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Cognitive Style, the Work Environment, and Strain: The Case of Object-Oriented Developers

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COGNITIVE STYLE, THE WORK ENVIRONMENT, AND STRAIN: THE CASE OF OBJECT-ORIENTED DEVELOPERS

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Abstract

Although object-oriented development (OOD) represents a promising approach to information systems development, its adoption has been slow. One of the major obstacles to OOD adoption is the lengthy and costly transition of developers to the new paradigm: it takes time and there is no guarantee that the developer will successfully make the transition to the new approach (Van der Salm, 1998). One possible explanation for both the time it takes and the inability of some people to completely make the transition is the poor fit between the cognitive style of the person and the new work environment associated with OOD. Incongruence between cognitive style and work environment is expected to result in increased strain for the developer (which, in turn, negatively influences performance). This study investigates the fit between cognitive style and work environment and the resulting affect on strain. Based on a field study of 123 object-oriented developers, findings suggest a significant relationship between fit and strain as hypothesized: the higher the fit, the lower the strain (and vice versa).

Introduction

As the demand for larger and more complex systems grows, information systems professionals have realized the need for better ways to shorten development time and improve software quality (Weinberg, Guimaraes, and Heath, 1990). Many innovations, such as structured development, prototyping, CASE tools, and 4GLs have been introduced in response to this need, although no single improvement has solved all IS development problems. Object-oriented development (OOD) is one such innovation that has existed for more than 30 years, but has only recently enjoyed increased interest in its use. Although many believe OOD to be a viable solution to several of the problems facing current IS development, its adoption has been slow (Smith and McKeen, 1996).

Object-oriented development requires developers to acquire new skills that are a radical departure from the way they had previously thought of systems development. Early evidence suggests that it may take from six months (Van der Salm, 1998) to one year (Fayed, Tsai and Fulghum, 1996) to complete this transition. In fact, some who attempt the transition may never make it (Van der Salm, 1998). Therefore, one of the major problems facing companies today as they evaluate this decision to change technologies is largely a matter of the selection of personnel who can guide them through the change. One way to speed the transition to this new technology is to identify characteristics in people that allow them to better manage this change. These characteristics are related both to their own cognitive and personal traits and to their perceptions of the environment in which they work. Once a firm has made the decision to make this transition, the identification of such traits would provide a valuable tool in managing the transition. It would do so by providing some direction as to how to go about it. That is, identify the characteristics of the people and how they deal with change, and then identify the course of action to help them deal with the change. The purpose of this study is to examine an IS developer's level of strain resulting from a shift to object-oriented development. Strain is expected to result from poor fit between a developer's cognitive style and their work environment created by the move to object-oriented development. As strain directly influences performance, this study provides the first step in understanding the transition to object-oriented development and a developer's corresponding performance.

Theoretical Background

Cognitive Style

Cognitive style determines how a person might prefer to solve problems, work with others and conform to rules. Adaption-innovation (A-I) theory suggests that an individual's preferred cognitive style lies somewhere on a bimodal continuum ranging from highly adaptive to highly innovative (Kirton, 1976). People who are highly adaptive differ in very specific ways from those who are highly innovative, and often the two types of people conflict when faced with situations requiring mutual action and/or change. Most people tend to score somewhere in the middle between the two extremes, but when people find themselves working with others who are far apart on the scale, the differences not only become noticeable, they become a hindrance to the work at hand. A-I theory does not presume to say that people cannot operate outside their preferences, but it does suggest that they must invoke a coping mechanism of some sort when they do. It claims that these two groups of people accept change in very different ways, that they solve problems in different ways, that they differ in how they see detail and that one group prefers more structure than the other.

All people operate within a specific paradigm that frames the way they think, act and feel. High adaptors are reluctant to venture outside their current paradigm until they can be assured that the new paradigm provides them with some net benefit (Van der Molen, 1994). At that point, they simply mold their current paradigm to fit the new one. High innovators, on the other hand, often get bored with the current paradigm and will switch to a new one much more quickly than their adaptive counterparts (Goldsmith, 1994, Van der Molen, 1994).

The Kirton adaption-innovation inventory is an instrument designed to measure a person's preferred cognitive style within the range of styles just discussed. It is a 32 item, 5-point Likert scale that ranges from a low score of 32 (highly adaptive) to a high score of 160 (highly innovative) with a theoretical mean of 95. It has been tested among some large groups and has an effective low score of 45; an effective high score of 145, and it is approximately normally distributed with an effective mean of about 95.8. It has been shown to be highly reliable and valid (cf. Bagozzi & Foxall, 1995).

Strain

Strains are generally considered to be manifested results from internalized stressors (Xie & Johns, 1995). Strain can take on such attributes as somatic tension, job satisfaction and job-induced tension, among others. The theory of person-environment fit suggests that the greater the congruence in the personal needs and abilities (i.e., cognitive style) with job supplies and demands (i.e., work environment), the lower the strain levels for workers and the higher their performance. People carry with them certain needs they expect from their work environment as they enter the workplace and they also have certain abilities to perform a job. By the same token, the work environment must meet the needs of its workers, but any particular job can be demanding of certain skills from a worker. To the degree that needs can be supplied by the environment, strains will be lowered. Likewise, the degree to which a worker can meet the abilities demanded by the job, performance is expected to be better (Edwards and Cooper, 1990). Several scales have been designed and used in the literature to measure strain. This study utilized a combination of scales that were aimed at somatic and job-induced tension, job satisfaction, and the nature of the work to measure individually perceived strain levels. The scales have all shown acceptable reliability and validity in past studies.

Proposed Model

The proposed model is a combination of adaption-innovation theory and person-environment (P-E) fit theory. It makes use of the tenet from P-E fit that claims workers must be able to match their abilities with the demands of the job in order to reduce strain levels; and the tenet from A-I theory that a work environment can be primarily adaptive or innovative in nature depending upon the type of work and the preferred styles of the people in charge. For example, accounting firms tend to attract high adaptors and engage in work that requires highly adaptive steps (e.g., highly detailed, very focused, lots of rules that cannot be broken). Research and development firms seem to attract highly innovative people and engage in work that is innovative in nature (e.g., rapidly changing designs, techniques and styles, less rigid structure and focused on a longer term, big picture objective). This study attempts to explain some of the variance found in strain levels of information systems developers who are undergoing radical change (to object-oriented development) based on the environmental demand for either adaption or innovation.

Radical change, or paradigm shift can occur to both high adaptors and to high innovators. It is how they go about accepting this change that is different (Goldsmith, 1994, Van der Molen, 1994). Thus, if a high adaptor found himself in a job undergoing a

paradigm shift, but was in a job primarily performed by high innovators, the theory would suggest that his strain levels would be very high. Conversely, the same high adaptor might be perfectly at home in an environment that demanded adaptive solutions and suffer much lower strain levels. The same is true for high innovators. Thus, to the extent that a person's preferred cognitive style matches the demands of the workplace, the lower the strain levels should be; and the greater the divergence in individual style and workplace demands, the higher the strain levels should be. The hypothesis, as shown in Figure 1, is:

> *The fit between personal abilities (cognitive style) and environmental demands (work environment) for IS developers involved in a paradigm shift is inversely related to strain.*

> *We expect this relationship will cause strains to be minimal when cognitive style and work environment are perfectly matched and for strains to increase rapidly in a curvilinear fashion as we move away from the point of perfect fit.*

Methods

Data Collection

This field study involved collecting perceived attitudes from 123 systems developers currently working in object-oriented systems development jobs. Subjects were asked to complete the Kirton adaption-innovation inventory and a composite measure of strain levels. The subjects represented a variety of different industries in both large and medium sized companies in the U.S. Subjects were assembled in rooms, given a standard set of oral and written instructions, and asked to complete the survey forms. Time to complete the forms averaged about 25 minutes.
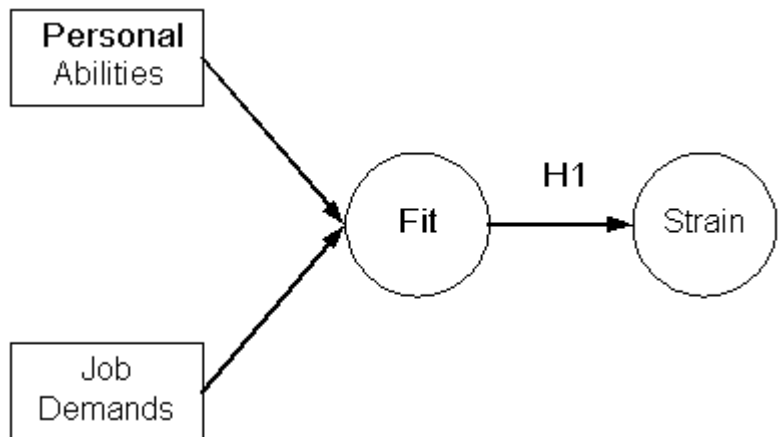

Figure 1. Fit and Strain

Scales were summed and averaged to reduce the number of variables prior to entry into regression models. Also, all scales were checked for internal consistency (reliability) using coefficient alpha and factor analyzed for validity. Coefficient alpha ranged from a low of 0.88 to a high of 0.92 for the scales. Construct, discriminant and convergent validities were all assessed using confirmatory factor analysis and each scale showed acceptable results.

The strain scale in particular showed three distinct factors that were labeled, tension, job satisfaction and nature of the work since the indicants loaded in such a way that they seemed to describe these abstractions.

Analysis and Results

Since P-E fit issues should normally be analyzed using additive relationships (Edwards and Parry, 1993) and can be evaluated using second order regressions, the approach here is to do the same and to use response surface methodology in the analysis. The regression equation tested was:

$$Strain = person + environment + person^2 + person * environment + environment^2$$

where **strain** is a variable indicating a subject's perception of their own strain levels, **person** is a variable describing individual preferred cognitive style (adaption or innovation), **environment** is a variable describing the worker's perception of what is required of him or her in the workplace (adaption or innovation) and the remaining variables are second order terms of these two. Standardized estimates of the coefficients and the statistical tests performed on them are shown in Table 1. Because the interaction between person and environment is significant, hypothesis 1 is supported.

Table 1. Parameter Estimates for a Second Order Model

Variable	Standardized Coefficient	Standard Error	t-value	Pr > |t|
Person	1.81	0.95	1.91	0.05
Environment	1.08	1.12	0.96	0.34
Person Squared	-0.36	0.82	-0.44	0.66
Interaction term	-2.38	1.05	-3.73	< 0.01
Environment Squared	0.58	0.64	0.56	0.58

$R^2 = 0.11$; $F = 3.02$; $Pr < |F| = 0.01$

In order to investigate the interaction, surface response methodology is used. The resulting response surface, as shown in Figure 2, displays the strain response in the vertical dimension, the person variable along the axis running into the page, and the environment variable along the axis running left to right. A contour map is also projected onto the horizontal plane below the surface to further accentuate areas along the surface with equal strain responses.
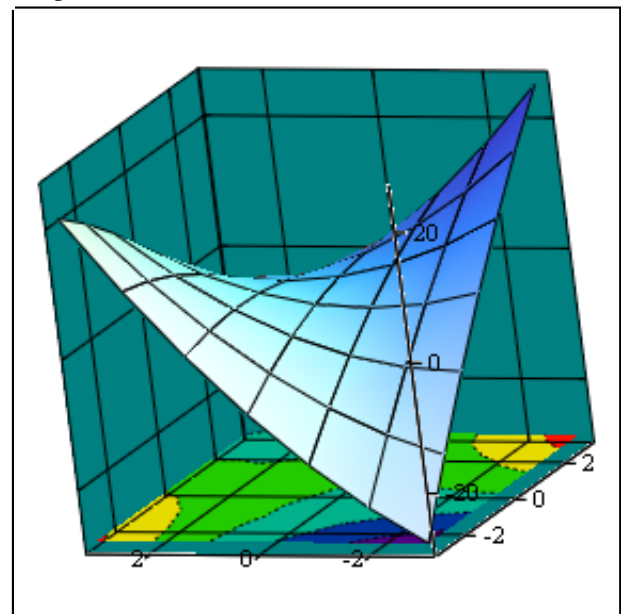
Although units are arbitrary in any of the variables, the independent variables were allowed to vary between –3 and +3. This created strain units from about –20 to about +20. This surface is generated from a statistically significant second order regression, as shown in Table 1 and represents the strain level for any particular combination of person and environment fit. There are two paths in particular that require attention and explanation. These are the diagonals that run across the surface. The first runs from the near lower corner to the back corner and the other runs from the upper right corner to the upper left corner.

The first diagonal is important because it represents the path along which all points are perfect fit. This means that demands and abilities are highly adaptive in the near corner and highly innovative in the back corner, but equal in every case. Notice that strain levels are minimal at each of these two corners and that strain increases up to some point in the middle. This suggests that people who are highly adaptive and work in an environment that requires highly adaptive people and techniques and people who are highly innovative and work in an environment that requires highly innovative people and techniques will suffer the lowest strain levels. People in the middle between highly adaptive and highly innovative will suffer from some positive strain level, but much less than is exhibited by the other diagonal.

$(p, e, z), (p, e, z)$

Figure 2. Response Surface for Strain on Fit

The second diagonal represents that path along which we find subjects who range from high innovators in a highly adaptive environment to high adaptors in a highly innovative environment. These are the two extreme corners where misfit is maximal. As the diagonal reaches the middle of the surface, it becomes a point of optimal fit with people and their workplace perfectly matched, but somewhere in the middle. Notice that at these two corners, strain levels are at their highest. Turning the figure somewhat shows the curvilinear nature of this relationship. It shows us simply that the more we deviate from optimal fit, the greater the strain levels, and that the rise will be very rapid.

Conclusion

This study investigated the influence of the fit between cognitive style and work environment on strain for object-oriented developers. A field study of 123 developers confirmed the hypothesis that greater fit leads to lower levels of strain (and vice versa). These findings lend insight into why, in many cases, it takes a long time for a developer to make the transition to object-oriented development or, in some cases, fail to make the transition altogether.

A response surface map, generated from the second order regression equation, revealed the specific nature of the fit / strain relationship. An interesting feature of the response surface depicted in Figure 1 is that strain actually rises as both the work environment and cognitive style rise at the same rate and remain equal. It then begins to fall off again as these variables become extremely high. An interesting extension to this study would be to further develop reasons for this curious oddity. Perhaps because it seems to affect people in the middle of the scale who prefer innovative responses in some situations and adaptive responses in others that this effect occurs. Because this study only looked at the influence of fit on strain, further studies will need to investigate the subsequent influence of strain on the performance of object-oriented developers.

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