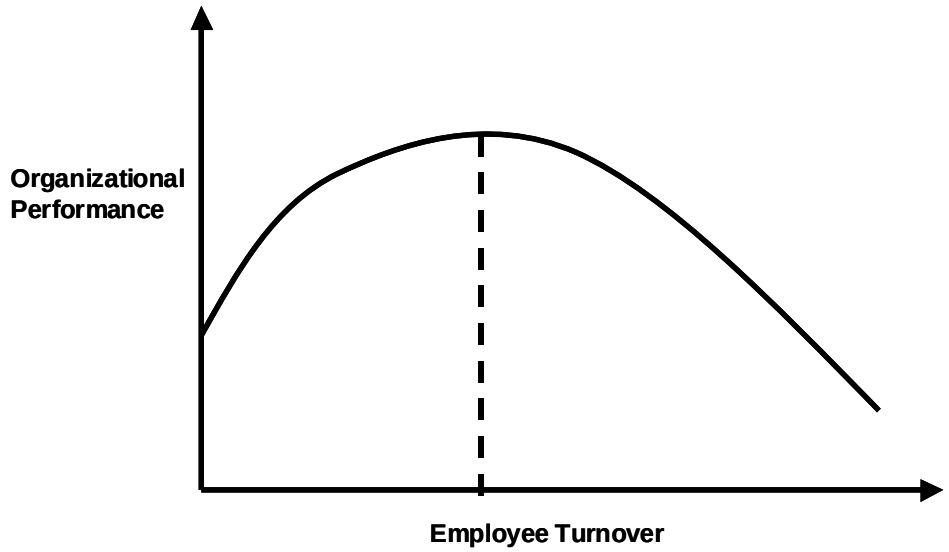
A Test of Abelson and Baysinger's (1984) Optimal Turnover Hypothesis In the Context of Public Organizations Using Computational Simulation



A Research Dissertation

Submitted by

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To the Faculty of the Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
in
Public Administration and Policy

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25 March 2008
Alexandria, VA

Keywords: Employee Turnover, Organizational Modeling, Simulation

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ABSTRACT

Both practitioners and researchers have long noted that employee turnover creates both positive and negative consequences for an organization. From a management perspective, the question is how much turnover is the right amount. Abelson and Baysinger (1984) first proposed that an optimal level of turnover could be found based on individual, organizational, and environmental factors. However, as Glebbeek and Bax (2004) noted, their approach was overly complex to empirically verify, let alone utilize at the practitioner level.

This study is an attempt to demonstrate whether a logic- and theory-based model and computational simulation of the employee turnover-organizational performance relationship can actually produce Abelson and Baysinger's optimal turnover curve (the inverted U-shape) when studied in the context of a public organization. The modeling approach is based on developing and integrating causal relationships derived from logic and the theory found in the literature. The computational approach used parallels that of Scullen, Bergey, and Aiman-Smith (2005).

The level of analysis of this study is the functional department level of large public organizations placing it below the macro level of entire agencies as studied in public administration, but above the level of small group research. The focus is on agencies that employ thousands of employees in specific professional occupations such as engineers, attorneys, and contract specialists.

Employee attrition (equivalent to turnover as this model has been structured) is the independent variable. Workforce performance capacity and staffing costs are the dependent variables. Work organization and organizational "character" (i.e., culture, HRM policies, and environment) are moderating elements that are held constant. Organizational parameters and initial conditions are varied to explore the problem space through the use of a number of case scenarios of interest. The model examines the effects on the dependent variables of annual turnover rates ranging from 0% to 100% over a 10-year period. Organizational size is held constant over this period.

The simulation model introduces several innovative concepts in order to adapt verbal theory to mathematical expression. These are an organizational stagnation factor, a turbulence factor due to turnover, and workforce performance capacity. Its value to research comes from providing a framework of concepts, relationships, and parametric values that can be empirically tested such as through comparative analyses of similar workgroups in an organization. Its value for management lies in the conceptual framework it provides for logical actions that can be taken to control turnover and/or mitigate turnover's impact on the organization.

The simulation model used a 100-employee construct as per Scullen, Bergey, and Aiman-Smith (2005), but was also tested with 1000 employees as well and no significant differences in outcome were found. Test cases were run over a 10-year period. The model was also run out to 30 years to test model stability and no instability was found.

Key findings and conclusions of the analysis are as follows:

1. Results demonstrate that Abelson and Baysinger's (1984) inverted-U curve can occur, but only under certain conditions such as bringing in higher-skilled employees or alleviating stagnation.
2. Results support Scullen, Bergey, and Aiman-Smith's (2005) findings that workforce performance potential increases under the condition of increasing the quality of replacement employees.
3. Organizational type, as defined in the public administration literature, does not affect the results.

In addition, an analysis of recent empirical work by Meier and Hicklin (2007) who examine the relationship between employee turnover and student test performance using data from Texas school districts is provided as an Addendum. This analysis demonstrates how the modeling and simulation methodology can be used to analyze and contribute to theory development based in empirical research.

Dedication

To my wife Marsha who bore with me for seven years as I worked through the classes and reached the point of completing this dissertation.

Acknowledgments

I'd like to thank my committee members, Jim Wolf, Kevin Carlson, Anne Khademian, and Colleen Woodard for their support and time, and for helping me focus in on the research question and the presentation and significance of the results.

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"Vacancies and personnel turnover continue to plague the Department of Homeland Security and are unquestionably impeding the agency's effectiveness."

Website of the Democratic Office of the
House Committee on Homeland Security
Posted 31 July 2006

1.0 INTRODUCTION

The flow of people through an organization's positions is an inescapable feature of all organizations. The common terms to describe this flow are turnover (at the working level), succession (in the managerial ranks), and internal mobility (from position to position). As people join, leave, and move about in an organization, changes are created in the organization's membership (its human capital and demographics), their social relationships (social capital), and organizational costs (hiring, wages, training, retirement). These changes, in turn, have consequences for organizational outcomes. The connection between the flow of human resources and organizational consequences has long been noted in the research and practitioner literature.

Turnover adds to and subtracts from an organization's human capital through several mechanisms which are addressed in the literature. The impact of turnover on the organization (in both performance and cost) depends on factors such as organization-specific vs. general human capital needs, learning curves, organizational structures, labor cost structures, vacancy rates, and other factors. Recognized costs must include separation costs, replacement costs, and training costs. Internal mobility is a semi-independent factor sometimes wholly dependent on turnover flows (in a vacancy chain context) and in other contexts, totally independent. Internal mobility has impacts on an organization with regard to diversity, promotion opportunities, and performance.

From an individual supervisor or line manager's perspective, turnover and mobility have generally been negatively viewed. This is understandable as they view the loss of experienced

personnel as a costly and time-consuming event requiring the time and energy needed to select, hire, and train a replacement. From a higher-level organizational perspective, employee turnover can be viewed as a symptom of organizational health – like the temperature of the human body. If it is too high or too low, it is indicative of an internal problem. What's going on inside is what affects workforce performance.

1.1 Significance for Public Organizations

Public organizations today, at all levels, face a wave of retirements that will create greater than normal turnover in the ranks of civil servants. In addition, public organizations face budget constraints and pressure to improve performance. The Dept. of Defense, for example, has devised a Civilian Human Capital Strategic Plan[1] which specifies outcome goals such as an "acceptable rate of attrition," an "acceptable rate of internal movement," and an "acceptable level of new-hire turnover." Unaddressed, however, is the fact that there is no metric for managers to judge whether turnover is occurring too quickly or too slowly and how it affects workforce performance and costs. This aspect has not been addressed to any great extent in the literature, and not to any extent at all for public organizations.

Two recent news articles demonstrate the nature of the problem from the management perspective.

Example 1 - TSA's Problem – too much turnover[2]

"TSA is seeking $10 million in FY2007 to address what the budget calls "a high rate of attrition." The money would be used to offer extra pay, bonuses, retention allowances, college credit reimbursements, and other incentives, the budget request said. The turnover, TSA said, has driven up recruitment and training costs as the agency constantly seeks to replace screeners who quit."

Example 2 - The Army's problem – too little turnover[3]

"The service looks to develop flexible, highly skilled managers who can be plugged into almost any leadership position. Senior Army leaders say…that

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[1] DOD Civilian Human Capital Strategic Plan 2006-2010, Office of the Under Secretary of Defense for Civilian Personnel Policy, Washington DC

[2] Washington Post, 10 Feb 06, p. B2

[3] Washington Post, 3 Mar 06, p. A15

individuals often got stuck working for one command or in one subject area and never had the opportunity to develop different skills. Executive leaders need more diverse assignments and regular turnover, both to allow for career opportunities and for the Army to make 'an investment' in those opportunities."

The effects of the flow of personnel (or lack thereof) are clearly recognized by the practitioners in the field. The following are a number of quotes that clearly demonstrate the recognition, and sometimes, contradictory views, of the problem.

"*Among other problems, (FBI) officials blame…a rapid turnover among the bureau's information technology personnel…"*[4]

"Current overall turnover rates for federal IT workers are low. Clearly, a certain amount of turnover is desirable. More mobility between the public and private sectors would infuse the work force with a dynamism particularly important for IT."[5]

"Many Metro employees have never worked anywhere else and can't draw on the broader experience of the industry in tackling problems. He (Richard White, the new head of the Washington DC Metro system) also said the agency is suffering from an influx of new, inexperienced employees."[6]

"*The benefits of turnover include getting rid of poor performers and introducing new blood. The costs of turnover include a drain of institutional knowledge, lost productivity while positions are vacant, additional recruitment efforts, and training for new employees*."[7]

"Insufficient turnover can be a problem if it prevents the hiring or promotion of better-trained or more-skilled personnel, or if it dulls the efforts and retention incentives of high-

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[4] "FBI May Scrap Vital Overhaul of its Outdated Computer System" New York Times, 14 Jan 2005

[5] "Tomorrow's IT Work Force" The CIO Viewpoint, Federal Times, 19 May 2003, pg. 21

[6] "Newest Metro Rider is the System's Boss" by Steven Ginsberg, Washington Post, 8 Nov 2004, pg. B1

[7] "Government's Staying Power" by Brian Friel, Government Executive, Oct 2001, pg. 66-67

quality junior personnel by allowing mid- and late-career personnel to block promotion opportunities for others." [8]

In addition, the following is an interesting quote from the academic literature on agency development that clearly articulates the issues addressed here.

"*Informational and programmatic capacity depend on the ability of bureaucracies to attract, keep and secure the commitment of skilled technical and administrative personnel. Although many agencies suffer from too little turnover and the rigidity that may result from this stasis, high turnover is usually more damaging. Among policy analysts, experts, and technicians, high turnover can be quite damaging to agency capacity. Officials with longer tenure, rising to authority within their bureaus (with experience at many different levels), possess enhanced leadership skills and the ability to solve organizational dilemmas. Longer-tenured officials possess a better sense of the history of their programs, and are better able to make comparisons over time. In other words, bureaus with lower turnover are usually better equipped to learn."* [9]

These comments summarize express the consequences and complexities of human resource dynamics as experienced in organizational life as summarized in Table A below.

[8] Asch and Warner, (1999) RAND Corp. Separation and Retirement Incentives in the Federal Civil Service

[9] Carpenter (2001), The Forging of Bureaucratic Autonomy, Princeton University Press

Table A
Internal Consequences of Flow

Lower Rates of Flow	
Positive	**Negative**
Stability, employee security	Organizational stasis
Stronger corporate memory	Minimal inflow of new skills
Lower recruiting and training costs	Little opportunity for advancement
More stable workgroups	High performers may prefer to leave
Higher Rates of Flow	
Positive	**Negative**
More opportunities for advancement	Communication and coordination disrupted
Organization can change and adapt quicker	Less organizational memory
More rapid infusion of new ideas and skill sets	Higher costs to recruit and train replacements
More opportunities to bring in higher performing employees	Team cohesion reduced

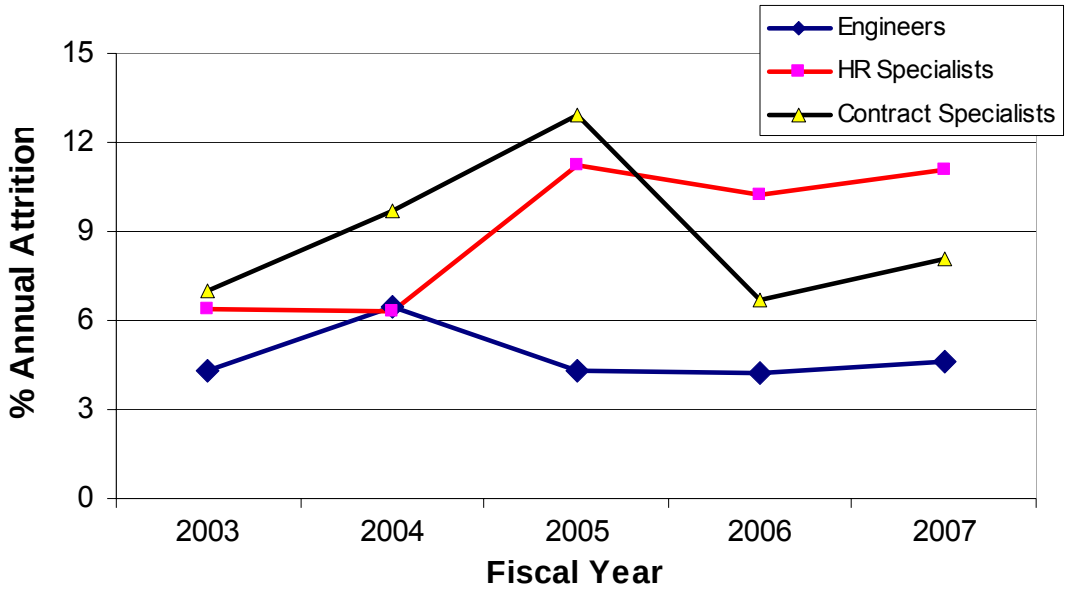
1.2 The Manager's Question

Federal employee attrition has historically been relatively low compared to private sector organizations, and as the baby boomer generation approaches retirement, the rate of attrition is beginning to increase. But as Figure 1 below shows, the rate in just one agency can vary widely across departments and from year to year.[10] Given the prospects for the expected wave of federal employee retirements, it is reasonable for managers to ask, what level of turnover should management strive for? Given organizational goals and budget limitations, should the rate be 8%, or 6%, or 10%? Is there an optimum rate of turnover? While the questions appear simple, development of an answer has been an open research issue for years because it presents significant empirical challenges. For management, how to answer the question 'how much turnover is best for my organization' raises the question of how to balance the positive and negative consequences of differing levels of turnover, how to assess those consequences,

[10] Data is from the Federal Aviation Administration in this case.

and balance that against the costs of controlling turnover or mitigating its consequences. For researchers, the challenge is methodological and this issue in particular will be addressed in the research approach presented in Section 3.

Figure 1
One Federal Agency's Attrition Rates



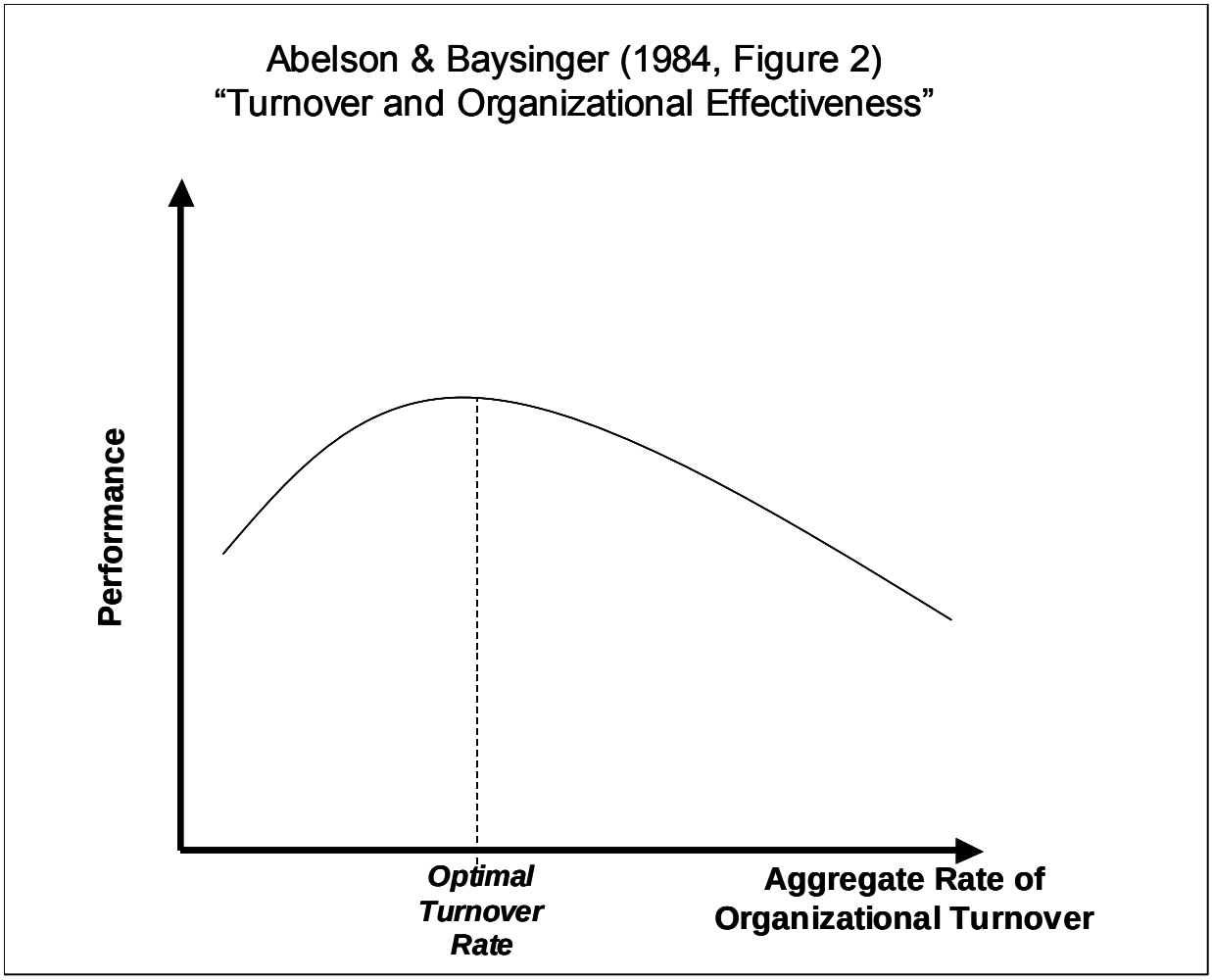
From a managerial perspective, there is no "metric" against which to judge whether turnover is too high or too low, nor by which to judge the impact this may be having in critical segments of the workforce population. If employee turnover was a totally uncontrollable factor, this question would be of no significance to managers as there would be nothing they could do about it. But in reality, managers can affect turnover rates, and can therefore be held accountable for organizational outcomes.

1.3 Abelson and Baysinger's Hypothesis

In the early 1980's, Abelson and Baysinger (1984) presented a conceptual paper that attempted to answer this very question – how can the optimum rate of employee turnover for an organization be determined. Abelson and Baysinger framed their idea primarily from a staffing costs perspective but included a smattering of human relations concerns. As they defined it, "The optimal organizational turnover rate is the rate that minimizes the sum of the costs of turnover plus the costs associated with reducing it." They extended their cost perspective to

include organizational performance by replacing the cost measure with a performance measure which they define as “any acceptable measure of the organization’s total, long-run financial performance.” This was depicted in their inverted U-curve shown in Figure 2 below.

Figure 2
Abelson and Baysinger's Curve



Drawing on the work of Bluedorn (1982) and Dalton and associates (1979, 1981, 1982a,b) they recognized that employee turnover has both positive and negative consequences. Bluedorn, in particular, cited several earlier empirical studies that suggested various turnover-organizational performance relationships. Bluedorn noted that the nine earlier studies “moderately support an inverted U-shaped relationship between turnover rates of the top executive and organizational performance.” But they concluded with, “Whether this is the pattern of the relationship between overall turnover rates and organizational performance

cannot be answered without further research." What distinguished this particular work by Abelson and Baysinger was that its "primary objective (was) to present an organizational rather than individual perspective on turnover." They addressed the problem primarily from the economic perspective of balancing the costs of keeping the better employees (i.e., paying higher wages to retain employees) against the savings of paying lower wages but suffering the additional costs generated by turnover. They also recognized that the optimal rate of turnover for different organizations would vary according to the "differences in circumstances" between organizations.

Abelson and Baysinger did not specify a time frame. Since the focus of their discussion is on human resource management policies, it is reasonable to assume that they were looking at a time frame of years, perhaps a few to several. Their reference to long-run financial performance in the discussion of the impact of the rate of employee turnover on performance supports this assumption.

With regard to scale, Abelson and Baysinger refer to their analysis as being at a "macro-organizational level." Their paper does not address the size of the organization or the number of employees; the tenor of the discussion implies large organizations having hundreds to thousands of employees – certainly not small teams.

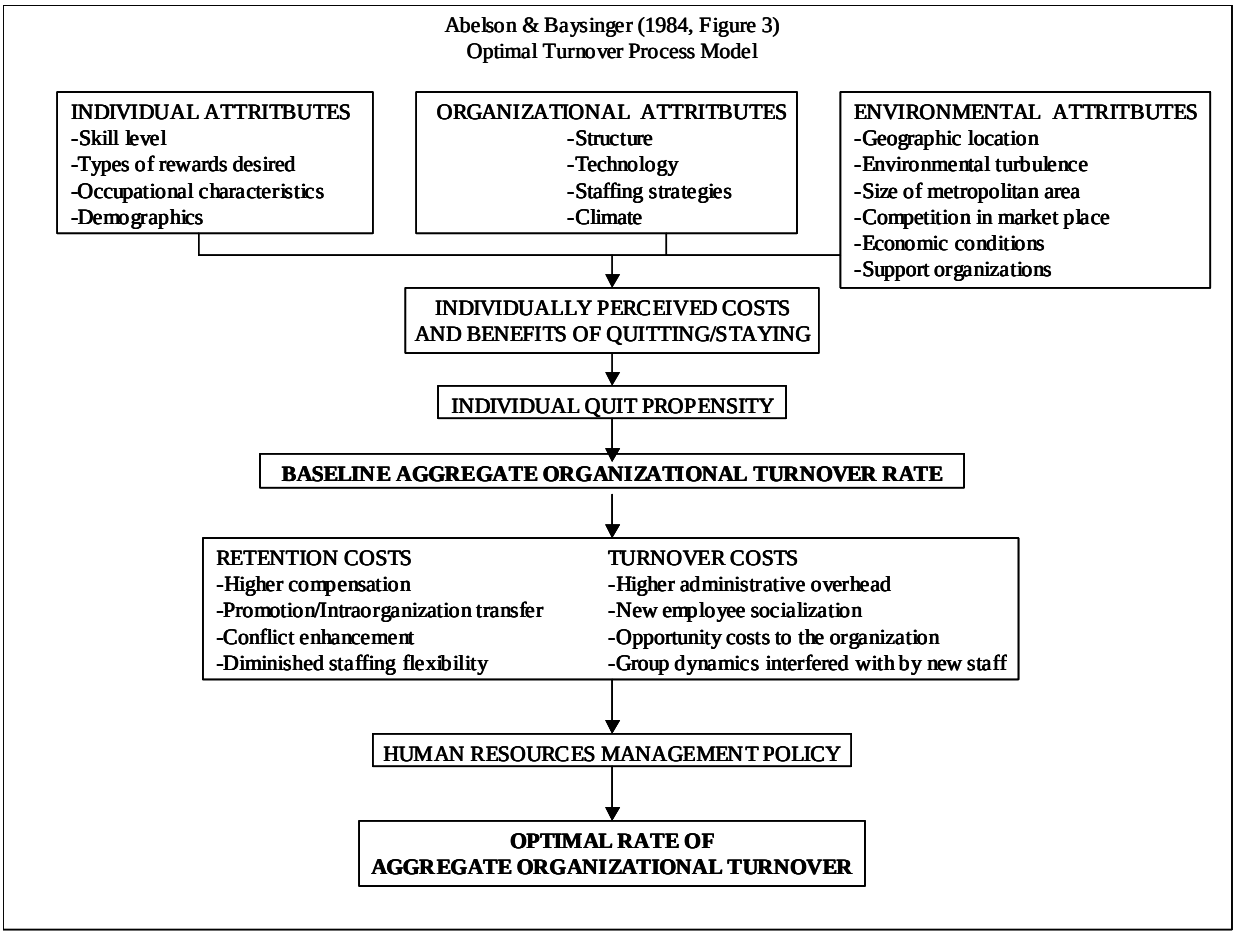
Abelson and Baysinger did not go into a lot of detail regarding the specific positive and negative effects of varying rates of turnover, making reference instead to the contemporary turnover research literature. Specific elements that Abelson and Baysinger do cite are categorized under two "cost" categories.

Retention costs	Turnover costs
• Higher compensation	• Higher administrative overhead
• Promotions/transfers	• New employee socialization
• Conflict enhancement	• Opportunity costs to the organization
• Diminished staffing flexibility	• Group dynamics interfered with by new staff

Their model is provided as Figure 3 below. Abelson and Baysinger refer to it only as a conceptual model to guide analysis, not as a causal model from which to perform calculations. In fact, it is truly more of a framework, a set of factors or analysis process steps, rather than a

model. To get from the top line of Individual, Organizational, and Environmental factors, to the bottom, the Optimal Rate of Aggregate Organizational Turnover, they identified a complex of factors that in their view determine the Baseline Aggregate Rate (current rate). The connection between their model/framework and the inverted U-shaped curve occurs in the box where the tradeoff between Retention Costs and Turnover Costs is made. Human Resources Management Policy is the box where the tradeoff is operationalized (e.g., through compensation policy or other incentives) to achieve the optimum rate. While the concept of an optimum rate is intuitively plausible, their model/framework has never been empirically tested due to its complexity and non-specificity. Their discussion of causal relationships and factors is open to criticism in light of current understanding of attrition causes, particularly their emphasis on economic factors. Further, and most problematic, is that the Baseline Aggregate Turnover Rate will not likely be stationary as the federal agency example provided in Figure 1 shows, which implies that the optimal rate would not be stationary either.

Figure 3
Abelson and Baysinger's Model/Framework



Abelson and Baysinger's place in the literature is further discussed in the literature review below.

1.4 The Research Question and Approach to be Taken

From a practitioner's perspective, the manager's question, "what level of turnover should management strive for?" appears straightforward, yet development of an answer is still no closer than when this question was asked decades ago due to the inherent complexity of the problem. Abelson and Baysinger (1984) suggested that finding an optimal point of aggregate employee turnover is theoretically possible. Their hypothesis was based in research on the positive and negative consequences of employee turnover, and was, and still is, intuitively plausible given what we know to this date. But the framework in which Abelson and Baysinger based their hypothesis, as subsequent researchers have noted, was overly complex to empirically verify, let alone utilize at the practitioner level. The problem, as will be discussed in Chapter 3, is that Abelson & Baysinger's hypothesis falls into a general category of theoretical hypotheses that by their very nature, are difficult or impossible to actually test in the real world.

Therefore, this analysis will take an alternative approach: that of modeling and simulation, to test whether Abelson & Baysinger's hypothesis that an optimum aggregate employee turnover rate exists, can be demonstrated. The framework in which this work will be placed is that of large federal organizations that employ thousands of employees in specific professional occupations such as engineers, attorneys, and contract specialists. Rather than seek an empirical source of data, existing theory and first-order logic will be used to construct a cause-and-effect (causal) model of the relationship between employee turnover and organizational performance. By testing the model over time and under various scenarios, it is hoped to see whether Abelson and Baysinger's hypothesis can be demonstrated and under what conditions.

The more narrowly and precisely defined research question to be addressed is this: *whether a logic- and theory-based model and computer simulation of the employee turnover-organizational performance relationship can support Abelson and Baysinger's hypothesis in the context of public organizations*. To accomplish this goal, the following will be addressed:

- The general nature of the employee turnover-organizational performance relationship,
- The organizational characteristics and mechanisms that drive the relationship,
- Whether the type of organization studied affects the nature of the relationship,

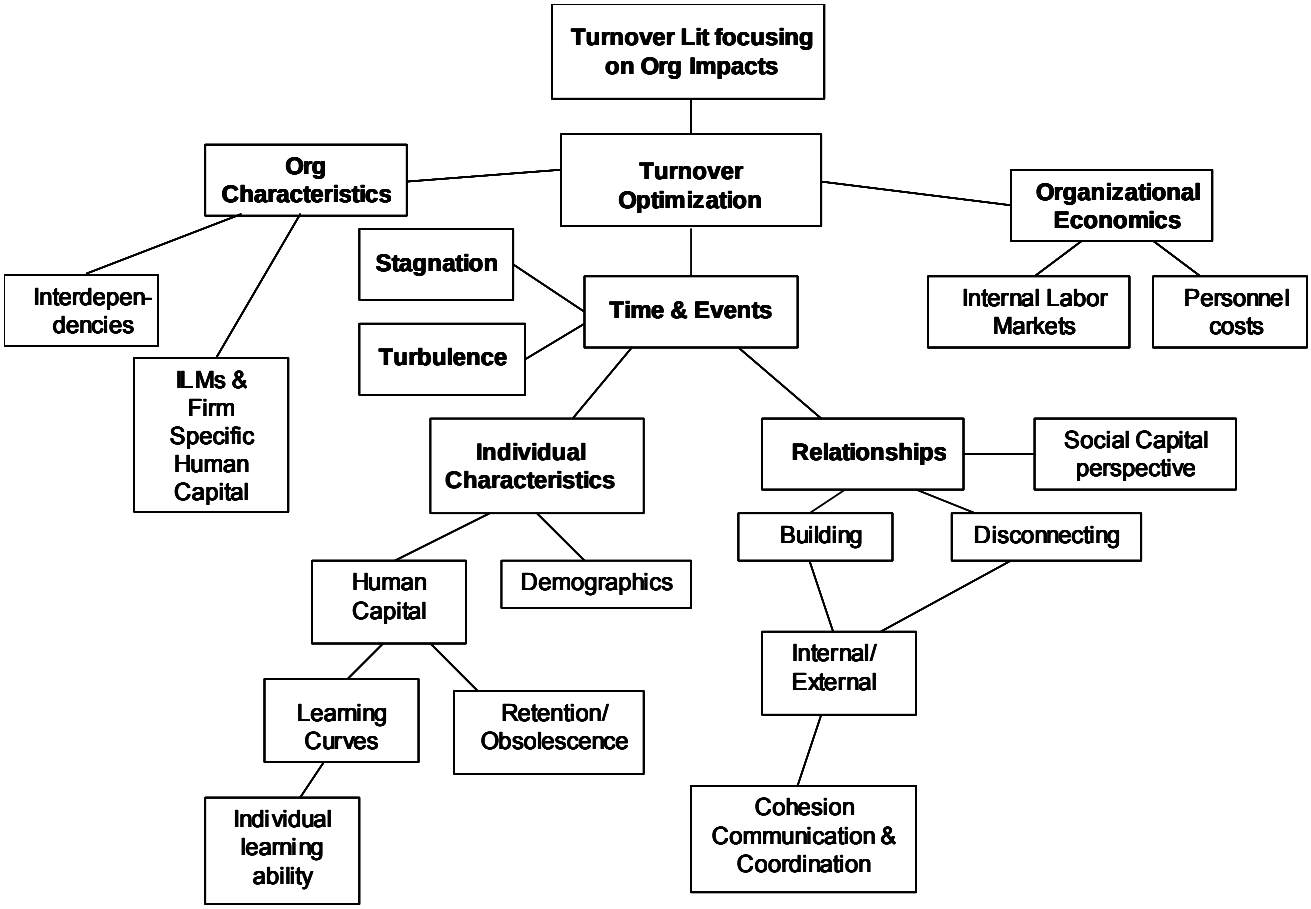
These issues will be approached through a review of the pertinent research literature in Chapter 2 and development of the model and simulation in Chapter 3. Test results will be discussed in Chapter 4. Significance of the results for research and management are discussed in Chapter 5.

2.0 THE LITERATURE

The goal of this review was to deconstruct the issues addressed in the literature so as to be able to identify the fundamental factors underlying the employee turnover-organizational performance relationship. This literature is based in a number of primary theoretical streams: human capital, social relationships, demographics, individual learning, and organizational economics as well as several ancillary areas. Figure 4 provides a pictorial overview of these areas of literature that I have examined and discuss in the sections below.

Figure 4

Organization of Literature Review



2.1 Employee Turnover

Turnover is an overarching term that connects the distinct processes of attrition (departures from the organization) and accession (finding and hiring new people). Attrition may be voluntary, involuntary, planned, or unplanned. Turnover refers to the filling of positions by new people as old ones leave. Van Der Merwe and Miller (1971) cited the definition used by the British Institute of Management, which aptly defined turnover as "the process of change in the composition of the labor force."

Literature on the subject of employee turnover and its organizational consequences can be found as far back as the early 1900's in works such Slichter (1919) who studied the causes and costs of factory labor turnover. Mosher and Kingsley (1936) devoted an entire chapter to the subject in their public administration text. Mayo and Lombard (1944) studied labor turnover in the wartime aircraft plants of southern California, Gouldner (1954) presented a case study that described the organizational consequences of a succession in management. Cornog (1957) reviewed employee turnover research in the personnel administration literature in the first half of the 20th century noting the abundance of statistical studies but little in the way of what could be done with that data. Trow (1960) ran experimental tests of membership turnover to gauge its effect on team performance. The issues of turnover, organizational consequences, and related areas came to be studied in greater depth in a body of later work such as Price (1977, 1989), Dalton and Todor (1979, 1982), Staw (1980), Bluedorn (1982), Abelson and Baysinger (1984), Martin and Bartol (1985), Argote, Insko,Yovevitch, and Romerio (1995), Huselid (1995), Guthrie (2001), Baron, Hannan and Burton (2001), Dess and Shaw (2001), Shaw, Gupta, and Delery (2002, 2005), Glebbeek and Bax (2004), Shaw, Duffy, Johnson, and Lockhart (2005), Kackmar, Andrews, Van Rooy, Steilberg, and Cerrone (2006) and as recently as Ton and Huckman (2008). The examples of work cited here are those primarily concerned with turnover, its positive and negative effects, and organization-level consequences, rather than that concerned with the causes and control of voluntary attrition, which is a much larger body of literature. The cited references as well as others are discussed further in the relevant sections.

2.1.1 Turnover Optimization Literature

Employee turnover is a recognized factor driving the performance all organizations, private and public. It is well recognized in the literature and by practitioners that turnover has both positive and negative effects on an organization (cf. Mosher & Kingsley, 1936; Bluedorn, 1982; Hom & Griffith, 1995) and that too much turnover or conversely too little turnover are both

considered to be bad for an organization. Intuitively, this would suggest that somewhere in between the two extremes must lie the "right" amount of turnover. The question that arises then is, what is the "best" or optimum level that an organization should strive for.

The earliest statement of the recognition that an organization can suffer from either too little turnover or too much turnover that I have been able to find comes interestingly from the public administration literature. A textbook authored by Mosher and Kingsley in 1936 devoted a chapter to the issue of employee turnover. These authors viewed too little turnover as leading to agency stagnation and too much turnover as creating instability and loss of expertise. They recommended that turnover should ideally be sufficiently large to prevent stagnation but sufficiently small to achieve and maintain healthy working conditions. While no single rate of turnover could be prescribed as best for all agencies, it behooved management to find this point. As Mosher and Kingsley expressed it in classically literate terms:

> "*The task of management, then, is to avoid the Scylla of a stagnant service while steering clear of the Charybdis of inordinate instability.*"

While no formula was provided to find this ideal point, the authors did suggest using turnover rate as a benchmark measure of organizational health for comparison against other similarly situated agencies.

This same sentiment was expressed many years later in Meyer, Beville, Magedanz, and Hackert's (1979) analysis of the turnover of South Dakota state government employees. Their work referred to the need to "determine what constitutes a 'healthy turnover rate,' i.e., a rate which represents normal attrition in an organization and which thereby allows an organization to change and adapt while continuing an experienced, competent work force." They also noted that "What constitutes a proper turnover rate for a particular agency, department, division, age group, or occupation is rather problematic at best, and at any level not easily established."

The work of Abelson and Baysinger (1984) addressed this question when they suggested that finding an optimum point balancing the costs of turnover versus the costs of retention as a function of the turnover rate, as well as a point of maximum performance, or optimal aggregate turnover, was theoretically possible. They too noted, as others did before, that, "The optimal turnover rate for different organizations is likely to vary according to differences in circumstances that influence the balance point between retention and turnover costs. Because this is peculiar to individual organizations, there probably is no general benchmark for the

optimal, non-zero rate of turnover." Abelson and Baysinger proposed a comprehensive model that identified a large number of factors they believed would lead to identifying that optimum rate, a point lying at the top of the inverted U-shaped curve.

Twenty years pass with no further research on the issue of optimization along the lines proposed by Abelson and Baysinger (1984). Glebbeek and Bax (2004) attribute this paucity to the complexity of Abelson and Baysinger's proposed model. They noted that "Even for academic researchers, it would be difficult, if not impossible, to identify a level of optimal turnover with the help of this method." After addressing all the technical challenges, they write "we have to conclude that Abelson and Baysinger (1984) have set researchers and practitioners an impossible task by linking the application of their model to data that have to be obtained outside a given company itself." Despite these challenges, however, Glebbeek and Bax set out to (1) demonstrate that Abelson and Baysinger's hypothesis is correct, and (2) to demonstrate that the analysis could be performed using only intraorganizational records. Their work tested Abelson and Baysinger's hypothesis that employee turnover and firm performance have an inverted U-shaped relationship: both overly high and overly low turnover are harmful. Their analysis was based on financial performance data they obtained from the 110 offices of a Dutch temporary employment agency. These offices were structurally similar, but had variations in turnover and sales performance. Regression analysis showed a curvilinear relationship; high turnover was harmful, but an inverted U-shape was not clearly evident.

Shaw, Gupta, and Delery (2005) pursued this same path but postulated three alternative curve shapes. Their empirical analysis confirmed the non-linear nature of the turnover-performance relationship finding greater marginal performance impacts at low rates, and lower marginal performance impacts at higher rates of turnover. They did not, however, find support for the inverted U-shape curve as Abelson and Baysinger had postulated. Conversely, that same year, Scullen, Bergey, and Aiman-Smith (2005) developed a simulation to study the effects of Forced Distribution Rating Systems (i.e., those in which the lowest performers in the workforce are fired each year and replaced) in which the inverted-U does appear, in part, in the results. Additional evidence supporting the inverted-U appears in Harris, Tang, and Tseng (2003) in their study of labor productivity in Australia, where they found that productivity peaked at an annual labor turnover rate of 22%.

That this subject is still of interest is indicated by two recent and contradictory papers: one by Siebert, Zubanov, Chevalier, and Viitanen (2006) who performed an empirical analysis of the relationship between labor turnover (low-skilled retail personnel) and productivity (sales per labor hour) in a UK retail chain. They found that productivity peaked at around 20% annual turnover improving productivity by 2.5% compared to the zero turnover level. Their work is the first to clearly demonstrate the inverted U-shaped curve.

The other paper is by Meier and Hicklin (2007) who use data from Texas public school districts to examine the relationship between teacher turnover and student test performance. In their analysis, they use two measures of performance – state standardized tests (low difficulty) and college-ready criteria (high difficulty). By inference, a low difficulty task requires less skill and a higher difficulty task requires more skill. As they describe it, "The aim of (their work) is to demonstrate that differentiating levels of task difficulty reveals the underlying curve." That is, whether the curve is linear or not (i.e., the inverted-U curve). Based on their analysis, they conclude that both their hypotheses are supported: that (1) at low levels of task difficulty, the relationship is linear and negative, and (2) that high levels of difficulty, the relationship has an inverted-U shape. While their results in the latter case support Abelson and Baysinger's (1984) hypothesis, their conclusion regarding low difficulty tasks directly conflicts with Siebert et al.'s (2006) findings. The differences can be imputed I believe to both author group's unstated assumptions: Siebert et al that replacing employees can improve organizational performance and Meier and Hicklin, that there is no benefit from replacing employees.

2.1.2 Organizational Stagnation

Cameron, Kim and Whetten (1987) discuss the concept of organizational stagnation in the context of their study of declining organizations. Stagnation is most prominent in organizations that change little over time, that is, those that have little inflow of new personnel over long periods of time. Organizational stagnation is described as having the characteristics of rigidity, centralization, formalization, conservatism, and little to no internal mobility. These characteristics "erode organizational effectiveness and undermine member satisfaction and commitment."

Geles, Lindecker, Month and Roche (2000) provide an interesting social-psychological perspective on organizational stagnation in the context of the management of scientific research laboratories. They view stagnation as the declining portion of a cycle of organizational growth,

degeneration, and (hopefully) regeneration as an organization ages. Externally, the decline is visible through a decrease in research reports, patents, and new developments. Internally, the signs of stagnation become clear as people put their own interests ahead of the organization, mistakes go unchecked, and there is a great deal of general apathy.

Writing in the context of a computational study of organizational learning, March (1991) defined what we would describe as organizational stagnation as "a dramatic long-run degenerate property under conditions of exogenous turbulence." What he was describing was the decline over time, in the absence of turnover (i.e., the infusion of new people), of the organizational knowledge base ("code" as he refers to it) relative to changes in the organization's external environment. As he put it, "the knowledge of the code and individuals are systematically degraded (over time) through changes in reality." In this view, stagnation can be viewed as an unchanging internal environment while the external environment changes around it.

The small group dynamics literature also provides an interesting perspective on a form of intellectual stagnation referred to as "groupthink" – a term coined by Janis (1972). The key antecedent leading to all the decision-making disasters studied by Janis was a high degree of group cohesiveness fostered by group stability (i.e., no turnover that could bring in dissenting voices). Forsyth (1990, p. 298) commenting on Janis' work on the Bay of Pigs Advisory Committee noted that "no replacements were ever needed (on the Committee) because no one ever left the group" and that "the group retained all its members for the duration of the decision-making process" thereby precluding the entry of any potentially dissenting voices.

A similar effect was noted by Katz (1982) in his empirical study of R&D project groups (predating the work of Geles et al. (2000) above). His analysis showed that "project groups become increasingly isolated from key information sources both within and outside their organizations with increasing stability in project membership. Such reductions in project communication (i.e., information inflow) were shown to adversely affect the technical performance of project groups."

2.1.3. Turbulence

The counterpoint to organizational stagnation is organizational turbulence. Cameron, Kim and Whetten (1987) also addressed the concept of organizational turbulence in their study of

declining organizations. Organizational turbulence "creates uncertainty" because it reduces the ability of organizational members, particularly managers, to plan and control outcomes. Turbulence differs from simple rapid change in that turbulence is change that is both rapid and unpredictable. In the context of this research project, turbulence results from the unpredictable departure and replacement of employees, the consequent breaking of existing personal and working relationships, and the effort and time needed to build new relationships, thereby reducing organizational performance capacity in the interim. In small group research, for example, Arrow and McGrath (1993) found that the frequency, duration, regularity, and predictability of group membership changes influenced how groups interpreted and reacted to the changes. Different organizational outcomes can be expected depending on how and at what rate change has occurred.

2.2 Time and Events

The starting point for this framework is the foundational element of time. Bluedorn and Denhardt (1988) provide an overview of the research related to time and organizations noting that there are many ways to view the passage of time. In this analysis, time is viewed through two perspectives: biological time (aging of organization members, the time required for learning), and economic time (its financial value). Further, embedded within the smooth stream of time, are life and organizational events that span the range of complete predictability to complete randomness. Time and events, as reflected in an organization's pattern of human resource attrition, accessions, and internal mobility, are the sources of the dynamics of the conceptual framework underlying this analysis. Time and events provide the clock mechanism and the punctuations behind human resource flows.

The passage of time underlies the life cycle of the organization's human resources – from entry to exit. Life events for organizational members are sometimes highly predictable, such as conclusion of a term employment contract, or a mandatory retirement age. Other events in life are not as predictable. One cannot predict when an employee may resign, get a promotion, suffer an illness or death, or marry and move to a new city. Yet, we can be certain, that in any organization over time, these events will happen. These latter events may be considered random, yet randomness in the context of human resource flows is not the same as unpredictability. Though the chance events of organizational life are unpredictable in their specifics, human resource flows in organizations are probabilistically predictable in many ways. Bartholomew (1982) discussed the random (stochastic) yet predictable nature of events that are

directly related to turnover and mobility events. It is this quasi-predictability at the macro level that enables an organization or an entire society to institutionally live on while its members come and go.

Time is a fundamental characteristic of the physical world, possibly unending, but time as we experience it in our daily lives is a finite resource. Time is a significant organizational constraint that has impacts on human behaviors and relationships. The elements of time of concern to management, from the human resources perspective, are the time needed to acquire employees for the organization, the time needed to train and develop them, the time needed for social relationships to develop and organizational learning to occur, and the inevitable aging of organizational members. An organization buys labor, i.e., its human resources, in units of time whether by the hour or by the year. From an economic perspective, one need only cite the aphorism that "time is money." No organization exists that does not incur costs, direct and/or indirect, as time passes.

Working in this time-based perspective, Dierickx, Cook, and Barney (1986) presented a conceptual framework based on the idea that certain strategic assets (such as firm-specific human capital) cannot be bought on the open market but can only be developed over time. In this same vein, Morecroft (2002) presents a time-based view of the development of organizational resources – dynamic resource systems as he refers to them – in the context of organizational performance and competitive strategy.

Writing from the team (small group) perspective, Rico, Sanchez-Manzanares, Gil, and Gibson (2008) note that time is (or should be) an important element of team performance research studies. The passage of time plays an important role in the development of shared knowledge, coordination, and mutual learning at the implicit, cognitive level of team functioning. They view the longevity of team membership as a key parameter in the establishment of shared knowledge structures thereby enabling higher levels of team performance. In this same perspective, DeRue and Morgeson (2007) examined how the factors that influence person-team fit and person-role fit change over time. They found that individuals' satisfaction and performance were positively related to increases in fit over time. In a parallel study, Ilies, Wagner, and Morgeson (2007) showed how the affective linkages between team members, both positive and negative, evolve over time.

Organizational change can be viewed as a consequence of the passage of time and the occurrence of events. The occurrence of events leads to the attrition of individuals and their replacements, to the internal mobility of individuals, and to the making and breaking of social relationships. All these events create organizational change, and it is change that creates organizational consequences. As Burke (2002) noted, "Organizations change all the time, each and every day. The change that occurs in organizations is, for the most part, unplanned and gradual." Organizational change can be imputed in part to the dynamics of an organization's human resources. In this regard, the rate of human resource change is a significant influence on the organization. An organization with a very low rate of flow is a very different one than an organization where movement occurs very frequently.

2.3 Individual Employee Characteristics

In the economics literature, the "firm" was defined by Penrose (1959) as an assemblage of productive resources – physical and human – administratively organized to supply goods and services to its customers. This is the macro perspective used by Abelson and Baysinger in their analysis. The term "human resources" (or its equivalents – personnel, workforce, or employees) is used in this framework in the human capital perspective.

2.3.1 Human Capital

Human capital is the term used to describe the productive value of the knowledge, skills, abilities, behaviors, and experience embodied in an organization's or society's members. The first mention of the value of human capital can be found in Adam Smith's 1776 treatise, *The Wealth of Nations.* Adam Smith recognized that skilled labor was a form of productive capital that complemented the other forms of capital used in the production of goods and services. The term found general use within the economics field, but it was not until the 1960's when two Nobel Prize winning economists, Theodore Schultz (Schultz, 1961) and George Becker (Becker, 1964) gave the concept wider exposure. Today, the term has entered the practitioner's language and is commonly used to refer to what used to be called personnel, the workforce, or just employees. Typical are current GAO reports (e.g., GAO, 2000) and trade literature (e.g., Davenport, 1999; Breul and Gardner, 2004).

Human capital is *the* fundamental and necessary resource of all organizations, but human resource flows impact that human capital by adding to or subtracting from its total "value." The research literature provides numerous examples of the role of human capital flows and its

relationship with organization-level outcomes. Hitt, Bierman, Shimizu, and Kochhar (2001) examined the role of human capital in the relationship between strategy and organizational performance in professional service (law) firms confirming the importance of human capital. Shaw, Gupta and Delery (2002), in their studies at concrete plants and trucking companies, found a relationship between voluntary turnover and workforce performance attributed to the loss of human capital with turnover. Argote and Kane (2003) reviewed the literature on the effects of turnover on workgroup performance which showed that the effects were contingent on a number of factors related to the specific human capital of the individuals, the nature of the task performed, and the stability of the environment. In further small group research, Levine and Choi (2004) empirically demonstrated that as workgroup turnover occurred, performance varied with newcomer ability and status relative to the departing member. Pennings and Lee (1998) studied the loss of human and social capital as factors in the dissolution of firms in Dutch accounting firms. They found that greater human and social capital decreased the likelihood of firm dissolution. In a complementary study, Brochelera, Maijoor, and van Wittel (2004) looked at the relationship between human capital and the survival rates of Dutch audit firms. Not surprisingly, they found that greater levels of human capital increased the likelihood of survival.

If an organization's human capital is viewed as the aggregated capabilities of the organization's members, these capabilities, by definition, will directly change with the flow of the organization's human resources. Warren (1999, 2002), building on the resource-based view of the firm, wrote that organizational performance ultimately "depends upon strategic resources (e.g., human resources) whose behavior over time depends on rates of gains and losses." In other words, the ebb and flow of critical organizational resources will determine the performance of the organization.

As Warren above emphasized, changes in organizational resources will affect organizational outcomes. The literature has long recognized that even the loss of a single key individual can have significant impacts on an organization. Christensen (1953) documented the impact of the loss of the business head in small businesses. Gouldner (1954) described the organizational consequences of the replacement of a plant manager. Haveman (1993) studied the impact of executive management turnover on the survival of small organizations, finding that turnover did increase failure rates, particularly in young organizations. In the government sector, the unexpected loss of a government head (e.g., Kennedy in 1963 or Nixon in 1972) creates profound organizational consequences.

An additional and fundamental characteristic of human capital is its variance. James Thompson (1967), in fact, titled one of his chapters "The Variable Human" in recognition of this characteristic. Each individual possesses a unique set of human capital characteristics, of knowledge, skills, abilities, and experience that varies about the average for any given occupation or job. Given this variance, or deviation from the mean, it is the organization that determines how tight or how wide a variance is acceptable. This decision has significant organizational consequences as it determines how and what kinds of members are recruited and selected. Organizational hiring practices, an organizational characteristic, do not in general control such variance very well, leading to downstream organizational consequences resulting from poor job matching or personality conflicts

2.3.2 Learning Curves

The learning curve concept first appeared at the end of the 19th century with research on the improvement seen in Morse code skill of telegraph operators over time (Jovanovic et al.. 1995). Empirical evidence on the time needed to train new workers to reach full proficiency can be found in the manpower studies of the early 1900's (e.g., Slichter, 1919). Further research over the years on the psychological aspects of learning confirmed that individual learning is a progressive process, i.e., it occurs over time as an individual learns to do an intellectual task better or become more skilled in a physical task activity (Schilling, Vidal, Ployhart, & Marangoni, 2003). The learning curve represents the time it takes for a new organizational member to become a fully productive employee. Trost (2002), for example, noted in passing the average 1-1/2 years needed to train a quality control engineer in the review of complex ship construction drawings. A study by the National Academy of Public Administration of the US Patent Office[11] found that it took three to five years to fully train a patent examiner. In the blue collar environment, an article in the trade literature[12] noted the time required for learning a highly-specialized skilled trade: "…it takes six to eight years to train workers in advanced (shipbuilding) construction and maintenance skills."

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[11] National Academy of Public Administration, "US Patent and Trademark Office – Transforming to Meet the Challenges of the 21st Century," August 2005

[12] "Navy to Shift Workers to Meet Shortages in High-Skill Positions" by Chris Strohm, GovExec.com, 13 Nov 2003

Argote (1993, 1999) describes the multi-disciplinary literature that has addressed this subject at three levels – the individual, group, and organization. There is not a simple relationship between the levels. They are affected by nature of the task, and organizational structures, communication, and socialization patterns. Group and organizational level learning curves are not merely the aggregation of individual learning curves.

2.3.2.1 Individual Learning Differences

Learning ability is clearly one of an individual's fundamental attributes (Robotham, 2004) and also one of fundamental importance to an organization. It is recognized that individual differences play an important role in learning ability due to differences in intelligence, cognitive styles, and personality (Jonassen & Grabowski, 1993). The learning curve is a fundamental element of the impact of human resource flows on organizational performance because each new employee progresses through a learning curve that varies from individual to individual based on their learning ability, all other things being equal. Given the same task complexity and work environment, the relative difference in individuals' ability to learn and adapt to their jobs will be referred to as an element of employee quality which will be discussed further in the research analysis section.

2.3.3 Human Capital Retention

The long-term retention of personnel is an important goal for organizations where corporate memory and experience-based expertise are valued. As Paul Carpenter (2001) wrote in the quote above (Section 1.1) "*Longer-tenured officials possess a better sense of the history of their programs, and are better able to make comparisons over time."* This is exactly the case in federal agencies where hard-earned experience in developing policy and managing complex programs is highly valued.

2.3.4 Human Capital Obsolescence

While knowledge retention may be valued in some organizations, the counter point is the obsolescence of employee knowledge and skills. Employees in fields where the external technical environment (as in information systems technology) or business environment (as in contracting or financial management) has changed, find themselves to be of less value to the organization as time passes. Pynes (1997) recognized the impact on public employees and agency performance of job obsolescence and emphasized the importance of career development activities. Using a simple system dynamics model, Winch (2001) demonstrated how in times of stability or slow/incremental change, retaining existing staff (minimal turnover) is

the best strategy. However, in times of major change, as the obsolescence rate of the firm's existing skill base increases, bringing in critical skills with new recruits (high turnover) may be the only realistic way of boosting the skill-base to the necessary levels.

2.3.5 The Demographics of Human Capital

While an organization seeks to acquire human resources for its economic value, its demographic characteristics come along with the deal, so to speak. Organizational demographics have a strong influence on the nature, culture, and behavior of organizations. Demographics are a direct reflection of, and to some extent a contributor to, organizational patterns of turnover and mobility. Empirically, we know that attrition has two demographically related variables: employee age and employee length of service. Pfeffer (1983, 1985) described how the demographics of an organization can significantly affect its functioning in a number of areas such as managerial succession, performance, innovation, cohort relationships, and mobility opportunities. McNaught and Barth (1992) describe their study of employees at a national hotel chain's reservation center. They found that older, retired employees had greatly lower attrition rates than younger, entry-level employees. Abbott (2005) described how the changing American workforce over the past century has changed workplace attitudes and behaviors including rates of turnover. Organizational change may thus be considered a function of cohort replacement (that is, human resource flows) over time in this view.

McNeil and Thompson (1971) reflect early work on organizational demographics. The authors studied the consequences of the rate of change in the ratio of younger newcomers to older members in terms of its effect on socialization of newcomers, organizational change, leadership succession, and institutional continuity. Stewman (1988) described the rich potential that organizational demographics holds for turnover analysis when combined with the internal labor market flows typical of public organizations. In his review of the organizational demographics field, noted that "demographic variables and processes have considerable explanatory power, yielding…insights into organizational behavior" citing examples such as "organizational innovation and productivity, internal power struggles, career development or blockage." The economic impacts of organizational demography include labor costs that increase with seniority and age, the likelihood of labor strikes decreasing with worker age, pension assets and liability costs, and health insurance costs directly connected to the age of the workforce.

Demographic diversity also encompasses race, national origin, gender, as well as other characteristics; however, for purposes of this project, these characteristics will not be addressed as they do not directly impact Abelson and Baysinger's proposition.

2.4 Social Relationships

A characteristic of humans is that they develop social relationships (whether good or bad) with other members of their group; and these relationships have organizational consequences. This characteristic has long been recognized in the workplace. Even the early literature such as Slichter (1919) noted the importance of the quality of the social relationships between labor and management as a key factor in the amount of labor turnover experienced: good relationships reduced turnover, while bad relationships increased turnover. Mayo and Lombard (1944) found similar results in their study during the war years at the aircraft plants of southern California. Workers who did not develop social relationships with their coworkers, and workers with poor supervisor relationships had higher levels of absenteeism and termination.

Several more recent research works demonstrate the role of social relationships in organizational outcomes. Pennings and Lee (1998) connected human capital and social capital in their work on Dutch accounting firms. Their work made clear that both are connected and have a direct influence on organization-level outcomes. Greve and Benassi (2004) investigated how human and social capitals contributed to individual productivity in an Italian construction consulting organization. Their study found that social relationships contributed as much as human capital in determining individual productivity. Whereas Nahapiet and Ghoshal (1998) addressed the organizational advantages that accrue in the formation of social relationships for creating and sharing knowledge inside a firm, Droege and Hoobler (2003) addressed the linkage between the diminution of a firm's store of tacit knowledge and employee turnover through the loss of these same social network structures.

Arrow, McGrath and Berdahl (2000) make the point that while both task relationships and member relationships are essential elements of group structures, they are not equivalent. They write that "The people who are the group's members have a special relation to the group that is quite different from the relations of projects (tasks) and technology to the group." Individuals with their range of attributes and behaviors bring a whole level of variability to the member-to-member relationship.

The management literature, both trade (cf.. The Wisdom of Teams) and research (cf. Mealiea & Baltazar, 2007), is rife with guidance on team building for "improving interpersonal relationships and cohesion at work in order to enhance employee performance" in order to strengthen the social relationships among workgroup members (Grant, Christianson & Price, 2007). The very existence of this literature indicates that the strength of relationships is a variable that is dependent on local conditions. Social relationships can therefore be viewed as a variable facilitating task relationships as Barrick, Bradley, Kristof-Brown, and Colbert (2007), did in their study of top management teams. This view is further supported by Gratton and Erickson's (2007) research where they found that managers who were strong on *both* task relationships and social relationships led the most productive and innovative teams.

2.4.1 Relationship Building

The literature shows that two factors must be present for the building of social relationships: time and stability. Mueller (1996) wrote that truly valuable intangible organizational assets are created by skill formation, cooperation, and the creation of tacit knowledge, which result from the natural evolution of social networks inside organizations. A key factor in the development of these characteristics is the passage of time. The passage of time has a similar effect on the collaboration and reduction of social conflict among demographically different organization members (Harrison, Price, Gavin, & Florey, 2002). Leanna and Van Buren (1999) presented a concept they defined as "organizational social capital" to reflect the character in terms of shared trust and goal orientation of the social relationships within an organization. Stable relationships over time are a necessary element for the development of organizational social capital.

2.4.2 Relationship Disconnections

While much of the literature is focused on the positive aspects of relationship building, the breaking of social relationships due to member losses has organizational consequences as well. In his work on internal job movements, Chamberlain (1950) noted that the empirical evidence available at the time suggested that disruptions of a working group, particularly frequent ones, had a disorganizing effect contributing to lower morale. Gouldner's (1954) case study detailed the organizational behavior at a gypsum plant resulting from the retirement of the plant manager and his replacement with a new man who had no social connections to the workers, disrupting the existing social relationships, which led to an increase in formalization of the plants operating procedures. In the fast food industry, Krackhhardt and Porter (1986) found that turnover does not occur randomly throughout an organization, but rather is concentrated along social network

lines precipitating a "snowball effect" when one member leaves. Shaw, Duffy, Johnson, and Lockhart (2005b) empirically tested the impact of social relationship losses due to voluntary turnover in the stores of a restaurant chain finding some support for the connection between turnover, social relationships, and organizational performance. Summarizing the literature on the impact of group member turnover in work teams, Levine, Choi, and Moreland (2003) noted that the consequences can be significant for the functioning of a team specifically because of the changes in member human capital and the social relationships among the members.

2.4.3 External Social Relationships

The development and loss of a relationship with a customer or client can have organizational consequences as well. Florin, Lubatkin, and Schulze (2003) provided empirical support that demonstrated a positive relationship between social capital and firm performance in high-growth business venture firms based on the external social relationships that enhanced the firm's human resources. The consequences of breaking social relationships was vividly demonstrated in the patient care field in the work of Kahne (1968) and Coser (1976) who reported empirical studies connecting increased patient suicides with the turnover of experienced doctors and staff in psychiatric hospitals. In the advertising industry, Broschak's (2004) work showed that both the exit and promotion of customer managers increased the likelihood of a diminished business relationship due to the loss of the customer relationship.

2.4.4 The Social Capital Perspective

Whereas human capital is a measure of the value of individuals, the social capital perspective is recognition of the value of the relationships among those individuals. Social capital can be viewed as a measure of the strength of those relationships. Social capital supports the view that an organization as a whole is greater than merely the sum of its human capital.

Coleman (1988) described social capital in this way: "Social capital…is a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions…Unlike other forms of capital, social capital adheres in the structure of relations between actors and among actors. It is not lodged either in the actors themselves or in physical implements of production." Burt (1997) made use of the concept of social capital in his work on networked organization structures by analyzing how its value accrued to managers in certain positions. Portes (1998) reviewed the development of the

concept of social capital in the sociological and economic disciplines. All writers recognized the importance of relationships as opposed to the individualistic emphasis of human capital theory. Adler and Kwon (2002) reviewed the use of social capital concept in organizational studies, noting, "It (social capital) proves to be a powerful factor explaining actors' relative successes in a number of arenas of central concern to organizational researchers." Tomer (1987, 2001) developed the concept of organizational capital as a form of social capital and identified its importance in driving organizational performance in high performance work systems. For turnover researchers, Dess and Shaw (2001) raised the issue of the need to consider the social capital dimension when looking at the turnover-organizational performance relationship as opposed to simply using the human capital perspective.

2.4.5 Group Cohesion

The use of the term "social capital", like its counterpart, human capital" arises from the desire to place a value on the strength of internal and external organizational relationships. A term used in the sociological literature, "cohesion," is used to describe the strength of a group's interpersonal relationships, rather than its value. Based on experimental work, Berkowitz (1955) found that group cohesion can be a two-edged sword for organizations: "members of cohesive groups will tend to conform to the perceived group standard – by raising their production if the standard is for higher production, or lowering it or not increasing as rapidly, if the standard is for lower production." The more cohesive the group, the more likely group standards will prevail. Later work took a more positive view. Lakhanpal (1993) described how group cohesion positively affects the performance of software development teams. Chang and Bordia (2001) noted that "there has been considerable debate over the definition and structure of (group) cohesion" but their empirical work did confirm the positive nature of the group cohesion-group performance relationship. Barrick, Bradley and Colbert (2007) found that group cohesion had a positive influence on highly interdependent top management teams. For the purposes of this analysis, group cohesion is viewed as an expression of the strength of social relationships as opposed to simply formal task relationships. Employee turnover reduces group cohesion and by extension group performance. It is interesting to note the difference between Berkowitz above and the later work. The later work all seem to assume a positive group standard. Berkowitz's negative standard supports the view that organizational stagnation is a group phenomenon where low performance is the group norm.

2.4.6 Communication and Coordination

In the white collar, bureaucratic environment found in public organizations, communication and coordination are the primary mechanisms through which work is accomplished. Activities include interacting with colleagues, management, and others within and outside the organization. The purpose ranges from coordinating task activities to building consensus for decision-making on actions and goals. Downs (1967) devotes an entire chapter to communication in government bureaucracies, and Wilson (1989) devotes several pages to the role of coordination in and between governmental agencies. Thompson (1967), in his discussion of the interdependence of organizational components, saw communication and coordination as the essential means by which "concerted action comes about," in other words, how the organization accomplishes its goals. Organizations can be viewed in effect as networks consisting of communication relationships (cf. Roberts & O'Reilly, 1978) that connect task, social, and authority structures. This body of research demonstrates that relationships, both formal and informal, are the vehicles through which communication and coordination are enabled. Thus, given the key role of relationships, disruptions (turbulence) in those relationships due to employee turnover create communication process interruptions with subsequent work and decision delays. The extent of this effect though is an open question. Guastello (2001) notes that research has shown that "a coordinated group can withstand changes in personnel up to a point before coordination breaks down" although no specifics were provided as to where this point might be.

2.5 Organizational Economics

The economic relationship between an organization and its members falls under the branch of economics known as organizational economics. Two broad streams are found here: the cost side – transaction cost economics, and the "benefits" side – the resource-based view. Both streams provide perspectives on the relationships between individual characteristics, organizational social relationships, and organizational economics.

2.5.1 The Individual-Organizational Economics Relationship

Organizations acquire and utilize human capital for the benefits provided. But unlike financial capital (other than interest payments), there are a number of costs directly attendant to the use of human capital – driven by the employee life-cycle so to speak. These can be broken out as costs related to acquisition (the costs of recruiting and hiring employees), maintenance (salary, benefits, payroll taxes), motivation (pay raises, bonuses), improvement (training and

development costs), and disposition (severance or pensions). As individuals move through their employment life-cycle, these costs are incurred by the organization at various times. Each of these costs represents a transaction between employer and employee.

The concept of transaction costs as developed by Coase (1937) and Williamson (1981) is directly applicable to the costs generated by turnover and mobility events. Within the transaction costs stream of theory, a sub-field dealing specifically with the economics of human resources has developed and is represented by the work of Lazear (1996), Cascio (2000), and Backes-Gellner (2004).

The flow of human resources creates costs due to work interruptions, lost productivity, and the risk associated with new hires. The costs to an employer of labor turnover were well recognized in the early 1900's when Slichter (1919) detailed the costs connected with hiring, training, and productivity lags due to the replacement of workers. In a more contemporary, but similar, example, Hilmer, Hilmer, and McRoberts (2004) provide a detailed breakout of costs in their analysis of call center turnover.

Causey's (1977) work noted that, in general, when new personnel are added to an organization, numerous interrelated elements are involved which affect costs - the relative skill levels of new and old employees, the rate of addition of new employees, and the balance between less experienced and more experienced employees. These variables are especially important where labor costs per unit follow a learning curve as new employees learn their jobs. Shafer, Nembhard, and Uzumeri (2001) presented such an example of the effect on productivity resulting from the variance of the learning curves of assembly line workers.

While most managers tend to view turnover or even internal mobility as a negative for their organization in light of the costs cited above, and therefore desire to minimize it, researchers have long recognized that human resource flows in an organization create positive effects as well (cf. Chamberlain, 1950; Dalton & Todor, 1979, 1982; Staw, 1980; Ableson & Baysinger, 1984). The resource-based view sees human resources from the perspective of the benefits provided. Balancing the costs of turnover and mobility are organizational benefits that include opening up promotion opportunities, increasing staff diversity, and bringing new skill sets into the organization. For the resource-based view of the firm, the latter effect is the most important.

2.5.2 The Social Relationships-Organizational Economics Relationship

Smelser and Swedberg (2005) provide an overview of economic sociology and how it differs from neoclassical economics. They note that neoclassical microeconomics differs from economic sociology in that "the former generally assumes that actors are not connected to one another; the latter assumes that actors are linked with and influence one another."

The connection between the social relationships among organization members and their economic impacts was the focus of the Human Relations School of the 1930's and 1940's, represented by researchers such as Mayo, and Roethlisberger and Dickson. Workgroups, both formal and informal, were viewed as a major factor in determining the attitudes and performance of individual workers. Their empirical studies found that poor social relationships led to increased absenteeism, turnover, and reduced output, thereby reducing workgroup productivity overall. Their insights still remain valid today. More current literature focuses on social networks and business relationships. Droege and Hoobler (2003) addressed how employee turnover affected a firm's store of tacit knowledge (and implicitly its performance) from the perspective of the network of employee social relationships. Florin, Lubatkin, and Schulze's (2003) empirical study demonstrated the positive relationship between social relationships and firm performance in high-growth business venture firms. The resource-based view of the firm clearly encompasses such relationships as competitive assets, or in the case of public organizations, as productive assets.

2.5.3 Organizational Efficiency

The reason for management interest in the subject of employee turnover is the impact on organizational performance, productivity, and costs. For the public sector, this has been a topic of long-standing concern (cf. Mosher & Kingsley, 1936; Berman, 1998). In a recent article, Donald Kettl (2008) noted that due to the increased stress on federal as well as local and state budgets, "there will be no alternative but to force more productivity improvements to keep programs from failing and further straining budgets." A characteristic of low-turnover, stagnant organizations, is that over time, productivity falls while their compensation costs increase – a "double whammy," so to speak, against organizational economic efficiency.

2.6 Organizational Characteristics

Organizational characteristics shape the relationships between individual characteristics, task and social relationships, and economic relationships. When looking at any organization,

there are clearly evident characteristics that distinguish, for example, a heavy industrial firm from an office-based firm, a firm employing day laborers from a professional services firm, a private firm from a government agency, a new start-up from a long-established family business. In each of these varied types of organizations, the individuals employed, their task and social relationships, and organizational economics are determined by the characteristics of those organizations. These characteristics reflect internal factors such as organizational structures, processes, technology, leadership, culture and climate. All these factors are combined under the common heading of "organizational characteristics" as the shaper and mediating influence on the organization's human resource flows and the consequent organizational impacts.

2.6.1 Interdependence

Interdependence is the measure of the coupling of task-to-task relationships in a process or workgroup, or as Saavedra, Early, and Van Dyne (1993) put it, "task interdependence is the degree to which group members must rely on one another to perform their tasks." In her study of Xerox technicians, Wageman (1995) noted that task interdependence is a function of work design. "Task interdependence is a structural feature of work, but tasks can be designed to be performed at varying levels of interdependence." That is, management can structure work tasks to be highly interdependent using team-based approaches or they can be structured to be highly independent. Daft (2004) provides a table that summarizes Thompson's (1967) classification of organizational interdependence and the implications for communication and decision-making. Thompson identified three levels of interdependence: "pooled" where each workgroup or employee has little need to interact with others and can do their own work independently (e.g., patent examiners, retail sales people), "sequential" processes where the down-stream employees are only dependent upon the up-stream employees (e.g., invoice processors, production workers), and "reciprocal" where each employee is mutually dependent upon the other (e.g., air crews, software teams). The degree of communication and coordination required in each of these three categories ranges from low to medium to high, respectively.

Barrick, Bradley and Colbert (2007) noted in their review of the small-group research literature, that the degree of interdependence is a key moderating variable in the process-performance relationship of small groups. This is particularly the case when studying the turnover-organizational performance relationship. Interdependence moderates the importance of communication and social cohesion in organizational performance. That is, communication and group cohesion are more important under highly interdependent conditions than under low

dependence conditions. They note that "there are two different conceptions of team interdependence (in the literature): (1) structural and (2) psychological." Rico, Sanchez-Mazanares, Gil and Gibson (2008) confirm this perspective in their work on "implicit" coordination among team members and task performance where they propose that there is a direct and positive relationship between the degree of task interdependence and the importance of implicit coordination.

2.6.2 Internal Labor Markets and Firm-Specific Human Capital

An internal labor market (ILM) describes an organizational staffing approach that is essentially a closed system. Internal labor markets are characterized by hiring primarily at the entry level into career track jobs with higher level jobs filled by promotion from within. Internal mobility is governed by institutional rules and procedures. A consequence of an ILM system is the heavy emphasis on what is referred to as "firm-specific human capital" that can only be obtained through internal development programs. Organizations requiring firm-specific skills tend to hire at the entry level, while those requiring only general skills hire at any level of experience as needed. ILM theory developed by Doeringer and Piore (1971) is, in fact, very descriptive of the workforce staffing behavior of public organizations. Government agencies have historically hired at the entry level, creating in effect, a system where public work is firm-specific.

On the positive side, Hatch and Dyer (2004) found in a study of the semiconductor manufacturing industry that investment in firm-specific human capital has a significant positive impact on individual learning and firm performance. Firms having a reduced level of firm-specific human capital due to turnover significantly under performed their rivals. However, they also noted that an organization that places a high emphasis on firm-specific human capital also limits its ability to bring in skilled people from outside the organization at anything other then the entry level.

A common theme that runs through the economics literature is the distinction between firm-specific human capital and general human capital. This is a characteristic of organizational human capital that directly connects to learning curves and the turnover-organizational performance relationship. Williamson (1981) specifically addressed this distinction in human capital and how it affects organizational characteristics. Turnover has a direct impact on an

organization's ability to maintain its firm-specific human capital, as opposed to simply incurring the administrative costs of losing and hiring replacement employees.

2.7 Discussion

Across the many streams of literature discussed above, the definition of turnover that best defines it is that cited by Van Der Merwe and Miller (1971) as "the process of change in the composition of the labor force." How that process of change unfolds is determined by many factors. The purpose of this literature review is to deconstruct those factors and identify the fundamental elements and processes underlying the employee turnover-organizational performance relationship. As people leave and new ones join an organization, changes are created in an organization's membership, work relationships, and operational costs. The nature and impacts of these changes are determined by its organizational characteristics, which in turn, determine organizational consequences. The connection between the flow of human resources and its organizational consequences is well documented in the research literature. In general, this literature is based in one or some combination of the theoretical perspectives related to individual characteristics, their relationships, and organizational economics.

The purpose of this literature review is to provide a comprehensive foundation for the analysis of human resource flows and organizational consequences. It is said that the measure of an efficient theory is that nothing can be parsed away – the Occam's razor criterion. The components of individual characteristics, their working relationships, economic relationships, temporal effects, and organizational characteristics must be viewed as integrated and inseparable elements that shape the human resource flows process and subsequent consequences.

My review and study of the literature shows that there are five primary elements that underlie the employee turnover-organizational performance relationship. These are:

- Individual employee characteristics
- Employee working relationships
- Time and events
- Organizational economics
- Organizational characteristics

The connections between these elements can be summarized in the following statements.

Given an existing workforce, time and attrition events are the underlying driver behind the process of change in the workforce. Over the time period of interest, the attrition rate may range from zero to some upper limit. At no to very low attrition, stagnation is the predominant concern affecting the organization. As time goes by, stagnation tends to increase and performance capability decline. At higher rates of attrition, stagnation is alleviated due to the inflow of new people, and a new phenomenon occurs – that of turbulence – the breaking of existing relationships among employees. While breaking relationships can occur instantaneously, the making of new ones requires time to build familiarity and trust. In addition, new people brought into the organization, depending on their level of proficiency, must have time to learn and adapt to the organization to reach their full performance level. The quality of these new people relative to the departing employees is a function of the original workforce's characteristics and the organization's hiring policies. The importance of working relationships– the interdependencies among coworkers is a further determinant of organizational performance. Thus, change in the composition of the workforce causes change in aggregate human capital, its working relationships, and the consequent performance capacity of the organization. At the same time, the inventory and flow of employees affects staffing costs from the level of total compensation to recruiting, training, administrative, and retirement costs, while their performance capacity relative to staffing costs determines the organization's economic efficiency.

A narrow focus on individual organization members, their relationships, or organizational economics when taken alone provides a static view of human resources. It is the passage of time and the occurrence of personal and organizational events that drive the flow of human resources through the organizational structure. Given the inescapable passage of time, both planned and unplanned events result in changes to the human resources in all organizations. These changes cause human resource flows and the resultant organizational consequences. This process exists in all organizations, irrespective of organizational characteristics. *This last statement is significant to note. While the context of this analysis is in the realm of public organizations, there is nothing at this foundation level that distinguishes a public organization from any other type of organization.*

3.0 RESEARCH APPROACH

3.1 The Research Question

As discussed in the Literature Review in Section 2, the connection between employee turnover and organizational performance has been recognized for nearly 90 years. In their discussion of this subject, Mosher and Kingsley (1936) expressed their belief that turnover should ideally "be (1) sufficiently large to prevent the stagnation of the service and (2) sufficiently small to reflect healthy working conditions" although only general guidelines could be provided as to where this point lay. Forty-three years later, Meyer, Beville, Magedanz, and Hackett (1979) reiterated the need to "determine what constitutes a 'healthy turnover rate,' i.e., a rate which represents normal attrition in an organization and which thereby allows an organization to change and adapt while continuing an experienced, competent work force."

Abelson and Baysinger (1984) suggested that finding an optimal point of aggregate employee turnover is theoretically possible. They proposed that the relationship has an inverted U-shape (a single optimum point) as shown in Figure 2. *The research question that this analysis addresses is whether a logic- and theory-based model and computational simulation of the employee turnover-organizational performance relationship can demonstrate Abelson and Baysinger's curve in the context of public organizations.* To answer this question, the specific research issues that are addressed are:

- The general nature of the employee turnover-organizational performance relationship,
- The organizational mechanisms and characteristics that drive the relationship,
- Whether the type of organization studied affects the nature of the relationship,

3.1.1 Frame of Reference

Large public organizations, such as the DOD or IRS, have functionally organized departments with tens of thousands of employees in specific, well-defined occupational fields – e.g., Engineering, Contracts, Budgeting, Legal, and Information Technology. The "organization" referred to here is most commonly a functional departmental unit such as an engineering department or a contracts department having defined occupational groups and a defined staffing level requirement or at least a budget level that can be translated into a specific staffing level. This is the "technical core" of an organization as described by Mintzberg (1979) and Daft (2004) – i.e., the employees who do the core work of the organization. While many organizations have adopted matrix-style workgroup approaches combining different functional

specialists (e.g., Integrated Product Teams), from a managerial and employee perspective, there is still a discrete community and career path for each occupational specialty that is managed along functional occupational lines.

The prototypical employee in this analysis is a civil servant in a traditional 30-year career path from entry to retirement (i.e., they work 30+ years). The only demographic characteristic utilized in this analysis is tenure, also referred to as Length-of-Service (LOS).

3.2 Methodological Approach

My study is an attempt to demonstrate whether a theory-based model and computer simulation of the employee turnover-organizational performance relationship can actually produce Abelson and Baysinger's (1984) curve. As discussed in Section 2, there are several bodies of theory that are applicable to this problem. My challenge lay in (1) identifying those elements of organizational theory and computational simulation methods that apply to the problem, and (2) finding those points where the theory can be connected into a computationally coherent whole. I have done this by identifying those elements of theory specifically needed to address the Abelson and Baysinger hypothesis and by building on simulation approaches that have already been successfully used in the research literature.

The methodological approach used in my research work is presented in Figure 5. I have adapted this from Frantz's (1995) work on model development. Frantz identified six steps: Step 1, Abstraction from Observations of Organizational Behavior begins with the application of theory and the development of a conceptual model of how the organizational world works. This is the step that Abelson and Baysinger (1984) took in developing their hypothesis. Where Abelson and Baysinger ran into difficulty however is in Step 2, Validation. Their conceptual model was simply too intractable to empirically test. Therefore, my proposed alternative is the use of simulation. Step 3, Implementation, begins with the development of a Conceptual Model as shown in Figures 6 and 7. This is followed by development of the computational sequence and code, samples of which are provided in the Appendices. Step 4, Verification, is needed to ensure that the algorithm and code do what the conceptual model says it should. Once the adequacy of the production code is verified, Step 6, Output, begins which is evaluated by the Analyst to see whether the original theoretical hypothesis is supported or not.

Figure 6 presents the Conceptual Model of Employee Turnover which is addressed in detail in Section 3.4 beginning on page 46. Figure 7 places the Employee Turnover conceptual model and its elements in the context of other organizational elements. As discussed in the literature review, human resource flows occur at the foundational level of organizational outcomes. At this level, looking only at the dynamics of employee flows, there is no distinction to be found between public and private organizations. All these differences between the two occur at the higher levels of work organization and especially at the level of what I call organization "character." That is, the level at which all those characteristics such as environment, culture, policy, and law that differentiate a public organization from a private organization, are found.

3.2.1 Definition of a Model

The term "model" in the scientific and engineering context is the term used to verbally, visually, or mathematically describe a simplification of an entity or system of much greater complexity. The purpose of the model is to improve our understanding of more complex relationships, processes, and dynamics. Models can range from simple mathematical expressions such as $E=mc^2$ to large econometric models running on supercomputers to physical models of aircraft used in wind tunnel testing. In the realm of organization theory, models are simplifications of relationships and processes that are expressed through words and/or diagrams. Figures 6 and 7 represent two types of models. Figure 6 is a cause-and-effect model that connects employee attrition with changes in workforce performance capacity and organizational costs. By comparison Figure 7 is a conceptual model that depicts only relationships rather than cause-and-effect.

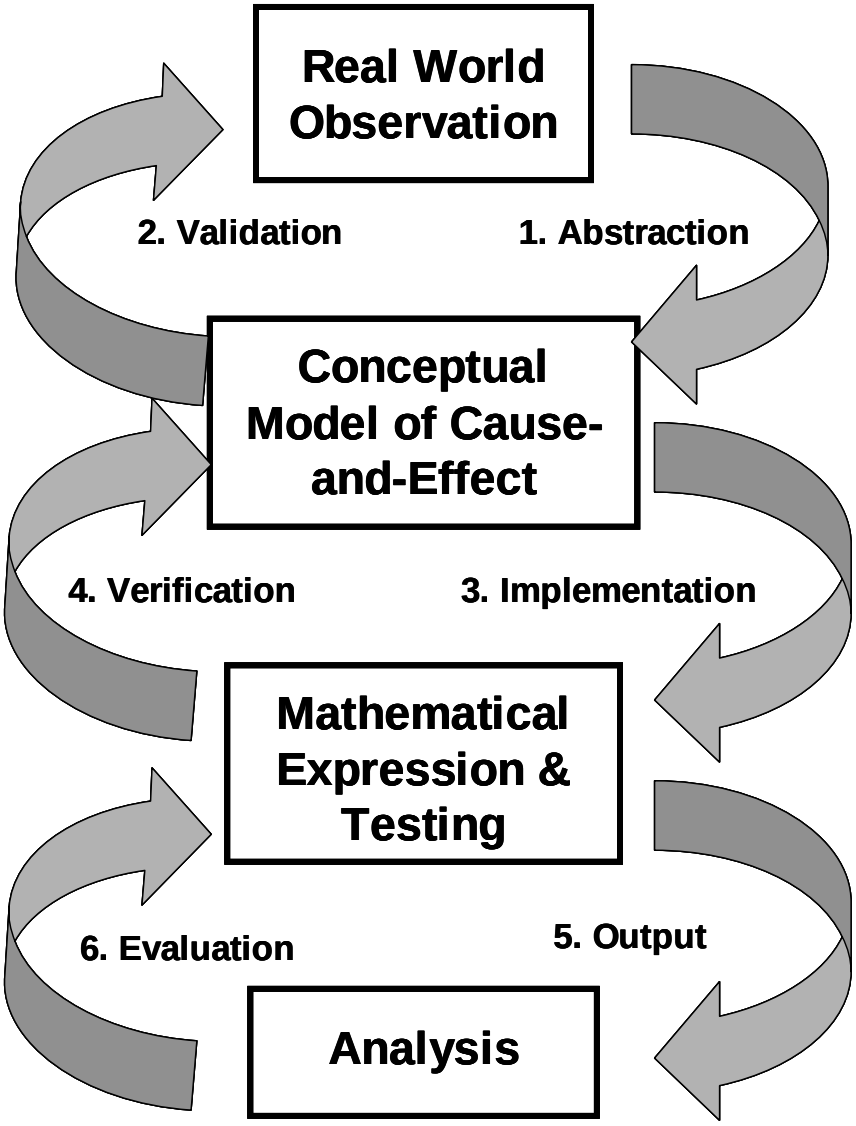
The term "computer model" refers to the computer program that is written to simulate the behavior of a system whether physical or abstract. The purpose is to better understand the operation of the system and its behavior under operating or varying conditions. In this context, the term "simulation model" refers to both the abstract cause-and-effect model and the coding structure that are used to perform the simulation. The term "computational simulation" is simply the term used to refer to the discipline of using computer code as the vehicle for performing simulations (as opposed to using physical models such as the aircraft model).

The computer code connects the dependent variables to the independent variables so that as the independent variable changes, the code calculates the changes in the dependent variables. Initial conditions, such as workforce tenure and quality level, are the starting point for

the calculations. Parameters are the things that can be changed in the model (the system variables) that will affect the outcome of the calculations. In this model, two parameters are the time it takes an employee to reach full proficiency and the level of interdependence of employee relationships. The simulation model is "tested" by selecting various combinations of initial conditions and parameters (the test cases) and observing the outcome.

Figure 5

Steps in the Process of Modeling and Simulation



Adapted from Franz (1995)

3.3 Testing the Hypothesis

"Theory is the source of all hypotheses, but not all hypotheses are amenable to evaluations by all methods…" (Ilgen and Hulin, 2000)

The two predominant methods used to test a hypothesis in the social sciences today are the analysis of existing or survey data (looking for correlations), or less frequently, through controlled experiment. The correlational method is highly context dependent and sophisticated statistical analysis methods are used to control factors that need to be held constant. For my project needs, the correlation method has several shortcomings: First, this method cannot be used to find an optimum without a large number of cases. For example, in the work by Glebbeek and Bax (2004), they explicitly note that they considered themselves fortunate that they were able to access turnover data from an organization that had over two hundred identical field offices. Second, it is difficult to generalize the analysis beyond the context of the data utilized; even if completely successful, Glebbeek and Bax's work could not be generalized to other organizations, as an "optimum" HR flow is specific to a particular organization in a particular time and place. Lastly, in real life, no large organization could operate at the boundary points of zero turnover nor the high turnover rates near organizational collapse over any substantial period of time.

Ilgen and Hulin (2000) propose modeling and simulation as a "third method" to complement correlational and experimental research. Computational modeling and simulation enables working with realistic and representative data, and enables running "experiments" that cannot be done in the real world or which span years or decades of time. These are research capabilities that neither the correlational nor experimental methods can provide. Bankes and Gillogly (1994) called this exploratory modeling where insufficient data exists to build an empirically-based model of the system under study. Such situations arise where it is physically or ethically impossible to collect actual data. The study of employee turnover over several years and at varying levels of attrition, while maintaining controlled conditions, is such a situation. Thus, this research project should be viewed as an exploration of the employee turnover-organizational performance space, rather than a problem in searching for an optimum.

3.3.1 Simulation in Organizational Research

Simulation in engineering and science research has been employed since the 1960's as computer and software technology developed. Operations Research has long used simulation as basic tool. Simulation in organization theory development has had some limited use, the best known example is Cohen, March, and Olsen (1972, A Garbage Can Model of Organizational Choice). Some other examples worth citing are Sastry (1997, Problems and Paradoxes in a Model of Punctuated Organizational Change), Scullen, Bergey and Aiman-Smith (2005, Forced Distribution Rating Systems), and Harrison and Carroll (2006, Culture and Demography in Organizations). In general, simulation as a research methodology in the social sciences did not begin to be more widely used until the 1990's when more powerful personal computers and software became widely available. Gilbert and Troitzsch (1999) describe a number of simulation methods ranging from simple mathematical methods to complex multi-agent systems that are now commonly employed in organizational research.

The approach I have used builds directly on the two recent works using modeling and simulation: Scullen, Bergey and Aiman-Smith (2005), *A Forced Distribution Rating System and the Improvement of Workforce Potential: A Baseline Simulation,* and Harrison and Carroll's (2006), Culture and Demography in Organizations.

Scullen, Bergey and Aiman-Smith (2005) used a simulation study to examine how a forced distribution rating system, where the lowest performing percentage of employees are fired every year, affects workforce performance potential over a period of several years. They look at how the system behaves under variations in parameters such as ratings reliability, new employee selection validity, selection ratio, and voluntary turnover. They used an Excel spreadsheet and VBA to perform their computations and analysis.

Harrison and Carroll (2006) in their long-running study of cultural transmission and maintenance over time use a combination of equations and matrix analysis to simulate the processes of enculturation of new organizational members. They model the process by incorporating the influence of management and peers on individual members and vary the levels of socialization intensity and susceptibility that lead to the dependent variable of enculturation. Their model has three main components: a hiring function (selecting who gets hired), a socialization (enculturation) function, and a departure (attrition pattern) function. The demographic variable used in their work is tenure (length-of-service) with the organization.

They provide a very detailed analysis and tutorial on the modeling and simulation process in organizational research.

3.3.2 Levels of Simulation

There are three "levels" of simulation in use today: systems dynamics which deals with the aggregate flows and changes of an entire system, multi-agent simulation which takes a bottom-up, individual behavior approach, and a middle level known as microsimulation.

Systems dynamics (SD) was developed by Forrester (1961) and further developed by Sterman (2000) and others. As North and Macal (2007) describe it, systems dynamics (SD):

> "is a 'whole system' modeling approach that is used to model dynamic processes, which change continuously over time. SD models tend to be highly aggregated, or higher-level, representations of systems and processes. Systems dynamics models consist of two main elements: stocks that represent the state variables of the system, and flows that describe how the stocks change over time."

In the model presented in this research, the workforce inventory is the "stock" of employees at any given point in time, while employee attrition and accessions are the "flows" that change the stock of employees. For analysis of human resource flows, the systems dynamics approach has one shortcoming and that is it cannot distinguish between individual elements of the flow – i.e., differences in employees that are coming and going. Thus a lower-level approach must also be incorporated. The following paragraph from Gilbert and Troitzsch (1999) gives a good explanation of the simulation approach, known as micro-analytical simulation or microsimulation, which is also used.

> "The microsimulation approach overcomes this problem (that of treating populations as aggregates rather than as individuals) by going back to the individual level, modeling individual persons with a number of attributes (such as sex, age, education, marital status) and a number of transition probabilities. This makes up a stochastic micro model…"
>
> "The data are entered into a database (the microdata file). Its rows correspond to the individual members of the sample, and its columns correspond to the selected properties. Then the microdata file is updated ('simulated')…the

demographic structure of the model population is changed by ageing the model persons individually. The same applies to all the other attributes in question."

These techniques are implemented in a spreadsheet-based model where each row represents an individual employee while the columns provide data fields for individual attributes or other categorical values. At each time step or after an attrition event, the fields are progressively updated and aggregated to provide an overall picture of the organization's workforce. This is the approach successfully used by Scullen et al. (2005) to analyze through simulation the outcomes of a forced-ranking employee rating system.

The computational model I have developed combines two approaches: the stocks and flows of system dynamics and the aggregation of individual units (employees) of microsimulation.

3.3.3 Validation

The issue of the validation of computer simulation models has been raised since the time of the first computer models (Hanna, 1971). Generally validation of models is done by correctly predicting the results of experiments or finding support in existing or gathered data. A figure presented by Pace (2004) graphically depicts the range of relationships between model domains and empirical data. They range from complete overlap to none at all. The complete overlap is, of course, most desirable for model builders. But as Bankes and Gillogly (1994) note, "…for exploratory modeling…this sort of validation is not a possibility. Thus, in exploratory modeling, rather than validate models, one must validate research strategies." The weight of the effort must rest on valid theory application and model building.

The basic elements of the overall modeling and simulation process on which I have based my approach are shown in Figure 5. In the first step, *abstraction*, I rely on the theoretical base of literature from which to draw the components of the model. To build this model, I have relied on inferential logic and empirically observed theory. For example, an attrition event creates a chain of subsequent events that can be logically derived; the impact of social turbulence on team performance, for example, can be empirically observed.

Lehman (1977), in the context of simulation models, proposed three standards:

1. the underlying theory must be able to account for the observed behavior of the real world
2. the conceptual model must be an accurate representation of that theory

3. the computer program must accurately implement the model

The first standard, that of the adequacy of the underlying theory, is a crucial one for my proposed research, and is in fact the key issue that I am addressing: *Does the body of existing turnover theory (specifically Abelson & Baysinger's,1984) accurately account for observed behavior in the real world?* In this case, where the theory itself is in question, the simulation model can only be validated against the theory it seeks to represent, not the "real world." My work is in essence an analysis of an analysis attributable to the lack of specificity in current theory.

To meet Lehman's second standard, two tests can be applied to the model at this stage: face validity and path logic – that is, do the proposed cause-and-effect relationships make sense in a qualitative manner when followed through to their logical conclusions. In the face of weak theory (Meehl, 1990) this is perhaps the best that can be achieved until empirical tests can demonstrate otherwise.

3.3.4 Verification

Lehman's third standard must be met in the next step, the development of the computational simulation. This simulation is in actuality simply an Excel spreadsheet (supplemented with some programming) in which the theoretical relationships become algorithms and equations. How to ensure that a good computational system has been built is done through the verification process. Gilbert and Trotizsch (1999) present a good discussion of the issues of validation and verification. They state that the computational simulation must demonstrate the ability to produce the system behaviors specified in the logic model. In practical terms, this means the simulation must be checked (verified) to ensure that there are no mathematical or systemic errors. Best practice is to use test cases that isolate certain elements of the system to produce results that can be tracked through the program. Fishman and Kiviat (1971) recommended verifying sub-structure outputs to determine whether they behave acceptably. Similarly, Saysel and Barlas (2004) recommend testing simple structures then building up to more complex aggregates of model structure. In addition, the simulation should be tested at its extreme boundary conditions to ensure its stability at the limits. This is why I have run the range of turnover from 0% to 100%.

3.4 The Conceptual Model

The employee turnover-organizational performance problem can be envisioned in this way:

> The Workforce Inventory is really a room with 100 people in it. (The task master has determined how many people are needed.) They are organized in some way so as to accomplish their assigned tasks. On the left is a door where people leave the room at varying rates (attrition), on the right is a door where new ones of varying experience and quality enter to replace them (accessions). The comings and goings of people interfere with established relationships and accomplishment of the tasks (turbulence). However, if too much time goes by when there is no change in the group, stagnation begins to set in and group performance declines. An outside observer assesses at sequential points in time, the group's performance capacity based on the quality and experience of the people in the room, and the impact of disruptions or stagnation. A series of experiments are run where the flow rates and parameters are varied to see if an optimum flow rate can occur where the group's performance capacity is maximized over time.

Using the above narrative as the "real world observation" I have constructed the conceptual model as shown in Figure 6 using the methods of logical reasoning and causal inference derived from observation and through study of the literature and step-by-step analysis of the process of turnover and organizational consequences. As can be seen, the process begins with the independent variable of employee attrition. Loss of an employee reduces the workforce inventory and the employee's contribution to workforce capacity. At the same time, the remaining employees' task and social relationships are disrupted, and administrative costs are incurred. When a replacement employee arrives, some time is required before the new person can be fully proficient and establishes working relationships with the other employees. At the same time, hiring, administrative, and training costs are incurred for the new employee. The capacity loss due to employee attrition and the contribution of new employees as they arrive and reach proficiency is fundamentally a mechanical process. Likewise, the breaking of relationships and forming new ones as employees come and go is also a mechanical process from which the process steps are logically derived. Changes in workforce inventory also changes staffing costs in terms of salary levels paid. From the human resources perspective, changes in the workforce lead directly to changes in workforce performance capacity.

The consequences of attrition on workforce capacity follow two paths: stagnation and turbulence. Based on the literature, stagnation is an organizational condition which occurs at zero to very low levels of turnover, and grows with time. At low levels of turnover there is minimal inflow of new people to alleviate stagnation's negative influence on organizational performance capacity. At higher levels of turnover, stagnation decreases but turbulence begins to grow in importance. Turbulence represents the making and breaking of the working relationships (task and social) which enable an organization to function. These disruptions can be causally inferred to lead to a reduction in workforce performance capacity in some functional proportion to the rate of turnover. Time acts on a number of components in the workforce box: employee tenure steadily increases as time passes, time is needed for new employees to move up the learning curve, time is needed for relationships among employees to develop, while staffing costs for hiring, training, and salaries change over time. These are all empirically observed elements.

Occam's razor has served as my guide to model development – only those elements absolutely necessary and no more were included. Using this approach, the elements that my analysis indicates are the minimum necessary from a theoretical perspective to test Abelson and Baysinger's (1984) hypothesis are as follows:

- Time
- Working (task/social) relationships importance
- Employee time-to-full proficiency (learning curve)
- Workforce Performance Capacity calculation
- Stagnation impact on performance capacity
- Turbulence impact on performance capacity
- Employee Proficiency and Quality differences
- Attrition pattern
- Accessions pattern
- Staffing Costs

From a simulation modeling perspective, additional information, distinct from the theoretical need, is required to develop and run the model. These are:

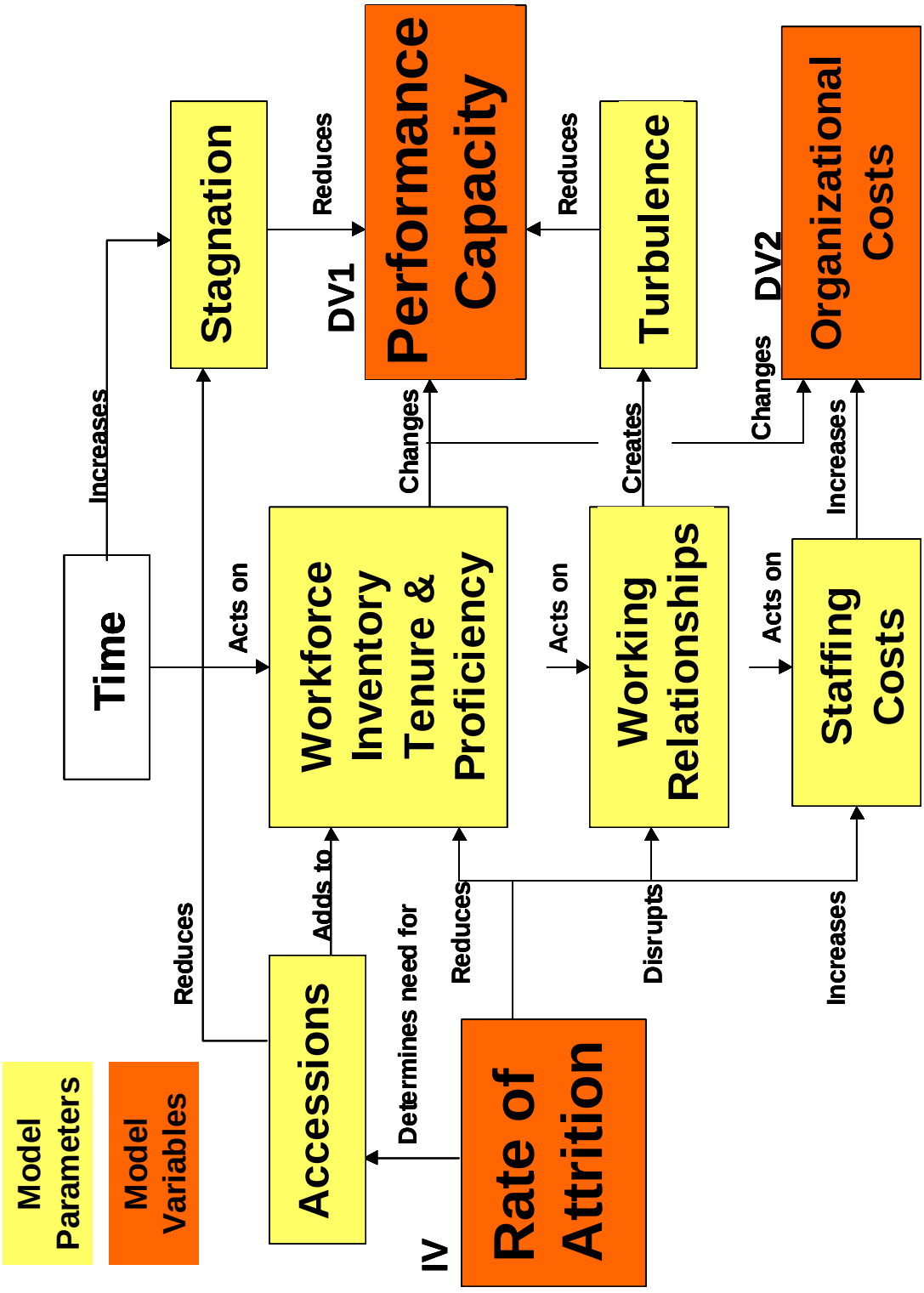
- Number of employees
- Workforce characteristics at the start of the analysis

The causal relationships diagram (the Conceptual Model) connecting all these elements is depicted in Figure 6. As can be seen, the process begins on the left with Attrition – the Independent Variable, moving through the right to the Dependent Variables of Performance Capacity and Organizational Costs.

It can be noted, for those familiar with systems dynamics, that a missing feedback path is the role of management – management would (or should) respond to the organizational outcomes and attempt to address the source(s) of attrition and attempt to mitigate the impacts. This model's goal, however, is only to examine the impact of varying the rate of attrition on organizational outcomes, and to demonstrate whether the relationship can follow the path proposed by Abelson and Baysinger (1984).

Figure 6

The Conceptual Model of Employee Attrition and Organizational Effects



3.4.1 How the Conceptual Model Fits into the Overall Organizational Relationship between Turnover and Performance

The flow of employees through an organization can be thought of as the element that all organizations have in common. What distinguishes one organization from another, whether public or private, are the way work is organized, its technology and structure, and what I refer to as the organizational "character," that is, its leadership, supervision, culture, environment, and HRM policies. The capacity of an organization's workforce to produce an outcome, its latent capability, is mediated by the two large blocks shown in blue in Figure 7. Workforce performance capacity, the "output" of the Conceptual Model, is that latent capacity that all organizations have in common. Work Organization and Organizational Character are what determine eventual organizational output.

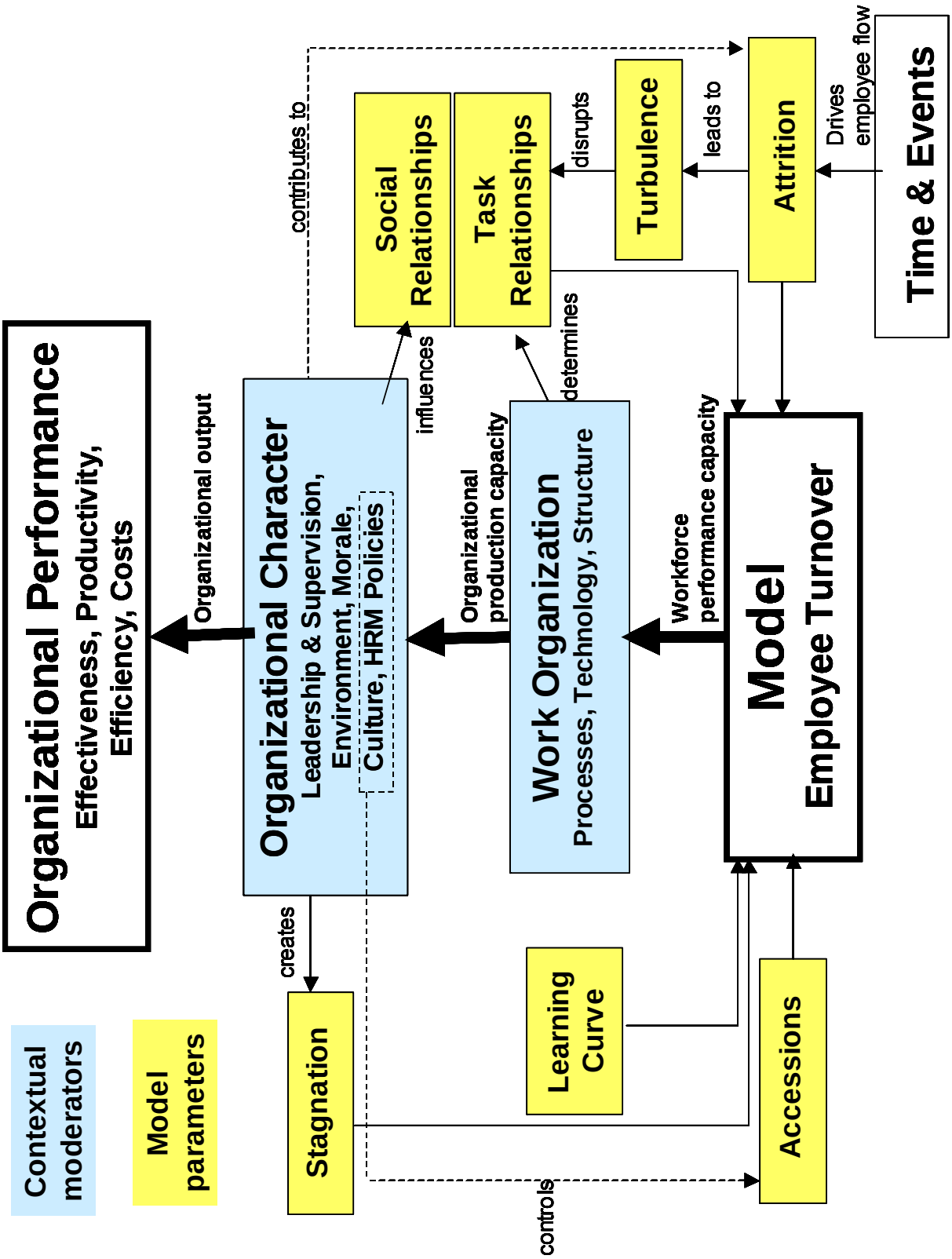
Figure 7 identifies the sources of the parametric variables used in the Conceptual Model presented in Figure 6. Stagnation is viewed as a function of organizational environment, morale, supervision, and culture. When there is little incentive for employees to perform, or change, and little opportunity for professional growth or promotions, norms of performance decline and result is the degradation of performance capacity. Stagnation's counterpoint, Turbulence, results from the impact of attrition on task and social relationships. Learning Curve is a function of Work Organization. The average time it takes employees to become fully proficient is a function of the occupation and the organization's processes, technology, and work structures. Task Relationships (i.e., employee interdependencies) are similarly a function of the organization's technology, processes, and structures. Social relationships are developed through task relationships, but also by the milieu of the organization's culture and social environment. How these effects are converted into mathematical relationships is the subject of the sections that follow.

Turnover, as earlier noted, is the term used to denote two distinct processes – employee attrition and employee accessions. In the Conceptual Model, attrition is treated as an Independent Variable, therefore, antecedent causes of employee attrition are not included in the model. However, for clarity, it is noted that, as depicted by the dashed lines, attrition is greatly influenced by the elements of Organizational Character. Supervision, morale, culture, and HRM policies play a very large role in individual employee quit decisions. Similarly, accessions are viewed as entirely controlled by the organization. The decision as to whom to hire is entirely up

to management within the constraints, of course, of law and organizational policies. Within these constraints, organizational culture plays a very large role in the decision of who gets hired into the organization.

Figure 7

The Conceptual Model in Relation to Other Organization Elements



3.4.2 Further Development of the Model

Kitts (2006) described the steps that his model, like other complex computational models, employed to examine a theoretical hypothesis. Like Kitts, I have taken these same steps (Kitts' steps are given in the italics).

- *Mathematical expression of relationships:*

  Developing these expressions is what I refer to as the quantification problem in the areas of:

  - Organizational capacity as a function of individual proficiency and quality
  - Learning curve (time to proficiency) of individual employees as a function of time
  - Relative quality differences among current and potential employees
  - Degradation of individual employee proficiency over time due to technical obsolescence
  - Degradation of group capacity due to turnover in working relationships (my "turbulence factor")
  - Degradation of group capacity due to stagnation (lack of turnover)
  - Staffing costs as a function of compensation level, recruiting, training, and administrative expenses.

- *Integration of these mathematical expressions into a single framework:*

  Integration of the individual mathematical relationships in both a logical cause-and-effect manner and in the programming of computer code are the key elements of the modeling and simulation effort. This step was depicted in Figures 6, 7, and 8, and discussed in Section 3.4, The Conceptual Model.

- *Selecting system conditions:*

  The parametric values and conditions that define the model to be tested are listed in Table E – Parametric Variations.

- *Running the model over a number of periods:*

  In this model, the 10 periods are equivalent to 10 years, and the model is run at rates of employee attrition from 0% to 100% per year.

- *Examining the behavior of the model under varying initial conditions and parametric variables settings:*

This is the simulation equivalent of running controlled laboratory experiments, and analyzing the results. The varying initial conditions and parametric settings are the various test cases described above.

The biggest challenge in going from theory to model is the quantification of values and relationships that are addressed only in qualitative terms in the literature. Though frequently mentioned, the literature provides no guidance on what quantitative values to use to calculate the impact of turnover on working relationships or the impact of stagnation on organizations over time. Richmond (2001) distinguishes between quantification and measurement of abstract intangibles in the context of organizational simulation and analysis. In his view, quantification of intangibles such as trust, cooperation, and commitment, when used in a specific problem context, is concerned with placing relative, subjective, differences on a non-dimensional scale. Measurement is concerned with the identification of absolute values such as the number of employees or total costs where there is an absolute scale against which to measure. At this point in the process of theory development, the concern is primarily with quantification rather than measurement.

For example, organization performance capacity – the latent ability of an organization to do things – is clear enough in concept but is exceedingly difficult to measure in practice. At the individual level, this would require an assessment of human capital in terms of employee competencies before taking into account job matching and other factors affecting the realization of that potential; at the workgroup level this would also include measuring the value-added of social capital. The difficulty is that workforce performance capacity is only a *potential* value, while performance is visible, but determined by many factors besides the ones addressed here. Sculle, Bergey and Aiman-Smith (2005) dealt with this issue by positing a “true” value which may exist, but is difficult to measure.

This model has been developed from the perspective of the organization as a collection of individuals working relationships of varying levels of importance. This is a non-hierarchical perspective that treats the organization as simply one aggregate collection of individuals and task/social relationships, in effect, as one large workgroup. It does not address internal labor market hierarchy structures or realistic workgroup differences.

3.4.3 Development of the Computational Algorithm

The conceptual starting point for the computational aspect of the simulation is a list of employees and their characteristics, in this case simply tenure and quality level. With the passage of time and attrition events, employees drop off the list and are replaced by new employees. It is the changing pattern of aggregate employee characteristics over time that this model tracks.

The computational algorithm has been developed using an Excel spreadsheet and VBA. A flow chart of the computational approach is provided in the Appendix. Sample code is also provided in the Appendix.

3.5 The Model Elements

The following sections describe the detailed development of each of the elements that compose the conceptual model.

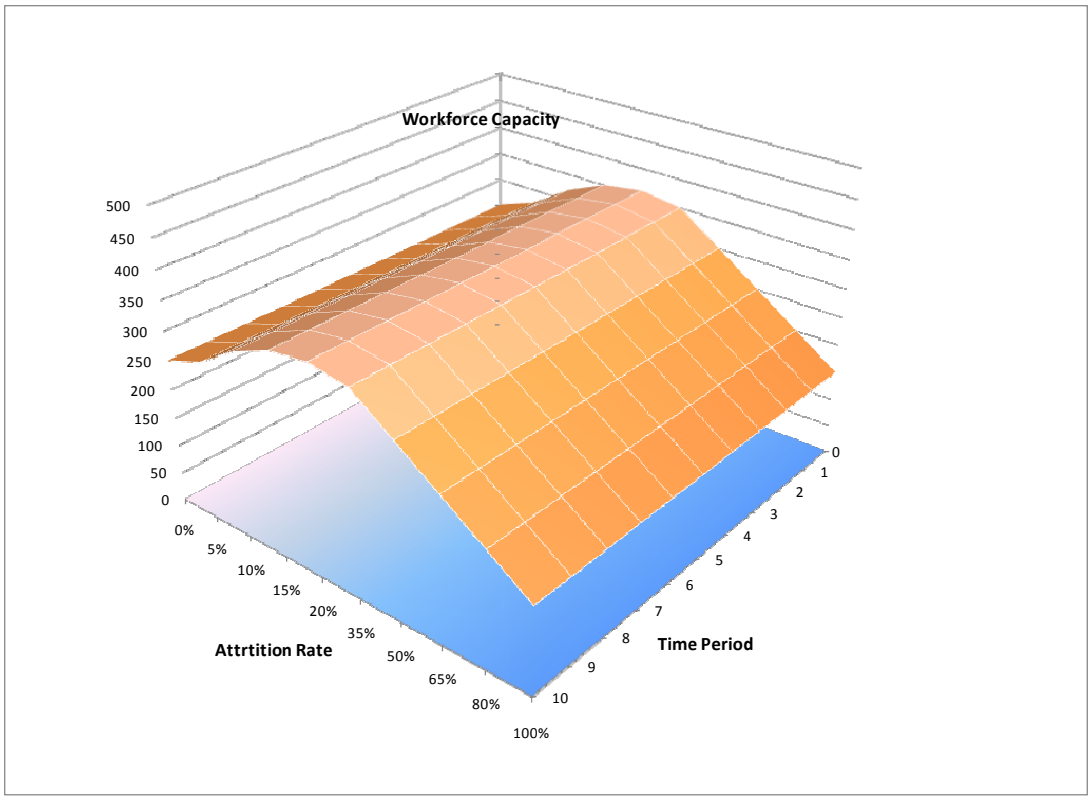
3.5.1 The Role of Time

What distinguishes my approach from Abelson and Baysinger's (1984) presentation is the role of time in the turnover-organizational performance relationship. Time, as in all dynamic models, is the fundamental driver of the conceptual model processes of Figure 6. The inclusion of time implies a third dimension (a "z" axis) to the relationship as shown in Figure 8 below. This should be compared to the two-dimensional (x-y) relationship presented by Abelson and Baysinger in Figure 2 (pg. 6). Abelson and Baysinger's approach did not explicitly or even implicitly address the dynamics of factor changes over time. The significance of including time as a third analytical dimension will be seen in the simulation results presented in the case analyses section.

As per Scullen, Bergey and Aiman-Smith (2005), and Harrison and Carroll (2006), I use annual time periods, but differ in only that I am running the simulation for 10 periods rather than 30 and 25 periods respectively. The duration of 10 years was selected to match the time horizon of 5 to 10 years typically used in public organizations for strategic and human capital planning (e.g., FAA Flight Plan, DOD Future Years Defense Program). By contrast, Ton and Huckman (2008) performed an empirical analysis of employee turnover at Border's book stores where employee turnover was measured in months. An analysis of employee turnover at a fast food restaurant could be appropriately set in terms of weeks or months, while organizations

Figure 8

The Three-Dimensional Analytical Framework



using day labor would perhaps be best analyzed in terms of days. The analytical time periods must be matched to the nature of the problem under study. Ten years is a reasonable time perspective geared to the analysis of white collar career jobs; however, the model will be further tested out to 30 years to examine the long-run behavior of the model output.

3.5.1.1 Note on Methodology

In simulation work, my approach is termed a discrete simulation as it moves forward in discrete time steps. In social research methodology, this simulation can be viewed as a longitudinal series of panel data. Panel measurements are made at the time points, thus 11 measurement points are provided from T=0 to T=10. The discrete simulation approach is

equivalent to taking a snapshot of workforce performance capacity at 11 time points, holding the rate of turnover constant, and looking at the effects of employee flows at each time point.

3.5.2 Organizational Goals

The external environment of relevance to this analysis has two separate components: The first component consists of those forces such as political demands, technology changes, or federal personnel policy shifts that change the organization's operating goals and characteristics. In the case of an agency such as the Federal Aviation Administration, for example, budget pressures have resulted in outsourcing functions and great scrutiny of union labor costs. In addition, the increasing sophistication of air traffic control systems is driving the need for increasing technical expertise. The second component is the external labor market – the pool of potential employees that are available to the organization as it seeks to fill its vacant positions. This pool may vary in size and quality for any number of reasons. These external conditions directly influence the relationship between employee flows and organizational outcomes by directly affecting the numbers and types of employees needed (demand) and the available supply.

From a modeling perspective, however, these external issues are translated into specific model elements. For example, the organization needs to maintain staffing levels at a certain size to handle the current workload, or sets goals for organizational growth, downsizing, or capability changes in response to its environmental conditions. Similarly, the external labor market is translated into availability and costs. It is assumed that organizational needs/goals can be translated into a specific workforce inventory number over the time periods of interest. The model is thus in effect is a closed system for analysis purposes.

This analysis assumes that the organization size, that is, the number of employees, remains constant over the period of analysis. Growth or shrinkage in the number of employees would, of course, affect the model by changing the accession pattern in the case of growth, or the attrition pattern in the case of downsizing.

3.5.3 Workforce Inventory

Workforce Inventory is the stock of employees onboard at any given point in time, in this analysis, at the time points of T=0 through T=10. A key model parameter is the characteristics of the workforce at T=0, the initial measurement point. Workforce characteristics are specified

at the beginning of the analysis and change over time as the workforce evolves due to time, attrition, and replacement. In the general case analysis, initial workforce characteristics can be varied in terms of tenure distribution, quality level, proficiency levels, and attrition patterns. For the analysis of a specific organization, workforce characteristics would be a given.

As per Scullen, Bergey and Aiman-Smith (2005), I am using a workforce size of 100 employees as simply a convenient round number. Scullen et al. addressed this very point in their paper by noting that none of their variables were affected by the size of the workforce. The methodology employed is not changed in any way by scaling up to greater numbers; however, greater numbers can improve the precision of calculated values, and this will be further checked by running the model with a workforce size of 1000 employees.

3.5.4 Individual Employee Characteristics – Proficiency, Quality, and Experience

Employee Proficiency Level is a calculated value for each employee that is a function of their LOS or YOE relative to the parametric value of average time-to-full proficiency (learning curve time). Proficiency is a measure of an employee's overall expertise on a scale of 0 to 5 (no experience to expert). Movement up the proficiency scale in the first few years of a job is referred to as movement up the learning curve. Over time, however, employee proficiency may remain constant, grow or decline. The pattern of employee proficiency over time is treated as a model parameter that can be seen in the case test parameters.

The generic proficiency scale used in this analysis is similar to one used at various government agencies (e.g., FAA, Navy System Commands).

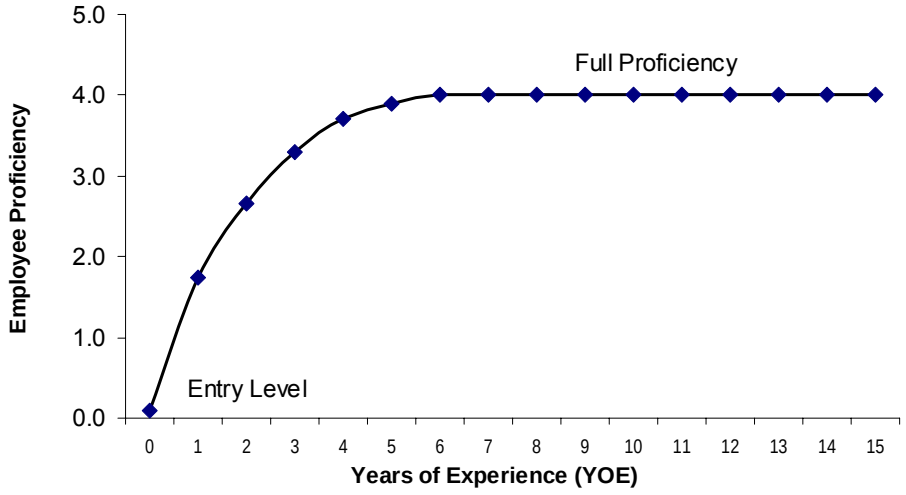
5 = Expert – able to train and coach others
4 = Full Proficiency – able to work independently on routine items
3 = Intermediate
2 = Foundational
1 = Basic knowledge of the subject area
0 = No knowledge of the subject area

Each of these ratings only implies having technical expertise in a particular subject area as determined by either self-assessment or supervisor assessment.

Figure 9 below depicts a proficiency learning curve from entry to full proficiency level as a function of years of experience.

Figure 9

A Typical Time-to-Proficiency Learning Curve



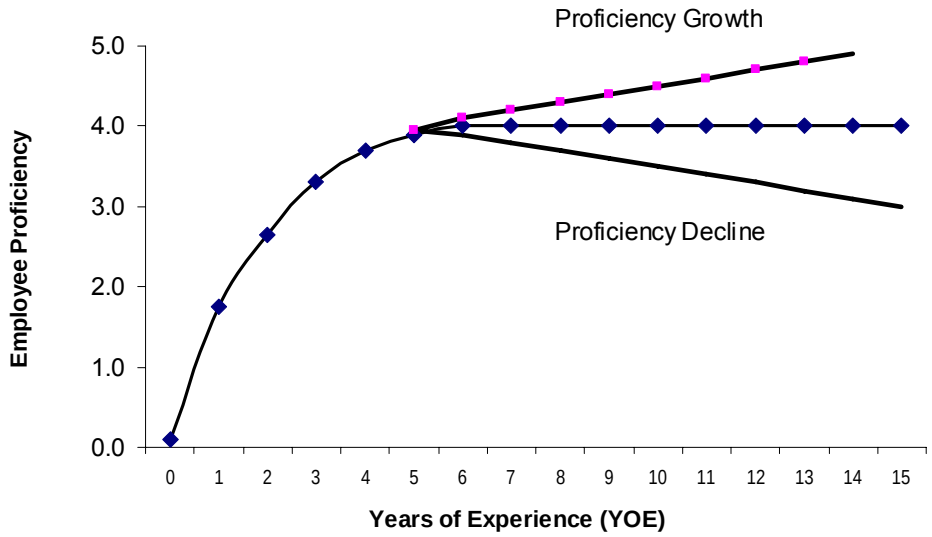
3.5.4.1 Proficiency Change over Time

The human capital (knowledge, skills, and abilities) possessed by individual employees is a dynamic value that changes over time. Depending on individual characteristics, occupation, organizational technology, and external environment, the proficiency of employees relative to organizational needs may change over time. Over the career of individual employee, expertise may grow while in legal or policy positions stay constant in administrative positions, or decline in technical fields. Using a meta-analytical approach, Sturman (2003) looked for a time-based effect in the relationship between job tenure, age, and experience. He found that there exists an inverted U-shaped relationship between time and performance in low complexity jobs, but for high complexity jobs, the relationship though non-linear showed that performance is positively related to experience acquired over time. It is important to note that these are aggregate patterns, not predictors of individual performance.

Figure 10 depicts three possible notional trajectories for average employee proficiency over time. In terms of the model, these curves form the basis for calculating the individual employee proficiencies that are aggregated to yield overall workforce performance capacity.

Figure 10

Notional Proficiency Changes over Time



3.5.4.2 Technical Obsolescence

Proficiency, as used in my model, reflects having technical skills and technical currency. IT specialists, contract specialists, and financial specialists may lose technical currency over time so that long-tenure employees are functionally less proficient than newer employees who come into the organization at lower grade levels already highly educated in these specialized technical areas.

In fields where high levels of technical proficiency are needed, new employees will be brought in at higher-grade levels or with more years of specialized experience. The MSPB reports that "in four of the top ten occupations hired in FY 2005 (business administration, management analysts, criminal investigators, and information technology management) agencies hired a majority of their career entry employees at the GS-9 level or equivalent – meaning that the new hire must have prior relevant experience or a graduate-level degree."[13]

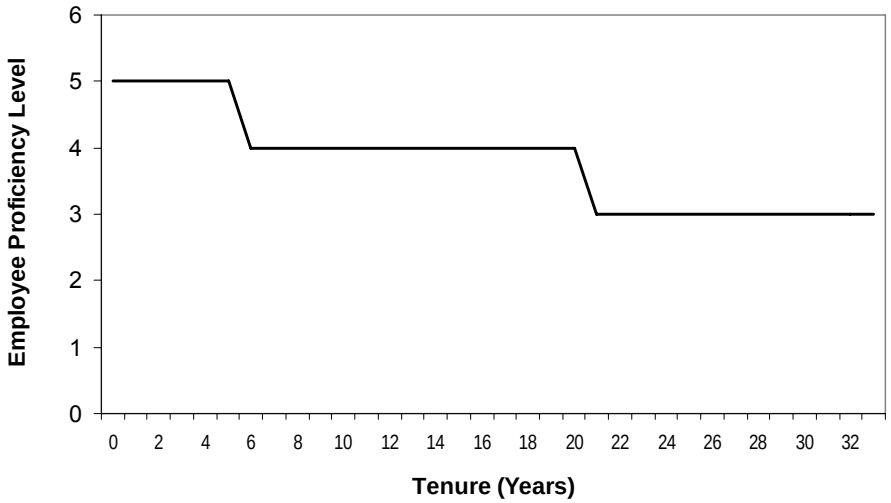
[13] Merit Systems Protection Board *Issues of Interest*, 11(4), Sept 2006, p.5

This indicates that these new employees are being brought in at higher levels of technical proficiency than the agency's current workforce.

Figure 11 below depicts a notional proficiency obsolescence curve and the differences between new and long tenure employees.

Figure 11

Notional Proficiency Obsolescence over Time of Long Tenure Employees versus New Employees with High Proficiency



3.5.4.3. Employee Quality

Quality Factor is an assigned value given to each employee. The quality concept is drawn from Scullen, Bergey and Aiman-Smith (2005) to differentiate employees. A value of 1.0 for an average quality employee is assumed as the reference point. The quality factor is used to adjust the proficiency level of current and replacement employees.[14] In the calculations, I have used three employee quality levels described as average = 1.0, below average = 0.9, and above average = 1.1.

[14] Although I am not addressing job characteristics as a variable in this analysis, it is interesting to note that Hunter, Schmidt and Judiesch (1990) reported that employee quality differences become more significant as job complexity increases. This is an area that could be pursued for further analysis.

While the two concepts of quality and proficiency are closely related, for purposes of this analysis, I am distinguishing the two. Proficiency represents the competency to do a job – the KSA's and experience requirements of government vacancy announcements. Quality represents the difference between people doing the same job – the criterion managers use when doing performance evaluations or in making hiring decisions. I am using the concept of employee "quality" here the same sense that Scullen, Bergey and Aiman-Smith (2005) use to describe the relative or potential performance contribution to the organization of current and replacement employees. For this analysis, the definition of quality includes social characteristics (i.e., interpersonal relationship skills) to differentiate it from simply technical proficiency. Higher quality of employees in this sense also serves to mitigate the impact of the social relationship disruptions created by turnover. Employee quality is assumed to remain constant over time as compared to proficiency that may change over time.

With regard to the quantification of quality, Harrison and Carroll (2006), in a parallel manner, use a single measure to describe the "fitness" or desirability of an employee as compared to other employees when ranked by managers for hiring selection. In both cases, in this analysis and theirs, the measures are relative – no absolute values are implied.

3.5.4.4 Individual Employee Data Elements

The model requires only three data items for each employee: a unique identifier number, their initial number of years of tenure or experience, and a quality factor as shown here.

Table B
Sample Employee Data Structure Showing The
Three Data Elements Needed to Characterize Each Employee

Employee Number (Emp #)	Initial Tenure or Years of Experience (YOE)	Quality Factor (QF)
1	3	1.0
2	0	0.9
:	**...**	**:**
n	x	y

The Employee Number is merely a device to keep track of each individual employee. Initial Tenure (length of service – LOS) measures years of service inside the organization and ranges from 0 to 30+ years. For replacement employees, the equivalent is Years-of-Experience (YOE)

prior to joining the organization, varying from 0 to 20 years as an upper limit. LOS or YOE = 0 indicates that the employee has no experience before joining the organization – a new recruit. Higher levels of LOS or YOE indicate that the employee has some years of experience.

3.5.4.5 Calculation of Individual Employee Potential Performance Capability

Potential performance capability is simply that – the potential (latent) capability of human capital. This latent value needs to be distinguished from realized capability. Realized capability is a function of many factors such as quality of job matching, supervision, workgroup fit, tools, attitude, and so on. This value should be viewed as merely the potential of an employee to perform before all other mitigating factors.

For calculation purposes, each employee, based on his/her years of experience (YOE), is assigned a proficiency level on a scale of 0.1[15] to 4.0 (entry to full performance). Each employee, then based on their Quality Factor (QF), has their proficiency level adjusted. Thus:

Equation 1:

Employee Potential Performance Capability = Avg. Proficiency Level X Quality Factor

For example, Employee #35 has YOE = 10, thus his proficiency level = 4.0. Employee #35 has a QF = 1.1 (better than average), thus this employee's performance capability = 4.0 X 1.1 = 4.4. By comparison, Employee #36, with the same YOE, but QF = 1.0 (just average) has a performance capability of 4.0 X 1.0 = 4.0. While Employee #37 with same YOE, but QF = 0.9 (below average) has a performance capability of 4.0 X 0.9 = 3.6. This calculation is shown in Table C below. For the lower-tenure employee #38, his proficiency based on YOE is 3.8, but has a QF of 1.1; therefore he has a performance capability of 4.2, which is higher than two other employees with greater tenure.

[15] 0.1 is used here, rather than 0, to avoid multiplying the QF by zero and enable distinguishing between higher and lower quality entry level people.

Table C
Employee Potential Performance Calculation Based on the Three Factors of Experience, Proficiency, and Quality

Emp. #	Years of Experience (YOE)	Avg. Proficiency Level based on YOE	Quality Factor (QF)	Potential Performance Capability
:				
35	10	4.0	1.1	4.4
36	10	4.0	1.0	4.0
37	10	4.0	0.9	3.6
38	4	3.8	1.1	4.2
:				
Calculation assumes 5-year time to full proficiency (learning curve) with no change in the out-years				

3.5.5 Initial Workforce Conditions

Workforce Inventory initial conditions must be specified at T=0. In this analysis, two workforce demographic characteristics are used: tenure and quality. Tenure and quality are used in various combinations in the model test cases. There is of course an infinite number of potential tenure or quality variations that could exist in any given organization, though many federal agencies today have a predominantly senior workforce with an average age well into the 40's. The variations shown below are designed to test the model rather than try to reflect any specific organization.

3.5.5.1 Initial Workforce Variations - Tenure

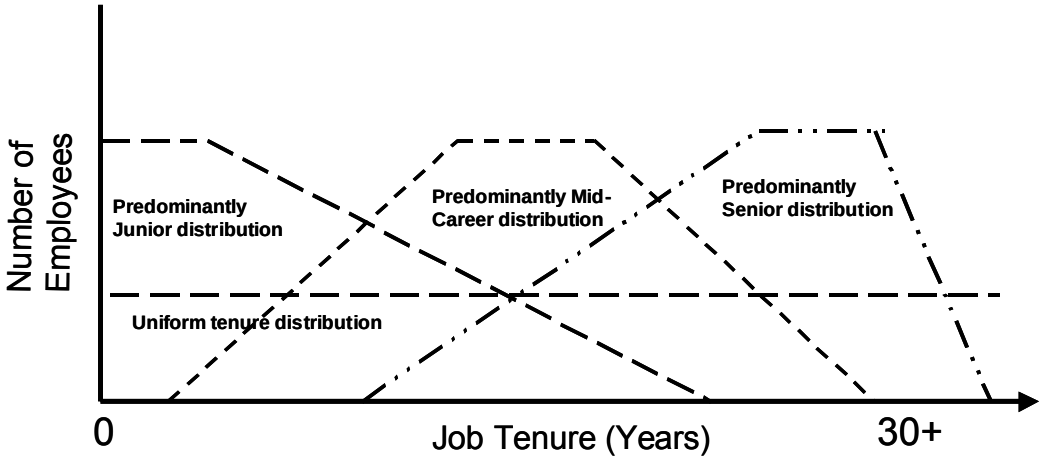
The following are four generic tenure distribution variations used in this analysis:

- Uniform number of all tenures
- Predominantly junior workforce
- Predominantly mid-career workforce
- Predominantly senior workforce.

These variations are depicted in Figure 12 below.

Figure 12

Workforce Initial Tenure Distributions showing Four Generic Variations



3.5.5.2 Initial Workforce Variations - Quality

The initial workforce inventory can also be described in terms of quality where "quality" is defined as whatever characteristics (knowledge, skills, learning ability, or behaviors) that management considers desirable. For computation purposes, Scullen, Bergey and Aiman-Smith (2005) used a mean quality level of 1.0 as the baseline level of quality of the existing workforce. Therefore, paralleling the three categorical groupings used by the MSPB[16].

- Average quality employees have a quality value of 1.0
- 10% better than average quality employees have a quality value of 1.1
- 10% less than average quality have a quality value of 0.9.

The +/- 10% is an arbitrary percentage used for calculation purposes only.

3.5.6 Attrition

Employee attrition can be specified along three dimensions: the rate of attrition, the quality (performance level) of those leaving, and the type (employee-specific characteristics) of employees leaving. This can be phrased as how fast are they leaving (rate) and who is leaving

[16] Merit Systems Protection Board, *Issues of Merit* 12(3), July 2007, p. 6, used a similar three-category classification (same, better, worse) in a survey of the quality of supervisors and of co-workers, although without quantification of the category differences.

(quality and type). The “who is leaving” is treated as a parametric variable, of which I have identified seven cases.

Although Turnover is typically expressed as a percentage of total employees lost and replaced, I have broken this out into its two components: attrition and accessions. Attrition rate (losses from all causes each time period) is treated as the primary independent variable. Attrition patterns are treated as parametric cases, of which I have identified several below. Attrition of individual employees is a Monte Carlo selection based on the attrition pattern.

3.5.6.1 Attrition Patterns based on Tenure

Patterns of employee attrition based on tenure used in the case analyses are of two basic types as shown in the figures that follow:

1. A random uniform distribution with equal probability of attrition irrespective of tenure (Figure 13).
2. A “typical” Civil Service pattern (Figure 14).
3. A “typical” Civil Service pattern adjusted for high early-career attrition implying low hiring selectivity (Figure 15).
4. A “typical” Civil Service pattern adjusted for low early-career attrition implying high hiring selectivity (Figure 16).

Other variations are, of course, possible as well.

Figure 13

Random Uniform Attrition Pattern

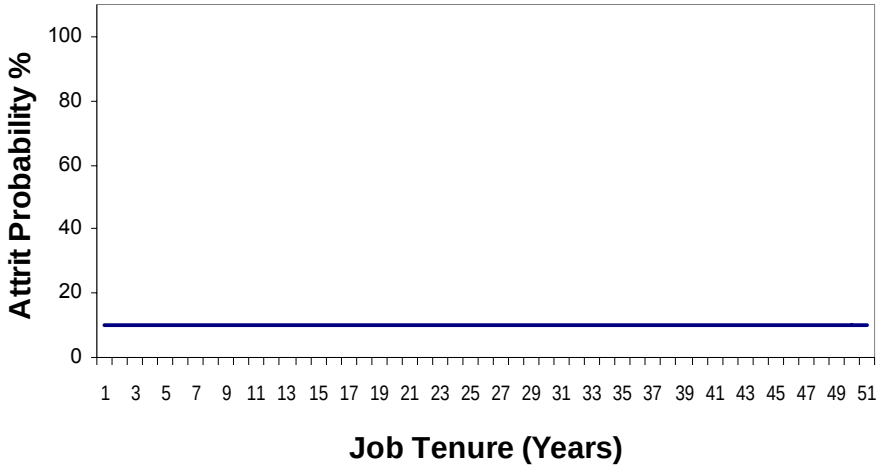


Figure 14

Typical Civil Service Attrition Pattern

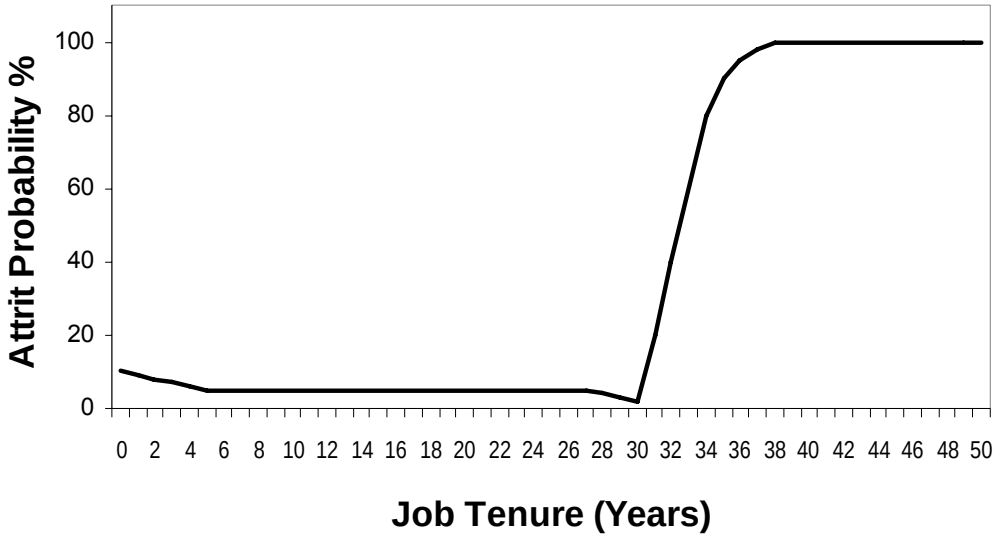


Figure 15

Civil Service Pattern with High Early Attrition

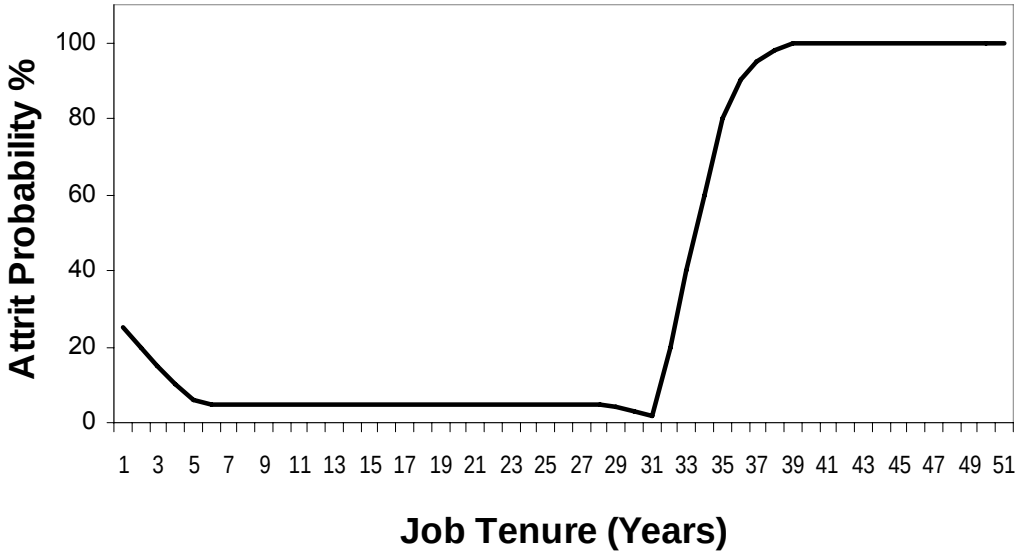
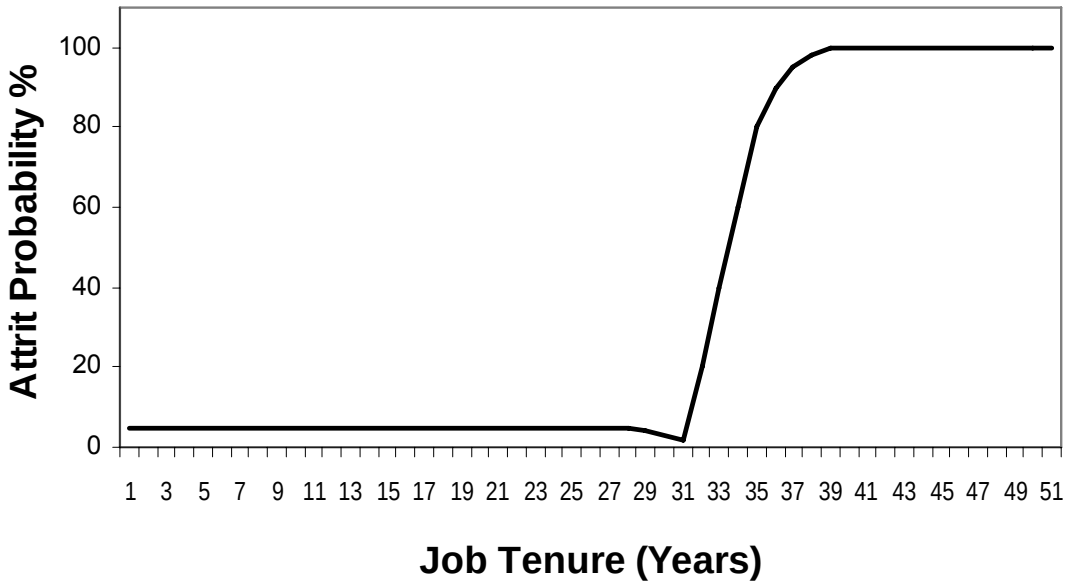


Figure 16

Civil Service Pattern with Low Early Attrition



3.5.6.2 Attrition Patterns based on Employee Quality

Patterns of employee attrition based on employee quality used in the case analyses are based on three categories of employee quality:

– Average quality employees (1.0)

– High quality employees (1.1)

– Low quality employees (0.9)

The model test cases are based on variations of these patterns relative to accessions.

3.5.6.3 Monte Carlo Selection

Driving the overall dynamic of the problem is the probabilistic attrition of employees. The attrition can be based in one or a combination of the characteristics of tenure, age, and performance. Using tenure for example, individual employees are selected for attrition from

each tenure group using a random number Monte Carlo algorithm.[17] Selection of replacement employees from the outside labor pool has a similar probabilistic character in that selections are somewhat random in nature (the less random the more selective). Selectivity with regard to the quality (fitness) of the replacements is a function of organizational standards and the driver of hiring costs and the time taken to fill vacancies.

3.5.7 Relationships

Employees are dependent upon both task and social relationships to be able to perform their jobs. The combination of both task and social relationships are referred to as working relationships. The importance of employee working relationships is treated as a uni-valued, case-specific parameter. I base this on Wageman's (1995) approach in her empirical study of workgroup effectiveness where a total value was used to combine both task and outcome (social) interdependence.

3.5.7.1 Calculation of Relationship Strength

As noted above in the literature review, Daft (2004) developed a table that summarized Thompson's (1967) classification of organizational interdependence. Thompson identified three levels of interdependence: "pooled" where each workgroup or employee has little need to interact with their coworkers or other groups and can do their own work independently, "sequential" processes where the down-stream employees are only dependent upon the up-stream employees and "reciprocal" where each employee is mutually dependent upon the other.

Using this categorization as a starting point, the interdependence of all employees and workgroups can be viewed as lying within a range that has two extreme boundary points: total independence to total dependence. Mathematically, total independence is assigned a value of 0.0, while total dependence is assigned a value of 1.0. Thompson's categories can thus be viewed as occupying three points on this scale: pooled at 0.0, sequential at 0.5, and reciprocal at 1.0.

---

[17] For example, if there are 100 employees in the five years-of-service tenure group and their attrition rate is 4%, then four employees of the 100 would be randomly selected for attrition over the course of a year. At the end of the year, the remaining 96 employees would continue on to the six years-of-service group and a similar random selection would be made once again using the appropriate attrition percentage. Additional attrit criteria can be used in addition to tenure. Further, the pacing of attrit events over the course of the year can be regular, randomized, or clustered.

While formal task relationships can be quantified on the Thompson scale, the contribution of social relationships is more difficult to place on the same scale. Organization members in a pooled work situation may have little to no formal task dependence, but still highly value and rely on professional social relationships (as do for example, university professors); while employees in a reciprocal relationship may have high formal task dependence but have low social dependence (as for example air crews or surgical teams). Adjusting Thompson's three categories to include social relationships, the numerical ranges are expanded so that pooled relationships lie in the lower third (0.0 to 0.33), sequential in the mid-range (0.33 to 0.66), and reciprocal in the upper third (0.66 to 1.0) of the linear scale. This allows for adjusting the task-task relationship to account for employee-to-employee social relationship.

Calculating an overall value for the strength or importance of working relationships across an entire organization can be based on the social networks approach to connections between individuals. In any large organization, there will be multiple processes, employees, and workgroups operating simultaneously and dependent upon each other to varying degrees. I have developed Figure 18 to depict how this can be conceptualized by building on the approach used in social network analysis (cf. Burt 1997, Wasserman & Faust, 1994). Assigning a dyadic relationship value on a scale of 0.0 to 1.0 to all the relevant working relationships and calculating an average value can provide an average value that quantifies the importance of working relationships in the organization on an aggregate level. Bovasso (1992), for example, described a computer program called STRUCTURE developed by Burt that was used to quantify and analyze social network changes in a large corporate merger. This is also the calculation approach used by Kitts and Trowbridge (2007) where they define organizational cohesiveness as the average strength of organizational social ties. Table D on the following page shows how this average value can be calculated. The numbers shown in Figure 17 are for illustration purposes only.

In practice, due to the organization-specific and local nature of formal work arrangements and the variability of the strength of social relationships, there can be no a priori assignment of the score value without an empirical assessment of each case. Ideally, this would be done through survey of the organization being studied or by consulting with people familiar with the organization.

Figure 17

Conceptual Determination of Working Relationships Values

Values are Notional

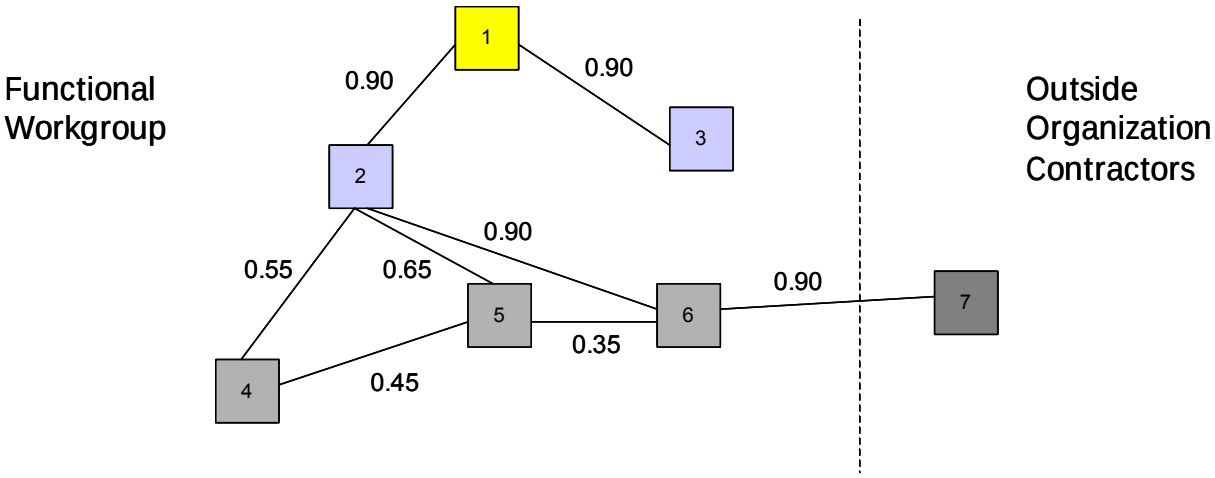


Table D

Calculation of Average Strength of Relationships Value

Employee #	Employee #	Strength of Relationship
1	2	0.90
1	3	0.90
2	4	0.55
2	5	0.65
2	6	0.90
5	4	0.45
5	6	0.35
6	7	0.90
Average Strength of Relationships =		0.70

3.5.8 Accessions

Management has the ability to decide whom to hire. Government agencies tend to prefer entry level hiring, but this is not always the case. They may be satisfied with the same quality employees and not make any changes in selectivity, they may decide to be more selective if they can afford the incremental increase in time to fill and the costs, or they may be less selective if in hurry to get people onboard. These variations are reflected in the following case patterns.

3.5.8.1 Accession Pattern Variations

I use two patterns for entry based on Years of Experience (YOE):

1. YOE = 0 (career entry level, typically GS 5/7/9)
2. YOE = 0 to 20 (random uniform)[18]

And four patterns for entry are based on Quality Level as previously defined

1. Same quality as current employees (all 1.0)
2. Higher quality than current employees (all 1.1)
3. Lower quality than current employees (all 0.9)
4. Same quality as current employees but with three quality groups
   (25% at 0.9, 50% at 1.0, 25% at 1.1)

3.5.9 Workforce Performance Capacity

The concept of workforce performance capacity is a key element to understanding how my model is constructed. I am building on Scullen, Bergey and Aiman-Smith's (2005) concept of performance potential (their "true score" measure) of the workforce in terms of its capacity to perform the organization's work after the impact of turnover or stagnation is included. Moving from latent capacity to actual performance is a function of many factors: how the organization is organized, its technology, its leadership, and numerous others that affect organizational performance. Given the model design, it should be understood that the model measures the relative changes in the human resource input to the production function of the organization, not the output performance of the organization. How an organization accomplishes its work is determined by the characteristics of that particular organization. Analytically, the production function is assumed to be held constant. A determination of the actual *values* of the human

[18] The MSPB in *Issues of Merit*, Sept 2007 noted that in a recent survey 80% of Federal new hires had 0 to 20 years of work experience.

resource inputs and the resultant outputs of a particular organizational process as a function of turnover would be a different research project (and one that would not be supported by the base of today's extant theory).

In mathematical terms, the Performance Capacity (PC_o) of the workforce equals the sum of the performance capabilities (PC_e) of the individual employees:

Equation 2

$$\mathbf{PC_o\ (organization) = Sum\ (PC_e)\ of\ all\ employees}$$

Organizational workforce performance capacity is a function of the total human capital and relationships of the workforce inventory at any particular point in time. Due to the variability of human resource flows, this capacity can be reduced by either organizational stagnation or working relationship disruptions (turbulence) as is described in the paragraphs below.

3.5.10 Organizational Stagnation

As discussed in the literature, organizational stagnation is the lack of movement of personnel in an organization. Though not clearly defined in the literature, organizational stagnation is modeled here as a function of time and turnover that reduces workforce capacity over time but only at very low turnover rates. Stagnation is treated here as a *group* effect – it is not applied to individuals. I have developed the "Stagnation Factor" (SF) as follows to account for the lack of inflow of new people. As the rate of turnover begins to increase from zero, the Stagnation Factor is reduced incrementally until it disappears completely at turnover equal to 5% as shown in Table E below. The 5% figure was selected based on Mosher and Kingsley (1936) quoting earlier work by Brissenden (1929) on "Labor Turnover in the Federal Service" who suggested that a turnover rate greater than 4% was needed to prevent stagnation. Unfortunately, I have not been able to find anything more recent in the literature that provides any guidance.

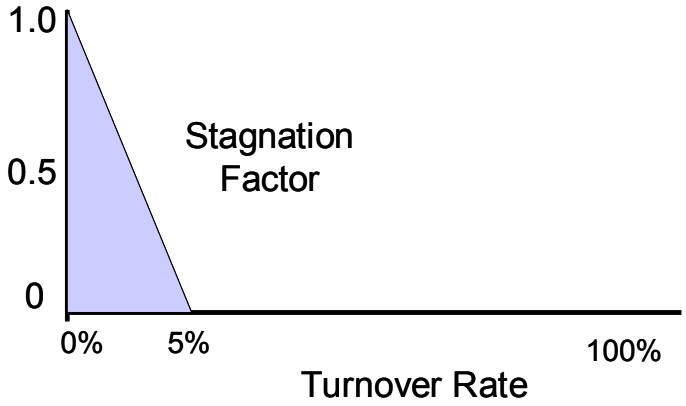
Table E
Stagnation Factor Range
As Turnover Increases, Stagnation Decreases

Turnover Rate	Stagnation Factor
0%	1.0
1%	0.8
2%	0.6
3%	0.4
4%	0.2
5%	0.0

Thus the range in which stagnation acts is confined to the narrow area under 5% turnover as depicted in Figure 18.

Figure 18

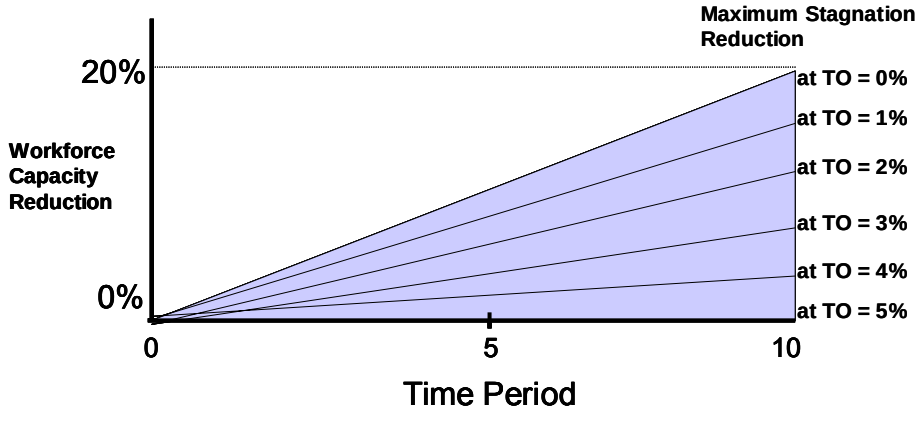
Zone of Stagnation



Along with this, I have made two other assumptions: (1) that stagnation increases linearly with time as depicted in Figure 19, and (2) that the maximum degradation of workforce capacity can be represented as a specified percentage reduction in capacity. At T = 10, this reduction is set (arbitrarily for test purposes) at 20% in general and at 40% in one test case. Thus, at T = 0, there is no stagnation effect, but at T=10 the reduction has increased to 20% of the zero turnover level. I have selected 20%/40% as arbitrary values for test purposes, selected due to the lack of any quantitative values that can be found in the literature to my knowledge. For this analysis, I have used a stagnation factor of zero at T=0. For organizations that are already considered to be stagnant, the initial stagnation factor can be set at higher values than zero at T=0. The issue of quantification and measurement are further addressed in the model discussion section.

Figure 19

Stagnation Growth over Time



3.5.10.1 Formulation for Reduction of Workforce Performance Capacity by Stagnation

Stagnation increases with time, but is reduced by the inflow of new accessions. As noted, I have assumed that stagnation increases steadily (linearly) with time. The formula is written as:

Equation 3

$$PC_o^* = PC_o \times [1-0.1(T) \times 0.20\ (SF)]$$

Where:

PC_o^* = Performance Capacity after stagnation reduction

T = the Time period from 0 to 10

0.1 = scaling factor*

SF = Stagnation Factor ranging from 1.0 to 0.0

0.20 = the assumed reduction of capacity at max stagnation (20%)

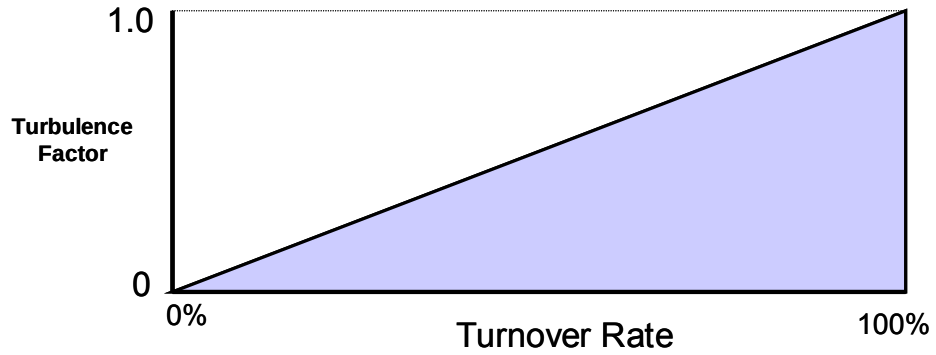
*0.1 is a scaling factor to keep the overall value of the expression between 0.0 and 1.0.

3.5.11 Relationship Disruptions (Turbulence)

"Turbulence" is the term I use to describe the disruptions of the task and social relationships that interrupt communication and coordination due to the breaking of existing relationships and the time needed to build relationships with the new employees. Like stagnation, I view turbulence as a *group* effect, not one that acts on specific individuals. I have quantified the effect as follows: at zero turnover, the turbulence factor = 0.0. At the maximum level of turnover used in this analysis (100% per year), the turbulence factor = 1.0. I have assumed a linear function between these two end points over the range TO = 0% to 100% as depicted in Figure 20. Unlike stagnation, turbulence is not a function of time.

Figure 20

Turbulence as a Function of Turnover Rate



3.5.11.1 Formulation for Reduction of Workforce Performance Capacity by Turnover

Performance Capacity as noted above is reduced by the level of turbulence which is moderated by the importance of task and social relationships (TSR). The formula is written as:

Equation 4

$$PC_o^* = PC_o [1- (TSR \times TF)]$$

Where:

PC_o^* = Adjusted Performance Capacity

TSR = Task and Social Relationships importance

TF = Turbulence Factor

Example:

100 average employees at Proficiency level 5 = 500

Task and Social Relationships value = 0.5

Turbulence factor = 0.25 at a turnover rate of 25%

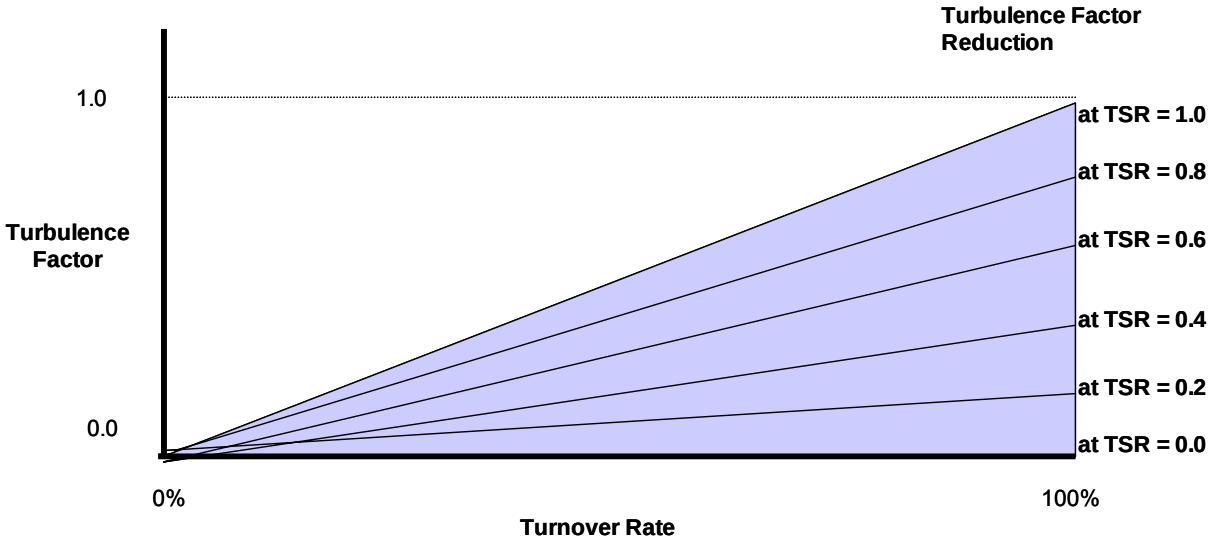
$PC_o^* = 500[1-(0.5 \times 0.25)]$

$PC_o^* = 437.5$

The figure below depicts how the Turbulence Factor value is reduced by the value of the Task Social Relationships (TSR) value.

Figure 21

Reduction in Turbulence Factor as a Function of TSR Value



3.6 Organizational Type Differences

The question arises as to whether the type of organization studied affects the outcomes of this analysis. In the context of public organizations, Wilson (1989) identified four types of organizations:

1. *Production* - those processing a steady stream of work, e.g., IRS, Social Security Administration
2. *Procedural* - those following rules and procedures, e.g., Dept of Justice, Federal Courts
3. *Craft* - those applying skills to problems and projects, e.g., National Institutes of Health, Army Corps of Engineers
4. *Coping* - those dealing with unpredictable events, e.g., Dept of State, FEMA, CDC

Wilson undoubtedly had the core functions of these organizations in mind when he developed this typology as the support functions found in all agencies (HR, Legal, Budget, Contracting) are generally similar irrespective of "type." Thus, rather than make sweeping generalizations about entire agencies, I believe it is more appropriate to apply Wilson's typology to specific *type functions* within any given agency.

3.6.1 The Organization

I use one agency, the Federal Aviation Administration (FAA) as the organization from which to draw some cases for examination. The FAA is an agency of the United States Department of Transportation. The FAA is charged with the responsibility to regulate and oversee all aspects of civil aviation in the U.S. Its responsibilities include regulating civil aviation to promote safety, developing and operating the system of air traffic control, encouraging the development of civil aeronautics and commercial space transportation, researching and developing the technologies to support the National Airspace System, and representing the U.S. in international civil aviation organizations. The FAA's overarching goal is to provide a safe and efficient air transportation system.

The FAA's workforce is a "mature" one, as is typical of most federal agencies today. At the beginning of FY 2007, 37% of FAA employees are 50 or older; and another 43% are 40 to 49 years old. Thus, 80% are 40 or older, while only 5% are under age 30.[19] These numbers imply that there will be significant turnover in the FAA workforce in the years ahead.

[19]Source: FAA Human Capital Plan, FY2007-FY2011, Washington DC

The FAA currently has over 44,000 employees, of which 79% are concentrated in just eight occupations:

- Air Traffic Controllers
- Air Transportation System Specialists (Maintenance Technicians)
- Aviation Safety Inspectors
- Certification and Compliance Inspectors
- Engineers
- Information Technology Specialists
- Human Resource Specialists
- Contract Specialists

Brief descriptions of each of the above occupational specialty's role at the FAA, along with their characteristics of relevance to this analysis are provided in Appendix C. This information was developed from FAA documentation[20] and discussion with senior agency personnel working in or familiar with these functions.

As noted above, I believe it is more appropriate to apply Wilson's typology to specific agency functions. In government agencies, these functions are typically performed by specific occupations, such as those described above. This, in effect, leads to an analysis by occupation rather than by function which simplifies the analysis. This also lies in line with government human capital management approaches, as does the FAA's, that address occupations (i.e., series) rather than organizational functions.

Using this approach, the occupations listed above can be classified using Wilson's typology. Using FAA documentation and discussions with senior agency personnel[21], parametric values for each occupation were developed as shown in Table F below.

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[20] Such as: FAA FY2007 ATO Strategic Human Capital Planning Activities June 2007, FAA Aviation Safety Workforce Plan 30 Jan 07

[21] In my discussions with these personnel, I asked the following three questions:

a. How many years are needed for an average new hire with no prior work experience to reach full proficiency in this function?
b. On a scale of 0.0 to 1.0, how dependent is an employee on the performance of co-workers to perform his/her job? (Cab drivers are 0.0, Space Shuttle crew members are 1.0) – i.e., how important are working relationships among co-workers.

Table F
Wilson's Organizational Typology applied to FAA Functions

Wilson Type	FAA Function	Parameters		
		LC	TSR	STG
Production	Air Traffic Controllers	3-4	0.2	0%
Procedural	Safety Inspectors	3	0.8	10%
	HR Staffing	4	0.2	30%
	C & C Inspectors	1	0.2	5%
	Contract Specialists	7	0.3	20%
Craft	Engineers	7	0.6	20%
	IT Systems Project Mgmt.	8	0.8	50%
	ATSS Technicians	2-4	0.2	5%
Coping	HR Labor Relations	4-5	0.3	20%
	IT Systems Maintenance	2	0.4	5%

The parameters given in the right-hand columns are as follows:

LC = Years to Full-Proficiency Level (Learning Curve)

TSR = Importance of working relationships with co-workers on a 0.0 to 1.0 scale

STG = Degradation of workforce performance due to stagnation.

Each of these three parameters is discussed below.

3.6.2 Observations

As discussed in the literature review, time-to-proficiency (learning curve) is driven by the complexity of the processes, procedures, and technology used in the organization; a change in technology or the complexity of work processes will change time to proficiency. An interesting outcome of the discussions with FAA personnel was learning that learning curve time is also dependent upon training availability. The time to proficiency is determined for technicians and controllers by the availability of required classes or hours of training instruction. Occupations that have specific training requirements – such as controllers, system technicians, and contract

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c. Thinking in terms of the consequences on organizational performance, if the people or their positions didn't change over a very long period of time (10 years), what might be the loss of organizational performance due to this stagnation on a 0% to 100% scale?

specialists – are dependent on the availability of training courses or instruction time availability. Longer waits for training resulted in longer times to reach certification (full proficiency level).

The importance of working relationships among co-workers is similarly organization-dependent. In the case of the Safety Inspectors for example, the FAA has chosen to use a team-based approach, thus the high TSR value. On the other hand, the Certification and Compliance Inspectors are independent actors processing and checking paperwork on their own at locations across the country.

Under the Craft category, looking at the impact of stagnation, there are two contrasting functions: IT Systems Project Management and ATSS Technicians are both connected to the nature of the technology they deal with. The IT Systems field requires people with currency in state-of-the-art technologies that are constantly evolving – 10 years is a very long time in this field. By contrast, ATSS (maintenance) technicians are required to be expert in systems that may not change for a decade or more; once a new radar or communication system has been installed, it undergoes minimal change for years at a time. No new learning is required of the technicians beyond initial certification other than keeping abreast of the small incremental changes that occur over time. Thus there is little performance impact if the status quo is maintained other than perhaps a boredom factor setting in.

Figure 7, shown previously, was created to show how employee turnover fits into the larger scheme of organizational elements. Workforce performance capacity, where my model resides, is at the foundation layer underlying organizational work processes, technologies, and structures, as well as the higher levels of organizational character – leadership, morale, culture, environment, and policy. As the heavy vertical flow arrows indicate, these higher levels mediate the latent capacity of the workforce up through where overall organization performance is reached.

From this depiction and noting the differences in the parametric values in the table above, it appears that the Wilsonian types describe the higher levels of organizational character and work organization and do not have a direct connection to the parameters that drive the model. Task and social relationships, stagnation, learning curves, and HRM policies are dependent upon multiple internal factors that are determined at the local level specific to a particular organization in place and time. As in the case of the FAA, technology and management decisions determine

the dependencies of the various occupations as the table shows. These are all subject to change as management deems best.

Other parameters, such as the workforce initial demographic distribution at the beginning of the analysis, and the employee attrition pattern are both organization specific. The workforce demographic distribution at T=0 is a function of the organization's prior staffing history; the attrition pattern reflects institutional policies and workforce demographics. Both workforce initial demographics and attrition pattern are organization-specific irrespective of organizational type.

Given these observations, I conclude that there is no functional connection between turnover parameters and Wilson's types.

3.7 Cost Structure

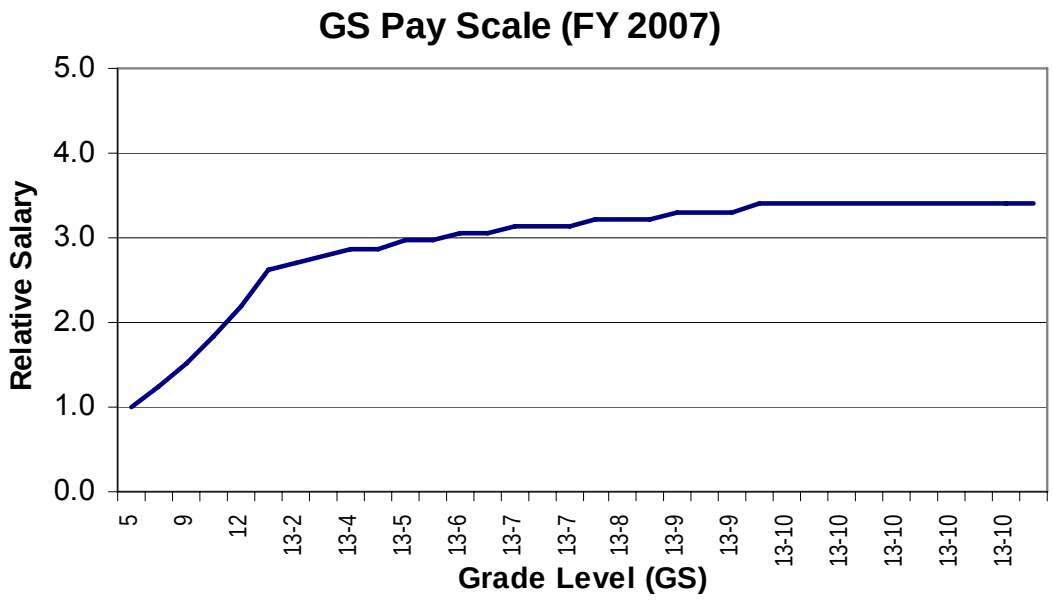
A cost structure based on the 2007 Civil Service General Schedule (GS) pay scale was used to create a cost level based on employee tenure. The pay scale was normalized so that entry at the GS-5 level was set to 1.0 as shown in Figure 22. As can be seen the curve rises rapidly in the early years and the incremental pay increases decrease as employee tenure rises. Nonetheless, there is still a steady increase in pay over time leading to the condition where as the workforce ages, its costs goes up while there is typically no concomitant increase in performance. The General Schedule pay system assumes that all persons with the same job at the same grade and step level perform their job at a similar level of proficiency. In concept, the longer an employee is in a position, the more proficient or productive one should become, hence the higher paid steps for seniority.

Other costs such as general administrative costs connected to hiring and attritions are set at (arbitrarily) one-tenth the cost of the first year salary. Training costs are set at one-tenth the first year cost but decline over the learning curve until reduced to zero. No long-term training costs are included. The exception to these cost values are those in Case F.2 where costs are increased to reflect the increased hiring and training resource expenditures (dollars and time) that accompany increased hiring selectivity.

Specific costs such as recruitment, review of applications, background checks, relocation, and orientation are included under general administrative costs.

Figure 22

Normalized Federal General Schedule Pay Scale



3.7.1 Performance-Cost Tradeoff

From both this model's perspective and the managerial perspective, there are two dependent variables: performance and cost. If focusing on performance, the optimum is found where the marginal change in performance capacity just start to decline but how does cost factor in? Agency performance is either set to political standards irrespective of costs (e.g., Nuclear Regulatory Commission or the Federal Aviation Administration) or to maximize performance given a fixed budget. I believe the performance-cost tradeoff in government is a value judgment, not an economic one. Therefore, this analysis does not attempt to address the performance-cost tradeoff beyond comparing the trajectory of the two curves.

4.0 Testing the Model

This section describes the model setup and the tests run against it.

4.1 Parametric Variables

As specified earlier, the independent variable is the attrition rate of employees from the organization. All other variables are parameters that can be set to examine how differences in initial conditions and other elements affect the outcome. The set of parametric variables used in this analysis are given in Table G below.

Table G
Parametric Variables

Parameter	Test Values
Workforce Initial Tenure Distribution	1. Uniform (0-32 yrs) 2. Junior 3. Mid-Career 4. Senior
Workforce Initial Employee Quality Level	1. Average (1.0) 2. Low (0.9) 3. High (1.1)
Workforce Proficiency	1. Stays same with time 2. Declines over tenure (obsolescence)
Avg. Time to Proficiency (Learning Curve)	1 to 10 yrs
Attrition Pattern by Tenure	1. Uniform Random 2. Junior, Mid-Career, or Senior
Attrition Pattern by Quality Level	1. Random employees 2. Lower quality employees 3. Higher quality employees
Accessions by Candidate Years of Experience	1. Entry level only (0 yrs exp.) 2. Random 0 to 20 yrs exp.
Accessions by Candidate Proficiency Level	1. Same levels as current employees 2. Higher proficiency than current emps
Accessions by Candidate Quality Level	1. Same as current employees (same cost) 2. Higher than current employees (more cost) 3. Lower than current employees (less cost)
Task-Social Relationships (TSR) Importance Value	Variable from 0.0 to 1.0 Average value = 0.5
Stagnation and Capacity Degradation	Occurs at under 5% turnover and increases linearly over time to a maximum degradation value of 0%, 20% or 40% at T=10
Turbulence and Capacity Degradation	Linear degradation value of 0 at 0% attrit to 1.0 at 100% attrit rate
Cost Structure	Civil Service General Schedule (GS)pay scale based on tenure

4.2 Simulation Test Cases and Results

Computer simulations are, in effect, scientific experiments. Scullen, Bergey and Aiman-Smith (2005) described the test approach they used for their model which had only five parameters of generally only two values each yielding a total of 80 test combinations. My model has 12 parameters, excluding cost, with typically two to three values. Assuming only two values per parameter, this would produce 4,096 combinations. Rather than test 4,000 combinations, I have opted to use a scenario-based approach in which a pattern of related parameter values are used to test the model. While admittedly less time consuming, I believe this is also a more realistic approach to take and serves the purpose of this research effort.

Table H following presents the seventeen cases tested, demonstrating various parametric combinations of interest. The pages that follow summarize each of the cases that were selected to highlight specific parametric comparisons. More detailed data are presented in the Appendices. In all cases, the attrition rate (equivalent to the turnover rate) varied from 0% to 100% and the simulation was run over ten periods (equivalent to years). Attention is called to Cases B.2 and C.2 which demonstrate that Abelson and Baysinger's (1984) curve is achievable under certain conditions.

Table H
Test Cases Parameter Settings

Case	Key Variation	Workforce Initial Tenure Distribution	Employees' Initial Quality Level	Time to Full Proficiency (Learning Curve)	Task and Social Relationships Importance	Attrition Pattern	Accession Pattern	Attrition Quality	Accession Quality	Stagnation %
A.1	Variation of new hires years of experience	Uniform 0 to 32 yrs	1.0	5 yrs	0.50	Random Uniform	All intake at 0 yrs	1.0	1.0	20%
A.2		Uniform 0 to 32 yrs	1.0	5 yrs	0.50	Random Uniform	Intake at 0 to 20 yrs	1.0	1.0	20%
B.1	Replacing below avg emps with above average	Uniform 0 to 32 yrs	0.9	5 yrs	0.50	Random Uniform	All intake at 0 yrs	0.9	1.1	20%
B.2		Uniform 0 to 32 yrs	0.9	5 yrs	0.50	Random Uniform	Intake at 0 to 20 yrs	0.9	1.1	20%
C.1	Higher Q emps leaving	Uniform 0 to 32 yrs	0.9 - 25% 1.0 – 50% 1.1 – 25%	5 yrs	0.50	Random Hi Q	Intake at 0 to 20 yrs	1.1	Same as initial	20%
C.2	Technical Obsolescence	Older	1.0	Declined over time	0.50	Civil Service	All intake at 0 yrs	1.0	High proficiency	0%
C.3	Professional Growth	Uniform 0 to 32 yrs	1.0	Growth over time	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	0%
C.4	Hi-Perform. Work team	11 to 20 yrs	1.1	5 yrs	0.90	Civil Service	All intake at 10 yrs	1.1	1.1	0%
C.5	Worst-Case Scenario	Older	0.9	5 yrs	0.90	Civil Service	All intake at 0 yrs	0.9	0.9	40%
D.1	Length of learning curve (time to full proficiency)	Uniform 0 to 32 yrs	1.0	1 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
D.2		Uniform 0 to 32 yrs	1.0	5 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
D.3		Uniform 0 to 32 yrs	1.0	10 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
E.1	Workforce initial tenure distribution	Younger	1.0	5 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
E.2		Mid-career	1.0	5 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
E.3		Older	1.0	5 yr	0.50	Civil Service	All intake at 0 yrs	1.0	1.0	20%
F.1	Hiring selectivity	Uniform 0 to 32 yrs	1.0	5 yr	0.50	CS w/hi early attrit	All intake at 0 yrs	1.0	1.0	20%
F.2		Uniform 0 to 32 yrs	1.0	5 yr	0.50	CS w/lo early attrit	All intake at 0 yrs	1.0	1.0	20%
G.1	Case A.1 with no stagnation	Uniform 0 to 32 yrs	1.0	5 yrs	0.50	Random Uniform	All intake at 0 yrs	1.0	1.0	0%
H.1	Boundary values of relationship dependence	Uniform 0 to 32 yrs	1.0	5 yrs	0.0	Random Uniform	All intake at 0 yrs	1.0	1.0	20%
H.2		Uniform 0 to 32 yrs	1.0	5 yrs	1.0	Random Uniform	All intake at 0 yrs	1.0	1.0	20%

<u>Cases A.1 and A.2</u> - Effect of new-hire years of experience when (1) new hires have no experience versus (2) new hires with 0 to 20 years of experience

Cases A.1 and A.2 are designed to look at one variable – the new employee intake pattern while holding all the other variables in a "neutral" mid-range status. In this, the significant difference between intake at 0 years of experience versus intake at 0 to 20 years of experience (0 to 20 provides a 10-year experience average), is that in the former, the time to reach full proficiency (the learning curve) takes its toll on performance capacity, while in the latter case, many of the new employees are already at the full proficiency level, and can therefore maintain workforce performance capacity despite the turnover. Case A.1 has one advantage, though as turnover increases – that of lower staffing costs. This is an example of where a tradeoff between performance and costs must be made by management.

Figure 23

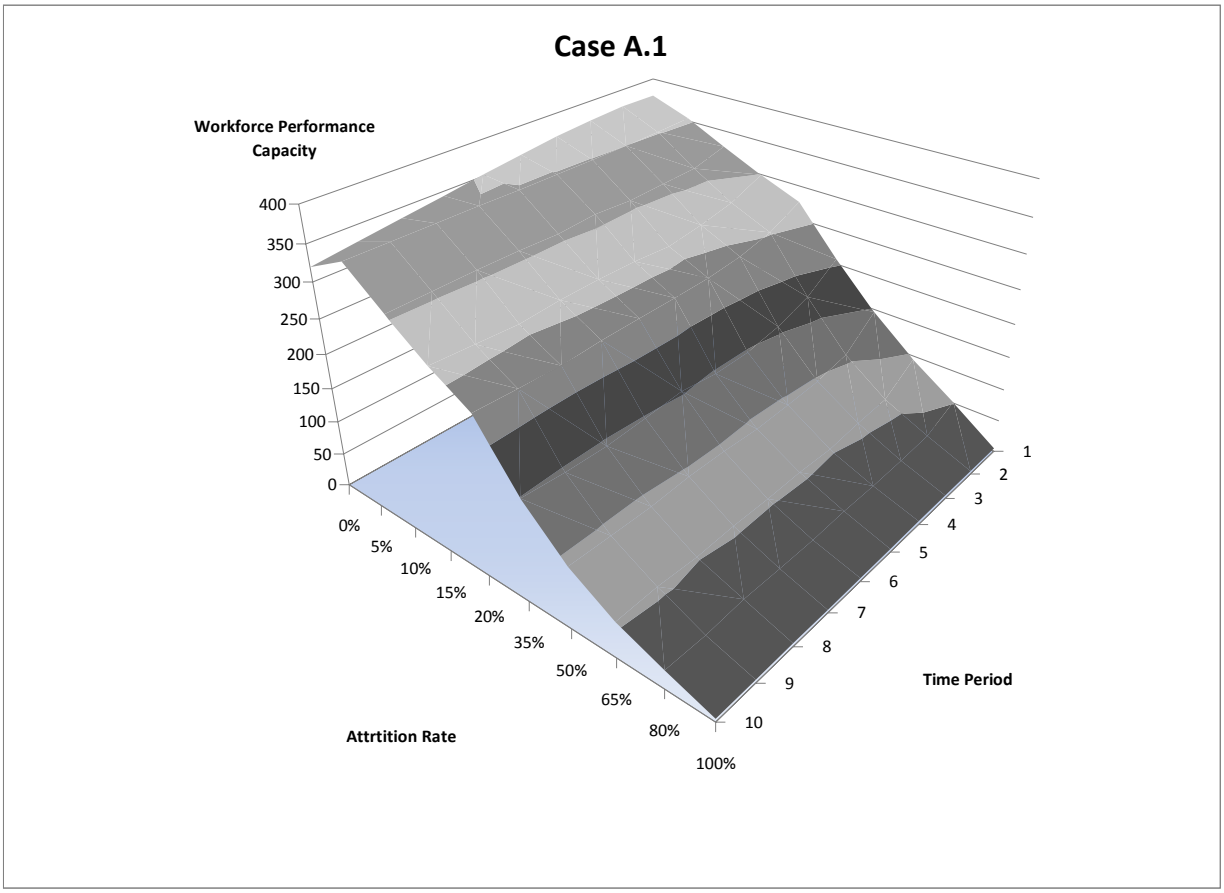


Figure 24

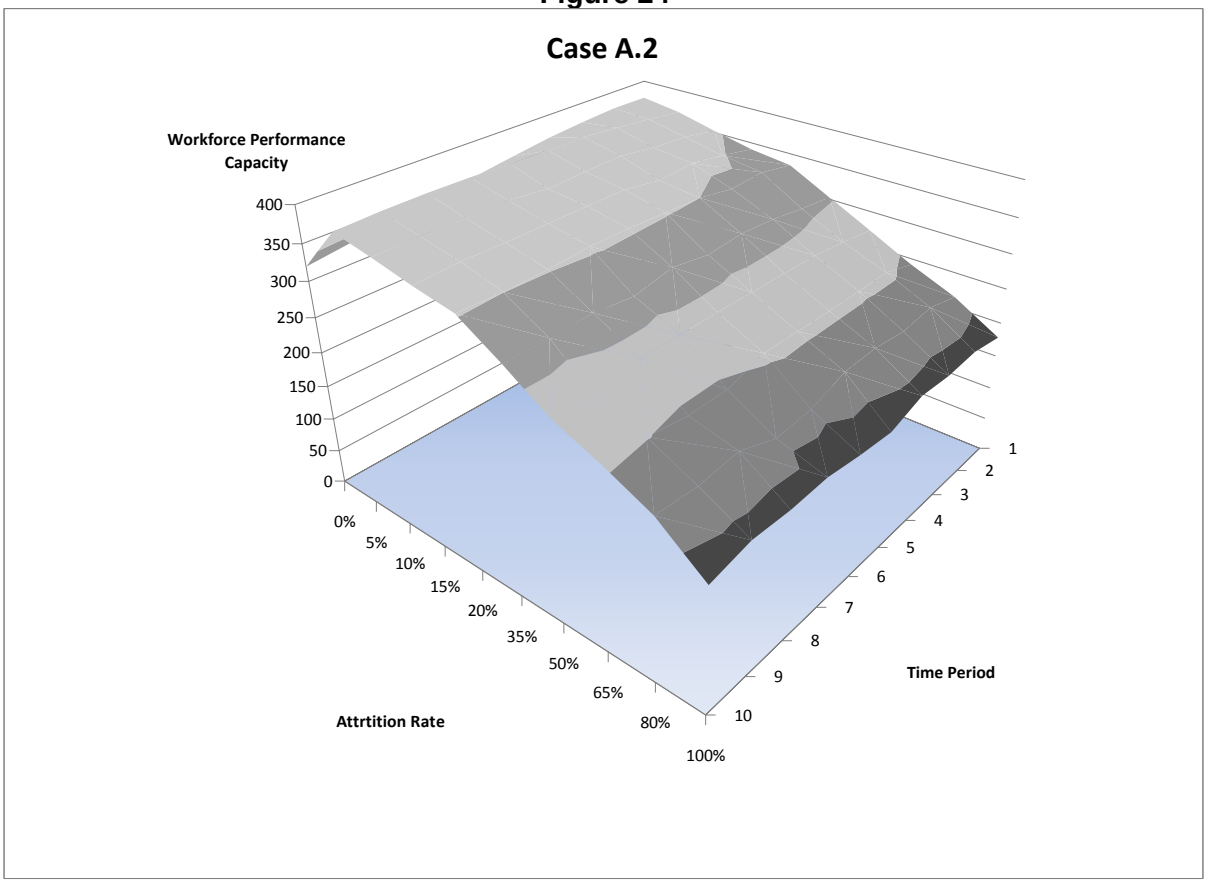


Figure 25

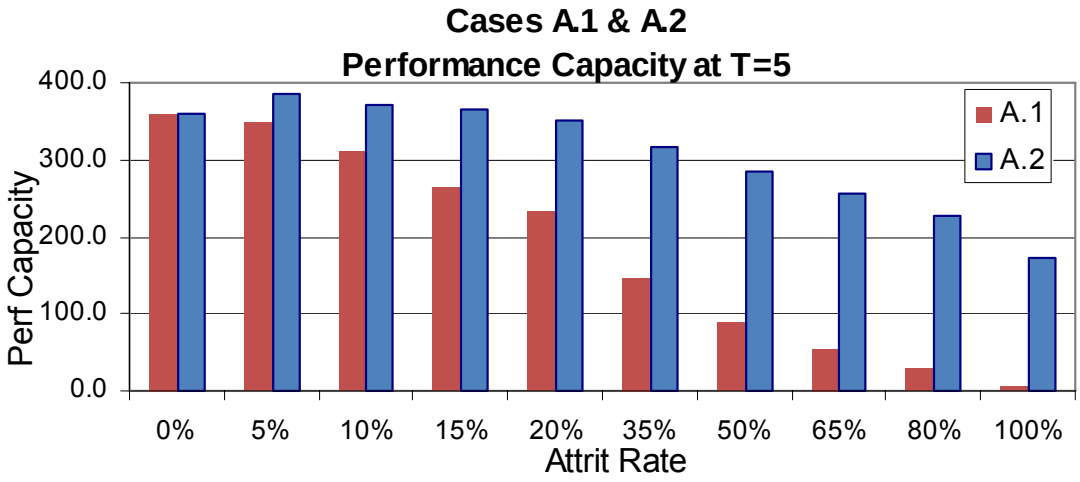
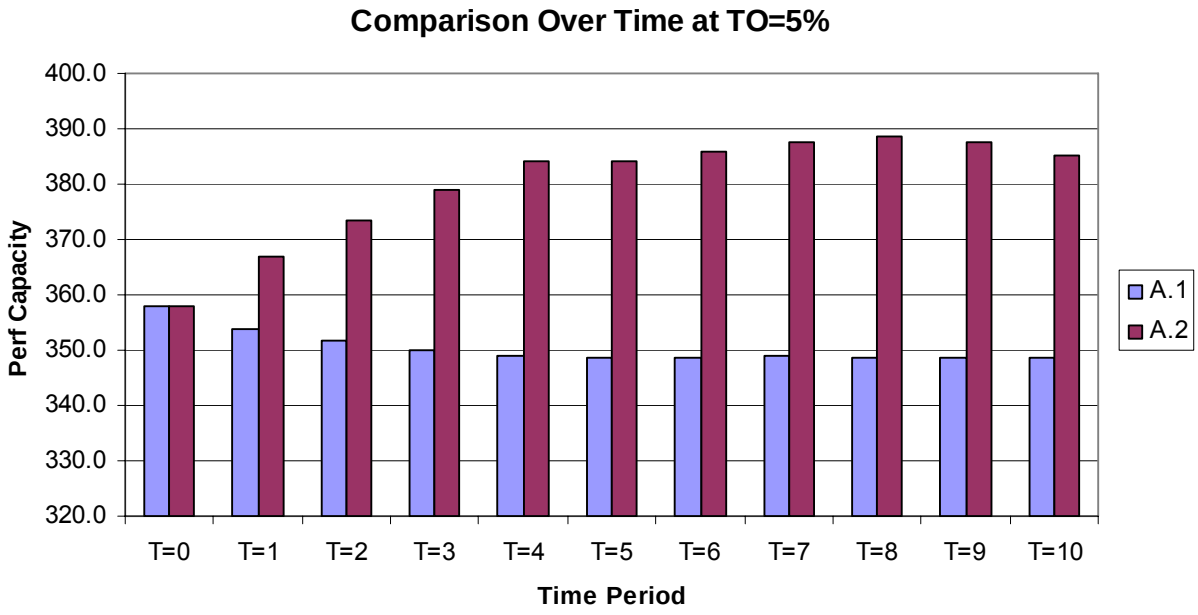
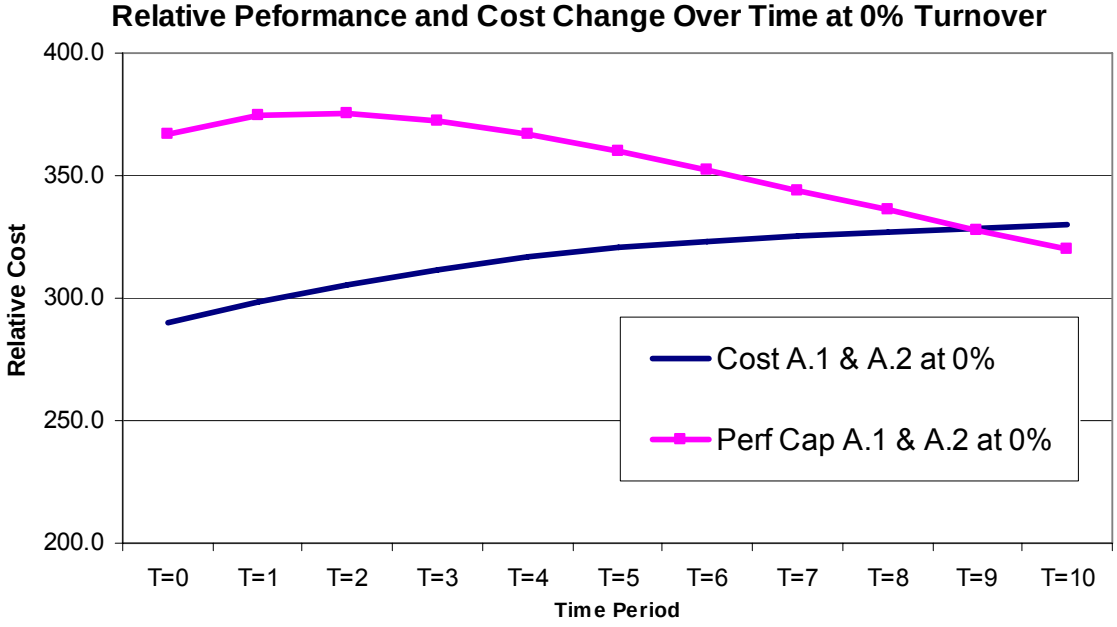


Figure 26



Cases A.1 and A.2 also demonstrate the drawback of the **no turnover** condition. At zero turnover, staffing costs rise steadily as lower tenured employees move up the salary scale, while performance capacity declines over time due to stagnation.

Figure 27



<u>Cases B.1 and B.2</u> - Replacement of below-average quality employees with above-average quality employees when (1) new hires have no experience versus (2) new hires who have 0 to 20 years of experience

Cases B.1 and B.2 parallel the work of Scullen et al. (2005) in that lower quality employees (QF = 0.9) are replaced by higher quality ones (QF = 1.1). The difference between cases B.1 and B.2 is only in the experience level of the intake, 0 years of experience versus 0 to 20. Case B.1 demonstrates what Scullen did not examine – taking into account learning curve time as a variable. Case B.2 on the other hand, does support Scullen, and also <u>demonstrates the Abelson and Baysinger curve</u>. Case B.2 brings in experienced replacements who are on average already fully proficient, thus having no learning curve time to proficiency. Like Scullen et al., it can be noted that the ability to continuously bring in *higher* quality people as opposed to *high* quality people will reach a ceiling point – the supply of ever higher quality people will reach a limit in either availability or affordability. Thus as time passes, the organization reaches a point where it is merely churning through equally high quality people, while suffering the disadvantages of the turbulence due to turnover.

Figure 28

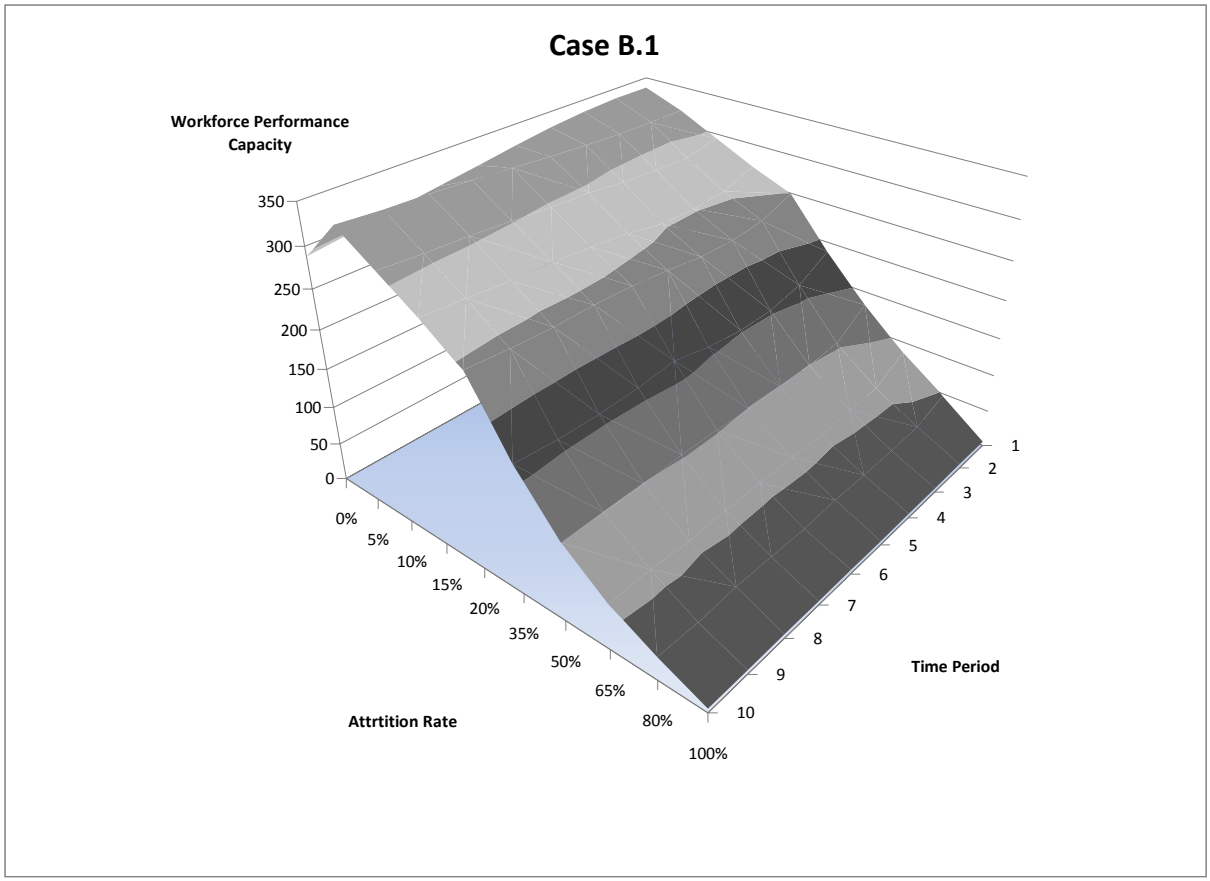


Figure 29

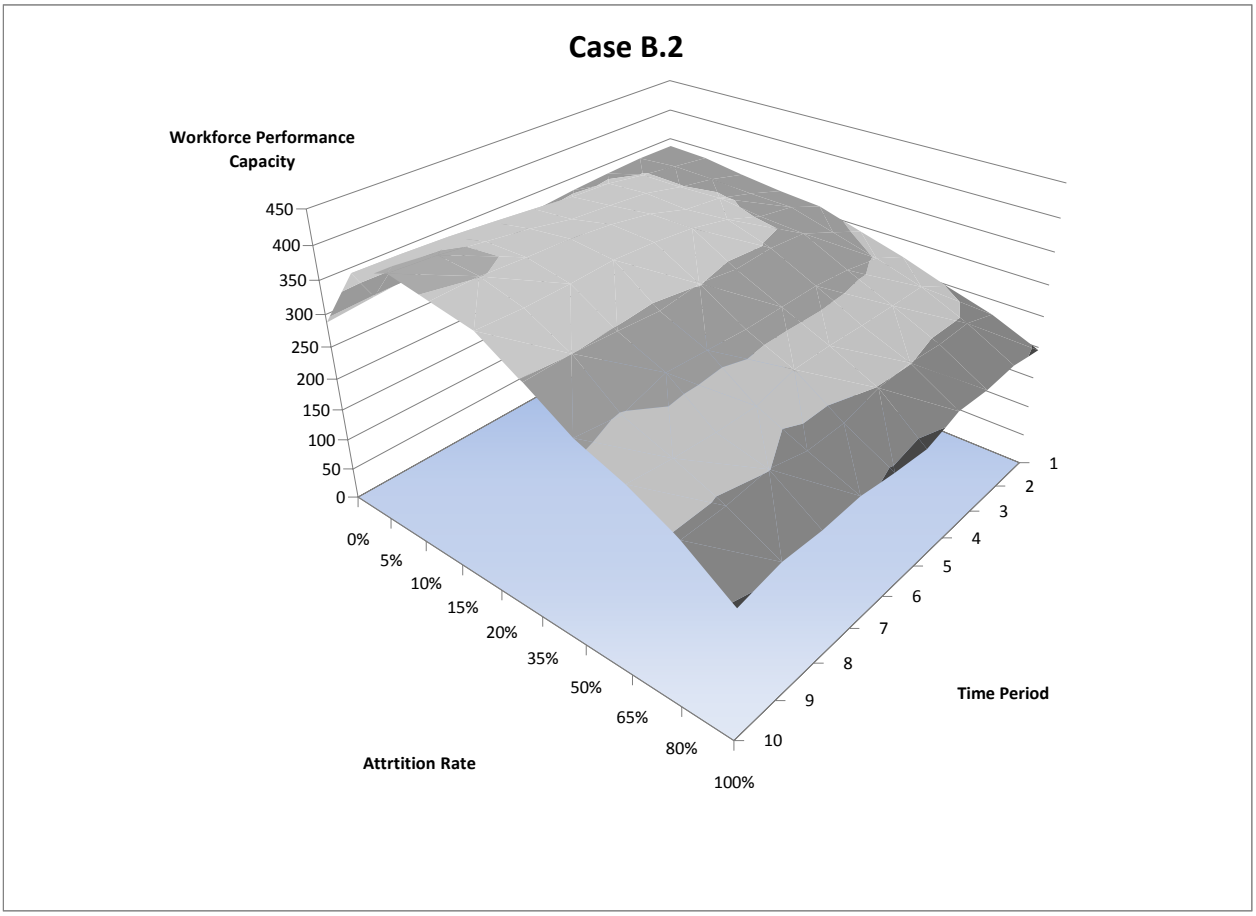

Case B.2
Workforce Performance Capacity
450
400
350
300
250
200
150
100
50
0
0%
5%
10%
15%
20%
35%
50%
65%
80%
100%
Attrtition Rate
1
2
3
4
5
6
7
8
9
10
Time Period

Figure 30

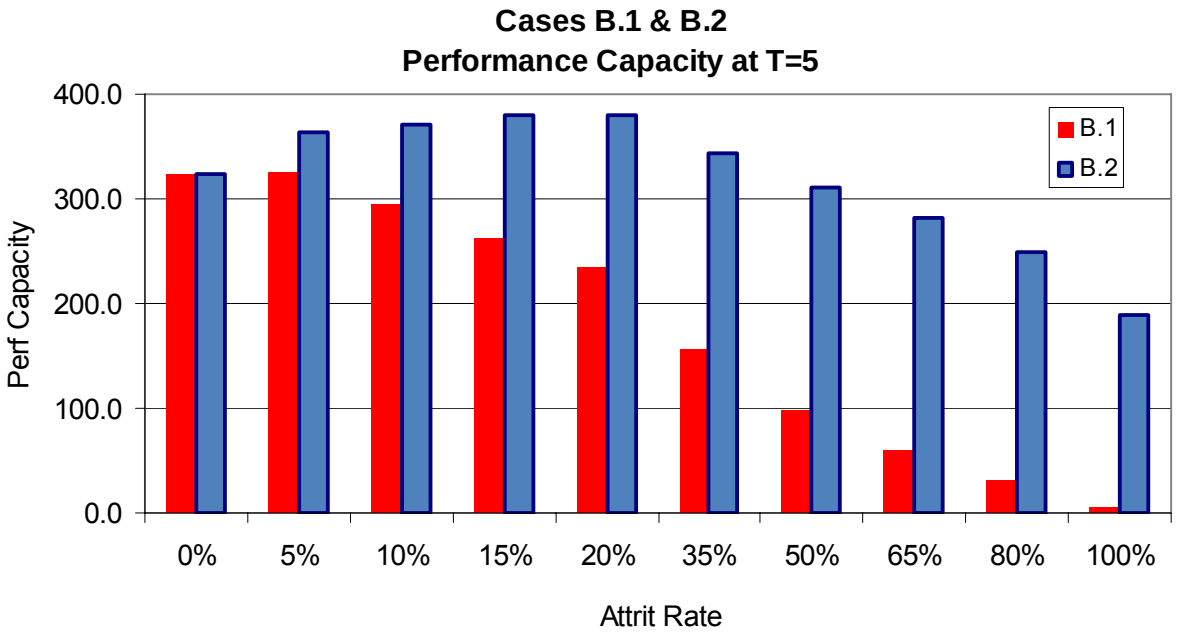
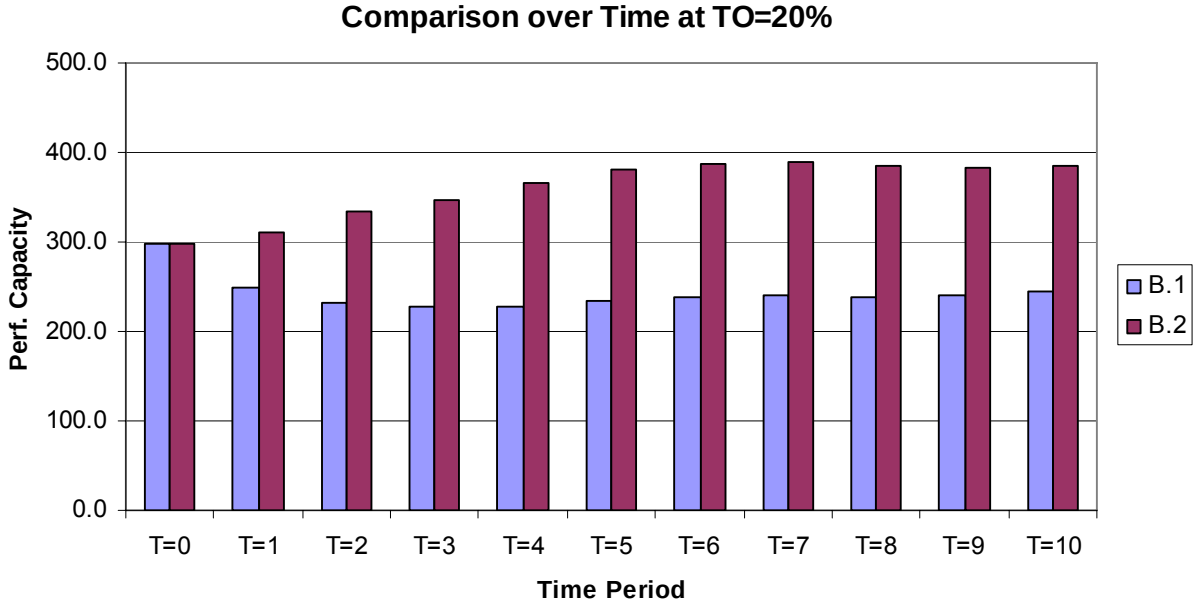


Figure 31



The following cases are presented in the Appendix:

Cases C.1 to C.4 - Testing of various scenarios:

1. Technically obsolescent employees replaced by high proficiency new junior employees
2. Professional growth where high-tenure employees have increased their expertise over time
3. A high-performance work team with mid-career, high quality employees
4. A worst-case scenario where older, low-quality employees are replaced by other low-quality employees.

Cases D.1 to D.3 - This case tests the effect of differing times to full proficiency (learning curve) on capacity

1. 1 year
2. 5 years
3. 10 years

Cases E.1 to E.3 - These cases look at the effect of the initial tenure distribution for three cases:

1. a predominantly younger workforce
2. a predominantly mid-career workforce
3. a predominantly older workforce

Cases F.1 and F.2 - These cases looked at the effect of differing hiring selectivity as reflected in the rate of early career attrition:

1. High early attrition – implying low selectivity
2. Low early attrition – implying high selectivity

Case G.1 - This looks at Case A.1 but without the stagnation factor affecting capacity.

Cases H.1 and H.2 - These two cases looked at the boundary values of the strength of employee working relationships dependence:

1. No dependence (0.0) on others
2. Total dependence (1.0) on others

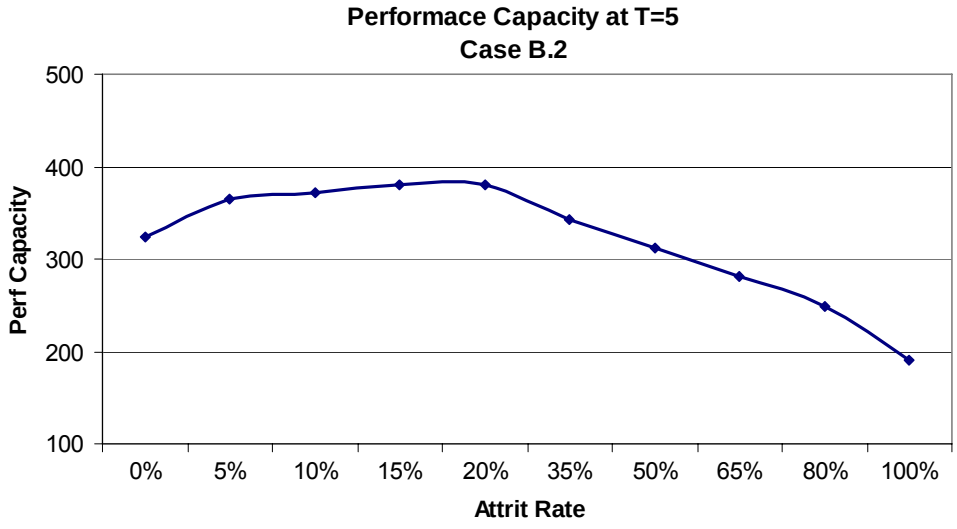
4.3 Review and Discussion of Test Results

The purpose of the evaluation phase of modeling and simulation, output analysis, is to determine whether the results generated by the simulation support the hypothesis. It is both the power and weakness of exploratory simulation that it attempts to build models of worlds or conditions that don't exist or can't be tested, thus there is little or no data to compare the output to. As a consequence, simulations of phenomena such as nuclear warfare, global warming, or even organizational experiments, must rely heavily on extrapolation, logic, and technical judgment. Nonetheless, there are some techniques that can provide greater confidence in a model. The key method is sensitivity analysis – observing the changes in outputs to changes in parameters and initial conditions. Bankes (1992) noted that for exploratory modeling, sensitivity analysis is a central goal of analysis. Rather than a full-blown multi-parametric sensitivity analysis involving thousands of variations, I have opted for a modified form of sensitivity analysis using the comparative scenarios that address various cases of interest as previously presented in Table F.

By exploring the model's behavior under these various scenarios as demonstrated in the various test cases, I was able to demonstrate that Abelson and Baysinger's (1984) inverted U-shaped curve can logically occur under "laboratory" conditions using realistic initial workforce, attrition, and accession conditions and plausible parametric values as Case B.2 (Figure 32) shows.

Figure 32

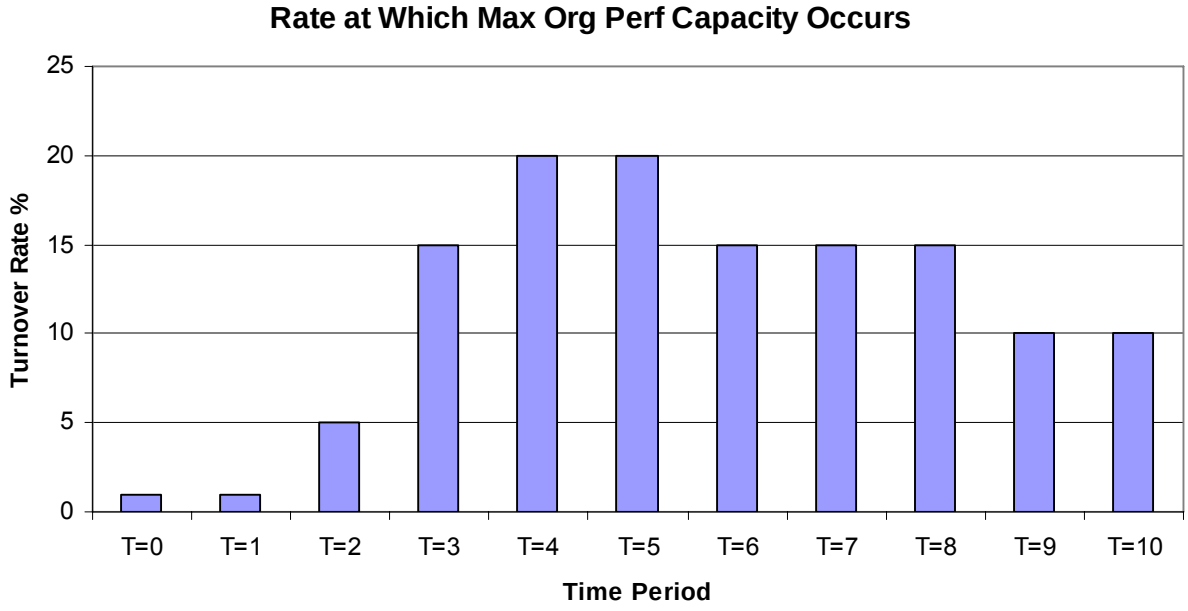
Abelson and Baysinger's Curve Demonstrated



It should also be noted that there is a non-stationary dimension to this problem, as shown in Figure 33 below which is taken from Case B.2. This results from the interaction of the attrition rate in each calculation pass from T=0 to T=10 with the non-linear distributions of workforce tenures, attrition and accession patterns, and learning curve time. The organizational system changes over time as a result of the relative differences in the shapes of these parameters and initial conditions. The high point of the inverted-U shown in Figure 32 above occurs at different rates as time progresses.

Figure 33

Optimum Rate Shift over Time



4.4 Discussion of the Model

It is important to note that this model has assumed a constant organization size over the 10-year duration, and that the attrition rates are held constant over the 10-year period. This implies that the attrition rates used are really an annual average – this does not specify what the variance from the mean might be over the course of the year. A deviation from the mean is likely over the course of a year in any organization; therefore a model with finer time periods, such as months, would need to be used to address this aspect.

A model design characteristic that should be noted is that at time T=0 and attrition rate = 0%, the model adds no value to organizational performance capacity for the quality of task and social relationships (TSR). The assumption is that whatever level exists, good or bad, is identified in the process described in Section 3.5.7.1, and that this value is not changed by the turnover process. This value can only be degraded by turnover, not enhanced. Thus, For T > 0 and attrition rate > 0, the turbulence factor reduces the aggregate total workforce performance potential.

The model assumes that the strength of working relationships values remains constant over time and regardless of attrition rate. As noted in the literature review, social relationships take time to develop. And with regard to social relationships in workgroups, the assumption of the relationship value remaining constant regardless of turnover rate and changes in individual employees who bring along various personality and demographic differences is one that deserves further study in future simulation work. If attrition rates were to significantly climb, it is likely that an organization would adapt in some way. Complex Adaptive Systems (CAS) theory suggests that organizational systems will adapt themselves to their conditions. Thus if high turnover is the norm, then the organization would likely move to decrease employee *structural* interdependency where possible. This is a testable assumption.

The model makes an assumption of linear behavior in both the Turbulence Factor and the Stagnation effect. All things being equal, the disruptions created by turnover in cohesion, communication, and coordination are in likelihood, non-linear relationships. This relationship may more likely be a knee-shaped line where a certain amount of disruption is tolerable until a breaking point is reached where the workgroup collapses. Similarly, it is more likely that the reduction in workforce performance capacity due to stagnation is nonlinear as well. The actual

shape and values of these curves must be empirically determined for each organizations as there is no base of theory that can predict this.

For employee intake (accessions), the model has assumed a simple employee quality distribution of only three levels: average (1.0), above average (1.1), and below average (0.9). A more realistic approach would be to select new employees at the desired quality levels from a representative distribution with the desired mean, enabling control of the level of hiring selectivity desired for the particular test case.

Cases H.1 and H.2 tested the boundary values for working relationships and demonstrated that there is a relatively small contribution from relationships as compared to employee proficiency levels. This may simply be a reflection of the scaling weights of proficiency relative to relationships that were used. This effect should be further investigated as there is some evidence (cf. Lakhanpal, 1993) that strong working relationships may outweigh individual human capital under conditions where teamwork is crucial, such as in software development.

Stagnation can be viewed as March (1991) does, maintaining an organizational status quo over a long period of time while the world outside changes, or as (2) Geles, Lindecker, Month, and Roche (2000), who took an internal perspective of cyclical organizational growth, decline, and renewal. As a closed system, this model has assumed a linear increase in stagnation over time, effectively an internal decline in performance capacity. For analysis purposes, the assumptions of both long-term linearity and the arbitrary degree of stagnation may be adequate as either can be varied and examined. In any case, verification of these assumptions could only be empirically determined as there is no theoretical basis for predicting either the path or degree of environmental change or organizational stasis. Stagnation and technical obsolescence are also difficult to separate in practice – these have been separated here for analytical reasons only.

Anyone familiar with real staffing systems would note that this model has assumed a zero time-to-fill vacant positions. That is, employees are replaced as soon as they attrit at the measurement points. The model is constructed on the assumption that the organization has a constant workforce size of 100 employees, thus there is no need to include vacant positions. Since this is a discrete-time model, the measurement points (T=0, 1, 2, etc.) represent only a point in time – what happens in between the measurement points is not factored in. Vacancies

are a function of the stochastic nature of attrition and the distribution of time-to-fill; a model with finer measurement points, e.g., months or weeks rather than years, could better address this aspect of organizational staffing processes. However, for the purpose of testing Abelson and Baysinger's (1984) hypothesis, the assumption of zero vacancies at each measurement point does not affect the outcome. (Including a vacancy rate would be a variation on this analysis.) Nonetheless, the workforce size would perhaps be better referred to as having 100 employees actual-on-board at the measurement points, rather than simply a workforce of 100 employees, thus leaving open the possibility that vacancies may have existed between measurement points. Further, by assuming that there is a constant workforce size and a zero time-to-fill vacancies, it is also assumed that the workforce has been matched to the workload. Thus, the model recognizes no understaffing issues and no stress due to vacancies and workload carried by other employees. A further refinement of this model could include these issues by the use of finer time steps – e.g., monthly rather than by years. Using months, of course, would multiply the number of data points by 12 – a not insignificant increase in data to analyze.

An area I have noted for future investigation is the characterization of inventory and attrition distribution patterns – these are model parameters, yet they are not typical simulation model parameters. In statistical work, parameters refer to the values determining the shape of a distribution. A system parameter as used in the modeling and simulation literature refers to a quantitative value or system setting given in arithmetic values. The closest I have come to finding a parallel are the shape parameters of statistical functions such as beta and gamma. For research purposes, it would be worthwhile if random inventory shape distributions could be specified in terms of a set of values rather than simply a picture. Statistical values such as the mean, median, mode, kurtosis, and skew are potential statistical parameters that could be used. But what is needed for comparison purposes is the ability to describe the shapes of randomly distributed sets of discrete (typically integer) values in mathematical terms.

It may also be noted that there is a noticeable discontinuity that occurs from T=0 to T=1. This is due the fact that reality exists in continuous time, while simulation models have a finite starting point, T=0. The discontinuity is due to the model adjusting itself to the selected attrition rate in each run. Therefore it is best to look at points several periods after T=0 to get a true picture of system behavior. I have generally used T = 5 in the presentation of results. For further examination of the stability of the model, I will run test cases out to T=30 as well.

This analysis has not addressed costs to any great extent; however, it is clear that staffing costs are a significant factor when looking at the overall impacts of turnover on an organization. Costs due to hiring, training, and administration are more or less proportional to the rate of turnover which organizations view negatively. On the other hand, under low turnover conditions the passage of time drives up staffing costs simply due to inevitable pay increases and overhead costs (such as health insurance and pensions) that accompany older workforces. While labor costs increase, productivity, if there is no increase in proficiency, remains the same requiring an agency to continually increase its budget simply to stay in the same place.

5.0 SUMMARY DISCUSSION

My goal in performing this research was to determine whether a logic- and theory-based cause-and-effect model and computational simulation of the employee turnover-organizational performance relationship could test a theoretical hypothesis that has never been empirically demonstrated nor fully developed conceptually. To do this, the following points had to be addressed:

- The general nature of the employee turnover-organizational performance relationship,
- The organizational mechanisms and characteristics that drive the relationship,
- Whether the type of organization studied affects the nature of the relationship,

The general nature of the employee turnover-organizational performance relationship has been covered in the literature review. As can be seen, there is a broad range of distinct theoretical streams that apply to this problem. From this literature, the organizational mechanisms and characteristics that drive the relationship have been derived. What can be said of this literature though is that it is broadly qualitative, there is relatively little in the various streams (excluding organizational economics related to costs) that can be described as quantitative material that can be applied to problems such as this one.

From the simulation literature, it was found that this problem is not a unique one – in fact it is a common problem when dealing with conditions that cannot be replicated in the real world – where only theory provides direction. The value that computational analysis brings to organization theory is that it enables a virtual experiment to be performed. Through a detailed decomposition of verbal theory, adding missing pieces where necessary, integration of the separate elements and testing their combined behavior under specified conditions, a series of "laboratory" experiments can be performed. It is the complex *interaction* of these elements over time and under varying initial conditions and parameter values that is being explored. In this, I have followed the approach taken by many others such as Cohen, March and Olson (1972), Sastry (1997), Scullen, Bergey and Aiman-Smith (2005), Harrison and Carrol (2006), Kitts (2006) and others who have utilized computational experiments to show how complex organizational problems can (*not necessarily will*) unfold over time under the specified conditions.

A fundamental concern about simulation models is whether the overall logical and computational construct reflects the organizational behaviors that it seeks to represent. Sastry (1997), in his development of a simulation model to analyze organizational change theory (a problem of similar nature to this one), used the criterion of comparing model output with descriptions of behavior from the verbal theory. This can provide confidence in the general direction of the model's behavior if there is confidence in the validity of the verbal theory. When it is the verbal theory itself that is under scrutiny, then, ultimately, logic and judgment are the only available standards by which to judge models of organizational conditions that can never be tested in reality. In the realm where only theory exists, the theory itself must be subjected to the test of logic and reason. A simulation model is no more than an analytical tool to test such theory.

This model has been created to test the logic of the Abelson and Baysinger (1984) hypothesis. The logic and nuances of the turnover-performance model as developed for this analysis must be understood in order to judge the results. Concepts such as capacity, proficiency, quality, stagnation, obsolescence, and relationships are difficult to quantify due to their intangible and dynamic nature. There is no attempt to place any of these concepts on an absolute scale for outside comparisons; rather, all are internal relative values. As Harrison and Carroll (2006) noted, where actual values do not exist, the analyst must use plausible and reasonable values. I have attempted to do this using logic and judgment. Though the specific values remain subject to empirical verification, representative numbers were selected to run the model and observe behavior. The model's purpose is to demonstrate and analyze *a concept* – the Abelson and Baysinger hypothesis, not to replicate the behavior of any one particular organization. But this is a necessary step toward achieving that desired capability.

As the test results have shown, Abelson and Baysinger's inverted U-curve can occur when employees are replaced by higher quality employees, more experienced employees, or by higher proficiency employees. Two cases in particular demonstrate where this occurs:

Case B.2 – Replacing below average quality employees with above average ones

Case C.2 – Replacing technically obsolescent employees with high proficiency ones

A fairly high rate of attrition is desired to quickly clear out the older employees and replace them with new ones. The caveat to this prescription for workforce performance is that an organization cannot indefinitely continue to increase the quality of its employees. At some point, when all employees in the organization are high quality, the likely outcome will be that of these cases:

Case C.3 – Highly professional employees who continue to develop their expertise

Case C.4 – High-performance work teams

In these two cases, it was assumed that the existing employees were the best possible ones in terms of performance capability and long-term proficiency development. Thus stagnation was not a factor. In these cases, the model showed that zero turnover was the optimum value and that any turnover at all would begin to disrupt the workforce, thereby reducing its performance capability. The curves in these cases are downward sloping from 0% to 100%.

Other cases tested were variations on initial workforce conditions, boundary values of the relationship values, length of the learning curve, and hiring selectivity. All showed variations of the same capacity decline over time and rate. The most interesting case set of this group was that of D.1,2,3 where learning curve time was set at 1 year, 5 years, and 10 years respectively. As turnover rate increases, the longer time to proficiency has a stronger impact on the workforce capacity of the organization. A longer learning curve works against capacity at the mid-range of turnover. Even at the relatively mild rate of 10% annual turnover, the model indicates a 20% drop in capacity for the 10-year learning curve versus the 1-year learning curve.

5.1 The Unifying Concept Underlying the Results

A fair question to ask at this point is what is the unifying concept or theme that ties all these test case results and observations together? Figure 34 below provides the answer. Let us compare two workgroups among a number of similar workgroups in a department, e.g., two engineering teams or two contract specialist teams, and say that one is the best performing group and the other the lowest performing. What would the effect of turnover be on these two groups? If the best performing group already has the best available workers either in the department or in the overall labor market, how would losing any of them and replacing them with new people improve the group? The answer is it wouldn't. The optimum turnover rate for this group is zero and any turnover would be detrimental to its performance capacity, thus as the turnover rate moves away from zero, the performance capacity line would be downward sloping. If there is no turnover, then what about stagnation? Stagnation is a potential outcome of long-term group stability as the literature has shown, however, if this is a high performing group there would be a number of counters that could be taken. These include ensuring adequate internal mobility so that workgroup members continuously have the opportunity to learn new skills and gain experience in different positions, ensuring that workgroup members have the opportunity for challenging training and development, and that leadership creates an environment where

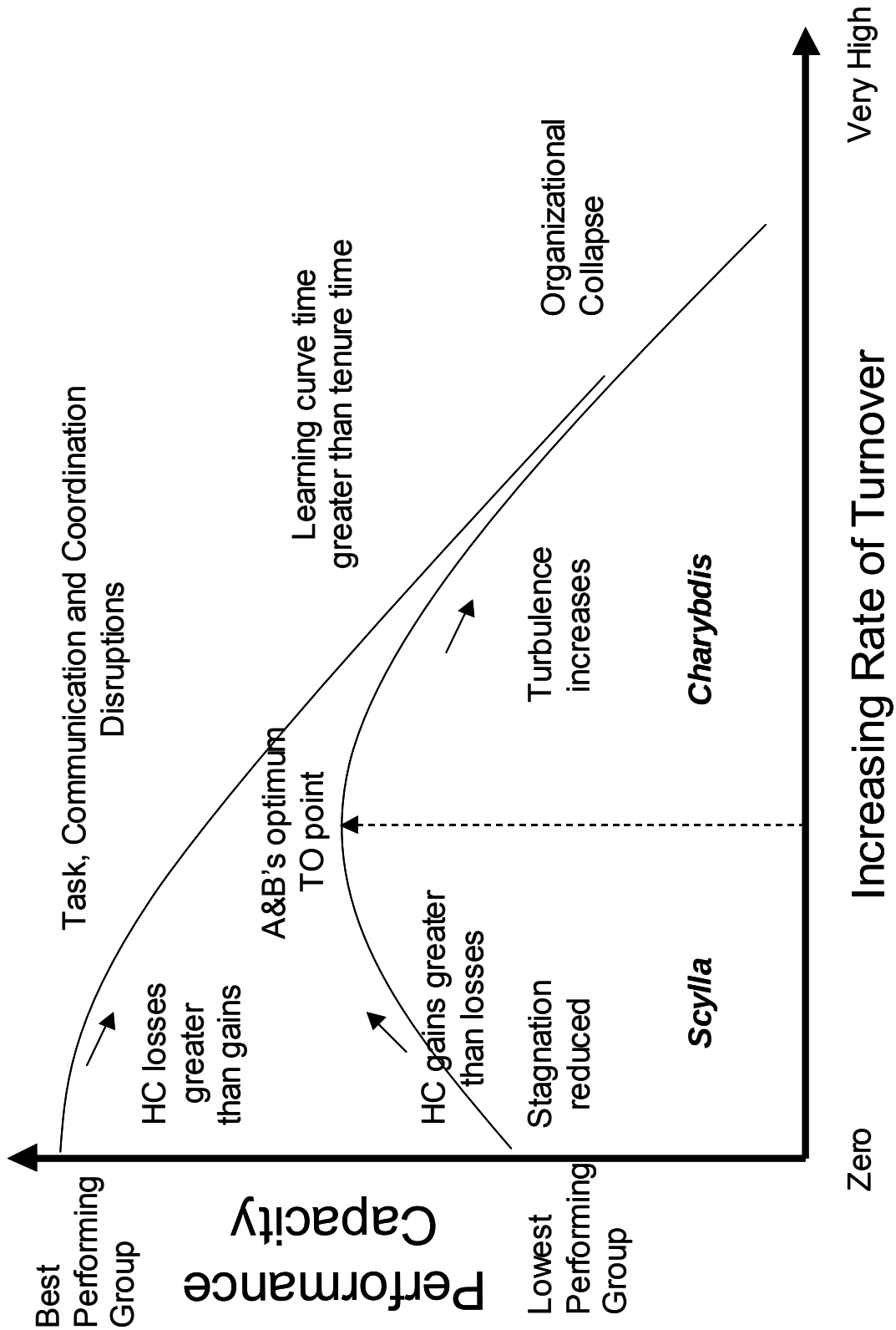
group norms demand the highest level of performance. By contrast, the lowest performing group can benefit from both an infusion of new talent and by breaking up the group norm of low performance expectations. This group would be moving uphill on the performance-turnover line until it reached the point where the benefit of bringing in new talent would be countered by the disruptions created by turnover. This is the optimum point described by Abelson and Baysinger (1984) and the clear path between the Scylla and the Charybdis of Mosher and Kingsley (1936).

It may be noted that one dimension does not appear on this diagram – that of time. When the optimum point occurs depends in part on the rate of turnover – the faster the turnover, the faster the lower quality employees will be moved out and replaced with higher quality employees, and depends on other factors such as the initial workforce inventory distribution and the pattern of attrition. Thus a number of factors contribute to the movement of the optimum rate over time.

Lastly, the downhill slopes of the curves for both the best performing and the lowest performing groups are seen to be similar. The effects of task, communication, and coordination disruptions are the same. As the turnover rate becomes increasingly greater, workgroup members come and depart before they can move up the learning curve to reach full proficiency, thus the groups become increasingly populated with less than proficient members. As the rate becomes even greater, the performance capacity of the individuals reaches the point where the groups can no longer even function and organizational collapse is reached. Rather than a smooth continuous line to zero, the likely shape would be a break in the line (a knee point) heading straight down to zero.

Figure 34

Unifying Concept Underlying the Model's Outcomes



5.2 Significance for Research

Paul Meehl (1990) expressed his concern with the state of theory development and theory testing in the psychology field by noting the difference between “strong theory” and “weak theory.” Strong theory enables generation of numerical predictions that can be subjected to tests of falsification. Weak theory can, at best, only predict direction or trend correlation. By this criterion, it is clear that the theory of employee turnover and its organizational impacts lies in the weak theory category. The turnover literature provides numerous examples of correlations that have been made between human capital, social capital, cohesion, coordination, and other related concepts, but none can provide a point prediction for any specific application. Given the limitations of the correlational research method discussed in Section 3.3, Testing the Hypothesis, simulation is an attractive alternative for organization theory development that can lead to testable predictions (Harrison, Lin, Carroll, & Carley, 2007).

As Harrison and Carroll (2006) noted regarding their modeling and simulation work in the area of culture and demography in organizations: “Whether or not the formalization (i.e., the model development) is correct in some sense, at least it promotes scientific advancement by forcing cloudy areas to be addressed, resulting in a clear specification (of theory) that can be subjected to analysis, testing and subsequent refinement.”

This analysis has introduced a number of concepts related to organizational turbulence, stagnation, relationships, and workforce performance capacity that can provide the basis for a future research program that includes both simulation and empirical testing. A key element of this research program should be the development of causal paths, or as Meehl (1990) called them, derivation chains, from premise to prediction similar to the conceptual model developed for this analysis. A logically tight path from cause to effect will help identify where the weak points are in extant theory and support development of specific tests.

A specific area of concern that this analysis has demonstrated the need for further empirical research in is organizational stagnation, particularly how to measure it and at what pace it evolves over time. Stagnation is a slow moving phenomenon and the marginal declination of just a small percentage a year adds up over the years as the model shows. Is stagnation a self-reinforcing phenomenon – i.e., as success breeds success, does stagnation breed more stagnation? Does it spread through social and task networks in the same manner that cultural

characteristics evolve? Can stagnation be viewed as an enculturation process? These are questions that are typically qualitatively addressed but not quantified.

Another specific area where this simulation model could be improved is in greater fidelity to reality. This analysis worked at the departmental level treating a large number of employees as one aggregate group. A research perspective that used a group-of-groups approach would be more useful for analyzing specific organizations by enabling finer distinctions in turbulence effects and stagnation levels. For example, in areas such as organizational learning, there are distinct differences between patterns of individual learning and group and organizational level learning, Argote (1993). It is recognized that there is a tradeoff between the ease of aggregate treatment of employee characteristics versus the effort needed to gather individual-level data. However, I believe that a methodology that incorporated better identification and comparison of workgroup characteristics and relationships among functional groups within a federal department rather than simply averaging the aggregate would be a fruitful area for research, and be particularly useful for practitioners.

It should be noted, and perhaps emphasized, that this analysis relied on “synthetic” employee data, that is, data that is created to represent real data, albeit in this case limited to tenure data alone. By adjusting synthetic data in ways that match representative sets of real data, a simulation can get much closer to a broader range of reality than can actual field data that is limited to relatively small samples. (A simulation such as mine could grow to include tens or even hundreds of thousands of employees.) I believe this aspect of organizational simulation has not yet been adequately explored. Using statistical comparison, test sets of virtual employees could be created to simulate real organizational populations. The counter argument is that we do not know enough about employee behavior to simulate how such virtual employees should act, which brings us back to the statement regarding the weak theory state of existing organizational theory. For public administration, I believe this is a particular weakness with regard to human resource policy development.

The structure of this type of model offers opportunity, for example, for examining the impact of organizational diversity as individual (i.e., synthetic) employees can be assigned characteristics of interest (age, race, gender, etc.). Changing demographic balances over time in simulation can allow examination of how an organization can evolve over time. In addition, this model structure allows for the incorporation of hierarchy and certain aspects of

organizational culture such as who gets hired, promoted, or fired based on the characteristics of interest. With regard to changing demographics, we know that the future workforce of public organizations will be different than those we know today due to the changing demographics of the American labor pool. This model structure would allow examining how varying the intake of new employees will change the demographic balance of these organizations and used to examine the impacts of various scenarios of demographic interaction on demographically diverse employees.

Lastly, a more advanced stage of analysis would be to incorporate uncertainty in attrition rates, relationships, turbulence, and stagnation values. The question to be addressed then would be: can an optimum turnover rate be identified in the face of uncertainty? The presence of uncertainty is closer to reality than the deterministic approach used thus far.

5.3 Significance for Management

Of what value is this work for management? Can this analysis answer the question raised at the outset of this research: what is the optimum level of turnover that a manager should strive for? Can these research results provide any guidance to human resources management in public organizations?

Annual turnover rates are often used as a measure of organizational health or for comparison purposes with other organizations. The results of this analysis should make it clear that broad statements about organizational turnover rates are essentially meaningless. Further, an organization's optimum can change from year to year. A single, overall organizational rate can be very misleading and hide the complexities and significance of the flows that underlie the aggregate number The aggregate number alone does not tell whether it is the better employees leaving or the junior employees or the mid-career or the senior employees. An aggregate rate hides significant information for managers such as demographic issues and potential adverse impacts, quality of departing employees, level of internal mobility, and differences by department, location, or specific managers.

Management needs to understand the factors that influence the impact that turnover will have on their organization. These factors include the length of the learning curve, their current workforce tenure distribution and attrition patterns, the dependence on working relationships, their hiring selectivity practices, and staffing cost structure. They also must put this

understanding into the context of organizational needs such as knowledge retention versus the new skill requirements.

This model presents two interesting observations for management: the first is the difference between the short-term perspective and the long-tern. While management may view as little turnover as possible as the ideal, as it minimizes their short-term costs, the long-run impact may not be so favorable. In the real world, to have little to no turnover over a long period of time without incurring stagnation would certainly require a significant investment in effort and resources. The two cases where a high quality workforce was in place (C.3 and C.4) were the only ones where zero turnover was actually a desirable long-term state. The corollary to having such as workforce, however, is the need for a high level of investment in the workforce. A tradeoff clearly presents itself here to management – would an investment in the workforce justify the potential gains, or conversely, is the lack of investment and reduced output an acceptable cost for the level of organizational performance expected. Glance, Hogg, and Huberman (1994) performed a simulation of this tradeoff in an industrial context and asked these same questions. An explicit discussion of this tradeoff would be desirable for public organization management.

The second observation is that strong working relationships are normally assumed to be important for a high-performing organization. The model indicates that high interdependency make an organization more vulnerable to employee turnover. As Cases C.3 and C.4 show, minimizing turnover should be the goal in high performing organizations, thus high interdependency is an acceptable risk where there is little likelihood of significant turnover. Organizations that have high turnover should adopt a turnover mitigation strategy and move to reduce *structural* interdependency among workers. However, in a loosely structured organizational environment, where working relationships are not well defined as the problem, environment, constraints, and resources are constantly changing, building relationships is a key way to get things done. This is why building relationships in a bureaucracy is so important. The structural relationships are not so well defined, therefore it is the *social* relationships that must be relied upon to achieve adequate communication and coordination.

As an abstract conceptual model, there is recognition that the real world is much more complicated from a manager's perspective. For example, the model indicates that higher quality employees are a path to greater workforce performance. Scullen, Bergey and Aiman-Smith's

(2005) work, for example, included the variable of degree of selection validity and reliability. Carlson, Connerley, and Mecham (2002) discussed the importance and complexities of effective recruitment procedures. De Corte and Lievens (2007) noted the potential conflict in the competing goals of personnel selection for quality and adverse impact.

This analysis' results confirms what I believe managers already know – that turnover in high performing workgroups should be minimized to maintain the investment in good people and working relationships. The analysis also confirms what I believe managers know about poorly performing workgroups, that some or even a lot of turnover is desirable. But for the majority of employees – the large mass in the middle – what the right rate of turnover is to maximize performance and keep personnel costs within budget must still be determined on a case basis. This model provides a path to develop the answer.

A long-standing challenge for workforce management analysts has been the prediction of attrition rates. While turnover rates are easy to specify in research models such as this, in practice the stochastic nature of year-to-year attrition data before a trend is clear presents a challenge for practitioner analysts. In addition, the non-stationary nature of the optimum rate from year to year as Case B.2 showed adds to the challenge. This model helps to ameliorate that problem by looking at the *impact* on the organization of varying rates and patterns. Figure 35 presents a potential solution by suggesting that management seek only to remain in an acceptable zone, rather than seek an optimum. If the current trend is moving toward a level that will cause unacceptable performance reduction or cost impacts, then management action can be taken to keep flows within the desirable range.

What distinguishes this model from that of Abelson and Baysinger's (1984) is that it provides a causal logic (cause and effect) path that can be used to guide management actions. Management can use this model to address both actions that can be taken to control attrition and actions to mitigate the impacts of attrition on the organization. These actions are depicted in Figure 36 below in relation to the elements of the model. As can be seen, there are a large number of potential attrition reduction and attrition mitigation actions that can be taken by management. Giving credit to Abelson and Baysinger, management does face a tradeoff between the costs and benefits of turnover; for public organizations, the public values of justice, safety, security, and equity must be factored into the balance.

Lastly, the value of this model for management is that it brings together many disparate organizational characteristics and staffing policies. Employee turnover at the macro level, in and of itself, is of no significance to the organization beyond the impact it has on the organization's performance capacity and operating costs. This model demonstrates a number of aspects of the employee turnover-organizational performance relationship that must be addressed by management if it is to manage effectively. Martin and Bartol (1985) described this as "managing turnover strategically" rather than reactively so as to maximize performance capacity and control costs.

Figure 35
Seeking to Remain within an Acceptable Range of Employee Turnover
May be the Most Practical Approach for Management

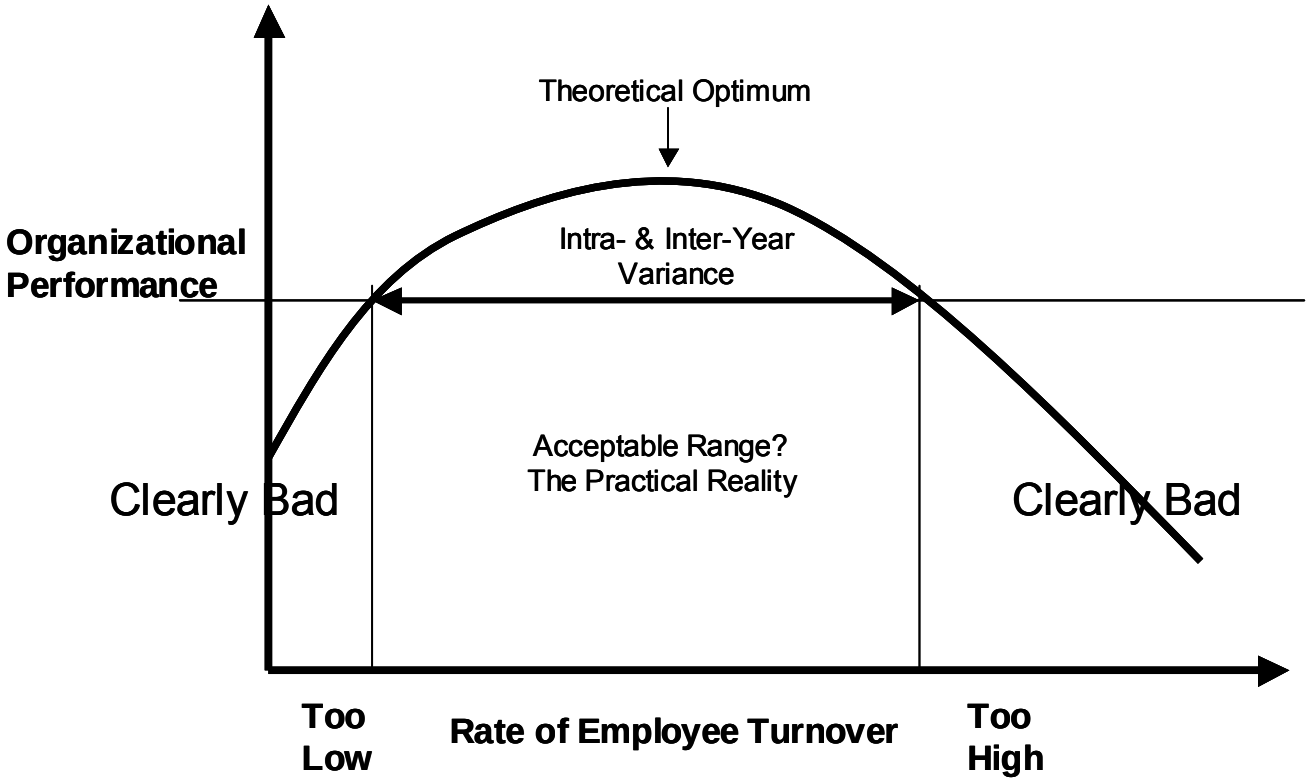
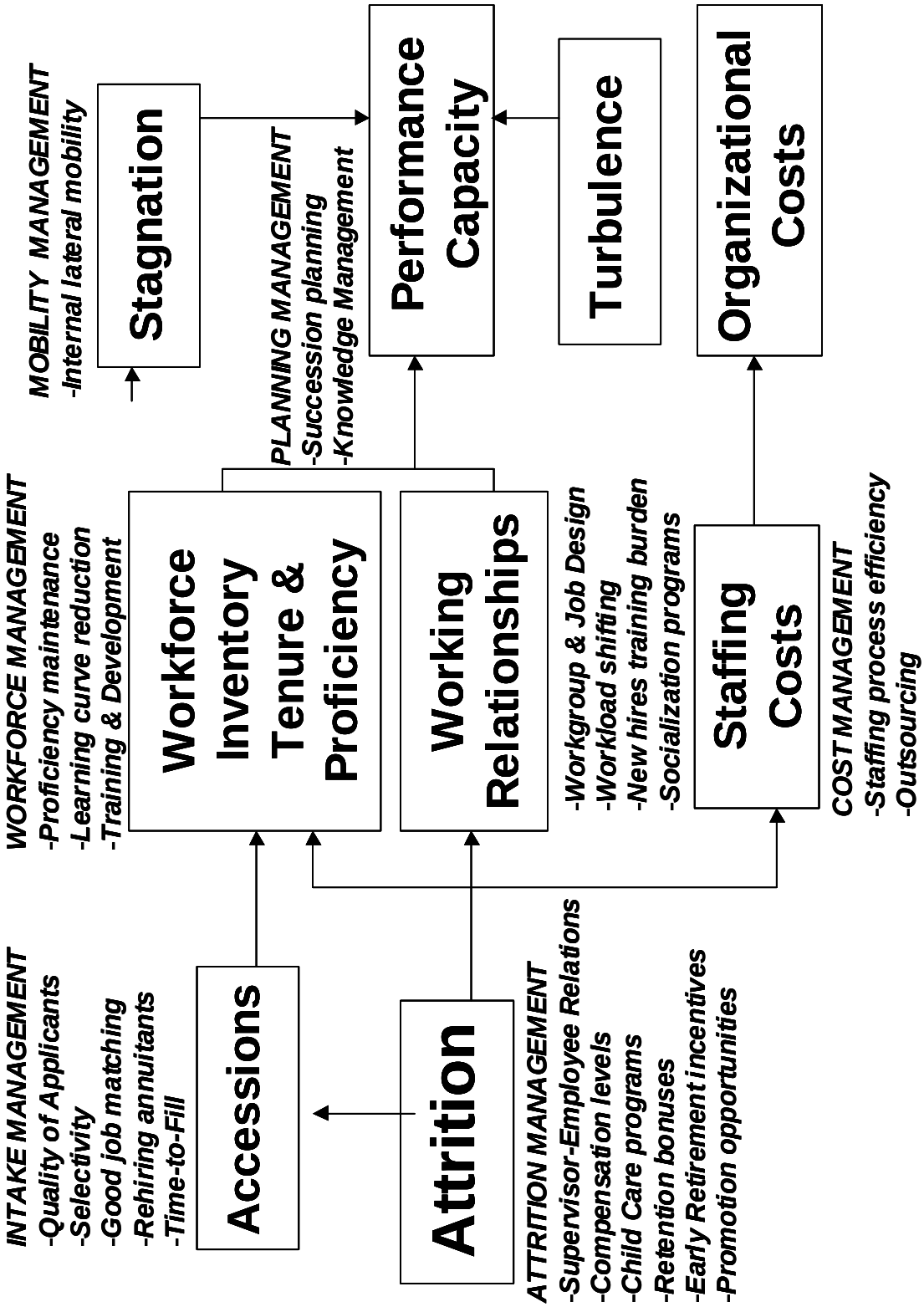


Figure 36

Potential Management Actions to Manage Attrition and Mitigate Its Impacts



5.4 Conclusion

From empirical observation and the research literature, it is seen that employee turnover has both negative impacts and positive benefits. Either too little turnover (stagnation) or too much turnover (turbulence) can be bad for an organization; therefore there must be some point in between where there is an optimum level of flow for an organization. Abelson and Baysinger (1984) presented a hypothesis that such a point could be found based on a large number of factors that they identified. My simulation results indicate that Abelson and Baysinger's inverted U-shaped curve can be demonstrated, but only under certain conditions, the primary one being that of replacing existing employees with better employees if possible. However, Abelson & Baysinger, by neglecting a number of considerations such as workforce tenure and quality distributions, length of the learning curve relative to average employee tenure, technical obsolescence considerations, the shape of attrition patterns, different hiring approaches, and particularly the role of time, they appeared to present a position that an optimum could be found as a simple pattern of turnover variation versus performance.

The employee turnover-organizational performance relationship is a complex one that involves numerous factors as discussed in the literature review. By including a multiplicity of imprecise factors, Abelson and Baysinger (1984) made empirical verification of their model and hypothesis extremely difficult which lead me to simulation as the alternative analysis tool. This work, I believe, has demonstrated the value that simulation can bring to organization theory analysis.

My work is unique, I believe, in working at the department level – that is, below the macro level of entire agencies as studied in public administration, but above the level of small group research. I have introduced a number of new concepts in order to adapt verbal theory to mathematical expression. These are an organizational stagnation factor, a turbulence factor due to turnover, and workforce performance capacity. The value to research comes from providing a framework of concepts, relationships, and parametric values that can be empirically tested. Its value for management lies in the conceptual framework it provides for logical actions that can be taken to control turnover and/or mitigate turnover's impact on the organization.

This research has taken the perspective of a government manager in large public agencies responsible for an entire functional group such as engineers, technicians, or attorneys. It provides, I believe, a framework for logical management of attrition control and mitigation

actions. While it does not provide a specific optimum point that a manager should strive for, it does provide direction and a framework for action. Given the uncertainty inherent in strategic workforce management and the non-stationary nature of the optimum demonstrated in this model, perhaps the best answer that could be provided by the research community is to identify a zone of acceptable attrition for typical public agencies given existing workforce characteristics and organizational goals.

For management (analysts), this research work can provide a tool for studying the effects of organizational policies on the flow of human resources, and the impact on organizational capacity as a result of those policies. This model is, in essence, a comparative tool, rather than one that provides absolute answers.

For researchers, this work has demonstrated the need for more longitudinal, quantitative studies of organizational stasis over long periods and the need to be able to quantify and measure organizational characteristics such as stagnation and turbulence.

Addendum

Analysis of Meier and Hicklin (2007), Employee Turnover and Organizational Performance: Testing a Hypothesis from Classical Public Administration, pre-press published in JPART Advance Access, October 2007

The purpose of this addendum is to demonstrate how my model can be applied to the analysis of empirical work.

Overview of MHs empirical analysis.

Meier and Hicklin (MH) cite early public administration literature (Mosher & Kingsley, 1936; Stahl, 1962)[22] that addressed the topic of employee turnover and how it affected agency performance. These early authors viewed too little turnover as leading to agency stagnation and too much turnover as creating instability and loss of expertise. These authors wrote that turnover would ideally be sufficiently large to prevent stagnation but sufficiently small to achieve and maintain healthy working conditions. While no single rate of turnover could be prescribed as best for all agencies, it behooved management to find this point. As Mosher and Kingsley put it: "*The task of management, then, is to avoid the Scylla of a stagnant service while steering clear of the Charybdis of inordinate instability.*" While no formula was provided to find this ideal point, the authors did suggest using the turnover rate as a benchmark measure of organizational health for comparison against other similarly situated agencies.

MH go on to cite many of the same references I do and build their argument on Abelson and Baysinger's (1984) inverted U-shaped curve proposition – that there is an optimum aggregate rate of employee turnover relative to organizational performance. However, their unique take on this relationship is their claim that task complexity mediates the shape of the curve. They use data from Texas public school districts to examine the relationship between teacher turnover and student test performance. In this analysis, they use two measures of performance – state standardized tests (low

[22] It is interesting that I never ran across these references in the private sector management literature, perhaps because these were textbooks that were general PA texts. One needed to be familiar with these texts, already several decades old, to know that this discussion was contained there.

difficulty) and college-ready criteria (high difficulty). By inference, a low difficulty task requires less skill and a higher difficulty task requires more skill. Organizational performance of the higher skilled task benefits from eliminating stagnation, while the lower skilled task is not affected by stagnation.

As they describe it: "The aim of this article is to demonstrate that differentiating levels of task difficulty reveals the underlying curve. Empirically assessing whether relationships are linear or not (i.e., the inverted-U curve) can be determined by merely including both turnover and the squared value of turnover in the same equation along with various control variables." They believe they can "suggest a modification of the Abelson & Baysinger theory. This modification is based on recognizing task difficulty as the major contingency for the precise form and location of the curve." Based on this assumption, they present two hypotheses:

> H1. *At low levels of task difficulty, the relationship between organizational turnover and firm performance will be linear and negative.*
>
> H2. *At high levels of task difficulty, the relationship between organizational turnover and firm performance has an inverted U-shape.*

Based on their data analysis, they conclude that both their hypotheses are supported. In the case of H2, their data shows the optimal annual turnover rate is 16.2%.

This analysis provides an interesting opportunity to test my model. There are a number of similarities. In the same manner as my model, their analysis is based on total attrition from all causes, not distinguishing between voluntary and involuntary. They have also addressed a white collar, professional occupation in the public organization context. However, I will address the issues that I believe MH have missed in their work.

MH provide little definition of the term "task difficulty" with regard to what this entails for teacher requirements. I interpret this to be the level of teacher proficiency required to perform the task. Attainment of task performance proficiency entails a time to reach full proficiency, a learning curve, no matter whether it is an extremely short one of only a few minutes or an extremely long one measured in years. Based on my discussion with a teacher acquaintance, I

will use a time-to-full proficiency of 2 years for the low difficulty teaching task, and a time-to-full proficiency of 6 years for the high difficulty teaching task.

No conditions are specified for the hypotheses; therefore I must make some assumptions. MH state that it is only in high difficulty tasks where "the skill levels and creativity of employees become more crucial" thus the benefit of an inflow of new people in reducing stagnation. But by their line of reasoning, this also implies that stagnation is not a problem in low difficulty, routine tasks where "new ideas" by employees are not so important. Therefore, I will assume 0% stagnation factor over time for the low difficulty task, and 40% stagnation factor over 10 years for the high difficulty tasks. In my standard model, I have assumed stagnation to occur at under 5% annual turnover. To more closely replicate MH's presentation, I will assume that stagnation can occur at up to 15% turnover.

Reduction in proficiency is an indication of stagnation. They have not addressed whether long tenure teachers are less proficient than new hires. If this were the case, then their replacement should increase student test performance. Otherwise replacing fully proficient teachers with new ones should not increase student test performance. But this is not specified in their analysis. They have not specified the attrition pattern; therefore I will use a typical civil service attrition pattern – some early in the career, stability in mid to late career, and rapid attrition at 30+ years.

MH say nothing about the quality of the teachers leaving or those arriving, therefore I will assume that both are the same. Nor have they addressed the level of hiring selectivity – is there high early attrition or low attrition. They noted that some school systems in their database have a turnover rate of only 2% while others have a high of over 30%. It is undefined as to whether 2% implies high stagnation and lack of alternative opportunities or high selectivity and good working conditions; or whether 30% implies low selectivity and poor working conditions or whether there is simply a high percentage of retirement age teachers who are leaving.

A key variable in my model is the importance of task and social relationships (TSR). I will assume a TSR value of 0.2 because teachers are not so dependent on other teachers to accomplish their work, that is, they accomplish their teaching task relatively independently of

other teachers. So attrition of a teacher in one classroom should not affect the performance of other teachers in the school to any large extent.

The following table summarizes the parameters needed to run my model compared to what MH have provided.

Table I
Parameters Comparison

Model Parameter	MH Specification	My Assumptions
Workforce Initial Tenure Distribution	None	Random uniform
Workforce Initial Quality Level	None	Average (1.0)
Workforce Proficiency	None	Constant over time once full proficiency is reached.
Avg. Time to Proficiency (Learning Curve)	None	Two years for simple task Six years for complex task
Attrition Pattern by Tenure	None	Civil Service pattern – 30 years to retirement
Attrition Pattern by Quality Level	None	Average (1.0)
Accessions by Candidate Years of Experience	None	Assumed entry at zero years of experience
Accessions by Candidate Proficiency Level	None	Minimal at entry
Accessions by Candidate Quality Level	None	Average (1.0)
Task-Social Relationships (TSR) Importance Value	None	TSR = 0.2. Teachers work independently of other teachers.
Stagnation and Capacity Degradation	None	Low difficulty task: 0% stagnation High difficulty task: 40% stagnation
Turbulence and Capacity Degradation	None	Linear from 0% to 100%

The following test cases were run to examine MH's hypotheses:

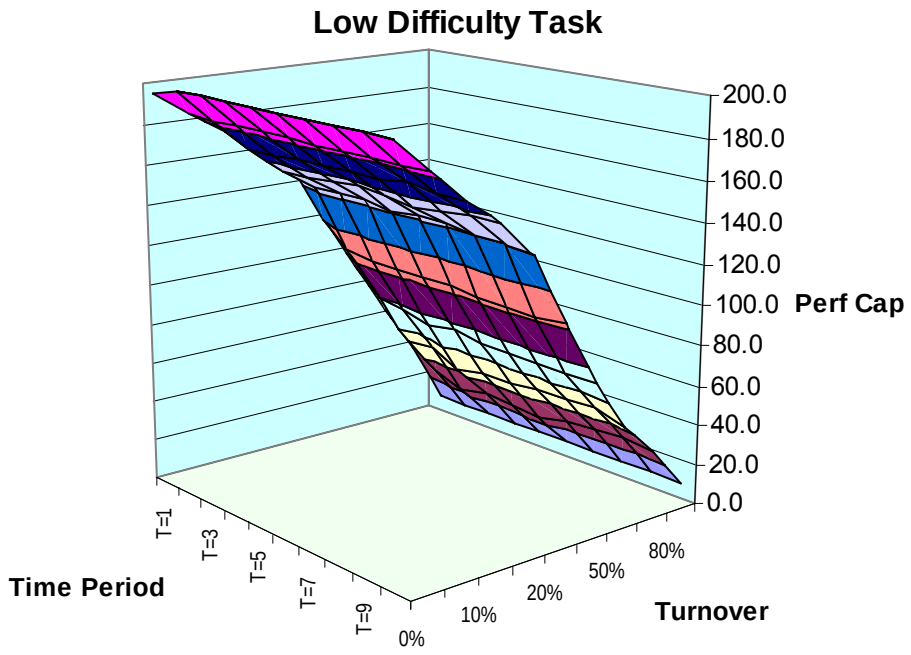
Table J
Test Cases

Case	Variation	Workforce Initial Tenure Distribution	Employees' Initial Quality Level	Time to Full Proficiency (Learning Curve)	Task and Social Relationships Importance	Attrition Pattern	Accession Pattern	Attrition Quality	Accession Quality	Stagnation %
MH 1	Low difficulty	Uniform 0 to 32 yrs	1.0	2 yrs	0.2	Civil Service	All intake at 0 yrs	1.0	1.0	0%
MH 2	High difficulty	Uniform 0 to 32 yrs	1.0	6 yrs	0.2	Civil Service	All intake at 0 yrs	1.0	1.0	40%

Discussion of Low Difficulty Task

Here we see a linearly negative relationship between turnover and organizational performance capacity from T=1 through T=10. This simulation of the Low Difficulty task supports MH's Hypothesis 1 but only with several qualifications.

Figure 37

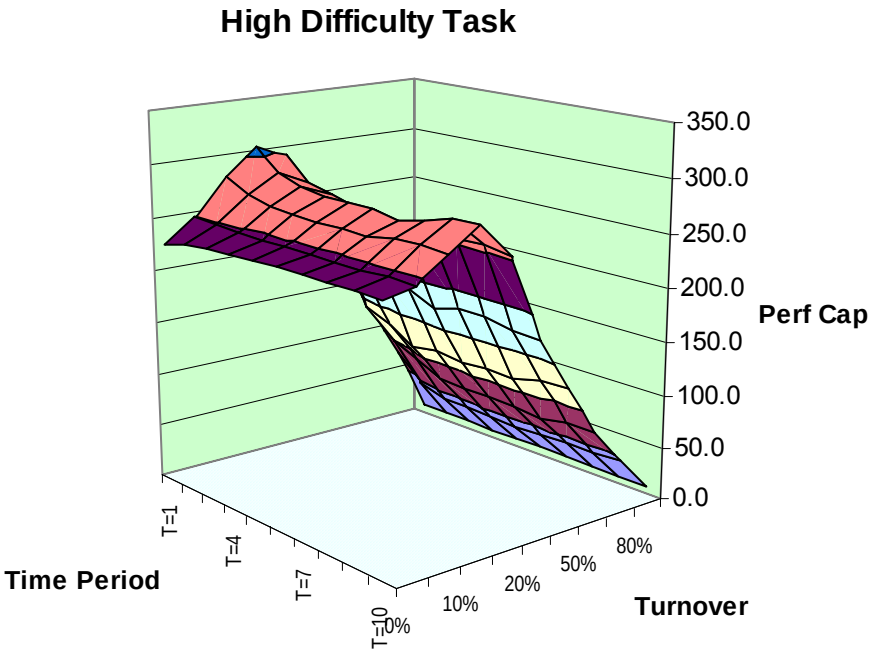


For this hypothesis to be supported unqualified, it must be assumed that the hiring process is so effective that all new hires are the best available and that no new hires will be filtered out due to unsatisfactory performance. However, in practice, if unsatisfactory new hires are replaced by other, better, new hires, there must be some attrition, and thus the optimum will not be at zero. Thus the curve can not be everywhere negatively sloped and still accommodate this low level replacement rate. A second point is that there is little likelihood that a strictly *linear* curve will exist. No organization is so uniform in staffing and process that the turnover-performance relationship would follow a straight line everywhere from 0% to 100% turnover for example. Positing a linear relationship is an overstretch.

Discussion of High Difficulty Task

Here we see the U-shaped curve which conforms with MHs second hypothesis over the range of T=1 to T=10. This outcome is based on the assumptions described in the table above.

Figure 38



Again, MH's hypothesis must be qualified. The only reason the curve has a rising positive region, from 0% to 15% turnover, is because both MH and I have posited that the negative influence of stagnation is reduced by the inflow of new people. This assumption is open to several criticisms. First is that the upslope could be due to the school system having such poor hiring standards, that 15% of new hires perform so poorly that they must be terminated and replaced. Secondly, the optimum point is determined in part by the degree of stagnation present in the organization – less stagnation would drive the optimum point turnover rate to a lower value, a higher level of stagnation would require more turnover to clear it. Third, if the school systems were already staffed with the highest quality people available and stagnation was not evident, then like the case above, the curve would be negative from 0% on out.

Conclusions:

This is not intended to be a critique of Meier and Hicklin's work, rather, this is intended to be a demonstration of how the modeling and simulation methodology can be used to analyze and clarify theoretical development based in empirical research.

The empirical methodology employed by MH does not claim causality. Thus MH does not cite specifically how teacher turnover in a school system improves student test performance. The treatment of how and why turnover should improve performance is left unaddressed. By this lack of causal analysis, the hypotheses presented are left open to criticism as to their generality and range of applicability. Modeling and simulation is likewise open to the criticism that relationships are sometimes treated as black boxes. In the work I have done, this is particularly applicable to the issue of stagnation and how it affects workforce performance capacity. Modeling can be tuned to mimic behaviors rather than generate behaviors through causal relationships. There is a small body of literature that addresses this very issue of simulation as an outcome mimic versus simulation based on causal relationships. I have approached the problem based on developing causal relationships, and as discussed in the dissertation, there is still much work that needs to be done to fully develop those relationships.

Appendices

Appendix A – Additional Simulation Case Results

Cases C.1 to C.5

Testing of various scenarios:

1. Case C.1 Higher quality employees leaving. In this case, the employee quality distribution is placed into three groups – average, below average, and above average. The higher quality employees are leaving at a rate of 2:1 to the other employees. The test results show that the longitudinal impact is rather mild; the 10% differential in quality does not appear to be significant enough to have any real impact. Looking at the mid-range of attrit rates (20% to 50%), the peak capacity value tends to shift up and down, but only modestly so.

Figure 39

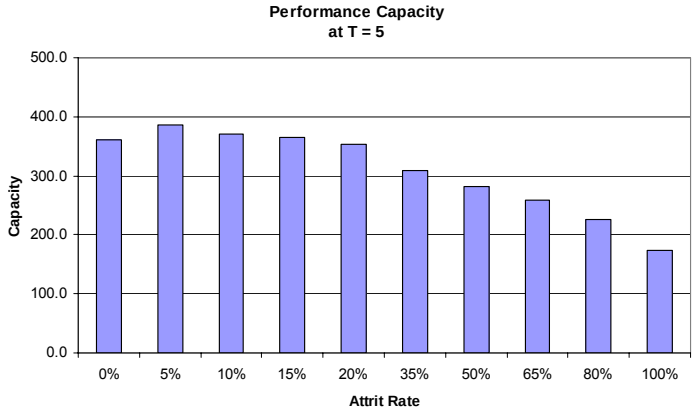
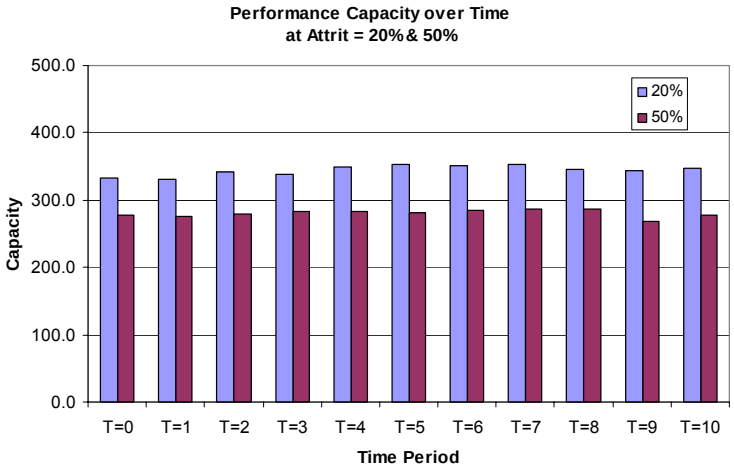


Figure 40



2. Case C.2 Technically obsolescent employees replaced by high proficiency new junior employees. This case can be considered a demonstration of a reverse learning curve - the newly hired employees have higher proficiency than the most senior-tenured employees. This case demonstrates a strong A & B curve. Replacing existing employees with more proficient ones is a clear strategy for capacity improvement over time.

Figure 41

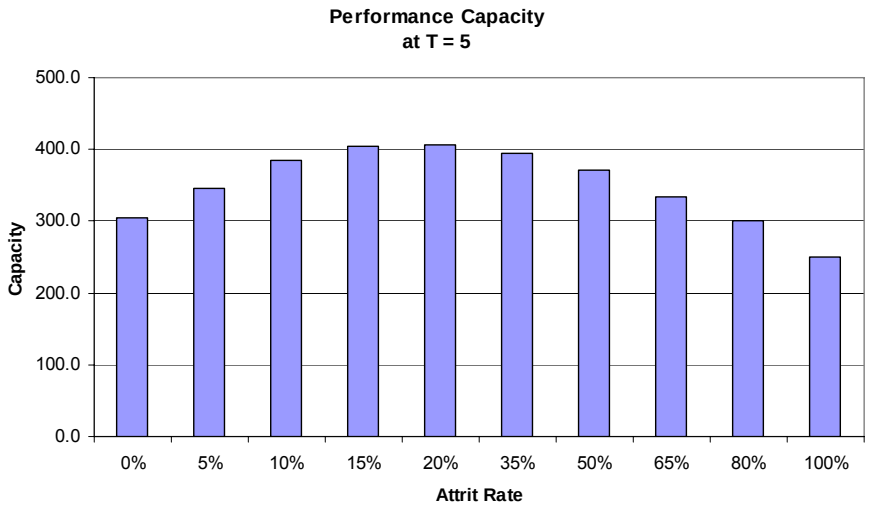
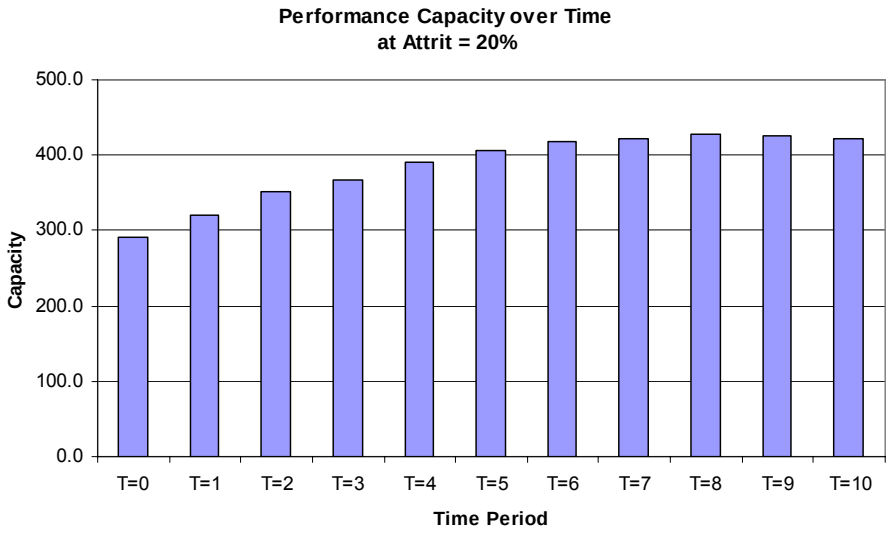


Figure 42



3. Case C.3 Professional growth where high-tenure employees have increased their expertise over time. In this case, it is assumed that the employees have a career-long learning curve that is always growing – these employees increase their proficiency as they age. Average candidates are hired at entry level and develop throughout their career. The test results show that in this case the optimum strategy is to minimize turnover as there is no stagnation penalty. Turnover only increases turbulence which reduces capacity.

Figure 43

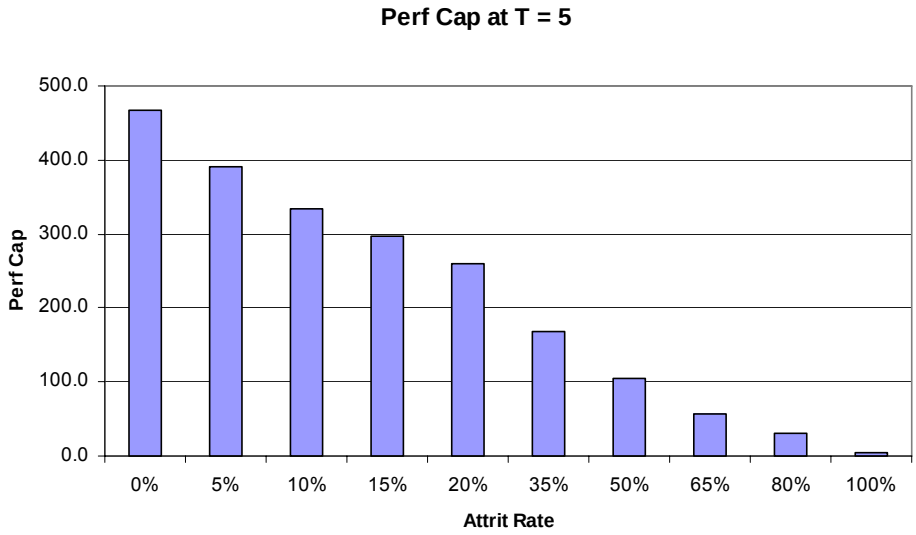
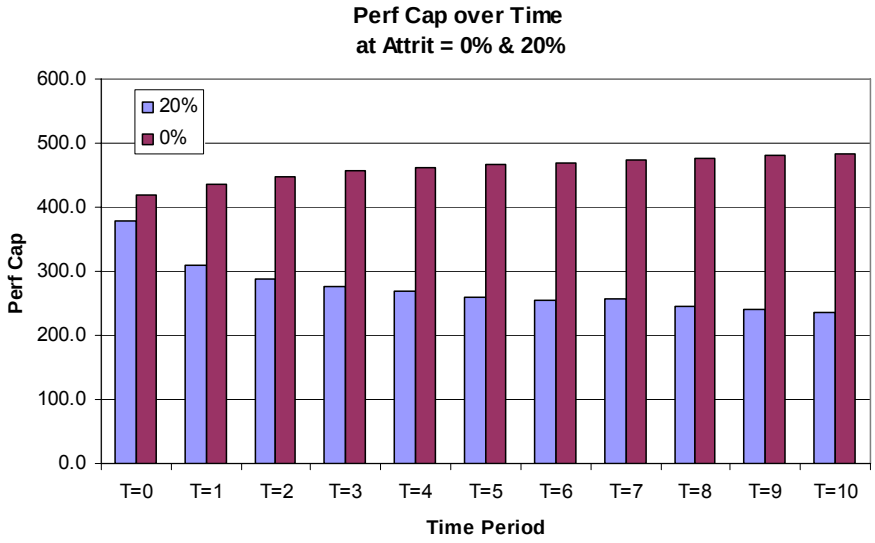


Figure 44



4. Case C.4 A high-performance work team with mid-career, high quality employees
   In this case I have assumed that all employees are mid-career, highly professional, high quality people utilizing training and management techniques that maintain high performance over time with no stagnation. Teamwork is highly important giving a high value to the working relationships variable. Intake to these teams is at the full-proficiency level. It can be seen from the test results that turnover only reduces performance capacity – the optimum is at zero over the entire 10-year period since there is no drop-off due to stagnation. This group has the highest performance capacity due to its hiring and proficiency maintenance policy.

Figure 45

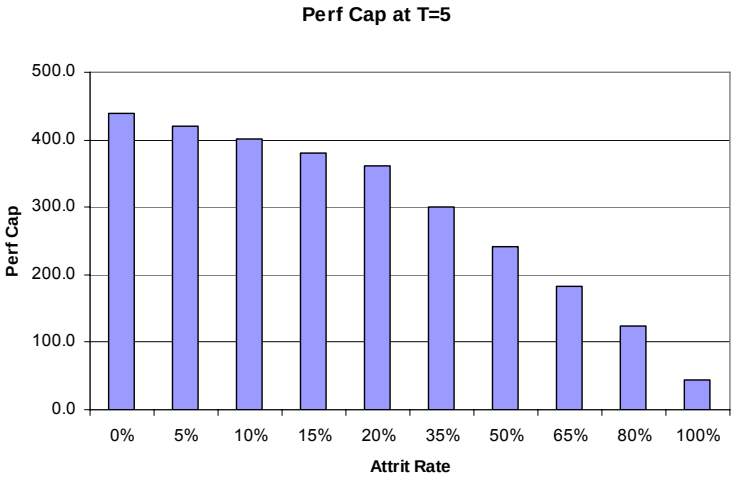
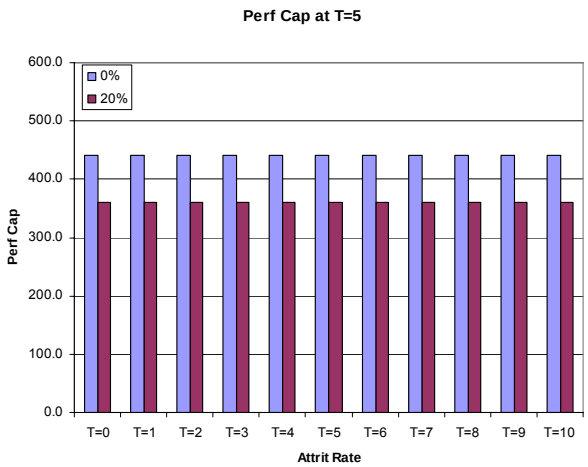


Figure 46



5. Case C.5. A worst-case scenario where older, low-quality employees are replaced by other low-quality employees. This is the case where there is a senior, below-average quality workforce requiring high task dependency. All intake of new employees are below average and have no experience even though there is a 5-year learning curve. There is a high stagnation rate as a result (40%). This is a mirror-image of the high-performance team. Test results show that even a low turnover rate to counter stagnation is desirable.

Figure 47

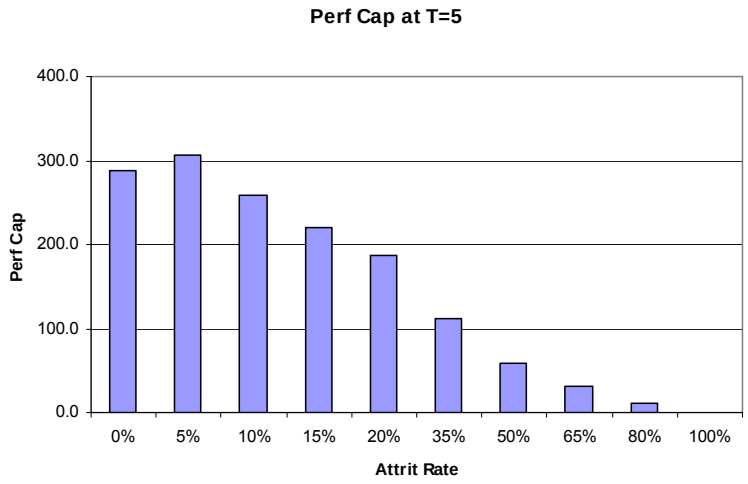
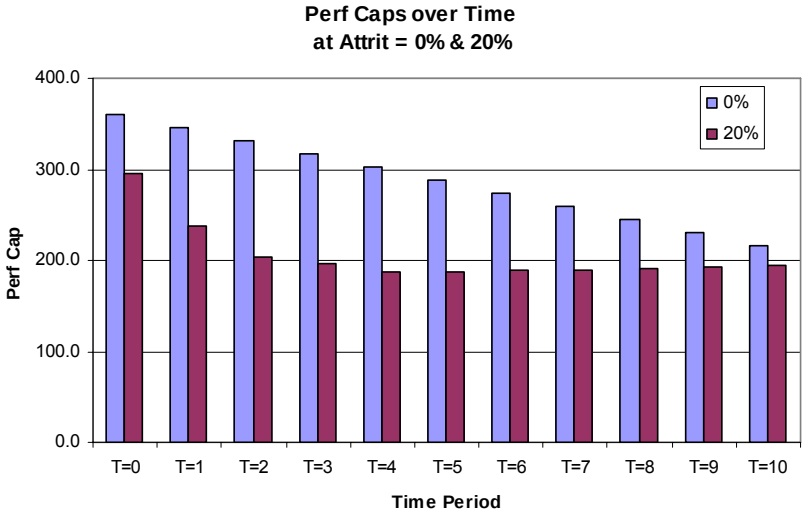


Figure 48



Cases D.1 to D.3

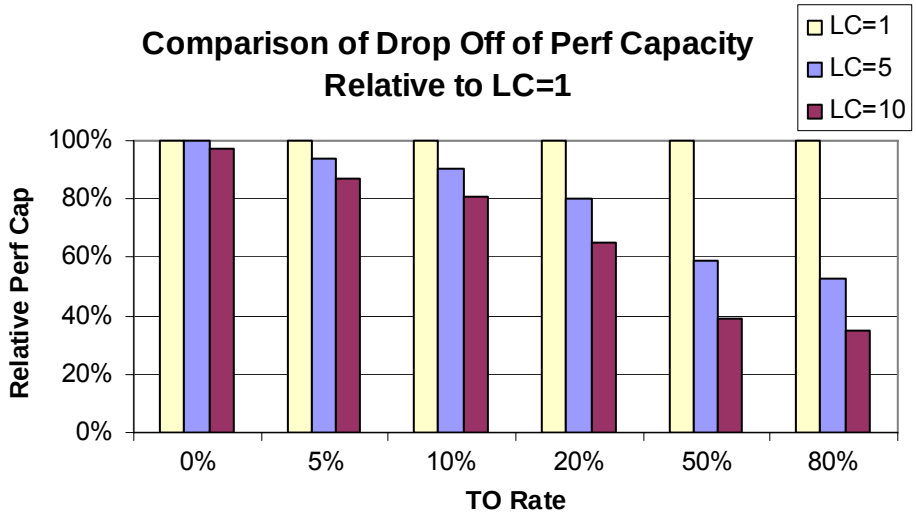
These three cases test the effect of differing times to full proficiency (learning curve) on capacity

D.1 - 1 year; D.2 - 5 years; D.3 - 10 years

While holding all other parameters constant, the full-performance level is set at 4.0 – the same for all the other cases for comparison purposes. Looking at the 5%, 50%, and 80% turnover levels, the differences between these three cases become most clear: as the turnover rate increases, the longer time to proficiency has a stronger impact on the capacity of the organization. A longer learning curve works against the organization at the mid-ranges of turnover. The curve in the 5% to 80% range shows that as turnover increases, the organization with the shorter learning curve is less vulnerable than that with a longer learning curve. At TO = 100%, all the organizations have collapsed to near-absolute incapacity because no one's employees are employed long enough to learn the job.

While this may point to a conclusion that long learning curve organizations should strive for minimal turnover, the counterbalance is that low to no turnover increases the impact of stagnation, demonstrating the need to find the balance point between stagnation and turbulence. LC=1 means 1 year to proficiency, LC=5 means 5 yrs, etc.

Figure 49



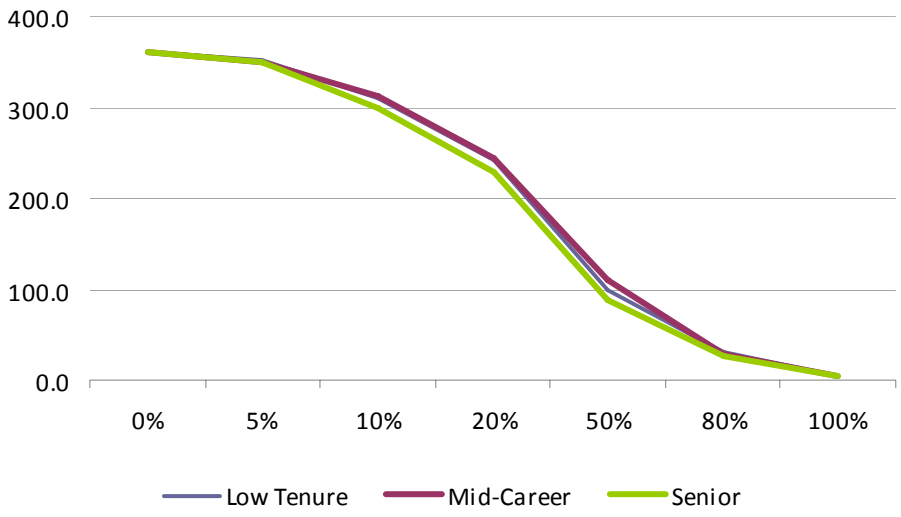
Cases E.1 to E.3

These cases look at the effect of the initial tenure distribution: E.1 - a predominantly younger workforce; E.2 - a predominantly mid-career workforce; E.3 - a predominantly older workforce

The initial starting point of every simulation model is a key consideration. In these three cases, all intake is at 0 years of experience. For these three cases, the differing initial tenure distributions shows that there is relatively little difference over a 10-year period with a 5-year learning curve – the junior employees eventually all reach full-performance level, while the mid-career and senior employees do not grow in proficiency. What does grow is staffing costs relative to the flat level of performance capacity.

Figure 50

Comparison of Initial Tenure Distribution



Cases F.1 and F.2

These cases looked at the effect of differing hiring selectivity as reflected in the rate of early career attrition:

F.1 - High early attrition – implying low selectivity

F.2 - Low early attrition – implying high selectivity

Over time, these results indicate that at low rates of turnover, high or low rates of new-hire selectivity does not significantly affect performance capacity or costs. Low early attrition is associated with high selectivity and generally higher training and development costs. The opposite is true with high early attrition and low selectivity. The recruiting and training costs of high selectivity employees are mitigated by their low numbers, the low costs of low selectivity employees are amplified by their high numbers – but the overall cost outcome can be the same for the organization. Only at very high turnover rates do costs become significant.

Figure 51

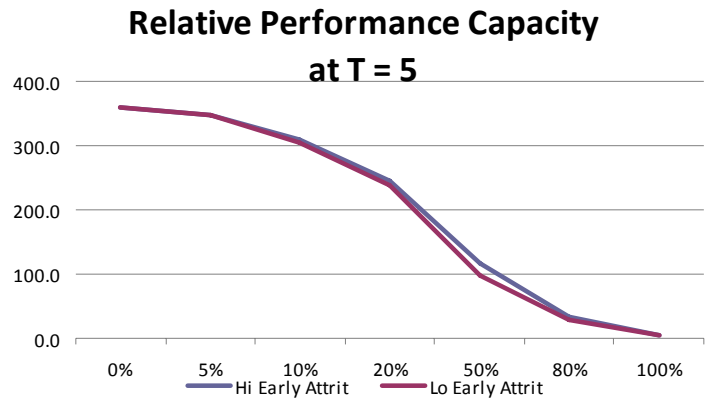
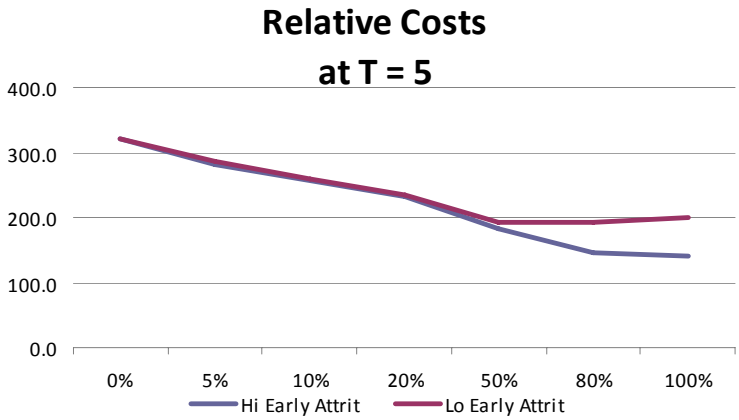
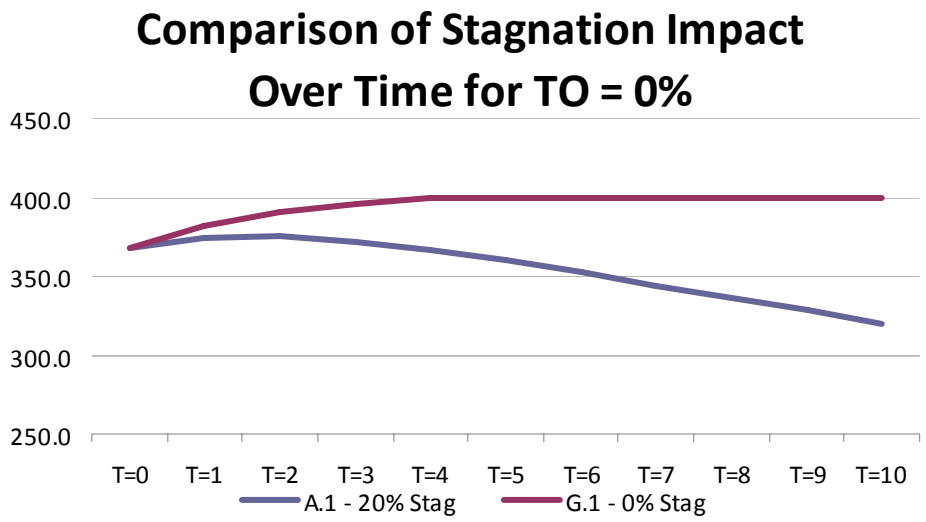


Figure 52



Case G.1. This looks at Case A.1 in the 0% to 5% turnover range but without the stagnation factor affecting capacity. The chart shows the impact of stagnation over time from T=0 to T=10 where stagnation has reached its maximum. Line G.1 (0% stag) starts off at the same value as line A.1 (20% stag) at T=0. The performance curves both rise in the first few years as the low-tenures employees move up the proficiency curve boosting overall performance capacity. However, as time goes by, the impact of stagnation starts to take hold and line A.1 starts to decline, while line G.1 holds at the maximum value of 400.

Figure 53



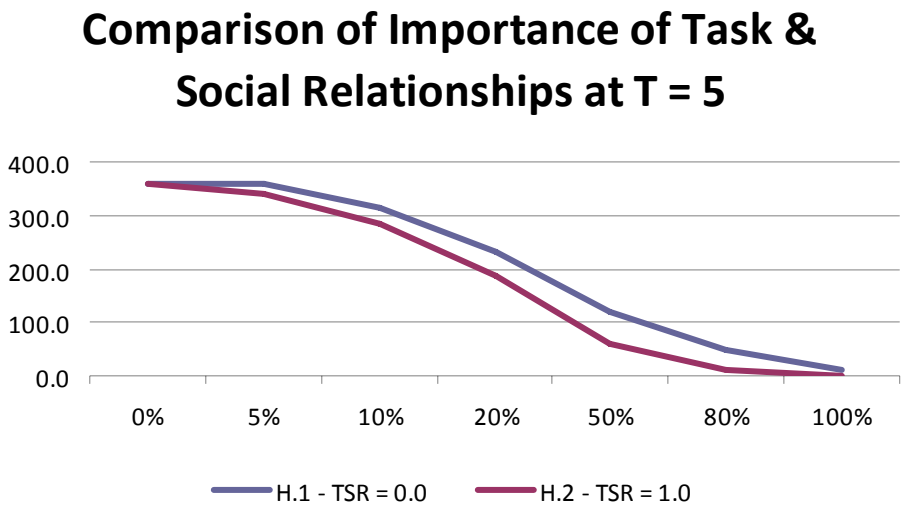
Cases H.1 and H.2 - These two cases looked at the boundary values of the strength of employee working (Task/Social) relationships dependence:

H.1 - no task or social dependence (TSR = 0.0) on coworkers

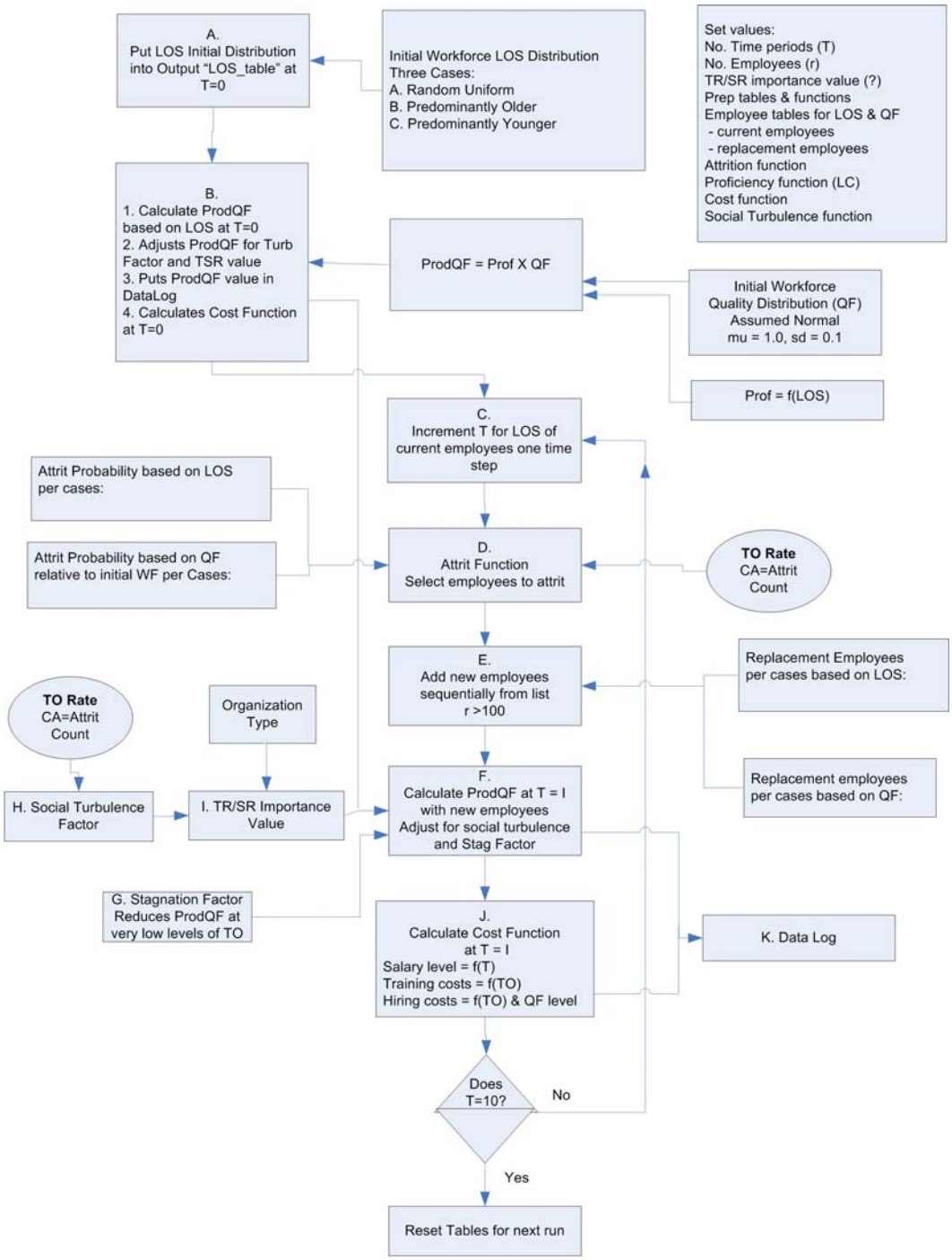
H.2 - total task/social dependence (TSR = 1.0) on coworkers

This is case A.1 with the TSR values set to the boundary limits. From the outcomes, it does not appear that TSR has a strong impact, as compared to simply the proficiency levels that the flow of employees brings in. This seems to be a triumph of human capital over social capital.

Figure 54



Appendix B1 – Functional Flow Diagram



Appendix B2 – Excel VBA Code for Case B.2

```
Sub Master82()
Dim r As Integer, s As Integer, q As Integer, T As Integer, CA As Integer, NE As Integer, A As Integer,
B As Integer, AC As Integer, SF As Single, p As Integer
Dim Status As Range
Set Status = Range("Status")
Dim LOS As Range
Set LOS = Range("LOS")
Dim QF As Range
Set QF = Range("QF")
Dim LOS_table As Range
Set LOS_table = Range("LOS_table")
Dim ProdQF_table As Range
Set ProdQF_table = Range("ProdQF_table")
Dim Attrit_Prob As Range
Set Attrit_Prob = Range("Attrit_Prob")
Dim Attrit_Count As Range
Set Attrit_Count = Range("Attrit_Count")
Dim TRSR As Range
Set TRSR = Range("TRSR")
Dim LOS_IC As Range
Set LOS_IC = Range("LOS_IC")
Dim ProdQF_Tot As Range
Set ProdQF_Tot = Range("ProdQF_Tot")
Dim SF_ProdQF_Tot As Range
Set SF_ProdQF_Tot = Range("SF_ProdQF_Tot")
Dim Adj_ProdQF_Tot As Range
Set Adj_ProdQF_Tot = Range("Adj_ProdQF_Tot")
Dim DataLog_table As Range
Set DataLog_table = Range("DataLog_table")
Dim Cost_table As Range
Set Cost_table = Range("Cost_table")
Dim Salary_table As Range
Set Salary_table = Range("Salary_table")
Dim Cost_Tot As Range
Set Cost_Tot = Range("Cost_Tot")
Dim SalarywTrng As Range
```

```
Set SalarywTrng = Range("SalarywTrng")
Dim Hiring As Range
Set Hiring = Range("Hiring")
Dim Admin As Range
Set Admin = Range("Admin")

For r = 1 To 100
If Status(r) = 1 Then
'A. Puts Initial Employee LOS's into Output Range table for T=0
Range("LOS_table").Cells(r, 1) = LOS(r)

'B.1 Calculates ProdQF for T=0
Range("ProdQF_table").Cells(r, 1) = QF(r) * Application.WorksheetFunction.VLookup(LOS(r), Range("Prod_table"), 2,
False)
End If
Next r

'B.2 Adjusts ProdQF for Social Turb factor and TR/SR Importance value
Range("Adj_ProdQF_Tot").Cells(1, 1) = Range("ProdQF_Tot").Cells(1, 1) * (1 - TRSR * Range("Attrit_Count") / 100)
Range("SF_ProdQF_Tot").Cells(1, 1) = Range("ProdQF_Tot").Cells(1, 1)

'B.3 Places the ProdQF value in the DataLog table
AC = Range("Attrit_Count")
Range("DataLog_table").Cells(AC + 1, 1) = Range("Adj_ProdQF_Tot").Cells(1, 1)
Range("Cost_table").Cells(AC + 1, 1) = Range("Cost_Tot").Cells(1, 1)

'B.4 Cost Function for T=0
For p = 1 To 100
Range("SalarywTrng").Cells(1, 1) = Range("SalarywTrng").Cells(1, 1) +
Application.WorksheetFunction.VLookup(LOS(p), Range("Salary_table"), 5, False)
Next p
Range("Hiring").Cells(1, 1) = 0.1 * AC
Range("Admin").Cells(1, 1) = 0.2 * AC
Range("Cost_table").Cells(AC + 1, 1) = Range("Cost_Tot").Cells(1, 1)

'C. Increments T for LOS & Prod
For T = 1 To 10
```

```
For r = 1 To 1101
If Status(r) = 1 Then
'This adds one year to the LOS & ProdQF in each sweep
LOS(r) = LOS(r) + 1
Range("LOS_table").Cells(r, T + 1) = LOS(r)
Range("ProdQF_table").Cells(r, T + 1) = QF(r) * Application.WorksheetFunction.VLookup(LOS(r),
Range("Prod_table"), 2, False)
End If
Next r

'Skip the Attrit and New Emp functions for zero attrit case
If Range("Attrit_Count") = 0 Then GoTo SkipAttrit

'D. Attrit function
CA = 0
Do Until CA = Range("Attrit_Count")
For s = 1 To 1101
If Status(s) = 1 Then
A = Application.WorksheetFunction.VLookup(LOS(s), Range("Attrit_Prob"), 2, False)
B = Int(((100) * Rnd) + 1)
If B <= A Then
Status(s) = 9
'Status 9 indicates an attrited emp
Range("LOS_table").Cells(s, T + 1) = IsBlank
Range("ProdQF_table").Cells(s, T + 1) = IsBlank
CA = CA + 1
If CA = Range("Attrit_Count") Then Exit Do
End If
End If
Next s
Loop

'E. New Emp added sequentially from list
NE = 0
Do
For q = 101 To 1101
If Status(q) = 0 Then
```

```
Status(q) = 1
Range("LOS_table").Cells(q, T + 1) = LOS(q)

'F. Calculates ProdQF after attrits and with new emps
Range("ProdQF_table").Cells(q, T + 1) = QF(q) * Application.WorksheetFunction.VLookup(LOS(q),
Range("Prod_table"), 2, False)
NE = NE + 1
End If
If NE = Range("Attrit_Count").Value Then Exit Do
Next q
Loop

SkipAttrit:

'G. Stagnation Function - Reduces ProdQF at low levels of TO
If AC <= 2 Then
    SF = 1
    Range("SF_ProdQF_Tot").Cells(1, T + 1) = Range("ProdQF_Tot").Cells(1, T + 1) * (1 - 0.1 * T * 0.2 * SF)
ElseIf AC = 3 Then
    SF = 0.66
    Range("SF_ProdQF_Tot").Cells(1, T + 1) = Range("ProdQF_Tot").Cells(1, T + 1) * (1 - 0.1 * T * 0.2 * SF)
ElseIf AC = 4 Then
    SF = 0.33
    Range("SF_ProdQF_Tot").Cells(1, T + 1) = Range("ProdQF_Tot").Cells(1, T + 1) * (1 - 0.1 * T * 0.2 * SF)
Else
    SF = 0
    Range("SF_ProdQF_Tot").Cells(1, T + 1) = Range("ProdQF_Tot").Cells(1, T + 1) * (1 - 0.1 * T * 0.2 * SF)
End If


'H/I. Adjusts ProdQF for Social Turb factor and TR/SR Importance value
'ProdQF_Tot is the single row at the bottom of the ProdQF table
Range("Adj_ProdQF_Tot").Cells(1, T + 1) = Range("SF_ProdQF_Tot").Cells(1, T + 1) * (1 - TRSR *
Range("Attrit_Count") / 100)

'J. Cost Function
For p = 1 To 1101
```

```
If Status(p) = 1 Then
Range("SalarywTrng").Cells(1, T + 1) = Range("SalarywTrng").Cells(1, T + 1) +
Application.WorksheetFunction.VLookup(LOS(p), Range("Salary_table"), 5, False)
End If
Next p
Range("Hiring").Cells(1, T + 1) = 0.1 * AC
Range("Admin").Cells(1, T + 1) = 0.2 * AC

'K1 Places the ProdQF value in the DataLog table
Range("DataLog_table").Cells(AC + 1, T + 1) = Range("Adj_ProdQF_Tot").Cells(1, T + 1)
'K2 Places the total costs into the Cost Datalog table
Range("Cost_table").Cells(AC + 1, T + 1) = Range("Cost_Tot").Cells(1, T + 1)

If T = 10 Then End
Next T
End Sub

Sub Reset()
Dim r As Integer, s As Integer, T As Integer
Dim Status As Range
Set Status = Range("Status")
Dim LOS As Range
Set LOS = Range("LOS")
Dim QF As Range
Set QF = Range("QF")
Dim LOS_table As Range
Set LOS_table = Range("LOS_table")
Dim ProdQF_table As Range
Set ProdQF_table = Range("ProdQF_table")
Dim Attrit_Prob As Range
Set Attrit_Prob = Range("Attrit_Prob")
Dim LOS_IC As Range
Set LOS_IC = Range("LOS_IC")
Dim LOS0_20 As Range
Set LOS0_20 = Range("LOS0_20")
Dim ProdQF_Tot As Range
Set ProdQF_Tot = Range("ProdQF_Tot")
```

```
Dim Adj_ProdQF_Tot As Range
Set Adj_ProdQF_Tot = Range("Adj_ProdQF_Tot")

'Resets LOS IC's and Emp Status for current and potential emps
For r = 1 To 100
LOS(r) = Range("LOS_IC").Cells(r, 1)
Status(r) = 1
Next r
For r = 101 To 1101
LOS(r) = Range("LOS0_20").Cells(r, 1)
Status(r) = 0
Next r

For r = 1 To 1101
For s = 1 To 11
's goes across from T=0 to T=10 which = 11 cols
Range("LOS_table").Cells(r, s) = IsBlank
Range("ProdQF_table").Cells(r, s) = IsBlank
Range("Adj_ProdQF_Tot").Cells(1, s) = IsBlank
Range("SF_ProdQF_Tot").Cells(1, s) = IsBlank
Range("SalarywTrng").Cells(1, s) = IsBlank
Range("Hiring").Cells(1, s) = IsBlank
Range("Admin").Cells(1, s) = IsBlank
Next s
Next r

End Sub
```

Appendix C - FAA Occupational Job Descriptions

Air Traffic Controllers (Series 2152) direct air traffic to safely and efficiently manage the flow of aircraft to and from airports and en route. Interestingly, the FAA views this as a production job because each controller must perform a certain number of control operations per hour. Each controller works, to a large degree, independently at their own radar screen therefore task/social relationships are relatively low. Time to full proficiency is 3 to 4 years. Attrition is relatively high for new hires due to the unique nature of the work, but once established, there is little attrition until retirement. Technical obsolescence is not an issue as controllers must maintain current certification.

Air Traffic Systems Specialist (ATSS) Technicians (Series 2101) install, test, and repair radar and communications equipment – all the equipment the air traffic controllers use. Their work is generally performed individually, though they work with others on larger equipment. Task dependencies are low and dependencies on social relationships are moderate – limited to coworkers and supervisors on the same shift. Technical obsolesce is not an issue as technicians must be certified on the equipment they service – which generally stays the same for years, and sometimes decades.

Aviation Safety Inspectors (Series 1825) perform safety process inspections and oversight of air carrier operations, or they may certify a new aircraft or manufacturing process. Due to the complexity of the technology and processes that they oversee, they work with either a partner or are part of a large team of inspectors. There is a great deal of information sharing, and joint decision making is the normal mode of operation. The growing complexity of aviation technology is forcing an upgrading of the skills of safety inspectors. Safety inspectors are thus at risk of technical obsolescence if they cannot stay abreast of newer technology and inspection methods. Safety inspectors typically have industry experience and are frequently on a second-career when working for the FAA.

Certification and Compliance Inspectors (Series 1801) perform security, hazmat, and drug and alcohol compliance checks. This is basically an administrative job to ensure that required activities are accomplished and that documentation is in proper order. These inspectors primarily perform their duties individually and independently of other inspectors.

Engineers (Various Series 8XX) develop, manage, and oversee the agency's technology and are responsible for new system development and acquisition. They also support regulatory oversight, safety analyses, and regulation development. They typically work in a program/ project structure work arrangement. There is relatively high task interaction and need for social relationships and contacts (i.e., knowing who and where does what) in a large complex organization such as the FAA. Full-proficiency level engineers are primarily project engineers who manage contracts, set schedules, evaluate test results, and provide direction to the FAA's contractors.

Information Technology Specialists (Series 2210) at the FAA have two primary functions: enterprise systems development and acquisition support as well as the operation and maintenance of air traffic control data and information systems, and FAA's internal systems. Enterprise level project management involves a high level of responsibility and experience as these are multi-million dollar projects. Systems maintenance keeps the systems going and is more similar to technician level work. Due to the rapid pace of information technology development, technical obsolescence is a common problem for managers and long-tenured employees in this field.

Human Resources Specialists (Series 201) perform general HR management, staffing, training, employee relations, and labor relations. In this group, FAA has two large functional areas – staffing and labor relations. The staffing specialists support the hiring of all FAA employees and play an important role in the hiring of air traffic controllers. Labor Relations (LR) Specialists also play a major role due to the strength of the air traffic controller's union. The LR specialists investigate union employee grievances, collect evidence, identify issues, and research contract terms/agency policy. Both the staffing specialists and the LR specialists work on a case basis. They generally work independently of their coworkers having little dependence on other specialists.

Contract Specialists (Series 1102) perform the agency's contracting tasks. Contracting specialists are now required to pass certain training courses and have a specified number of years of on the job experience to certified at Level III (full proficiency). Contracting specialists generally work individually on their own projects. For small contracts, they act as the agent for the requiring office by serving as the interface between the contractor and the agency. On large

acquisitions (multi-million dollars) they are generally part of a project team consisting of representatives from engineering, legal, budget, and contracting.

REFERENCES

Abbott, A. 2005. Sociology of Work and Occupations. In N. Smelser, & R. Swedberg (Eds.), *The Handbook of Economic Sociology*, 2nd ed.: 308-330. Princeton NJ: Princeton University Press.

Abelson, M., & Baysinger, B. 1984. Optimal and Dysfunctional Turnover: Toward an Organizational Level Model *Academy of Management Review*, 9(2): 331-342.

Adler, P., & Kwon, S. W. 2002. Social Capital: Prospects for a New Concept. *Academy of Management Review*, 27(1): 17-41.

Allen, G. 1997. Antecedents and Outcomes of Promotion Systems. *Human Resource Management*, 36(2): 251-260.

Argote, L. 1993. Group and Organizational Learning Curves: Invidual, System and Environmental Components. *British Journal of Social Psychology*, 32: 31-51.

Argote, L. 1999. *Organizational Learning: Creating, Retaining and Transferring Knowledge*. Boston MA: Kluwer Academic Publishers.

Arrow, H., & McGrath, J. 1993. Membership Matters: How Member Change and Continuity Affect Small Group Structure, Process, and Performance. *Small Group Research*, 24(3): 334-361.

Arrow, H., McGrath, J., & Berdahl, J. 2000. *Small Groups as Complex Systems*. Thousand Oaks CA: Sage Publications.

Backes-Gellner, U. 2004. Personnel Economics: An Economic Approach to Human Resource Management. *Management Revue*, 15(2): 215-227.

Bankes, S. 1992. Exploratory Modeling and the Use of Simulation for Policy Analysis. Santa Monica CA: RAND Corp.

Baron, J. N., Hannan, M. T., & Burton, M. D. 2001. Labor Pains: Change in Organizational Models and Employee Turnover in Young, High-Tech Firms. *American Journal of Sociology*, 106(4): 960-1015.

Barrick, M., Bradley, B., Kristof-Brown, A., & Colbert, A. 2007. The Moderating Role of Top Management Team Interdependence: Implications for Real Teams and Working Groups. *Academy of Management Journal*, 50(3): 544-557

Bartholomew, D. J. 1982. *Stochastic Models for Social Processes* (3rd ed.). Chichester UK: John Wiley & Sons.

Berkowitz, L. 1955. Group Standards, Cohesiveness, and Productivity. *Human Relations*, 7: 509-519.

Berman, E. 1998. *Productivity in Public and NonProfit Organizations: Strategies and Techniques*. Thousand Oaks CA: Sage Publications Inc.

Bluedorn, A. 1982. The Theories of Turnover: Causes, Effects, and Meaning. In S. Bacharach (Ed.), *Research in the Sociology of Organizations*, Vol. 1. Greenwich CT: JAI Press.

Bluedorn, A., & Denhardt, R. 1988. Time and Organizations. *Journal of Management*, 14(2): 299-320.

Borgatti, S. 2006. Identifying sets of key players in a social network. *Computational and Mathematical Organization Theory*, 12(1): 21-32.

Bovasso, G. 1992. A Structural Analysis of the Formation of a Network Organization. *Group & Organization Studies*, 17(1): 86-107.

Breul, J., & Gardner, N. (Eds.). 2004. *Human Capital 2004*. Lanham MD: Rowman & Littlefield Publishers.

Bröchelera, V., Maijoor, S., & vanWitteloostuijn, A. 2004. Auditor Human Capital and Audit firm Survival:The Dutch Audit Industry in 1930-1992. *Accounting, Organizations and Society*, 29(7): 627-646.

Broschak, J. 2004. Managers' Mobility and Market Interface: The Effect of Managers' Career Mobility on the Dissolution of Market Ties. *Administrative Science Quarterly*, 49(4): 608-641.

Burke, W. 2002. *Organization Change: Theory and Practice*. Thousand Oaks CA: Sage Publications.

Burt, R. 1997. The contingent value of social capital. *Administrative Science Quarterly*, 42(2): 339-366.

Cameron, K., Kim, M., & Whetten, D. 1987. Organizational Effects of Decline and Turbulence. *Administrative Science Quarterly*, 32(2): 222-241.

Carley, K. 1992. Organizational Learning and Personnel Turnover. *Organization Science*, 3(1): 20-46.

Carlson, K. D., Connerley, M. L., & Mecham, R. L. 2002. Recruitment evaluation: The case for assessing the quality of applicants attracted. *Personnel Psychology*, 55(2): 461-491.

Carpenter, P. 2001. *The Forging of Bureaucratic Autonomy*. Princeton NJ: Princeton Univ. Press.

Cascio, W. 2000. *Costing Human Resources: The Financial Impact of Behavior in Organizations* (4th ed.). Cincinnati OH: South-Western College Publishing.

Causey, D. 1977. Personnel Programming: an Accoutant's Approach Using the Learning Curve. *Managerial Planning*, 25(4): 37-40.

Chamberlain, N. 1950. *Management in Motion: The Corporate Decision-Making Process as Applied to the Transfer of Employees*. New Haven CT: Labor and Management Center, Yale University.

Chang, A., & Bordia, P. 2001. A Multidimensional Approach to the Group Cohesion-Group Performance Relationship. *Small Group Research*, 32(4): 379-405.

Christensen, C. R. 1953. *Management Succession in Small and Growing Enterprises*. Andover MA: The Andover Press.

Coase, R. 1937. The Nature of the Firm. *Economica*, 4(16): 386-405.

Cohen, M., March, J., & Olsen, J. 1972. A Garbage Can Model of Organizational Choice. *Administrative Science Quarterly*, 17(1): 1-25.

Coleman, J. 1988. Social Capital in the Creation of Human Capital *American Journal of Sociology*, 94: S95-S120.

Cornog, G. Y. 1957. The Personnel Turnover Concept: A Reappraisal. *Public Administration Review*, 17(4): 247-256.

Coser, R. 1976. Suicide and the Relational System: A Case Study in a Mental Hospital. *Journal of Health and Social Behavior*, 17(4): 318-327.

Daft, R. 2004. *Organization Theory and Design* (8th ed.). Mason Ohio: Thomson South-Western.

Dalton, D., Krackhardt, D., & Porter, L. 1981. Functional Turnover: An Empirical Assessment. *Journal of Applied Psychology*, 66(6): 716-721.

Dalton, D., & Todor, W. 1979. Turnover Turned Over: An Expanded and Positive Perspective. *Academy of Management Review*, 4(2): 225-236.

Dalton, D., & Todor, W. 1982. Turnover: A Lucrative Hard Dollar Phenomenon. *Academy of Management Review*, 7(2): 212-219.

Dalton, D., Todor, W., & Krackhardt, D. 1982. Turnover Overstated: The Functional Taxonomy. *Academy of Management Review*, 7(1): 117-124.

Davenport, T. 1999. *Human Capital: What It Is and Why People Invest in It*. San Francisco CA: Jossey-Bass Publishing.

De Corte, W., & Lievens, F. 2007. Combining Predictors to Achieve Optimal Tradeoffs Between Selection Quality and Adverse Impact. *J of Applied Psychology*, 92(5): 1380-1393.

DeRue, D., & Morgeson, F. 2007. Stability and change in person-team and person-role fit over time: The effects of growth satisfaction, performance, and general self-efficacy. *J of Applied Psychology*, 92(5): 1242-1253.

Dess, G., & Shaw, J. 2001. Voluntary Turnover, Social Capital, and Organizational

Performance. *Academy of Management Review*, 26(3): 446457.

Dierickx, I., Cool, K., & Barney, J. 1989. Asset Stock Accumulation And Sustainability Of Competitive Advantage. *Management Science*, 35(12): 1504-1514.

Doeringer, P., & Piore, M. 1971. *Internal Labor Markets and Manpower Analysis*. Armonk NY: M. E. Sharpe.

Downs, A. 1967. *Inside Bureaucracy*. Glenview IL: Waveland Press.

Droege, S., & Hoobler, J. 2003. Employee Turnover and Tacit Knowledge Diffusion: A Network Perspective. *Journal of Managerial Issues*, 15(1): 50-64.

Dubas, K., & Nijhawan, I. 2007. A Human Capital Theory Perspective of Sales Force Training, Productivity, Compensation, and Turnover. *Proceedings of the Academy of Marketing Studies*, 12(2): 21-25.

Eitzen, D., & Yetman, N. 1972. Managerial Change, Longevity, and Organizational Effectiveness. *Administrative Science Quarterly*, 17(1): 110-116.

Ellickson, M. 2002. Determinants of job satisfaction of municipal government employees. *Public Personnel Management*, 31(3): 343-359.

Fishman, G., & Kiviat, P. 1971. The Statistics of Discrete Event Simulation. In J. Dutton, & W. Starbuck (Eds.), *Computer Simulation of Human Behavior*: 595-609. New York NY: John Wiley & Sons.

Florin, J., Lubatkin, M., & Schulze, W. 2003. A Social Capital Model of High-Growth Ventures. *Academy of Management Journal*, 46(3): 374-385.

Forrester, J. 1961. *Industrial Dynamics*. Cambridge MA: Productivity Press.

Forsyth, D. 1990. *Group Dynamics* (2nd ed.). Belmont CA: Brooks/Cole Publishing.

Frantz, F. 1995. A Taxonomy of Model Abstraction Techniques, *Proceedings of the 27th ACM Winter Simulation Conference*. Arlington VA.

Geles, C., Lindecker, G., Month, M., & Roche, C. 2000. *Managing Science: Management for R&D Laboratories*. New York NY: John Wiley & Sons.

Gilbert, N., & Troitzsch, K. 1999. *Simulation for the Social Scientist*. Philadelphia PA: Open University Press.

Glance, N. S., Hogg, T., & Huberman, B. A. 1994. *Training and Turnover in Organizations*. Paper presented at the AAAI 1994 Spring Symposium on Computational Organization Design.

Glebbeek, A., & Bax, E. 2004. Is High Employee Turnover Really Harmful? An Empirical Test Using Company Records. *Academy of Management Journal*, 47(2): 277-286.

Gouldner, A. 1954. *Patterns of Industrial Bureaucracy*. New York NY: The Free Press.

Grant, A., Christianson, M., & Price, R. 2007. Happiness, Health, or Relationships? Managerial Practices and Employee Well-Being Tradeoffs. *Academy of Management Perspectives*, 21(3): 51-63.

Gratton, L., & Erickson, T. 2007. Eight Ways to Build Collaborative Teams. *Harvard Business Review*, 85(11): 100-109.

Greve, A., & Benassi, M. 2004. Exploring the Contributions of Human and Social Capital to Productivity, *Hawaii International Conference on System Sciences HICSS-37*. Hilton Waikoloa Village, Big Island, Hawaii.

Guthrie, J. P. 2001. High-Involvement Work Practices, Turnover, and Productivity: Evidence from New Zealand. *Academy of Management Journal*, 44(1): 180-191.

Hanna, J. 1971. Information-Theoretic Techniques for Evaluating Simulation Models. In J. Dutton, & W. Starbuck (Eds.), *Computer Simulation of Human Behavior*: 682-692. New York Ny: John Wiley & Sons.

Hanneman, R., Collins, R., & Mordt, G. 1995. Discovering Theory Dynamics by Computer Simulation: Experiments on State Legitimacy and Imperialist Capitalism. *Sociological Methodology*, 25: 1-46.

Harrison, D., Price, K., Gavin, J., & Florey, A. 2002. Time, Teams, and Task Performance: Changing Effects of Surface- and Deep-Level Diversity on Group Functioning. *Academy of Management Journal*, 45(4): 1029-1045.

Harrison, J. R., & Carroll, G. 2002. The Dynamics of Cultural Influence Networks. *Computational and Mathematical Organization Theory*, 8(1): 5-31.

Harrison, J. R., & Carroll, G. 2006. *Culture and Demography in Organizations*. Princeton NJ: Princeton University Press.

Harrison, R., Zhiang, L., Carroll, G., & Carley, K. 2007. Simulation Modeling in Organizational and Management Research. *Academy of Management Review*, 32(4): 1229-1245.

Hatch, N., & Dyer, J. 2004. Human Capital and Learning as a Source of Sustainable Competitive Advantage. *Strategic Management Journal*, 25(12): 1155-1179.

Haveman, H. 1995. The demographic metabolism of organizations: Industry dynamics, turnover, and tenure distributions. *Administrative Science Quarterly*, 40(4): 586-619.

Hillmer, S., Hillmer, B., & McRoberts, G. 2004. The Real Costs of Turnover: Lessons from a Call Center. *Human Resource Planning*, 27(3): 34-42.

Hitt, M., Bierman, L., Shimizu, K., & Kochhar, R. 2001. Direct and Moderating Effects on Human Capital on Strategy and Performance in Professional Service Firms: A Resource-based Perspective. *Academy of Management Journal*, 44(1): 13-29.

Hom, P., & Griffith, R. 1995. *Employee Turnover*. Cincinnati OH: South-Western College Publishing.

Hunter, J., Schmidt, F., & Judiesch, M. 1990. Individual differences in output variability as a function of job complexity. *Journal of Applied Psychology*, 75(1): 28-42.

Hunter, L., & Thatcher, S. 2007. Feeling the Heat: Effects of Stress, Commitment, and Job Experience on Job Performance. *Academy of Management Journal*, 50(4): 953-968.

Huselid, M. 1995. The Impact of Human Resource Management Practices on Turnover, Productivity, and Corporate Financial Performance. *Academy of Management Journal*, 38(3): 635-673.

Ilgen, D., & Hulin, C. 2000. *Computational Modeling of Behavior in Organizations: The Third Scientific Discipline*. Washington DC: American Psychological Association.

Ilies, R., Wagner, D., & Morgeson, F. 2007. Explaining affective linkages in teams: Individual differences in susceptibility to contagion and individualism-collectivism. *J of Applied Psychology*, 92(4): 1140-1148.

Janis, I. 1972. *Victims of Groupthink: A Psychological Study of Foreign Policy Decisions and Fiascoes*. Boston: Houghton Mifflin.

Jonassen, D., & Grabowski, B. 1993. *Handbook of Individual Differences, Learning, and Instruction*. Hillsdale NJ: Lawrence Erlbaum Associates.

Kacmar, K., Andrews, M., Van Rooy, D., Steilberg, R., & Cerrone, S. 2006. Sure Everyone Can Be Replaced...But at what cost? Turnover as a Predictor of Unit-Level Performance. *Academy of Management Journal*, 49(1): 133-144.

Kahne, M. 1968. Suicides in Mental Hospitals: A Study of the Effects of Personnel and Patient Turnover. *Journal of Health and Social Behavior*, 9(3): 255-266.

Katz, R. 1982. The Effects of Group Longevity on Project Communication and Performance. *Administrative Science Quarterly*, 27(1): 81-104.

Kearney, R., & Berman, E. 1999. *Public Sector Performance*. Boulder CO: Westview Press.

Kephart, W. 1950. A Quantitative Analysis of Intragroup Relationships. *American Journal of Sociology*, 55(6): 544-549.

Kettl, D. F. 2008. Fixing the Future, *Government Executive*, Vol. January: p. 40.

Kitts, J. 2006. Collective Action, Rival Incentives and the Emergence of Antisocial Norms. *American Sociological Review*, 71(April): 235-259.

Kitts, J., & Trowbridge, P. 2007. Shape up or ship out: social networks, turnover, and organizational culture. *Computational and Mathematical Organization Theory*, 13(4): 333-353.

Koslowsky, M., & Locke, G. 1989. Turnover and Aggregate Organizational Performance. *Applied Psychology*, 38(2): 121-129.

Krackhardt, D., & Porter, L. 1986. The Snowball Effect: Turnover Embedded in Communication Networks. *Journal of Applied Psychology*, 71(1): 50-55.

Lakhanpal, B. 1993. Understanding the Factors Influencing the Performance of Software Development Groups: An Exploratory Group-Level Analysis. *Information and Software Technology*, 35(8): 468-473.

Lazear, E. 1996. *Personnel Economics*. Cambridge MA: MIT Press.

Leana, C. R., & Van Buren, H. 1999. Organizational Social Capital and Employment Practices. *Academy of Management Review*, 24(3): 538-556.

Lehman, R. 1977. *Computer Simulation and Modeling: An Introduction*. Hillsdale NJ: Lawrence Erlbaum Associates.

Lemire, L., Saba, T., & Gagnon, Y.-C. 1999. Managing career plateauing in the Quebec public sector. *Public Personnel Management*, 28(3): 375-392.

Levine, J., Choi, H., & Moreland, R. 2003. Newcomer Innovation in Work Teams. In P. Paulus, & B. Nijstad (Eds.), *Group Creativity: Innovation through Collaboration*: 202-224. New York NY: Oxford University Press.

Liebowitz, J. 2005. Linking social network analysis with the analytic hierarchy process for knowledge mapping in organizations. *Journal of Knowledge Management*, 9(1): 76-87.

March, J. 1991. Exploration and Exploitation in Organizational Learning. *Organization Science*, 2(1): 71-88.

Martin, D., & Bartol, K. 1985. Managing Turnover Strategically. *The Personnel Administrator*, 30(11): 63-71.

McGregor, E. 1974. Politics and the Career Mobility of Bureaucrats. *American Political Science Review*, 68(1): 18-26.

McNaught, W., & Barth, M. C. 1992. Are Older Workers "Good Buys"? A Case Study of Days Inns of America. *Sloan Management Review*, 33(3): 53-64.

McNeil, K., & Thompson, J. 1971. The Regeneration of Social Organizations. *American Sociological Review*, 36(4): 624-637.

Mealiea, L., & Baltazar, R. 2005. A Strategic Guide for Building Effective Teams. *Public Personnel Management*, 34(2): 141-161.

Meehl, P. 1990. Why Summaries of Research on Psychological Theories are Often Uninterpretable. *Psychological Reports*, 66(Monograph Supplement 1): 195-244.

Mehra, A., Dixon, A. L., Brass, D. J., & Robertson, B. 2006. The Social Network Ties of Group

Leaders: Implications for Group Performance and Leader Reputation. *Organization Science*, 17(1): 64-82.

Meier, K., & Hicklin, A. 2007. Employee Turnover and Organizational Performance: Testing a Hypothesis from Classical Public Administration. *Journal of Public Administration Research and Theory* Advance online publication.

Meyer, C. K., Beville, M., Magedanz, T., & Hackert, A. 1979. South Dakota State Government Employee Turnover and Work Related Attitudes: An Analysis and Recommendation. *Midwest Review of Public Administration*, 13(2): 88.

Mintzberg, H. 1979. *The Structuring of Organizations*. Englewood Cliffs NJ: Prentice-Hall.

Morecroft, J. 2002. Resource Management Under Dynamic Complexity. In J. Morecroft, R. Sanchez, & A. Heene (Eds.), *Systems Perspectives on Resources, Capabilities, and Management Processes*. Amsterdam: Pergamon-Elsevier Science Ltd.

Mosher, W., & Kingsley, J. 1936. *Public Personnel Administration*. New York NY: Harper & Brothers Publishers.

Mueller, C. W., & Price, J. L. 1989. Some Consequences of Turnover: A Work Unit Analysis. *Human Relations*, 42(5): 389-403.

Nahapiet, J., & Ghoshal, S. 1998. Social Capital, Intellectual Capital, and the Organizational Advantage. *Academy of Management Review*, 23(2): 242-267.

North, M., & Macal, C. 2007. *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation*. New York NY: Oxford University Press.

Orcutt, G. 1957. A New Type of Socio-Economic System. *Review of Economics and Statistics*, 39(2): 116-123.

Pace, D. 2004. Modeling and Simulation Verification and Validation Challenges. *Johns Hopkins APL Technical Digest*, 25(2): 163-172.

Parise, S., Cross, R., & Davenport, T. H. 2006. Strategies for Preventing a Knowledge-Loss Crisis. *MIT Sloan Management Review*, 47(4): 31-.

Pennings, J., & Lee, K. 1998. Human Capital, Social Capital, and Firm Dissolution. *Academy of Management Journal*, 41(4): 425-441.

Portes, A. 1998. Social Capital: Its Origins and Applications in Modern Sociology. *Annual Review of Sociology*, 24: 1-24.

Price, J. 1977. *The Study of Turnover*. Ames, IA: Iowa State University.

Price, J. 1989. The Impact of Turnover on the Organization. *Work And Occupations*, 16(4): 461-473.

Pynes, J. 1997. *Human Resources Management for Public and Nonprofit Organizations*. San

Francisco CA: Jossey-Bass Inc.

Rico, R., Sanchez-Manzanares, M., Gil, F., & Gibson, C. 2008. Team Implicit Coordination Processes: A Team Knowledge-Based Approach *Academy of Management Review*, 33(1): 163-184.

Roberts, K., & O'Reilly, C. 1978. Organizations as Communication Structures: An Empirical Approach. *Human Communication Research*, 4(4): 283-293.

Robotham, D. 2004. Developing the Competent Learner. *Industrial and Commercial Training*, 36(2/3): 66-72.

Saavedra, R., Earley, C., & Van Dyne, L. 1993. Complex interdependence in task-performing groups. *Journal of Applied Psychology*, 78(1): 61-72.

Sargent, R. 2005. Verification and Validation of Simulation Models, *Winter Simulation Conference 2005*.

Sastry, M. A. 1997. Problems and Paradoxes in a Model of Punctuated Organizational Change. *Administrative Science Quarterly*, 42(2): 237-275.

Schilling, M., Vidal, P., Ployhart, R., & Marangoni, A. 2003. Learning by Doing Something Else: Variation, Relatedness, and the Learning Curve. *Management Science*, 49(1): 39-57.

Schmidt, F., & Hunter, J. 2004. General Mental Ability in the World of Work: Occupational Attainment and Job Performance. *Journal of Personality and Social Psychology*, 86(1): 162-173.

Scullen, S., Bergey, P. K., & Aiman-Smith, L. 2005. Forced Distribution Rating Systems and the Improvement of Workforce Potential: A Baseline Simulation. *Personnel Psychology*, 58(1): 1-32.

Shafer, S., Nembhard, D., & Uzumeri, M. 2001. The Effects of Worker Learning, Forgetting, and Heterogeneity on Assembly Line Productivity *Management Science*, 47(12): 1639-1653.

Shah, P. 2000. Network destruction: The structural implications of downsizing. *Academy of Management Journal*, 43(1): 101-113.

Shaw, J., Duffy, M., Johnson, J., & Lockhart, D. 2005b. Turnover, Social Capital Losses, and Performance. *Academy of Management Journal*, 48(4): 594-606.

Shaw, J., Gupta, N., & Delery, J. 2002. *Voluntary Turnover and Organizational Performance*. Paper presented at the Academy of Management Proceedings.

Shaw, J., Gupta, N., & Delery, J. 2005a. Alternative Conceptualizations of the Relationship between Voluntary Turnover and Organizational Performance. *Academy of Management Journal*, 48(1): 50-69.

Siebert, W., Zubanov, N., Chevalier, A., & Viitanen, T. 2006. Labour Turnover and Labour

Productivity in a Retail Organization. Bonn, Germany: Institute for the Study of Labor (IZA).

Slichter, S. 1919. *The Turnover of Factory Labor*. New York NY: D. Appleton.

Smelser, N., & Swedberg, R. (Eds.). 2005. *The Handbook of Economic Sociology*. Princeton NJ: Princeton Univ. Press.

Stahl, O. 1962. *Public Personnel Administration* (5th ed.). New York NY: Harper & Row, Publishers.

Staw, B. 1980. The Consequences of Turnover. *Journal of Occupational Behavior*, 1(4): 253-274.

Sterman, J. 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. New York NY: McGraw-Hill.

Stewman, S. 1988. Organizational Demography. *Annual Review of Sociology*, 14: 173-202.

Sturman, M. C. 2003. Searching for the Inverted U-Shaped Relationship Between Time and Performance: Meta-Analyses of the Experience/Performance, Tenure/Performance, and Age/Performance Relationships. *Journal of Management*, 29(5): 609-640.

Thompson, J. 1967. *Organizations in Action*. New York NY: McGraw-Hill Book Co.

Tomer, J. 1987. *Organizational Capital: the Path to Higher Productivity and Well-Being*. New York NY: Praegar.

Tomer, J. 2001. Understanding High-Performance Work Systems: the Joint Contribution of Economics and Human Resource Management. *Journal of Socio-Economics*, 30(1): 63-73.

Ton, Z., & Huckman, R. 2007. Managing the Impact of Employee Turnover on Performance: The Role of Process Conformance. *Organization Science*, Published online in Articles in Advance, December 12, 2007.

Van Der Merwe, R., & Miller, S. 1971. The Measurement of Labor Turnover: A Critical Appraisal and a Suggested New Approach. *Human Relations*, 24(3): 233-253.

Van der Vegt, G., & Janssen, O. 2003. Joint Impact of Interdependence and Group Diversity on Innovation. *Journal of Management*, 29(3): 729-751.

Wageman, R. 1995. Interdependence and Group Effectiveness. *Administrative Science Quarterly*, 40(1): 145-181.

Warren, K. 1999. The Dynamics of Strategy *Business Strategy Review*, 10 (3): 1-16.

Warren, K. 2002. *Competitive Strategy Dynamics*. Chichester UK: John Wiley & Sons Ltd.

Wasserman, S., & FAust, K. 1994. *Social Network Analysis: Methods and Applications*. Cambridge UK: Cambridge University Press.

Williamson, O. 1981. The Economics of Organization: The Transaction Cost Approach. *American Journal of Sociology*, 87(3): 548-577.

Wilson, J. 1989. *Bureaucracy: What Government Agencies Do and Why They Do It*: Basic Books.

Winch, G. 2001. Management of the "Skills Inventory" in Times of Major Change. *System Dynamics Review*, 17(2): 151-159.

Yahja, A. 2006. *Simulation Validation for Societal Systems*. PhD Dissertation, Carnegie-Mellon Univ., Pittsburg PA.