attained via a survey conducted in a large utility company. The description of the survey, its methodology, results and analysis are reported in the following sections.

**Hypotheses**

As discussed, this study has three objectives.

**Objective 1: Study the relationship between educational background and the type of programmers.**

The first objective of the study was to identify the attributes of the 3GL and the 4GL programmers to determine if certain educational characteristics can be related to any group in particular. The 3GLs are designed for use by a “technically trained” individual, while the 4GLs are geared to the individuals with a broader background. It was hypothesized that the 3GL and 4GL programmers will differ in their educational background. Specifically, three hypotheses were stipulated:

**Educational Background Hypotheses:**

Hypothesis 1: More 3GL programmers perceive their educational background as being quantitative than non-quantitative.

Hypothesis 2: More 4GL programmers perceive their educational background as being non-quantitative than quantitative.

Hypothesis 3: The 3GL programmers will have completed more college programming courses than the 4GL programmers.

**Objective 2: Identify the personality attributes of the 3GL and the 4GL programmers.**

The second objective of this study was to identify and compare the personality attributes (as defined in the Myers-Briggs Type Indicator (MBTI) questionnaire - see page 4) of the 3GL and the 4GL programmers. The individuals employed in end-user departments have been depicted as flexible and spontaneous (Kolodziej, 1987), while the 3GL programmers have a detail and procedural orientation in a scheduled environment.

It was expected in the hypotheses that the introverted individual would feel more comfortable in the 3GL environment while the extrovert individual would be attracted to the 4GL environment. Likewise, the perceiving individual would prefer a flexible, spontaneous user-oriented de-
partment, while the **judging** individual who tends to plan and schedule his/her activities would be located in the 3GL environment. It was hypothesized that the 3GL and 4GL programmers will differ in their personalities attributes. The following two hypotheses were postulated:

**Personality Hypotheses:**

Hypothesis 4: The centralized 3GL programmers would be
   A) introverted
   B) sensing
   C) thinking
   D) judging.

Hypothesis 5: The end-user 4GL programmer would be
   A) extroverted
   B) intuitive
   C) feeling
   D) perceiving.

**Objective 3:** Determine if there is enough evidence to distinguish the profile of a 3GL programmer from that of a 4GL programmer.

The following hypothesis was stipulated:

Hypothesis 6: The 3GL and 4GL programmers can be distinguished on the basis of their personality, educational background and previous experience.

**Dependent and Independent Variables**

**Independent Variables**

Evans and Simkin (1989) found that personality variables were good predictors of computer proficiency. Several previous studies have used the MBTI instrument to determine the personality traits of programmers (Bush and Schkade, 1985; Lyons, 1985). The MBTI uses four scales. The first scale is extroverted (E) versus introverted (I). Extroverts are fun-loving, outgoing and friendly, while the introverted personality tends to be careful with details and is contented working alone. The second scale is sensing (S) versus intuitive (N). Sensing individuals like the established way of doing things and are fact-oriented, while the intuitive people enjoy learning new skills and are imaginative, abstract and future-oriented. The third scale is thinking (T) versus feeling (F). Thinking individuals are logical, objective and technically-oriented, while the feeling individuals have a high sense of values and strong interpersonal skills. The final scale is judging (J) versus perceiving (P). Judging individuals are planners and organizers who dislike interruptions in their plans, while the perceiving individuals are spontaneous and flexible (Myers and McCaulley, 1985).

Studies by Lyons (1985) and by Bush and Schkade (1985) identified most 3GL programmers as being introverted, sensing, thinking and judging (ISTJ). These programmers are considered to be serious, quiet and logical. They make up their own minds as to what should be accomplished and work toward it steadily, regardless of protests or distractions (Myers and McCaulley, 1985). However, this type of programmer would not fit into a user-oriented 4GL environment with a flexible atmosphere designed to meet the changing demands of the user.

**Educational variables** also are important to computer programming positions. Quantitative background was identified as a critical factor in computer programming as early as 1972 by Alspaugh (1972). She found that the mathematical background of programming students appears to be the major influencing factor in programming classes. In 1979, Peterson and Howe (1979) found that the number of high school mathematical courses and the high school mathematical grade point average had a significant positive correlation with success in introductory computer classes. In 1986, Oman (1986) supported the findings that identified mathematical proficiency as a dominant factor in computer programming classes.
Ninety-five data processing managers revealed that they use a relaxed management style as well as an interest in hiring generalists as opposed to those with pure technical skills for the programming and systems function. As users are becoming active in the various stages of systems development, the generalists have fewer problems relating to the user. Seventy-four percent of the companies in a recent survey have in-house training and regularly scheduled classes. This allows managers to hire the generalists and train them in the technical areas. Although most companies still require a baccalaureate degree for programmers, a large number of managers have expressed frustration with the graduates from purely technical disciplines and are hiring liberal arts graduates (Friedman and Greenbaum, 1984).

A large banking institution started an entry level training program due to a shortage of MIS graduates. They sought out liberal arts graduates with the following qualifications: 1) a high grade point average, 2) aggressive, 3) articulate and 4) extraordinarily intelligent (Dight, 1986). In addition to the training program, the organization moved from 3GLs to 4GLs for all systems development. As a result, the productivity of the average trainee after two years of experience exceeds the productivity of IBM’s senior’s programmers in its Federal Systems Division by a factor of 3 to 4 (Abbey, 1984).

As a result of these previous studies, the college major, the number of programming courses, quantitative background and grade point average were included as independent variables in the current research project.

The final variable, the perceived language environment (3GL and 4GL) in which the programmers were employed, was an independent variable. Subjects were divided into groups based on their response to this variable.

**Dependent Variables**

The study contained one dependent variable. This variable was the perceived performance of the programmers by their supervisors.

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Research Methodology and Instruments

A survey was conducted in a major midwestern utility company. Questionnaires were administered to all 114 programmers who predominately used 3GLs and resided in a centralized information systems department, and to 47 programmers who used 4GLs and resided in various end-user departments. Top level MIS managers identified the 3GL and 4GL programmers and obtained their cooperation as well as that of their supervisors.

The fact that only one large organization was included in the survey is both a strength and a limitation. It is a strength because the researchers dealt with a single organizational culture and mission. In addition, far greater control over the research environment and the variables being tested was obtained. It is a limitation because 1) a consistent but erroneous pattern in the placement of 3GL programmers into 4GL environments could have been made and 2) the results cannot be generalized to other organizations.

**Instruments**

Three instruments were used in this study. Each subject completed an abbreviated version of the Myers-Briggs Type Indicator (MBTI) questionnaire, and a supplementary questionnaire about the subject’s educational background and previous experience. A third instrument, the subject’s performance appraisals, was utilized to determine the impact of some of the findings of this study.

**a. The Myers-Briggs Type Indicator**

C. J. Jung’s theory of psychological type introduced the ideas that differences in the behavior of individuals can be attributed to differences in the perception and judgment of individuals. “If people differ systematically in what they perceive and in how they reach conclusions, then it is only reasonable for them to differ correspondingly in their reactions, interests, values, motivations,
skills and interests” (Myers and McCaulley, 1985). The MBTI is a validated instrument use to apply Jung’s ideas on perception and judgment. The purpose of using this questionnaire was to identify the personality traits so that it could be determined if the traits of 3GL programmers differ from those of 4GL programmers.

b. **Education and Experience Questionnaire**

Information about the educational background, previous experience and work environment of each subject was obtained through the use of a close-ended questionnaire. The educational information covered the highest degree completed, the college grade point average and the number of college programming classes completed. In addition, the amount of quantitative work required by the college major for graduation was recorded. Quantitative work was defined as work with a mathematical or statistical orientation.

The work experience variables included the types of computer languages used in current and previous employment. Finally, the importance of technical knowledge and user involvement in each subject’s current and previous jobs was recorded.

c. **The Performance Appraisal**

In order to explain the impact of some of the statistical conclusions of this study, a performance appraisal of each subject was obtained. The performance appraisal, which was completed by the supervisor of each subject, used a seven-point rating scale for numerous attributes. The employee’s rating for each attribute was summed to obtain a quantitative figure of overall performance.

d. **Validation**

Since the MBTI is a validated questionnaire, there was no need for validation. The educational questionnaire and the performance appraisal were not formally pilot tested. However, an investigator met with small groups of programmers in order to clarify the meaning of questions.

**Sample Size and Response Rate**

Management distributed 161 copies of the MBTI and the demographic questionnaire to the programmers. All questionnaires were identified by the last four digits of the subject’s social security number. One hundred forty-three subjects returned their forms (88.8%). However, 13 forms were incomplete. This reduced the usable sample to 130 (80.7% response rate). Of these, 94 were in the centralized information systems department and 36 in end-user departments. All 130 programmers were full-time employees of the utility company.

**Demographic Results**

**Use of Languages**

All individuals from the end-user departments indicated that they were primarily users of fourth generation languages. The 4GL programmers worked with applications involving report generating, graphics and statistical analysis. The programming languages varied from FOCUS to SAS for the PC and mainframe. All 94 subjects from the information systems department did use 3GLs; however, 26 of them indicated an equal use of 4GLs. Seven individuals indicated that their primary language was in the third generation; however, on a rare occasion, they would code in the 4GL. The results, which are based on the predominant language cited, are shown in Table 1.

**Educational Background**

The educational background of the subjects ranged from a high school diploma to the completion of masters degrees. Table 2 shows the frequency counts of the highest degree completed by the subjects, segregated by their language classification.

**Quantitative Background**

There was a wide variety of college majors, varying from those with a quantitative emphasis such as engineering, mathematics, computer sci-
Table 1: Current environment

<table>
<thead>
<tr>
<th>Response</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Centralized information systems department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. All (or predominantly) 3GL programming</td>
<td>68</td>
<td>52.3</td>
</tr>
<tr>
<td>b. Equal mixture of 3GL and 4GL programming</td>
<td>26</td>
<td>20.0</td>
</tr>
<tr>
<td>2. End-user departments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. All (or predominately) 4GL programming</td>
<td>36</td>
<td>27.7</td>
</tr>
</tbody>
</table>

TOTAL 130 100.0

Table 2: Highest Degree Completed

<table>
<thead>
<tr>
<th>Information Systems Department</th>
<th>High School</th>
<th>Associate</th>
<th>Baccalaureate</th>
<th>Masters</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3GL</td>
<td>5</td>
<td>16</td>
<td>42</td>
<td>5</td>
<td>64</td>
</tr>
<tr>
<td>3GL &amp; 4GL</td>
<td>2</td>
<td>3</td>
<td>19</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>4GL</td>
<td>3</td>
<td>6</td>
<td>23</td>
<td>4</td>
<td>34</td>
</tr>
</tbody>
</table>

Table 3: College Major - Perceived Quantitative Requirements

<table>
<thead>
<tr>
<th>Grade Point Average</th>
<th>Information Systems Department</th>
<th>End-User Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>24 26</td>
<td>15 12</td>
</tr>
<tr>
<td>MEDIUM HIGH</td>
<td>11 9</td>
<td>7 7</td>
</tr>
<tr>
<td>MEDIUM LOW</td>
<td>3 1</td>
<td>0 0</td>
</tr>
<tr>
<td>LOW</td>
<td>0 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

Total 64 24 34

Table 3: College Major - Perceived Quantitative Requirements

while the end-user 4GL programmers had a 3.35 average. The difference was not found to be significant.

Analysis of Results: Educational Background

Hypothesis 1, 2 and 3

The objectives associated with the six hypotheses centered on the differences between the individuals using 3GLs and 4GLs. Therefore, for the analysis of the six hypothesis, only the 68 individuals who primarily used 3GLs and the 36 individuals who primarily used 4GLs were included.

The perceived amount of quantitative emphasis in each subject's college major was measured on a five-point Likert scale, where "one" indicated heavy quantitative emphasis and "five" indicated little quantitative emphasis. The information for the 3GL programmers from Table 3 was analyzed in a one-way chi-square test. It was shown that the college background of the 3GL programmers was more quantitatively oriented than non-quantitatively oriented (p<.0001). That is, hypothesis #1 was accepted.

The 4GL end-user programmers in this organi-
A comparison of the educational results for the 3GL and 4GL programmers is summarized in Table 4.

### Analysis of Results: Personality

#### Hypothesis 4 and 5

Table 5 shows the results of the MBTI for both the 3GL and 4GL programmer. The results show that, on the average, 3GL programmers differ from 4GL programmers by their personality traits. The table also shows the significance level of the results.

Through the use of the normal approximation to the binomial distribution statistical test, it was found that the 3GL programmers were: 1) equally likely to be extroverted as introverted ($p = .1112$), 2) sensing ($p = .0008$), 3) thinking ($p < .0001$), and 4) judging ($p < .0001$). Hypothesis 4 parts B, C, and D were accepted, while part A was could not statistically be proven. Even though the 3GL programmers were equally likely to be extroverted or introverted, they were more likely to be introverted than the general population ($p < .0001$) (Myers and McCaulley, 1985).

Statistical results about the 4GL programmers in this study are far less elucidating. With the use

<table>
<thead>
<tr>
<th>Category</th>
<th>3GL</th>
<th>4GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extroverts</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Introverts</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Sensing</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>Intuitive</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Thinking</td>
<td>37</td>
<td>20</td>
</tr>
<tr>
<td>Feeling</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Judging</td>
<td>38</td>
<td>14</td>
</tr>
<tr>
<td>Perceiving</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

* $p < .01$  ** $p < .001$

Table 5: Results of the Clear Preference Personality Data of the MBTI
of the normal approximation to the binomial distribution statistical test, it was found that the 4GL programmers were: 1) no more likely to be extroverted than introverted (p = .5000), 2) no more likely to be intuitive than sensing (p = .5000), 3) they are, however, thinking (p = .0314), and 4) no more likely to be perceiving than judging (p = .1423). Thus, all parts of hypothesis 5 were rejected. Similar to the 3GL programmers, 4GL programmers were more introverted (p = .0005) and intuitive (p = .0019) than the general population (Myers and McCaulley, 1985).

**Discussion**

As expected, the personality data showed the 3GL programmer to be sensing, thinking and judging. However, the results for the end-user 4GL programmer were inconclusive. A comparison of the personality results for the 3GL and 4GL programmers is summarized in Table 6.

Based on the analysis of these results, the researchers conclude that there might be two distinct types of 4GL programmers based on personality traits. Some possess the sensing and judging characteristics similar to the 3GL programmers. Others are more adaptable to the changing user-oriented environment since they possess the intuitive and perceiving traits.

The image of the 3GL programmer as quantitative, logical, and procedurally oriented has been substantiated by other studies. Lyons (1985) and Bush and Schkade (1985) found the programmer to be introverted, sensing, thinking, and judging.

The importance of a quantitative background was identified by Alspaugh (1972), Peterson and Howe (1979), and Oman (1986).

However, the image of the 4GL programmer is less definite. Huff and Rivard (1983) have found that the majority of user-programmers have a limited technical background. This study substantiated that the 4GL programmers have completed fewer college programming classes than the 3GL programmers. However, numerous hypotheses dealing with the personality attributes were not accepted. This led the researchers to conclude that the attributes of the 4GL programmer and environment may be varied. The second phase of the study, which is discussed next, will provide some insight into these diversified 4GL environments and programmers.

**Analysis of Results: Profile of 4GL versus 3GL Programmer**

During the analysis of the first five hypotheses, the variables of introversion/extroversion, sensing/intuitive, thinking/feeling, judging/perceiving, college major, quantitative background, grade point average and programming education were compared. These variables, along with the years of previous experience, was included in a stepwise discriminant analysis to determine the variables, if any, on which the 3GL and 4GL programmers can be differentiated. Also, through the use of discriminant analysis, an attempt was made to establish a procedure for matching specific individuals with an appropriate computing environment (either 3GL or 4GL).

**Hypothesis 6**

The stepwise discriminant analysis identified the following six variables on which the two groups could be distinguished:
1. sensing/intuitive
2. thinking/feeling
3. number of college programming classes
4. grade point average
5. years of 3GL experience
6. years of 4GL experience

For the discriminant analysis, the 26 programmers, who indicated an equal use of 3GLs and 4GLs in a centralized environment in their present job, were included in the 3GL programmers’ group because they all had work experience in their previous jobs using 3GLs and no previous experience with 4GLs.

The actual results of the discriminant analysis were enlightening. The results supported the suggestion that the 3GL programmer possesses unique characteristics. Only one individual was substantially different from the entire group! Thus, the well-documented traits of the 3GL programmer are again supported by the current study. In contrast, the results of the discriminant analysis for the 4GL programmers were mixed. Forty-seven percent of these programmers were identified as possessing the traits of the 3GL programmers. The classification matrix of the discriminant analysis is shown in Table 7.

The substantial proportion of 4GL programmers with attributes and background similar to the 3GL programmers (and the numerous hypotheses about the 4GL programmers that were rejected imply that further investigation is required. This investigation is described next.

**Discussion of Unique Programmers’ Profiles**

(for Hypothesis 6)

The 4GL programmers were divided into two groups: 1) the 17 programmers who were placed in the 3GL environment by the discriminant analysis, and 2) the 19 programmers who were placed in the 4GL environment by the discriminant analysis. The 17 programmers who were placed in the 3GL environment had indicated on their questionnaire that technical expertise is being stressed more than user-involvement in their positions (p<.05). In contrast, the 19 programmers who were placed in the 4GL environment indicated a perceived heavier emphasis for user-orientation than for technical skills (p<.05).

Thus, there appears to be two types of 4GL programmers and two types of 4GL environments. Therefore, the 4GL programmers and environment can be subdivided into the following four groups:

1. Individuals with traits resembling the 3GL programmer with a technically-oriented job.
2. Individuals with traits resembling the 3GL programmer with a user-oriented job.
3. Individuals with traits resembling the 4GL programmer with a technically-oriented job.
4. Individuals with traits resembling the 4GL programmer with a user-oriented job.

Performance evaluations were obtained from the supervisors of these programmers. The performance scale used a seven-point rating scale for numerous attributes. The employees’ rating for each attribute was summed to obtain a consolidated quantitative figure of performance. A two-way ANOVA with performance ratings as the dependent variable was conducted on the 36 4GL subjects. The researchers found increased performance, as perceived by the supervisors, when the attributes of the programmers were consistent with the programming environment. This relationship is noted in Table 8.

Other statistically significant conclusions about the two groups of 4GL programmers included:

1. The judging individual performs better than the perceiving individual in the technically-ori-
indicated that, as a group, they possess predictable traits. There is notable consistency in these research findings. The 3GL programmers tend to be introverted, sensing, thinking and judging individuals. In addition, they are quantitatively-oriented with numerous college programming classes. The present study has confirmed these findings.

No single profile of the 4GL programmer emerged from the current study. However, the researchers found that some managers of end-user departments are creating a flexible atmosphere in order to meet the changing demands of the users. The 4GL programmers in such departments tend to be perceiving and extroverted. In these departments, the 4GL programmers are being hired primarily for their ability to relate to end-users. Additionally, in some end-user departments, managers tend to hire programmers with attributes and educational background similar to that of the 3GL programmers. Such managers create a procedurally-oriented, structured work environment. In these departments, the 4GL programmers were hired mainly for their technical skills.

Throughout this study, an administrative assistant in the information systems department was in constant communication with the researchers. The researchers gained invaluable insights into the organization through these conversations. A copy of the results, including the suggestions for matching the attributes of the programmers with the work environment, was given to the manager of information systems at the utility.

The results of this study are important because they not only replicate prior research with respect to 3GL programmers, but also reveal that performance increases when attributes of the individual are properly matched with the demands of the environment. Thus, this study adds a new dimension to management’s policies about recruitment, selection, placement, development and reward systems, which might be designed to better motivate a productive 4GL user-oriented work force.

This study was executed in one organization and, therefore, it should be replicated before generalizations. However, the findings are partially

<table>
<thead>
<tr>
<th>4GL Programmers Placed in the 3GL Environment</th>
<th>4GL Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>User emphasis</td>
<td>Better performance (p&lt;.0001)</td>
</tr>
<tr>
<td>Technical emphasis</td>
<td>Better performance (p=.0504)</td>
</tr>
</tbody>
</table>

Table 8: Subdivision of the 4GL Programmers as Indicated by the Discriminant Analysis

1. The introverted individual performs better than the extroverted individual in the technically-oriented 4GL environment. (p=.0359)

2. The introverted individual performs better than the extroverted individual in the technically-oriented 4GL environment. (p=.0599)

3. The perceiving individual performs better than the judging individual in the user-oriented 4GL environment. (p=.0411)

4. The extroverted individual performs better than the introverted individual in the user-oriented 4GL environment. (p=.0315)

Just as there were two types of 4GL programmers, there appears to be two types of 4GL environments. In one environment, the user-oriented environment, interpersonal skills are emphasized. This environment is characterized by a flexible, spontaneous atmosphere. In the second environment, the technical environment, the skills and knowledge of the programmer are emphasized. This environment is more structured and has formal policies and procedures. There should be a fit between the user-oriented 4GL environment and the traits of the individuals working in that environment. Likewise, there should be a fit between the technical 4GL environment and the traits of the individuals in that environment.

Conclusions and Suggestions for Future Research

Third generation language programmers have been the focus of several personality studies which
supported by a recent study conducted by Moncada (1990) in three organizations. She used the MBTI instrument and a questionnaire about the position in which the subject is employed. The 3GL and 4GL programmers in her study possessed similar personality traits to the programmers in our study. Thus, the findings of her study basically confirmed the personality results of this study.

Further research is encouraged not only to confirm the findings of the study with respect to the two groups of 4GL programmers, but also future studies could explore several other related managerial issues ranging from appropriate structures to different computing environments to appropriate human resources development policies for programmers.

References

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