Application of Constraints in a Human-Activity System: A Game-Play Approach for Business

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A thesis submitted for the degree of Doctor of Philosophy of The Australian National University.

December 2001
I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university, and that, to the best of my knowledge, it does not contain any material previously published or written by another person except where due reference is made in the text. The work in this thesis is my own.

Margaret R. Rossiter

Margaret R. Rossiter
For Clive - Always
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Abstract

Central to this thesis is the issue of how to apply constraints within a human-activity system so that the endeavours of the team are coordinated and the creative freedoms of the individuals are supported. It is not a straightforward problem. A broad approach may serve the team well but fails the individuals. A narrow approach, that serves the individuals within an organisation, invariably fails at the team level. This dilemma is a continuing problem for business managers.

A team sports model (netball) has been used to build an understanding of the effects of constraints in a complex business environment. The theoretical analysis focuses on the decision-making process in netball, in particular the effects on decision-making of different levels of constraint. The result is a process improvement tactic that is termed 'the Game-Play Methodology'. The netball analysis also exposes several management practices in netball that are important in business management.

The Game-Play Methodology was tested with teller teams in two bank branches. The results were excellent. In both cases the approach provided a process improvement tactic that allowed staff to improve not only their performance in regard to a team-defined goal: 'maximising the number of over-the-counter (OTC) customers who queue for less than three minutes', but also to improve their efficiency and productivity in related areas.

In the first case study the improvement was dramatic – four weeks after the introduction of a tailored game-play, the team at this branch affected a 143% improvement measured against the goal. At the second branch the baseline performance was much higher so that the improvement was less spectacular, but nonetheless significant – 38% improvement within two weeks of game-play application. In the first case study computer simulation of the extant operating system and the game-play operating system was used to validate the process improvements. In the second case study the modelling process was used to design, develop and justify the game-play, and to educate the service operators prior to its application. While mathematical models are difficult to 'sell' in the workplace, the visual aspects of computer simulation make it a user-friendly medium for the education process.
Abstract

The application of the Game-Play Methodology in the OTC service section of a bank led to the development of a game-play that was termed state based management (SBM). SBM uses knowledge of the operating states of the individuals in a team to establish an understanding of the operating state of the overall system. This is a continuous management process, so that currency of state knowledge is maintained. The design of a response or series of responses to predetermined system states was part of SBM. SBM can be applied in any single-queue, multi-server system that is characterized by random customer arrivals and randomly distributed transaction times.

Current queueing theory provides limited assistance in OTC queue management because of its reliance on queue-length as the state descriptor. In addition, service managers are hampered by the poor standard of service data that is typically collected in the industry. SBM allowed both queue-management and queue psychology to be targeted, thereby reducing the real-time wait for the customers and increasing their patience threshold for waiting.
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# Abbreviations

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<th>Description</th>
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<tr>
<td>ATM</td>
<td>Automatic Teller Machine</td>
</tr>
<tr>
<td>EBD</td>
<td>Express Business Deposit</td>
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<tr>
<td>ET</td>
<td>Express Transaction</td>
</tr>
<tr>
<td>FDB</td>
<td>Flexi-Deposit Box</td>
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<tr>
<td>FIFO</td>
<td>First-in First-out</td>
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<td>LT</td>
<td>Lengthy Transaction</td>
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<td>OTC</td>
<td>Over-the-Counter</td>
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<td>PT</td>
<td>Prolonged Transaction</td>
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<td>QMET</td>
<td>Queue-Manager / Express Teller</td>
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<td>SA</td>
<td>Service Advisor</td>
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<td>SBM</td>
<td>State Based Management</td>
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<td>SSA</td>
<td>Sales and Service Advisor</td>
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## Netball Playing Positions

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<td>GA</td>
<td>Goal Attack</td>
</tr>
<tr>
<td>WA</td>
<td>Wing Attack</td>
</tr>
<tr>
<td>C</td>
<td>Centre</td>
</tr>
<tr>
<td>WD</td>
<td>Wing Defence</td>
</tr>
<tr>
<td>GD</td>
<td>Goal Defence</td>
</tr>
<tr>
<td>GK</td>
<td>Goal Keeper</td>
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Chapter 1 Introduction

1.1 Problem Definition

In the business world the link between the welfare of the organisation and the behaviour of individuals is recognised. Managers in all areas of human activity face the challenge of applying constraints such that efforts to coordinate the team do not compromise the creative freedoms of the individuals. In acknowledging the need to support a worker’s freedom to be responsive and innovative, while enforcing constraints to maintain the vision of the organisation, both academics and business practitioners have identified a key management issue. Work in this area has discussed the need for judicious application of constraints and examined the impact of constraints on overall business performance, but has failed to offer pragmatic advice on how a balance of individual freedom and constraint may be achieved.

*How should workers be constrained to ensure coordination of their efforts, without limiting their individual abilities to be creative in support of corporate goals?*

The problem has two parts: that of applying constraints to the individual so that the overall team effort is supported, and that of sponsoring the individual’s freedom to investigate and develop creative responses for the organisation. The dilemma is that these endeavours are orthogonal in purpose - their conflicting nature dictates the need for a balance. Attempting to optimise either aspect in isolation will undermine the other and ultimately the organisational system.

In this thesis it will be argued that a set of constraints may be designed to support simultaneously the corporate or team goals and the freedom of the individual. Further, the success of the designed constraints will be greater in a working environment that not only embraces, but also ‘teaches’ creativity. Central to these ideas is the notion that a balance between freedom and constraint for the organisation is an emergent property requiring achievement of a balance at the individual level. Thus, three hypotheses frame the approach that will be taken:

**Hypothesis 1:** That new freedoms for the team and the individual will emerge once the appropriate constraints have been designed for the individual.
Hypothesis 2: That a set of constraints may be designed to support simultaneously the corporate goals and the creative freedom of the individual.

Hypothesis 3: That the probability of success of the constraints so designed will be greater in a working environment that not only embraces, but also 'teaches' creativity.

1.2 The Framework for Analysis

The complexity of business organisations is an impediment in the analysis process. Sterman (2000, p. 38) argues that effective learning is not possible in complex settings, making simulation essential. Business models to date have either attempted to describe the complexity of the system or, as is more common, have focussed on a particular aspect of the business (Forge 1993, Hartley et al 1997, Lyons et al. 1995, Jarzabek 1996). The latter approach often leads to simple, tractable models 'where simplicity dominates utility [and] elegant theorems are derived from questionable axioms,' (Sterman 2000, p. 37). System complexity, and the consequent failure of investigations to develop useful business models, has hampered research into the problem of balancing individual freedom and constraint.

The approach taken in this thesis depends on the identification of a working human-activity system that can provide lessons in organisational and individual control, without the complexity that typifies the business world. The system chosen is that of the team sport netball. Here netball is used to provide a detailed model of team activities. Thus, the approach taken here is much stronger than that taken in studies where team sports provide no more than an analogy for business activities. The team sport environment closely maps the competitive and goal-driven nature of the business world, and a netball team provides a robust model of an organisation within that environment. The choice of netball as the human-activity system for analysis is based on its unique character. The rules of the game ensure that the organisation of netball closely represents a business work structure, making it a better model than other popular team sports.

The balancing process suggested in this thesis is the result of an iterative process of theoretical analysis using the netball model and application of the theory in the business domain to provide feedback to the theoretical development. Critical analysis of control in netball resulted in design of the game-play methodology, which is a technique for the
design and application of constraints. A balancing process developed within the netball framework, and incorporating the game-play approach, was tested in two business case studies in the service industry. The approach proved to be highly successful, resulting in significant throughput increases without changes in time allocated to customers.

### 1.3 Freedom and Creativity

The concepts of constrained freedom and team-directed, individual creativity play a crucial role in this research. Constrained freedom is not the oxymoron that it would at first appear to be – it provides a rational, descriptive view of individual ‘freedom’. The netball case provides a framework for understanding this concept of constraints that support freedom. Constraints are necessary to support a range of individual and team freedoms (Schwartz 2000).

Understanding of creativity has expanded from the early concept of genetically endowed human ability (origin-oriented creativity) to the concept of an ability that can be learned and enhanced (process-oriented creativity). (Marakas & Elam 1997, Ogilvie 1998) If a business is to survive and prosper then individuals in the organization must be able to exercise creativity in the same way as they can in a successful netball team. Basic to this work is the assumption that the competitive power of creativity can be harnessed to address the problem of balancing freedom and constraint.

### 1.4 Literature Review

Business is one of the most examined, measured and analysed environments of human activity. It is also one of the most competitive. In their drive to succeed, organisations constantly seek to improve the way they do business. Freedom and constraint issues appear in the recent literature under the heading of ‘organisational control’. Such control is often viewed as an emergent property of the imposed structure. While reference to the problem may be found in a number of management works, no practical solution was found. Philosophical aspects of the topic are addressed in works on job design (Campbell 2000, Campion et al 1996, Cunningham & McGregor 2000, Gill 1996, Hayslip et al 1996), empowerment of the worker (Hardy & Leiba-O’Sullivan 1998, Malone 1999, McEwan & Sackett 1998, Semler 1994), centralization and

1.4.1 A Balance for the Individual

The notion of subjugating individual freedom to control is not new. Too much freedom increases waste and reduces predictability – tight control improves predictability and thus seems much safer. Hierarchy and formalisation typified business at the turn of the last century when the German philosopher Max Weber (1946) introduced the word ‘bureaucracy’ to describe an explicitly organized structure. Frederick Taylor (1911) promoted the advantages of a strictly controlled approach in his Principles of Scientific Management. Taylor advocated tight constraints on every aspect of a worker’s tasks. A strict hierarchy of supervision was established to ensure adherence to the imposed constraints, and bureaucracy flourished on the factory floor. Initially, measured process improvements gave impetus to the spread of the new ‘science’, but while the technical aspects of work design were being addressed, the human aspects were being ignored. The drive for predictable, controlled performance and outcomes had overlooked both the needs and potential of the workers.

After 20 years of persistent management control that saw the advent of time and motion studies, activity scheduling and the moving assembly line, Elton Mayo (1945) suggested that appreciation of the human contribution to the workplace was an avenue for improved job design and business performance. Mayo was the leader in a series of experiments conducted at the Hawthorne division of the Western Electric Company, in Chicago (1927-1932). His team discovered that job satisfaction increased through employee participation in decisions, rather than through short-term incentives. In Mayo’s words (1945, p. 112), "... the eager human desire for cooperative activity still persists in the ordinary person and can be utilized by intelligent and straightforward management." Worker motivation was identified as a key issue in improving productivity. Total control was in effect a de-motivator. To improve the ‘bottom line’, businesses would need to balance the needs of the workers with the control-driven needs of the company.

Quality issues came to the fore over the next half-century, with a more balanced focus on product and people issues. The American engineer / philosopher, W. Edwards
Deming provided a philosophy that pushed concepts of quality and reliability back to the design stage where they belong, and gave workers control over their work (and the work of their teams) and shared responsibility for product quality and organisational performance. Deming's management method combined the statistical control processes of his teacher, statistician Walter Shewhart, with a philosophy on empowering workers. 'Total Quality' approaches (Deming 1982, Juran 1988, Taguchi 1989) spread in the 1950's and 60's, spurred on by the widespread use of automation. The freedom of workers to design and implement quality process improvements was an integral part of the Total Quality Management (TQM) approach.

While quality issues are still important, business managers are now focussing on customer service, and timeliness of ideas and innovation. Businesses must find a balance between the individual freedoms that support creativity, and the constraints that allow coordination of individual efforts in support of corporate goals. A number of researchers have identified this need. Derek Pugh (1971, p. 10) made these comments in the introduction to a book of selected readings on organisation theory – "... it is one of the basic tasks of management to determine the optimum degree of control necessary to operate efficiently. ... It is through a study of the constraints in relation to the objectives that the most efficient organisational control systems can be established." A quarter of a century later, Charles Handy (1995, p. 19) had similar advice – 'Organisations will need to give more freedom to individuals than they may be comfortable with if they are to retain their commitment and creativity, finding the beneficial compromise behind the corporate need for control and the individual pressure for autonomy.' In neither case did the authors offer any practical advice on how this might be achieved. The problem of a balance of freedom and constraint for the individual is widely recognised in business and management science fields, but remains unsolved.

1.4.2 A balance for the Organisation

"There is a widespread, almost universal under-estimation of the impact of organisation on how we go about business. "Get the organisation right, and the people and the managers ... will be enabled to work." (Jacques 1996, p. 22 & 2) Heckscher (1994) suggests that work on 'getting the organisation right' is 'a domain in which practice is outstripping theory'. Research is failing management practitioners and organisational
practice seems to be a ‘an oscillation between centralizing and decentralizing moves; in recent years it appears this oscillation has speeded up in many companies, because neither solution deals with the essential problems.’ When one form fails, the reaction is to move as far as possible away from that structure, and so the pendulum swings between two ends of the control continuum. Others reiterate Heckscher’s line of reasoning, for example (Mitchell 1979, Wickens 1994, Prahalad & Hamel 1994, Heckscher & Donnellon 1994). Prahalad and Hamel argue for ‘not absolute decentralization, nor a heavy-handed corporate strategy, but what they describe as ‘enlightened collective strategy’, blending the strengths of both.

Intuitively it seems that the very factors that drive organizational change towards decentralization are the ones that force the reversion to centralized control:

<table>
<thead>
<tr>
<th>Decentralization Initiatives</th>
<th>Centralization Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of individual initiative</td>
<td>Organizational fragmentation</td>
</tr>
<tr>
<td>Removal of checks and balances</td>
<td>Disjointed control</td>
</tr>
<tr>
<td>Delayering</td>
<td>Loss of custodians of values</td>
</tr>
<tr>
<td>Removal of rigid hierarchy</td>
<td>Confusion on authority issues</td>
</tr>
<tr>
<td>Loosening of communication rules</td>
<td>Degradation of communications</td>
</tr>
<tr>
<td>Removal of inflexible values</td>
<td>Mismatch of values</td>
</tr>
<tr>
<td>Distribution of task area</td>
<td>Lack of focus</td>
</tr>
</tbody>
</table>

While this ‘pendulum swing’ appears to be self-sustaining, there is little concrete evidence to support this supposition. One of the difficulties in examining the phenomenon is the lack of definition. Mintzberg (1979, p. 18) maintains that ‘the words centralization and decentralization have been bandied about for as long as anyone has cared to write about organisation. Yet this remains probably the most confused topic in organization theory. The terms have been used in so many different ways that they have almost ceased to have any useful meaning’.

1995); whether it can be formalized or is driven by a natural equilibrium (Litterer 1963, Child 1984, Jacques 1996). The point that is critical to this study is one on which there is consensus – neither pure centralization (a hierarchy of rules) nor the ideal of decentralization (the distribution of control) serves the organisation well. A balance between the two, drawing on the strengths of both forms, is required.

### 1.4.3 The Goal

There is one aspect of the application of constraints and the endeavour to balance freedom and constraint for the individual that cannot be overlooked, for it provides the direction for the balancing process.

The importance to a business of “sharing a vision”, for its effect on individual and team motivation has been recognised (Bartlett 1994, Wickens 1995). It is a recurring theme in praise of successful organisations. Jacques\(^1\) (1996, p. 16) uses the word ‘values’ in place of goals, describing values as ‘what you want’ and the ‘vectors’ that give the organisation direction. Semler (1993, p. 300) defines ‘natural business’ as a guiding principal that focuses ‘everyone [on] the crucial corporate tasks’. Wickens (1995) views an ascendant organisation\(^2\) as one that develops a culture driven by the organisation’s goals. Collins & Porras (1995) stress that having ‘Big Hairy Audacious Goals’ is essential to organisational prosperity. Senge (1990, p. 206) talks of a ‘shared vision’ that is ‘vital for the learning organization because it provides the focus and energy for learning.’ If organisational structure is the lynchpin of sound organisational control, then the concept of ‘the goal’ is the overriding force necessary for efficient operation.

Businesses have embraced the concept of formulating mission statements, strategic plans, and long-term visions but more often than not these remain as statements of purpose, never becoming goals that guide the organization and its people (Senge 1990 p.206). The netball study revealed a further dimension to the importance of having goals – without goals a balance of freedom and constraint cannot be achieved.

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\(^1\) While Jacques does not underestimate the importance of an organisational culture, this is not the thrust of his work. Jacques argues that the imposition of an organisational structure cannot alter the inherent hierarchical nature of humans. Similarly, any attempt to remove hierarchical layers from the framework will face difficulties, as the ‘true’ nature of the workforce will assume its own order (without the formal chart).

1.4.4 Freedom and Creativity

Much has been written about the states of freedom and constraint for the individual, (Cranston 1953, Denbigh circa 1973, Beer 1973, Hale & Swuste 1998, Harney 1998, Schwartz 2000), and the consensus appears to be that definition of the state is intrinsically linked to the environment. A definition that serves the legal fraternity in understanding these issues may differ from the definition that is appropriate in the social welfare system and may differ yet again from the definitions used in discussion of the environment. Freedom and constraint are defined in this thesis to serve the specifics of this topic.

Too often those who impose constraints put little effort into understanding the balancing process, opting simply for complete control as the safe option. Outcomes are much easier to predict when the system and its players are tightly constrained; and predictability simplifies the decision-making (management) process. The logic is that a predictable, acceptable level of business performance is preferable to an unpredictable one that could as easily be lower as it could be higher. The downside to this approach, in business terms, is that it forgoes any opportunities for achieving ‘better’ outcomes. In human terms, it crushes initiative and stifles motivation.

Unchecked individual human interpretation, creativity, and adaptation have the potential to undermine the activities of an organisation, just as they offer the key to enhancing its performance. Fifty years ago scientific management techniques were introduced to constrain workers and limit the introduction of variation into the workplace. Today there is awareness that inhibiting individual creativity can result in lost business opportunity.

1.5 Summary

The following points are garnered from the literature:

- Unconstrained individual behaviour (no coordination of efforts) can be detrimental to organizational performance.
• Strict management controls (structure) can impede the worker's ability to be creative or responsive in support of the organization.
• Constraints can be supportive while also being restrictive.
• Organizations function best when the individuals and the organization are committed to common goals.

Many authors agree on the need to find a balance in the application of constraints – to reconcile the individual freedom required to be responsive and innovative, with the corporate constraints needed to maintain the vision. The aim of this work is to add some theoretical rigor to the discussion on individual freedom and constraint within an organisation, and provide a workable process for the application of constraints.
Chapter 2  Theoretical Framework – A Sports Model for Business

2.1 Sports Analogies

Using a sports team as an analogy of a business organization is a well-worn idea. For over half a century comparisons between the two have been made, to the extent that the language of sport has entered the business vernacular. Talk of teams and teamwork, coaching and mentoring, scoring a try, varying the play, striking out, hitting a home-run, being asleep in the outfield, could equally well take place at work as on the sporting field. These ideas from team games are readily conceptualised and translated to the business domain. Their simplicity and universality create a clear platform for business discussion at this superficial level.

Such analogies persist, with analysis restricted to a single attribute of team sports or the more general culture of a sporting team (Gephart 1999, Skinner 1998, Kamm 2001, Morris 2001, Carver 1992, Guilford & Hubbard 1995, Stirling 1997). The rush to emulate the best values of team sports has seen the business world grapple with incomplete concepts\(^1\) (Belbin 2000). An appreciation of the value of teamwork was one of sport’s greatest contributions to business, and teams were embraced as the answer to challenges that thwarted the individual. Nevertheless the idea of creating a team has repeatedly been reduced to grouping workers with a range of skills – a far cry from the complex process of selection, coaching and nurturing required to form a successful sporting team. To date most comparisons have dealt with sport in general – in particular the sporting view of competition and teams, and the application of this view to business. The sporting domain has more to offer the business world than behavioural catchphrases, but it demands a deeper analysis; a study of the specifics as well as the generics, of team sport.

Robert Keidel (1985) added a new dimension to the analysis with his framework for organisational structure based on three of America’s most popular sports: baseball, football and basketball. The three models mirrored the triadic constructs of theorists of

\(^1\) Compare the understanding on teams displayed in Jastrow (1999) with the ideas of Belbin (2000).
the previous two decades and provided a framework that could be easily understood by business managers. Keidel maintained that every organization could be represented by either:

- A baseball team, 'where the players (the employees) perform independently, at their own initiative',
- A football team, 'where the coach (the manager) prepares a comprehensive game plan in which the players’ roles are tightly specified', or
- A basketball team, 'in which players (workers) exercise a high degree of spontaneous teamwork, with the coach/manager as a catalyst constantly adjusting the game plan to fit the situation'.

In essence Keidel was suggesting that decentralization, centralization or some combination of the two (which Keidel views as the cooperative structure), could describe every organization. He found that 'the sports idiom could provide a systematic way to analyse a business organization' (Keidel 1985, p. x). Recognizing the appropriate structure for your organization could be as simple as recognizing that your strategy matched that of one of the aforementioned team sports. For a nation of sports enthusiasts the team models provided an understandable framework for business organization.

Keidel examined the usefulness of the sporting models at a strategic level, drawing parallels between the structures of the three sports and business organisations. For each of his sporting models he identified a dominant business challenge that matches the primary challenge to a sporting team:

- Baseball: Get the players right;
- Football: Get the plan right;
- Basketball: Get the process right.

Keidel argued that ‘for corporations, [these] challenges represent partially opposing pulls’ and that ‘all three pulls cannot be maximised at once; deciding which pull(s) to

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2 Keidel (1985) provides a tabulated comparison of his sports models in relation to the constructs of over 20 organizational theorists during the period from 1967 to 1985. He discusses the linkages between his work and theirs. (Keidel, Appendix 1) Thompson (1976) provided the initial theoretical framework used by Keidel to develop his sports models with three forms of task interdependence: pooled (baseball), sequential (football), and reciprocal (basketball). Galbraith (1973) proposed three organization design strategies – creation of self-contained tasks (baseball), investment in vertical information systems (football), and creation of lateral relations (basketball). A decade later, Ouchi (1984) divided organizational types into three forms – H-form (baseball), U-form (football), and M-form (basketball). Keidel uses these and others to both qualify and support his sports model theory.
favour is up to the corporation.’ Keidel suggested that corporations should ‘understand their dominant challenge and organize to meet it’. The result will be that ‘a change from one model to another over time may be the rule’.

Keidel’s work represents a step in the right direction, but his assumption that it is not possible to ‘get the players, plan and process right’ simultaneously will be challenged in this thesis. Each is an important management issue, but they are not mutually exclusive. Getting the players right will support the process. The right plan will enable the players to design the right process. The right process will ensure attainment of the plan.

This study takes a deeper view of the business/sports model than did Keidel and examines the issue of control within a single sporting team. The focus is on team processes and the role of individuals within a team. The analysis of netball will show that the ‘right plan’ is essential in achieving a balance of freedom and constraint for the individual in support of the organisation.

In this work it is argued that most organizations will need to impose corporate constraints and allow individual freedoms – the challenge being to find a balance between the two. The risks associated with the loosening of controls, which characterize decentralization (freedom), and the sacrifice of creativity and motivation, which characterizes bureaucracy (constraint), drive the need for a balance. This does not conflict with Keidel’s early work and his three sports models of business strategy – the balance between freedom and constraint for the baseball player is simply heavily weighted towards autonomy; towards dependence on imposed constraints for the footballer; and with less bias for the basketballer. Figure 2.1 illustrates this contention that different compositions of individual freedom and constraint are required in the different team sports.

American football requires a high degree of coordination and control, by the coach off the field and the quarterback on the field. Each player looks to the coach for definition and description of his role within the team. Keidel describes the ‘head coach’s composite task’ as being to prepare ‘a comprehensive game plan, exhaustively rehearse it [with the team], and then implement it’ (Keidel 1985, p. 8). The quality of the game plan and the ability of the individual players to follow instructions are of importance in
Keidel argues that 'Baseball simply is less controllable by the manager', and that 'team outcome – a win or loss – is the aggregate of individual efforts' (Keidel, p. 11). Autonomous effort – the success of each individual – is critical to the success of the baseball team. These two sports strategies might be viewed as models of centralized (football) and decentralized (baseball) business organizations. Their inappropriateness in the current business environment is central to the hypotheses of this thesis.

The business environment has seen many changes in the twenty-five years since Keidel's initial work on sports strategies for business, and his descriptions of the basketball-organization most closely reflect modern organisations and the pace of change that confronts them. '[They] are uniquely suited to change. They can survive in a dynamic milieu because they can adapt to unforeseen conditions. In an uncertain, rapidly changing environment, the central planning of a football-organization is often of limited usefulness. Things just change too quickly. The more long term the plan, the more quickly it will decay; as events unfold that undercut its assumptions. Such conditions favour a basketball-organization, which has the resources and flexibility to plan as it goes' (Keidel, p. 57). The balance between individual freedom and constraint is a key issue for a basketball-organization. Individuals within a basketball team must be flexible - able to follow instructions within a coordinated team when required, able to use personal initiative when needed, and able to recognise the differing requirements for each. '[It] combines football’s emphasis on the team with baseball’s emphasis on the individual' (Keidel, p. 64).
While endorsing Keidel's early work on team sport strategies, this study challenges the precept upon which Keidel's latest work is built. In *Seeing Organizational Patterns* (1995), he states that the idea of a continuum of control from centralization to decentralization is too simplistic. He argues that there is no allowance in the straight-line theory for the concepts of cooperation and collaboration. In this study cooperation and collaboration are seen as natural examples of endeavours to find the balance between freedom and constraint for an individual within a team.

Keidel chose his three sports models for their strategic differences. Balancing individual freedom and constraint for the individual is a tactical process so that a single team sport is appropriate. Netball has process attributes that make it a better model of business activity than other popular team sports. In netball each player is restricted to a specified area of the court, and success in the game is achieved only through the cooperative efforts of all players on the team. In basketball, soccer, hockey and football, the rules allow a single player to control the ball for the length of the court or field, and so enable an individual to score for the group. Although this type of 'star' play is not common in high-level games, it is permissible under the rules of those sporting codes. In netball, each player must rely on his or her team-mates and the team depends on a coordinated flow of work between players.

### 2.2 The Netball Model

It is possible to construct team sports models of business that are valid at both the organizational and individual levels. The comparisons listed in Table 2.1 highlight the functional and structural similarities. The bold dot-points are particular to netball. In other team sports it is possible for individual play to be a feature – netball demands coordinated effort and timely decisions from all players.

So there are two aspects of netball that make it a better model of the business case, compared with other team sports. The first is the need for a flow of work that is shared among the team members to move the ball to a successful goal. The second is the limited decision-time available in the game. In netball a three-second limit on holding the ball makes rapid decision-making critical. In business the decision-making constraints may be policy driven or part of the competitive environment, but invariably
decisions must be made within tight time constraints. (See §2.3 for discussion on constraints.)

Table 2.1 · Comparison of the Netball Model to Business

<table>
<thead>
<tr>
<th>The team:</th>
<th>The organisation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• consists of a number of players.</td>
<td>• consists of a number of structural subsytems which can be reduced at its lowest structural level to individual agents.</td>
</tr>
<tr>
<td>• has a goal that can be articulated.</td>
<td>• has a goal that can be articulated.</td>
</tr>
<tr>
<td>• has a workload that must be distributed among the players.</td>
<td>• has a workload that must be distributed throughout the organisation and among the individual agents.</td>
</tr>
<tr>
<td>• is subject to variations in workload from both internal and external sources.</td>
<td>• is subject to variation in workload from both internal and external sources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The player:</th>
<th>The individual:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• is constrained in her behaviour by the coach and the player’s own abilities.</td>
<td>• is constrained within the organisation by rules, local instructions and his or her abilities.</td>
</tr>
<tr>
<td>• is part of a complex human-activity system and behaviour is linked to that of the other players and the coach.</td>
<td>• is part of a complex human-activity system and behaviour is linked to that of other agents within the organisation and the manager.</td>
</tr>
<tr>
<td>• is subject to variations in workload from both internal and external sources.</td>
<td>• is subject to variation in workload from both internal and external sources</td>
</tr>
<tr>
<td>• is required to make timely (rapid) decisions.</td>
<td>• is required to make timely decision.</td>
</tr>
</tbody>
</table>

2.2.1 Background on the Game of Netball

Netball is the most popular women’s sport in the world, being played in over 50 countries. In Australia, an estimated 1.3 million players enjoy the sport and involvement ranges from social competition, through local and state representative
games to the national league. Australia has won eight of the ten World Championships held since 1963. Eleven nations took part in the first World Championship held in England; twenty-eight nations contested the 1999 World Championship in New Zealand.

The history of the development of netball spans more than a hundred years. In 1881, in Springfield, Massachusetts, a YMCA gym instructor devised the game of ‘basketball’ in an attempt to create an indoor game which would be less injurious to participants than the popular soccer or football were proving to be. James Naismith reasoned that if players were unable to run with the ball, were barred from tackling and forced to score by dropping the ball into a raised basket, much of the speed and physical danger of traditional ball games would be removed. Having 18 young men to instruct, Naismith settled on a team of nine - three forwards, three centres and three backs.

The development of women’s indoor basketball largely followed the men’s game, but at a more sedate pace. The women were hampered by long skirts, bustle backs, ‘leg of mutton’ sleeves and leather button-up shoes, none of which were conducive to bouncing the ball or passing the length of the court. But the women persisted and the game often moved outdoors on grassed courts.

In 1885, a physical education teacher from New Orleans, Clara Baer, requested a copy of the rules of basketball from Naismith with the intention of introducing her students to the game. In a misunderstanding, Baer read Naismith’s suggestions for the best playing areas for forwards, centres and backs as constraints on the playing areas available to each player. Baer restricted three players to each third of the court. This ‘mistake’ was ratified in 1899 when the rules of women’s basketball divided the court into no-go zones and the game began to evolve towards the netball form that we see today.

While the men’s version of basketball flourished in the US, women’s basketball first found its footing in the UK and subsequently spread throughout the Commonwealth. Clothing restrictions and the physical abilities of women, saw the game modified to one of stopping, catching, passing, and shooting from the ground - as opposed to the dribbling, moving, aerial game played by men. In 1960, The International Federation of Women’s Basketball and Netball was established and rules for both codes were
formalized. The name 'netball' has now been officially adopted for the amalgamation of the codes. Netball is no longer the sedate, ladies’ game of its conception. Both female and male players play the game with the same degree of frenzied athleticism that characterizes basketball.

2.2.2 The Game of Netball

Although an offshoot of basketball, the similarities between the two games are limited.

- Both games are played on a hard-surface court approximately 30m x 15m (either indoors or outdoors),
- Both games involve a round ball, and two opposing teams,
- In both games goals are scored by passing the ball through an elevated ring.
- The intention in both games is to promote a non-contact sport.

And here the similarities end.

![Figure 2.2 The Layout of a Netball Court](image)

The court in netball (Figure 2.2) is divided into thirds by two transverse lines. In each of the end thirds, the court is marked with a shooting semicircle, which bears the misnomer of 'goal-circle', of approximately 5m radius. A small 1m-diameter circle, the centre-circle, is placed centrally in the middle third of the court and is the starting point of the game and the restart point after a goal is scored. Goalposts are fixed at each end of the court. The goal-ring is approximately 3m from the ground, has no backboard for rebound scoring and is proportionally smaller than a basketball ring, to accommodate the size 5 international soccer ball that is used in netball. In the context of the game, the
post and ring are considered as a person - no intentional contact with the post is allowed, and a player can replay the ball after it has struck the post or the ring. Unlike basketball in which shots can be taken by anyone from anywhere on the court, netball allows only two designated players on each team to attempt shots and these must be taken from wholly within the goal circle.

A netball team consists of seven players - three designated attacking players, one centre player and three designated defending players. A brief description of the roles of players within a netball team is given in Table 2.2. The starting positions for the team (to begin the game and after a goal is scored) are shown in Figure 2.3.

![Diagram of netball positions](image)

**Figure 2.3 The Starting Positions for Players in Netball**

The netball zone and play restrictions mean that no one player can move the ball through the entire length of the court and likewise no one player can defend in all zones of the court. The set areas for each player are illustrated in Figure 2.4. These zone restrictions, together with a rule requirement that the ball must be touched or 'grounded' in each third, ensure that several players are instrumental in ball transition from one end of the court to the other, while the other team members work 'off the ball'.

Players wear identification patches - 150 mm initials of the playing positions - (worn above the waist, front and back) that allow umpires to enforce the zone restrictions.

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3 These three designations (attacking, centre court and defending) refer to the court restrictions and the primary role of these players within the team. In netball, however, every player is required to attack and defend throughout the game.
Chapter 2: Theoretical Framework – A Sports Model for Business

Direction of Attacking Play

Figure 2.4 Zone Restrictions in the Game of Netball

Table 2.2 Roles of the Players in Netball

<table>
<thead>
<tr>
<th>Attacking Players</th>
<th>Centre Court</th>
<th>Defending Players</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal Shooter (GS)</strong></td>
<td><strong>Centre (C)</strong></td>
<td><strong>Goal Keeper (GK)</strong></td>
</tr>
<tr>
<td>The GS is restricted to the attacking goal third. Her primary role is that of shooting goals and her accuracy in this regard is vital to team success. Failure at the point of shooting can render all the work that has gone before futile. GS may also be involved in the attacking lead-in to the goal-circle, effectively alternating roles with the GA for that play.</td>
<td>The C may move throughout the court, but not in the goal circles. She acts as a link between the two ends of the court, carrying a similar load to that of the WA and WD in their respective goal thirds, and driving hard through the centre court in both attack and defence. Traditionally this player has a fitness level second to none on the court.</td>
<td>The GK is restricted to the defending goal third. Her primary role is to ensure that the opposition does not score. She must also work to feed the ball from the defensive end towards her team's shooting end.</td>
</tr>
<tr>
<td><strong>Goal Attack (GA)</strong></td>
<td></td>
<td><strong>Goal Defence (GD)</strong></td>
</tr>
<tr>
<td>The GA may move in the attacking goal third and the centre third. There are two equally important aspects to her role - that of bringing the ball down court and that of shooting goals.</td>
<td></td>
<td>The GD may move in the defending goal third and the centre third. Her immediate opposition is the opposing GA, but the ultimate description of her primary role is to ensure the other team does not score. Her role in attack covers two-thirds of the court.</td>
</tr>
<tr>
<td><strong>Wing Attack (WA)</strong></td>
<td></td>
<td><strong>Wing Defence (WD)</strong></td>
</tr>
<tr>
<td>The WA may move in the centre third and in the attacking goal third outside the shooting circle. She must work hard to be clear for the centre-pass; and work with C and GA through the centre and around the goal circle to deliver the ball to the shooters. After an unsuccessful attempt at goal followed by loss of the ball to the opposition (a turnover), the WA must defend the opponents' play through the centre court.</td>
<td></td>
<td>The WD may move in the centre third and in the defending third outside the shooting circle. She must work hard off the centre-pass to prevent a pass to the opposing WA; and with C and GD through the centre and around the goal circle to defend the opposing play. Once a 'turnover' has been achieved and her team is in possession of the ball, the WD plays an attacking role to move the ball from the defending end and deliver it to the attacks.</td>
</tr>
</tbody>
</table>

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The article 'the' precedes all positional abbreviations in this document since it is intended that the abbreviations be read in full – i.e. 'the GA' is read as 'the Goal Attack', in the same way that one would read 'the FltLt' as 'the Flight Lieutenant'. The abbreviations appear on positional patches worn in all games of netball, but are always discussed in the expanded form since the title for each position also provides some understanding of the role of the player within the team.
While there are many nuances to the basic rules of netball, the overall intention of the rules can be summarized as follows:

1. Only two team positions on court may shoot for goal (and all shots must be taken from wholly within the goal-circle).
2. Once a player has caught the ball, she can only ground her first landed foot once before passing the ball. (In the official rulebook, this generalized rule covers several pages. While simple in its intent, the footwork rule requires a degree of interpretation before one can understand why a seemingly stationary player can be called for 'stepping', while a running player may legitimately cover nearly a third of the court.)
3. A player must pass the ball within 3 seconds of receipt and may not pass to herself.
4. There must be no contact, which interferes with the play, between players.
5. A defending player must stand at least 0.9m from an attacking player with the ball.
6. Each position on court has a restricted area of play.

### 2.2.3 Playing a Game

The game is started on the umpire's whistle. The team in possession of the ball aims to execute a series of passes to move the ball from the centre circle to one of their two shooting players in the goal-circle. The opposition aims to interfere with this process, intercept the ball and become the team in possession. Once either team scores a goal, the ball returns to the centre circle to restart play. Teams alternate taking the centre-pass\(^5\), irrespective of which team scored the last goal.

The time that elapses from centre-pass to the scoring of a goal may be less than 10 seconds or as much as several minutes, as possession of the ball alternates between the teams. The rules of netball ensure that at least two of the seven players must be involved in passing the ball from the centre circle before a goal is scored. Typically, four or five players are involved, while the other players work off-the-ball, using positional tactics, to support their team play.

\(^5\) The term 'centre pass' describes the pass that begins the game or restarts the game after each successful shot at goal. The pass is taken by the team centre who must be wholly within the centre circle before the umpire blows the whistle to start the game.
Netball can be played by anyone at any age, but is most enjoyable when the opposing teams are evenly matched in terms of skills and knowledge of the game. Novice players can enjoy competitive play with little understanding of the rules beyond the restricted playing areas and the demand that players must not ‘move with the ball’. At elite levels, intimate knowledge of all aspects of the game and the governing rules (constraints) is essential.

2.3 Defining Freedom and Constraint in the Netball Model

Freedom and constraint are generally viewed as opposites, diametrically opposed concepts like high and low, wide and narrow, right and wrong. The distinction within the pairs owes more to perspective, comparison and assessment of the norm, than it does to a definitive understanding of the states. How high is high? Relative to what? Wide by comparison to what? Whose moral stance dictates wrong? How strict is your version of right?

State descriptors of this nature can rarely stand alone. They require a gauge against which they can be measured. Maurice Cranston (1953) explained this need: “Whereas ‘I am hungry’ has one meaning, ‘I am free’ might have any one of a vast range of possible meanings. If we are to know which of those innumerable possibilities is intended, we must know what it is that a man who says he is free, is free from. He must name a constraint, impediment or burden.” Freedom cannot be understood without understanding the idea of a constraint, and the degree of freedom (or constraint) cannot be measured in absolute terms.

The categorization of constraints on the individual that is used in this analysis has been drawn from the netball case. A hierarchy of constraints – in terms of consequence, scope and intent– was observed in netball, and formed the basis for categorization that has been developed here. This hierarchy suggested three categories of constraints on the individuals – defined here as prescriptive, descriptive and ascriptive.

Prescriptive constraints are the rules that describe the game of netball. These would include the universal rules of the game as prescribed in the Netball Australia - Official
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Rule Book (1997), local rules prescribed by the official body administering the
competition, and any rules imposed by the club or association to which the team
belongs. While it may be possible to flaunt a prescriptive constraint, there are penalties
associated with such action; penalties that deem the action contrary to accomplishment
of the team’s desired outcomes or goals. The prescriptive constraints in netball
establish the broad game environment for the players and the scope of permissible
freedoms. Within this framework of constraints, the individuals and the teams will
develop their approach (their form of play), which allows them to achieve their goals. It
is the prescriptive constraints that distinguish this team game as netball (rather than
basketball or football or soccer etc).

Descriptive constraints are the external causal factors that constrain the individual in
the current game situation. They may include the physical environment (for example
weather conditions, court surface, lighting conditions, properties of the ball, goalpost
construction), the behaviour of other individuals (team-mates, opposition, umpires,
managers, coaches, spectators, sponsors) and the directives of the perceived goal or
mission. The descriptive constraints add to the prescriptive constraints in describing the
immediate environment for the individual.

Ascriptive constraints are set and managed by the individual: mental attitude,
understanding, creativity, speed, strength, anticipation, knowledge, flexibility, accuracy,
endurance, and aptitude. When the interpretation and application of constraints can be
ascribed to the individual, these are ascriptive constraints. The important distinction
between descriptive and ascriptive is that the ‘self’ has influence over ascriptive
constraints. One cannot change one’s height, so despite it being an individual property,
this would be a descriptive constraint, part of the causal environment in a game of
netball. Table 2.3 summarises these three categories of constraints that have been
developed for use in this analysis.

Changes to the form of prescriptive and descriptive constraints may influence the form
of the ascriptive ones in a human-activity system. In both the netball and the business
environments, management has a high degree of primary control over the prescriptive
constraints and internal descriptive constraints, but no control, sometimes not even
influence, over the ascriptive ones.
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Table 2.3 Categories of Constraints used in the Netball Analysis

<table>
<thead>
<tr>
<th>Prescriptive Constraints</th>
<th>Laws, orders, rules, commands, policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive Constraints</td>
<td>Causal environment</td>
</tr>
<tr>
<td>Ascriptive Constraints</td>
<td>Constraints of self</td>
</tr>
</tbody>
</table>

Those who impose constraints within an organisation must understand both the direct impact of the constraint and its indirect influence on other aspects of the system. The secondary effect of constraints is often overshadowed by the more obvious, first-order (or direct) consequences of control. An example of failure to recognise the secondary consequence of imposed constraints is given below.

At one of the local supermarkets, checkout operators are unable to immediately process customer purchases for items that the barcode reader will not recognise (scan). The management imposed constraint dictates that operators ring a bell to call the supervisor who must locate the item stock area, check the displayed price, return to the register, over-ride the system tamper lock and input the cost manually. The goal of this constraint is to avoid fraud against the supermarket – by either the operator or the customer. Certainly it has the potential to ensure achievement of that goal, but it can also have unintended consequences in other areas. For example, customers often choose not to purchase the item rather than wait for the checking process (loss of sale), or they wait along with a growing queue of disgruntled customers (loss of good-will). For the operator there is discomfort in not being able to satisfy customers in a timely manner and the demeaning feeling of not being trusted.

Across the road, the supermarket competitor has a different policy (prescriptive constraint) regarding items that will not scan. The checkout operator has discretionary powers to over-ride the scanning process for items of less than $10 value (the vast majority of grocery items) and input an amount that has been determined as satisfactory to the customer. The operator will query the customer – “Do you know the value of this item?” – and if the reply is reasonable, will input that value. If the customer does not know the price, the operator makes a generous estimate in favour of the customer and asks if the customer would be happy with that price. The process is quick, causes no delays for queued customers and is resolved to the satisfaction of the customer. Instances of fraud are no higher in this supermarket, but queues are shorter and goodwill is high.

Being able to categorize constraints allows differentiation of the areas of control, influence and no control. There are two further aspects that warrant consideration in
setting the control framework– how constraints affect freedom (supportive and/or restrictive), and how they are imposed (by inclusion or exclusion).

2.3.1 Restrictive and Supportive Constraints

The widespread perception is that all constraints are restrictive (decreasing) of individual freedom, and this view would hold if all freedoms were valued equally and existed independently. Many freedoms however, rely for their existence on the presence of constraints. For example, the freedom to play a game of netball is ‘supported’ by documented rules and the requisite environment (marked court, goal posts, a netball, positional patches, fourteen players) – prescriptive and descriptive constraints that establish an environment that allows the freedom.

Supportive constraints are generally prescriptive or descriptive and act on a broad system population to restrict the behaviours of the entire system population, in support of a higher-level freedom for all individuals. While they are also restrictive at the simplest level of understanding, supportive constraints increase overall freedom for the individual by allowing the individual to achieve goals that are higher up on his or her hierarchy of needs. The majority of prescriptive and descriptive constraints created for the legal and social systems are supportive ones – restrictive laws implemented ‘for the greater good of the people’ (for a majority of individuals).

In netball the performance of individual players is impeded if there is a lack of knowledge about the behaviours of team players and the opposition. The more often players compete together as a team, the more they are able to predict each other’s style of play. But a level of uncertainty remains. The imposition of strict controls on the behaviour of players in the team (§ 2.4.6) allows each player to excel within her own domain, in support of the team. Confidence in the behaviour of others on her team allows a player to creatively explore the boundaries of her own performance.

Constraints are necessary to support a range of individual freedoms. A study of the constraints that support higher-level freedoms in netball provides a model for control in business.
2.3.2 Inclusive and Exclusive Constraints

Constraints on the individual are imposed either by inclusion of the allowable states or exclusion of the disallowed states. Constraints imposed by inclusion are more restrictive than those imposed by exclusion, but not necessarily more specific, as demonstrated in the following examples.

An exclusive application of a pool safety rule may read: “You must not run while in the vicinity of the pool.” The intent is to avoid the dangers of slipping on the wet surrounds to the pool. But the prescriptive constraint does not limit skipping, somersaulting, hopping, etc. An inclusive application of the same pool safety rule may read: “You must walk slowly while in the vicinity of the pool.” Adherence to this rule leaves little scope for alternatives.

Compare the attitude of that example with the following, where the highly specific nature of the command is given by exclusion: “You must not smoke while pumping petrol.” When the weight of the constraint is high, the nature of an imposed constraint - inclusive or exclusive – is very important in defining freedom. An awareness of the scope of constraints will allow managers to avoid the pitfalls of over- or under-constraining.

2.4 Decision-Making and the Application of Constraints in Netball

Each time a player receives the ball in netball is a decision-point for every player on the team. The player with the ball must decide on a receiver, and the rest of the team must decide how to best organise their play to provide a receiver for the pass. And this must all happen in less than three seconds.

2.4.1 Play from the Centre-Pass

This analysis considers a single attacking play in netball\(^6\) - the play from the centre-pass to scoring – and examines the decision-making process in detail, with sequential

\(^6\) An attacking play has been chosen since it closely models the ambitions of an organization to control its destiny in the marketplace. Defence in sport applies different tactics based upon limited historic knowledge, rapid data collection and assimilation.
increases in the level of imposed control. At each stage in the analysis of the centre-pass process, the options and implications of decisions will be examined.

At the start of play, and after a goal is scored, play resumes from the midpoint of the court, with the centre-pass. This is a set, repeated element of the game and provides an ideal opportunity to analyse the decision-making aspects of netball. On the umpire’s whistle to begin the centre-pass, the attacking Centre is required to pass the ball within three seconds to a team-mate who has moved from the goal third into the centre third. One or several more passes may be made by the team to move the ball to either the Goal Shooter or Goal Attack in the goal circle, for a shot at goal. The opposition is intent on ensuring that this series of passes is unsuccessful.

The prescriptive constraints on the attacking team at the centre-pass are:
1. The centre has less than three seconds, from the time when the umpire’s whistle is blown, in which to pass the ball.
2. The centre may step forward on one foot, and lift but not reground the other foot until the ball is passed i.e. she is confined to the immediate area of the centre circle.
3. The ball must be received in the centre third, or by a player deemed to have jumped from the centre third.
4. The centre may not pass the ball to herself.
5. Players must not contact or intimidate opponents in their attempts to get the ball.

These universal constraints restrict the centre to four receivers at the centre-pass. Only the Goal Defence (GD), Wing Defence (WD), Goal Attack (GA) and Wing Attack (WA) may move into the centre third to receive the pass. The opposition has five players in defence of this pass, the opponents of the four potential receivers plus the opponent of the thrower, the Centre (C). Figure 2.5 illustrates the Centre’s decision options for this pass.
Figure 2.5 Options for Receivers at the Centre-Pass. The rules of netball limit the options for receivers to four players – two offensive players and two defensive players.

2.4.2 Levels of Control for the Centre-Pass Play

The control continuum (§1.3.2) is applicable in the netball case just as it is in the business case. The game may be played with no imposed constraints beyond the universal rules (commonly seen in social netball) or under strict instruction from the coach as to the form and timing for certain passages of play (at elite levels). In this analysis three levels of increasing control at the centre-pass will be examined:

- **No imposed constraints.** Only the universal rules and player ascriptive constraints operate to restrict the play. Analysis at this level will provide the baseline for understanding the effects of increased coordination (team controls).

- **Calling the centre-pass.** A code that indicates to the team who the receiver of the centre-pass will be.

- **Calling the play.** A code that dictates the form of play from the centre-pass to the scoring of a goal (or a turnover\(^7\)).

Table 2.4 illustrates this broad categorization of the levels of control that may be applied at the team level in netball, from the standard play where all controls are set by the rules of the game and by player ascriptive constraints, to the tight control of set, inflexible game-plays.

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\(^7\) A turnover occurs when the team in possession of the ball loses it to the opposition (other than after a successful shot at goal).
Table 2.4 Hierarchy of Control from the Centre-Pass

<table>
<thead>
<tr>
<th>Level of Control</th>
<th>Method of Application</th>
<th>Expected Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW I</td>
<td>No imposed constraints - all control is bound by the rules of the game and players’ levels of skill and knowledge.</td>
<td>The event - getting the centre-pass away - relies heavily on the individual efforts of the players, the inter-player responsiveness, and the level of skill of the opposition. The probability of making a successful pass is low if the opposition is skilled.</td>
</tr>
<tr>
<td>MEDIUM II</td>
<td>Calling the centre-pass - a player makes a coded call (or signal) which allows all players to ‘know’ who will receive the centre-pass.</td>
<td>All players know who will receive the centre-pass - removes uncertainty and allows other players to respond with efficiency to the choice of receiver for this first pass. The player selected increases her efforts to ensure the success of the first pass, while other players prepare for the second pass.</td>
</tr>
<tr>
<td>HIGH III</td>
<td>Calling the play - the coded call directs a game-play from centre-pass to goal</td>
<td>A coded call indicates to all players where, when and how the ball will transition the court. The number of plays in a team’s repertoire is limited only by their abilities to recall and execute the range of plays. This level of control removes team-introduced variation. If the game-play is carried out without error (or interference), it has the highest probability of overall scoring success, not just of getting the centre-pass away.</td>
</tr>
</tbody>
</table>

2.4.3 No (Team-level) Imposed Constraints

This first stage of the analysis will consider the situation in which no local constraints have been imposed. The prescriptive constraints (rules of the game) are enforced and the individuals are subject to ascriptive and descriptive constraints, but the coach has not imposed any local constraints. The centre has complete freedom in terms of her choice of receiver for the first pass; likewise the four possible receivers have total freedom regarding their form of play. These behaviours though will be linked by the goal-driven behaviour of all players: their aim is to score goals.

At the whistle, the options for the centre will be affected by the behaviour of the four receivers and the interference introduced by the opposition. Each of the attacking
players will either make a successful lead\(^8\) or fail to make (or attempt) a successful lead, as illustrated in Figure 2.6.

![Figure 2.6 Possibilities presenting to the Centre (Thrower) at a Centre-Pass involving No Locally Imposed Constraints](image)

If all players make successful leads, then the centre has four options, but can only select and utilize one of these. The behaviour of players involved in the second pass will be directly affected by the chosen option for the first pass. The decision-making process for the next pass cannot begin until the first pass is at least committed. At the lower skill-levels of the game, players will wait to confirm the success of the first pass before responding in support of the next pass. At the higher levels players will generally work upon a prediction about the outcome of the pass and begin organising their play accordingly. This aspect of non-confirmative behaviour\(^9\) will be considered later (§2.4.5) but at this point in the analysis the assumption is that players wait to confirm the outcome of any pass before proceeding. The sequence of events for two consecutive passes from the centre-pass would be as given in Figure 2.7. Decision-making

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\(^8\) A 'lead' in netball is a deliberate attacking move that places a player away from her opposition and in a position to receive a pass. The term originally described a move to be forward of one's opposition by 'leading' towards the player with the ball. These days any move to be clear of the opposition and available for a pass, even a move into available backspace, is considered a valid 'lead'.

\(^9\) Non-confirmative behaviour – behaviour based on an assumption about an outcome, without waiting to confirm the validity of that assumption (as in confirmative behaviour).
regarding a particular lead-and-pass play cannot begin until the input information from
the previous play has been received (under the current assumption of confirmative
behaviour). Prior to this, alternative actions may be considered using history-based
intuitive prediction of the play, but the decision to accept or reject these options cannot
be made until the pass has been received. So the decision-making time for a pass
cannot overlap the pass-time of the previous pass (under the current assumption).

\[
\Delta T_i = \Delta d_i + \Delta p_i \quad \text{where} \quad \Delta d_i < 3 \text{ s} \quad (1)
\]

where the subscript ‘i’ refers to a particular pass in a series of passes from the centre­pass \((i=1)\), to the final pass to a shooter for a shot at goal. ‘i’ will range from 2 to
about 6.

To minimise the opportunities for interference from the opposition, i.e. to minimize the
opportunities for external variation, \(\Sigma \Delta T_i\) must be minimised. The faster the pass is
made, the less time the opposition has to evaluate, react and interfere with the play
(introduce variation)\(^\text{10}\).

\(^{10}\) Players on the attacking team also have reduced time to evaluate, assess and respond to the current state
information, but have the advantage of some historic knowledge about ‘how’ their team-mates play, so
the advantage of minimizing \(\Delta T_i\) is with the attacking team.
In considering a particular pass from a fixed thrower to a fixed position where the receiver will take the ball, there is little scope for reducing $\Delta p_i$. The skill of the thrower and the distance of travel of the ball will be constant for the particular pass under consideration, and $\Delta p_i$ will be constant ($K_i$). Application of skills training over a period of time may reduce $\Delta p_i$ for the individual, but within a single game context, any attempt to reduce the pass-time $\Delta T_i$ for a particular pass, must address the delay $\Delta d_i$, in the decision-making process.

$$\Delta T_i = \Delta d_i + K_i$$  \hspace{1cm} (2) \\
$$\min \Delta T_i = \min \Delta d_i + K_i$$  \hspace{1cm} (3)

Minimum $\Delta T_i$ occurs when there is no requirement for decision-making and $\Delta d_i = 0$.

### 2.4.4 Calling the Centre-Pass

At the centre-pass there is greater opportunity than at any other time in the game to reduce $\Delta d_i$ to zero. The Centre can have decided who will receive the centre-pass prior to stepping into the centre-circle to take the pass. The decision will be based on her knowledge of the players’ abilities and information on their prior performances in the current game. Thus $\Delta d_i$ can be absorbed in the delay that necessarily exists between the scoring of a goal and the restart of play.

There is a measurable probability of a successful lead (outcome S, see Figure 2.6) associated with each of the four players. In general the player with the highest probability of making a successful lead will be the WA, since an important component of her ‘job description’ and hence her selection for that position, is to be fast in attack at the restart whistle. If the WA has the highest probability of making a successful lead for the centre-pass, and continually takes the centre-pass, then the opposition will take action to counter this predictable play, probably by ‘double-teaming’ on her - placing their Centre and Wing Defence in defence of the Wing Attack. This action would effectively reduce the probability of the WA making a successful lead and increase the probability of successful leads coming from the other three players. This will form part of the centre’s decision-making information at the next centre-pass.
There are many ways for the centre to signal her intention for the centre-pass to the rest of the team. Some teams use subtle hand-signals or foot-placement as the centre steps into the centre-circle. Others use vocal signals or codes for 'calling the centre-pass'. A coding technique is given in Figure 2.8.

The Centre decides who will receive the pass and calls the code while walking back to restart play after a goal is scored. The rest of the team players then have knowledge as to who will receive this first pass, and their subsequent behaviour can be organised to make the second pass a success. Teams will generally have a contingency plan in the event that the chosen receiver is unable to make a successful lead; such as the other odd or other even player providing back-up for the first pass (Figure 2.8).

In the 'No Imposed Constraints' analysis, four players are attempting successful leads since there is no shared knowledge as to who should attempt a lead. A lot of energy is expended to provide these leads, although the centre can only use one of them. Further, the recovery time from one lead to another slows the flow of effort and there is lost time (and increased opportunities for the opposition) while the three players who were not used at the first pass recover and take new action based on the updated state of play. Calling the centre-pass is the first step in coordinating the efforts of the team.

For the first pass only when calling the centre-pass,

$$\Delta d_i = 0, \quad \& \quad \Delta T_i = K_i$$  \hspace{1cm} (4)

While calling the centre-pass imposes fixed constraints for one ball transition, it also serves to broaden the scope of plays. In the 'No Imposed Constraints' case, the most frequent outcome is a forward pass to either the Wing Attack or Goal Attack. The Centre enters the centre-circle while facing her goal-circle to await the restart of play, a standard rather than dictated practice in netball. Once the whistle has blown, she has less than three seconds in which to make the pass, and most often will look for this opportunity in front of her, only looking backwards to the defences if no forward successful leads present.
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Direction of Attacking Play

WD

GA

GD

WA

Odd  Even

No Letter ↓ Letter

Coding the Center-Pass Call: This code uses a mix of numbers and letters to identify each of the possible receivers of the center-pass. The court is divided into halves through the centre circle – both sideways and lengthways. The attacking half is designated even; the defending half is odd; the left-hand side (facing the team’s goal end) has a letter; the right-hand side has no letter. The letter can be placed anywhere within a set of numbers to identify the left-hand side of the court, and the even / odd distinction is only relevant for the last numeric.

If the center makes a coded call of 6b3, (an odd alpha-numeric) the WD is to be the receiver. An even number identifies the WA, an even alpha-numeric identifies the GA, and an odd number identifies the GD, as receivers.

Figure 2.8 A Plan for Coding the Centre-Pass Call. This plan relies on players learning the positional identifiers for each of the four receivers. The code has the advantage of variety and flexibility in that it can easily be altered if the opposition gives an indication of having ‘cracked the code’.

Since only four players are also allowed in the goal-scoring third (attacking end) - the GS, GA, WA and C - if one of the attacking players receives the first pass, then the options for a forward pass to the goal third are limited to three (one being the C who would need to move past the receiver to be in a forward position). Had the centre-pass been played back to one of the two defences allowed in the centre-third, the options for a second forward pass are increased to five.

A repeated forward pass may therefore not be the best option. Not only is it likely to drive the opposition to a counter position, it also reduces the team options at the second pass. If both the GA and WA can drop back and re-offer on the second pass, rather than...
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lead for the first pass, more options will be available for the second pass. This type of play is supported when the Centre can call the centre-pass to alert the team to a reverse centre-pass. In calling the pass, the Centre has identified the receiver to the team, but not the process for the pass. Team-mates (and the thrower) are aware of who will receive the pass, but not how or where. Only the receiver has this knowledge or plan.

The same line of analysis that is used in the ‘no-constraint’ and ‘calling the centre-pass’ situations may be extended to every intervening pass until a goal is scored. The second pass can only go to one player, so theoretically only one successful lead is required, however without a coordinated plan for this event, every player will attempt a successful lead, in the event that it may be needed. The thrower will select from the options available, and the process will be repeated for the third pass. So for each pass where constraints are not imposed, considerable team effort is duplicated without adding value to the process. The probability of the pass being successful is also reduced when both the thrower and potential receiver are attempting to rapidly assimilate current information, forecast solutions, make decisions, and act on those decisions. The pace of the game barely allows receivers further down court to wait for the outcome of a pass to be confirmed, before they must take action. The downside in this approach is that time is lost in waiting for confirmation of the previous pass – time that could have been directed towards ensuring success of a subsequent pass.

2.4.5 Confirmative versus Predictive Behaviour

Confirmative behaviour is often considered ‘safe’ play in netball and always results in a slower game than when players operate with predictive behaviour. In the former mode, players take no action until the outcome of a pass is confirmed – until they know who has the ball and where. The player in possession may be a player on their team or the opposition team (if a turnover has occurred). No recovery time is required in the case of a turnover, since no action had begun in support of the previous flow of work.

Predictive behaviour sees the players assessing the current workflow, making predictions about the outcome and organising their play accordingly. If the prediction is that a team-mate will receive the ball centre-court near a sideline, then a player may position to drive centre-court at the instant that pass is received and provide the next
pass option for the receiver. If the prediction turns out to be wrong and the opposition gains control of the ball, the player will have extra work to recover from the attacking play and to position for effective defensive play. The ability to predict or read the play and respond appropriately is a sign of superior attacking and defensive skills in netball. Given the speed of play, this is not an easy skill to master.

### Outcome

<table>
<thead>
<tr>
<th>Successful Pass</th>
<th>Unsuccessful Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quadrant I</strong></td>
<td>Having anticipated incorrectly, the player is now ill positioned for the required defensive play. Response time to correct this will be greater than if the player had waited to confirm the pass. (As in Quadrants III &amp; IV)</td>
</tr>
<tr>
<td>Predictive behaviour – predicting a successful pass.</td>
<td><strong>Quadrant II</strong></td>
</tr>
<tr>
<td><strong>Quadrant III</strong></td>
<td>Having waited to witness the success of the pass, the player must now respond. While she has failed to capitalise on the lead-time available had she correctly predicted the play, her subsequent play is based on a certainty rather than a prediction, and requires no correction before continuing (as in Quadrant II).</td>
</tr>
<tr>
<td>Confirmative behaviour - allowing the outcome of the pass to determine behaviour.</td>
<td><strong>Quadrant IV</strong></td>
</tr>
<tr>
<td><strong>Quadrant IV</strong></td>
<td>Having witnessed the failure of the pass, the player can instantly adjust to the defensive role. The difference between this outcome and that of the quadrant above, is that ‘adjustment’ rather than ‘closure and adjustment’ is required - a less lengthy process.</td>
</tr>
</tbody>
</table>

**Figure 2.9 The Effect of Player Behaviour on Current and Subsequent Play** Two types of behaviour are considered in this table – predictive behaviour in which a player predicts the outcome of a particular pass and organises her response according to the prediction; and confirmative behaviour in which a player waits to confirm the outcome of a pass before making decisions about her play. The two possible outcomes for any pass are that it will be successful (retained by the team) or unsuccessful (lost to the opposition).

With each attacking pass, players not involved in the pass have two options – to predict the outcome of the pass and respond immediately based on that prediction; or wait to confirm the outcome of the pass before taking any part in the play. What are the risks in acting on predictions about the outcome of a pass? Or alternately, what are the risks
in waiting to confirm the outcome of a pass before organizing individual play? These questions are addressed in Figure 2.9.11

How can we maximise time spent in Quadrant I? Practiced plays (game-plays) provide the best opportunity for success between thrower and catcher and increase player confidence in the outcome of a pass. Players effectively act in a predictive, non-confirmative manner when involved in a game-play.

2.4.6 Calling the Play – A Game-Play

Calling the play in some team sports is a direct extension of calling the centre-pass. Knowledge about ‘the receiver for the pass’ is extended to ‘the receivers for a series of passes’. In netball, calling the play implies a much higher level of process knowledge than just who will receive the pass. Detailed information about the pass (how, when and where) is also given by constraint. A game-play is a tactic by which the entire team participates in a constraining, designated play in support of the team goals. The constrained, inflexible nature of a game-play enhances team (internal system) knowledge for all players.

Game-plays must not be confused with game plans. The idea of a game plan is well established in sporting arenas and provides the basis for Keidel’s triadic models of organizational structure. Game plans provide the overall strategy for the sporting team in the application of their skills against the immediate competition. The strategic vision of a game plan is in contrast to the explicit, tactical nature of a game-play. Compare the broad instruction of the game plan given below with the tightly constraining nature of the following game-play.

Game Plan: “The opposition play an aerial, running game with strong, rapid drives into the circle. When we gain possession of the ball, we will slow the play – hold the ball up – and pace the passes to our end of the court. We will not be drawn into playing at their frantic pace.”

11 In the discussion in Figure 2.9, the predictive behaviour is restricted to prediction of a successful pass – predicting that the current pass will find its intended receiver. Predicting a successful pass allows the second player to prepare a response in advance of the first player’s receipt of the ball.
Game-Play from the Centre-Pass – see diagram below

- On the whistle
  - The GD and WD lead forward to the transverse line of their scoring third.
  - The WA leads close to the C, feints for the pass, circles behind the C and moves to the L-H wing area (as back-up).
  - The GA leads into the centre then drives for the R-H wing, as if to take the second pass from the GD. •As the GD approaches the transverse line: –The C releases a tight lob to the GD and drives to the top of the shooting circle. •When the GD accepts the pass: –The GS drives to the edge of the shooting circle to draw the defence away from the post, turns tightly and leads to the post to accept the long lob from the GD.
- Notes:—As always, timing is very important in this play. The GS must hold until the GD has the ball, before initiating her run.
  –Back-up is provided by the GA, C and WA - so runs must be timed to be clear for the alternate pass, if needed.

2.4.7 Design of Game-Plays

Game-plays are not attempted with novice players. A level of proficiency in the basic skills of a game is essential for successful execution of the play. If it cannot be executed perfectly in an isolated practice environment, it is unlikely to succeed in a game situation. Further, the level ofascriptive constraints in a novice player would certainly over-ride any constraints placed upon the player by the coach, e.g. it is of little use to introduce aerial plays with players who are still earth-bound by their individual levels of proficiency. Players must also have confidence in their team-mates for a
game-play to be successful. Knowledge of current and future states is only partial if a player harbours concerns about another player’s ability to adhere to the play.

Control and predictability are key features of game-plays. By increasing current and future system state knowledge\(^{12}\) for all members of the team, the game-play approach attempts to remove internal variation and support the goal directed efforts of the players. As long as the play is goal-directed and appropriate to the skill level of the players, improvement in system performance is assured. These two factors are key requirements in the design of a game-play:

- Every aspect of the play must be designed to support achievement of the goals of the team. A misdirected play is simply constraining – not supportive.
- The ascriptive constraints that operate for each individual must be recognised in the design of the game-play.

The application of a game-play approach has further indirect benefits for the team:

1. The process of design and implementation of a game-play introduces players to possibilities for play outside the standard domain. Creativity is developed in the design phase so that players are exposed to new individual and team prospects. This process is a captivating one – opportunities for further creative expression emerge from player involvement in the tactics for process improvement and play design.

2. The development of team qualities such as cooperation, support, communication, and dedication are promoted in the process and have a positive impact on the working environment and commitment levels of the players. Game-plays require coordination and cooperation from all players and place team-based expectations on the individual. Failures at an individual level, which may have been overlooked in an organisation that promotes discrete effort, become obvious in the application of a game-play. Players cannot ‘hide’ within a team that operates at the game-play level. The contribution of all members of the team becomes clear in the game-play process.

\(^{12}\) System state knowledge is used in this thesis to mean 'knowledge of the operating state of the system'. In the netball case, a player would have current, internal system state knowledge if she knows the state of team play at that instant – where the ball is; who has it; where this is in relation to the goal; where the other players on the team are positioned, what the abilities of the other players are, etc. - knowledge of the state of the entire system, in relation to the goals of the team.
3. Since game-plays typically stretch standard plays beyond the ‘comfort zone’ for players, they also serve to extend player abilities and provide support for the creative process.

4. The game-play approach also forces the team to focus on goal definition so that the plays are well directed.

Two of these by-products of the game-play process - the increase in creativity and the emergence of team values among players involved in game-plays - warrant further discussion.

2.5 Creativity Development through Application of the Game-Play Approach

Creativity in netball is defined here as ‘original thoughts and/or actions, based on knowledge, which support the team goals’\(^{13}\). There are two types of creativity on the netball court - creativity by design, and spontaneous creativity.

In the first case, the creative process is taken off the court: the idea is formulated without time pressures and can be modified, practised and tested before its implementation in the game. In the second case, the creative response occurs on court and must closely match the response times within the game - any delay in the creative response in a game, lessens the likelihood of a successful outcome. Work which leads to improvement in the first form of creativity will have a positive influence on the other, but they are distinct enough to warrant separate analysis.

2.5.1 The Learning of Creative Plays

A new game-play is creative because it transcends the ‘standard’ boundaries. As the team practices and perfects the play it becomes part of the team’s ‘standard’ repertoire. When performed before the opposition, the play is ‘new’ for a second time, viewed as creative by those who are unfamiliar with it. Given enough exposure, the play will also become ‘standard’ to this audience. The opposition may learn to counter the play, mimic it, adapt it, improve it and eventually relegate it to their ‘standard plays’ basket.

\(^{13}\) This proviso eliminates original behaviour that creates chaos and is counter-productive, as may be the case when players with little knowledge of the game introduce new, but ineffective play.
The transformation of a team’s creative idea from the extreme, Zone IV, to the mundane, Zone I, (Figure 2.10) may be a rapid or lengthy process depending on the level of complexity and risk involved in the play. Figure 2.11 illustrates this process of transforming a creative play originated by team A to a general standard play. Some plays will never be relegated to Zone I, although they will feature in Zone II for a number of the teams in the top levels of the sport.14

![Figure 2.10](image)

**Figure 2.10** Transitional Zones for Team Plays – from the narrow zone of familiar standard plays to the unknown  At the lower levels of team sport, most play falls within Zone I - The Range of Standard Plays - generally familiar to all teams. Games are won and lost in direct relation to the level of mastery of standard plays. As skill levels rise, most teams develop their own ‘standard’ plays - Zone II. These may be variations or refinements of the general standard plays, or they may be creative plays that have developed to the point where they are considered routine by the team (i.e. developed in Zone III and transitioned to Zone II through practice and familiarity). The third zone is the zone in which creativity exists and is unexplored by many teams. The majority of players are content to master the standard plays and limit their potential in the game accordingly. This creativity zone involves far greater risk-taking than the combination of the inner zones. Outside this sphere in which creative invention takes place, lies the unknown - the scope for further creativity.

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14 In rare instances in sport, a play remains outside the ‘standard’ domain indefinitely, and while its application may no longer be seen as creative, it remains unusual. Most often this type of play requires physical ability or aptitude that is not common (or learnable) in the general population. The ‘reverse sweep’ in cricket is no longer novel, but it remains rare, requiring a batter to change his batting technique in the space of time during which the ball is delivered. This play is unlikely to ever be considered ‘standard’.
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Figure 2.11 A Flow Diagram of the Transformation of a Creative Play to a general Standard Play (using the four zones identified in Figure 2.10). Zone I – Standard Plays for the game of netball; Zone II – Standard Plays for a particular team; Zone III – Creative Plays; Zone IV – Unknown Plays (unbounded creative space).

The transition process illustrated in Figure 2.11 is described more fully in Figure 2.12.

1. Off court
   A new idea for a play is developed
   - a creative play

2. Off court
   The new play is practised, refined and perfected

3. Off court
   The new play becomes part of the team’s standard plays

4. On court
   The new play is presented in a game and is once again perceived as creative, this time by the opposition

5. Off & on court
   Opposition mimic, and adapt the play

6. On court
   The new play becomes part of the opposition’s standard repertoire

Range of General Standard Plays

An intimate knowledge of standard play, is necessary for creativity development

With exposure, the ‘creative play’ may become a Standard Plays

Figure 2.12 The Life-Cycle of a Creative Play in Netball (See text for discussion.)
Chapter 2 – Theoretical Framework – A Sports Model for Business

Creativity stems from a deep understanding of the standard play domain and an ability to recognize opportunities for non-standard application of the rules within that domain. Creative ideas have a limited life so that a continual process of creative search and design is required to maintain a competitive edge in the game.

2.5.2 Creativity and Risk

Creativity in netball is about ‘playing the rules at the extremes’. Since creative plays have not been tried and tested in the same way as standard plays, they are risky. Most teams are not prepared to either accept the risks associated with creative plays, nor to increase their workload to improve team competency and reduce the associated risks. For this reason, ‘standard application of the rules’ is standard at all levels of the game, from the novice to the advanced.

The competitive edge for teams that use standard plays rests with the strength of their skills. Against a skilled and creative team, a team that is bound by standard plays will not be competitive. Creative play demands more of the players, in terms of physical ability, skill, knowledge, and attitude, and increased competencies in these areas will reduce the risk of failure.

Teams that value the benefits of creativity in their play generally try to mitigate risks. Rather than simply accept the higher rate of turnovers (loss of possession in netball), advocates of creativity will increase their training workload to lower the level of risk. As a creative play is practiced and moves from Zone III to Zone I (Figure 2.11), it becomes standardized and the risks involved are reduced in line with the transition.

Diagram I (Figure 2.13) shows the reduction in risk associated with both creative and standard plays, with the application of training. Creative plays demand a longer ‘learning phase’, the period in which the form and intention of a play is conceptualised and demonstrated through the breakdown of play components. Typically the mastery phase for creative plays is also longer than the period required to master a standard play and results in a greater reduction in associated risks. Standard plays involve lower initial risks so that the risk reduction after training is proportionally less. Given sufficient time and training the creative play will become standard – for that team – and its performance will involve no greater risk than a ‘universal’ standard play.
Figure 2.13  Comparisons of Creative Plays and Standard Plays – Risks and Impact  (See text for discussion.)
Diagram II provides the rationale for persisting with creative plays that are inherently more difficult to master than standard plays (Diagram I). Initially the probability of success for a creative play is less than that for a standard play – an indication of the difficulty or complexity of the creative play. As mastery of the creative play increases, so does its success rate, which remains high because of its novelty and superior structure. Opposition teams will be less able to counter the creative play than they will the standard play.

The success rate for a creative play is not necessarily an indicator of the success rate of the team. Creative plays are interspersed with standard plays and provide many indirect team benefits, so that the isolated failure of the creative play does not translate to overall team failure. Diagram III illustrates this dichotomy. The by-products of designing, developing and practising game-plays – the learning of the creative process, the extension of the skill base beyond the standard, the development of key understandings in the work process, increased commitment through rationalization of the process, the growth of team values and attitudes, and the clarification of team goals – provide team successes that may precede competency in the creative plays. (See §2.6.5, p.51) for discussion of this aspect in the netball case study.)

The diagrams in Figure 2.13 illustrate that in netball the relationship between level of risk and team success is not the direct inverse linear function that one might expect. The risks associated with individual creative plays are offset by the broader benefits of creativity and innovation. Imposing the rigid constraints of a game-play in an environment that supports the creative process is more likely to lead to team success than will attempts to impose the play in an environment that restricts players to standard process. The third hypothesis of this thesis (§ 1.1) is supported by this observation -

Hypothesis 3: That the probability of success of the constraints so designed will be greater in a working environment that not only embraces, but also 'teaches' creativity. (p. 2)
2.6 A Netball Case

In parallel with the theoretical work for this thesis, a practical study was carried out with a netball team comprising seven, fourteen and fifteen-year-old girls. Three of the girls had played together before; the other four had played netball for a number of years but never with any of the other team members, so had no experience of their style of play. In essence, this was a newly created team.

2.6.1 Background to the Study: Winter 1999

The Canberra winter netball season is fourteen weeks long, plus three weeks of finals, and during that time the intention was to introduce the girls to the concept, design and application of game-plays while maintaining and fostering their creativity within the game. The players were of reasonable age and competition level to be introduced to the concept of game-plays. Five players were of a comparable solid standard; one player was somewhat below their level of play and the final player was quite weak; leading to a slightly unbalanced team in terms of netball ability. The strengths of each of the top five players though, matched nicely with the positional requirements of the game, so in this regard it was a reasonably strong end-to-end team. (Figure 2.14)

![Figure 2.14 Positioning of Stronger Players to Maintain End-to-End Court Flow](image)

The weakest player had physical attributes that suggested she could be a strong netball player – very tall, lean, flexible, and fit – but she was so timid of both the ball and the opposition that she was unable to capitalize on these strengths. There was a marked improvement in her determination for the ball over the season, but she remained well behind the other players in overall ability, as their season improvement was spectacular.
2.6.2 Design of Game-Plays

Well-designed game-plays are matched to the players' abilities and failure to acknowledge this aspect in the design can result in plays that simply restrict the players rather than constrain and support the players and team. (See Chapter 7 for further discussion on this aspect within a business case study.) It took five weeks of information gathering before plays that acknowledged the characteristics of this new team, could be designed.

The aspect of this study that caused most concern in the design phase was - How to introduce the discipline of plays without sacrificing the potentials of creativity? This was a new consideration in the netball environment and at the outset seemed like an untenable dilemma. In the end it proved surprisingly simple and was recognised as a by-product of the game-play approach.

2.6.3 Information Gathering for the Design of a Netball Game-Play

Ideally, game-plays should be devised before the start of competition and practiced in the pre-season training sessions. This was not possible with this new team as there was no information on their individual court play or their team play. The first play was designed and introduced at training before the sixth week of competition. The first play was unusual since it was a centre-pass attacking play requiring the first pass to be directed back towards the opposition's goal. This tactic was to capitalise on the skills of the Goal Defence and increase the offensive options for the second pass. The game-play also involved six of the seven players in its execution (although only three players were involved with the ball) so was an inclusive play that allowed the team to develop supportive skills. It took two weeks before the play could be successfully executed in practice - and even then not with a high level of confidence - and another four weeks before it was successful in a game situation. Throughout the remainder of the season, the players managed to execute the play 'perfectly' three of the sixteen times it was attempted. The team excitement on those three occasions was boundless.

15 The author’s experience of netball coaching had not revealed any directed effort in this area of creativity enhancement. Quite the contrary - players were apt to be chastised for attempting non-standard play (irrespective of whether the outcome was successful or not). Apparently the conflated relationship between risk taking and learning has not been generally recognised in netball coaching.

16 See the game-play on p. 37 for details.
The seemingly poor success rate\textsuperscript{17} of the play by mid-season was attributable to the delay in its introduction. Two options were considered to counter this impediment and allow plays to be practiced in pre-season work: use of standard plays tailored to the game rather than the particular players, or use of historic player data to develop a game-play for a particular team.

A tool that incorporated the second approach was developed throughout the season and is discussed in detail in Appendix A. Using relevant data on the team players, the Transition Matrix Method (TMM) as described in Appendix A, paints a picture of the individual player's abilities in relation to the goal, and allows game-plays to be designed with some contextual understanding, before the start of match play.

2.6.4 Player Response to the Introduction of Game-Plays

The change in the team with the introduction of the first game-play was extraordinary. Seven casual team-mates who came together for training sessions and competition immediately became focused and united in their efforts to master the play. The game-play provided the catalyst for this transformation. Individual players were less focused on their individual performance during the game as they strove to support the team roles within the play. The importance of each player to the team was suddenly apparent as the game-play highlighted the flow of work necessary for achieving team goals. The weaker players were no longer isolated by their inability to keep pace with the stronger players. The game-play gave them a role (designed to match their limitations) that was as critical as any other to the success of the play.

Team-building aspects that had previously required separate attention in the coaching process, were no longer an issue\textsuperscript{18}:

- **Motivation** – *The players asked to increase the length and frequency of training in order to master the plays (and demonstrate their new ideas). The downside to this newfound enthusiasm was that it did not stretch to the 'mundane old drills' that*

\textsuperscript{17} There were to be a lot more success factors to the implementation of a game-play than were originally anticipated.

\textsuperscript{18} For a detailed discussion on some of these issues and the role that sport can play in supporting these values see Corlett, 1996.
were a feature of the old regime and are a mainstay of skills maintenance. For this study the standard drills were discarded and the players were allowed to dictate where they spent their energy. Over a longer period than one season, some balance between the ritual skills drills and the ‘exciting’ game-plays would be required.

- **Team cohesion** – Until the introduction of the first game-play the team was settling into two camps of players – the strong and the weak. Ability in the game had provided a natural division, both on and off the court. Once the plays were introduced, all players became essential to the team and although the roles of the weaker players were less physically demanding they were no less vital to the success of the play. This on-court bonding infected the off-court training and social sessions.

- **Leadership** – No designated leader (team captain) was named for this team and the official duties\(^\text{19}\) were rotated throughout the 14 weeks of competition. Nonetheless, the team deferred to one particular player who clearly stood out as their chosen ‘leader’. She never imposed her will and would probably be surprised to hear herself described as the team leader, however, on court she controlled the pace and structure of the game and the attitude of the team to the game. When she played well the team lifted their game – when she played poorly they all struggled, unnecessarily. The emergence of a natural leader ensured there was no tension over this issue.

- **Team coordination** – Prior to the introduction of the game-plays the players had little understanding of the play of the weaker players since they were simply avoided where possible in the play (a reasonable strategy based on a high level of uncertainty). The game-plays gave all players valuable insights into the strengths and limitations of their team-mates, allowing them to tailor their interactive play accordingly. The overall play of the team (beyond the use of the game-plays that had limited success in competition situations) improved in line with this increased understanding.

\(^{19}\) The captain in netball is responsible for tossing a coin with the opposition to decide which team shall have the first centre pass; and is the only player on the team allowed to approach the umpires for clarification of rules and umpiring decisions.
• **Team spirit** – A *dynamic interaction between the players gave this team a signature spirit both on and off the court. They were always seen around the sporting venue in a pack – united by their secrets, their plans for the next game. Netball became more than a fitness activity for this team – they revelled in both the training and the competition.*

### 2.6.5 Reflections on Creativity Enhancement

The practical guidelines on creativity enhancement available in the literature suggested that it was an attribute that could be imbued and enhanced (Marakas 1997); that it blossomed in an environment that allowed the associated risk-taking (Amabile 1987, 1994, 1995, 1996); that it was often overlooked for the safer ground of ‘*rational-logical techniques*’ (Ogilvie 1998); and that task motivation and skills commensurate with the requirements of the creative domain (generally outside the standard domain) were essential ingredients in the creative process (Conti et al 1996). This latter proviso indicated that the weaker players would struggle to be creative given that they were yet to master many of the standard play skills. The other conditions for creativity implied that it could be taught and developed in an environment that embraced it. But the ‘how to’ was missing from these works.

Undaunted by the vague ‘instructions’ for creativity enhancement the team began experimenting with the ‘exciting’ concept of ‘trying to do things a little differently in our games’[^20] in a series of off-court talks followed by practical sessions. At each talk a creative play or action was introduced for discussion on how this play differed from the routine games of the players’ combined experience. Most instances of creative play that featured in these discussions were spontaneous situational creativity from one player, suggesting that team-developed creative plays were less a feature of the game (or less recognizable as such). Between discussions players were asked to think of their own ‘creative ideas that we might try’. They were encouraged to rethink the rules of the game beyond what they had learned as standard procedure and to develop their ideas ‘at the boundaries’ of what was considered ‘normal’.

[^20]: These terms were used to introduce the concept.
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An example of a creative action that applied the rules in an unusual way is given below:

The Rule: In netball, no player may play the ball to herself - another player (or the goalpost) must touch it before she can play the ball again. She is further not permitted to move with the ball.

The Creative Response: A player intercepted the ball, on the run, took her two allowed steps (in flight), and had no-one from her own team ahead of her to receive a pass. The momentum of her 'on the run' intercept prevented her from stopping and allowing her team players to 'catch up.' Traditionally, the player either steps and forfeits the ball (100% probability of losing control of the ball), or tosses the ball backwards over her head in the hope that a player from her team will regain possession (approximately 50% probability of losing the ball). In the creative response, the player played the ball off the back-shoulder of an opposition player, regained the ball and created time to land and allow her team players to respond to the intercept. Her behaviour was within the universal constraints (rules) and ensured her team kept possession.

The players' response to this idea of thinking about the game creatively was very satisfying. The more skilful players relished the concept and offered new ideas in a seemingly endless stream. Some of these were attempted in training sessions and discounted as 'just too difficult', 'impractical' or 'counter-productive', meaning they were of little value in trying to score goals or defeat the opposition. The players always made the decisions about whether to persist with an idea or discard it in favour of trialling other ideas. A favourite idea that survived the scrutiny involved the goal shooting pair and capitalized on rule 13.1 (ii) of the official rules, which states that

A player may .... Gain or regain control of the ball if it rebounds from the Goalpost.

A player offered the idea for the 'creative' use of this information after she had observed it happen 'accidentally' in another team's game.

From a base-line throw-in (bringing the ball into play from outside the court) the player would attempt to ricochet the ball off the goalpost, enter the court and catch the rebound to take a shot. Alternatively she might try to ricochet the ball to her shooting team-mate.

As most goalposts are made from round tubing, it took a degree of practice (many hours of work) before the players could master this play. This form of creative idea rarely worked more than once or twice in a game as the opposition became wary of it and took
measures to counteract the action. On the occasions that it was used, the play was highly successful. The modified version, a wider ricochet pass to the other shooter, was less controllable but had spasmodic success. Two years after the introduction of that play there was still no evidence of other teams in the district attempting to copy the technique.

Although the success rate with the use of these creative ideas was generally no higher than the success rate with the formally designed game-plays, the process of encouraging the girls to engage in actions outside the perceived norm, unleashed a new level of play for the team. The players were prepared to try (and fail) with a variety of spontaneous passes, in a variety of untested situations and, to borrow their phrase, ‘mix it up’. The creative responses seemed to confound the opposition more than traditional solutions to common problems and the team went from strength to strength throughout that season to be undefeated in all seasonal games and finals.\(^{21}\)

In the ensuing two years, the players have moved on to different teams with three of the players continuing in representative level netball. The play of these girls is still distinctive despite the more classical approach of succeeding coaches. The girls remain prepared to try unconventional, risky tactics, much to the frustration of their coaches who use instances of failure to reinforce the need for ‘safe’ play.

Creativity enhancement for this group of young, developing sports players proved to be a relatively simple process. They embraced the opportunity to ‘think outside the box’ of standard plays and relished testing ideas without fear of retribution for failure. The dominant impression on creativity enhancement that emerged from this case study was that:

\textit{Once the players have been motivated towards creative innovation and have experienced the excitement and rewards it returns, it is much more difficult to quell that enthusiasm than it was to develop it.}

\(^{21}\) The season result for this team overall was zero losses. They played in the top division for their age (with two under-age players in the team) and were never threatened with loss (no opposition reached half their score in a game).
2.7 The Sporting Advantage of the Game-Play Approach

In netball, a game-play is a precise, repeatable sequence of player movements and ball passes to move the ball from a designated position on the court to a scoring position in the shooting circle. This may be a one-pass move involving only two players, or a more complex tactic based around input from the entire team. Such play demands a high level of skill – skill in the standard play domain and skill in the creative domain.

The game-play approach:
- increases internal system state knowledge – both current and immediate future;
- promotes goal definition at a tactical level;
- organises player involvement in 'process improvement' and 'job design';
- supports the development of the team;
- leads to rapid process improvement;
- extends player abilities; and
- teaches the creative process.

The game-play approach will improve players' abilities to analyse and act outside the learned domain. It is not possible to design game-plays to pre-empt every outcome in a game of netball. This ability to improvise in support of the team is very important, and its development is one of the major advantages of using the game-play approach in team sports.

2.8 Game-Play Methodology – An Approach for Business

The benefits of the game-play approach identified in the sporting environment (§2.7) also apply to the business environment. In business, at the team level, a game-play is a set of constraints applied to the members of a team with the intent of increasing system state knowledge (both current and immediate future) for all members, and thereby supporting achievement of the team goal. The application of constraints that increase system state knowledge enhances both control and predictability. The design criteria for a game-play in business are the same as those in netball:
- Every aspect of the play must be designed to support achievement of the goal of the team. A misdirected play is simply constraining not supportive.
- The design must acknowledge the ascriptive constraints that operate for each individual.
- The design activity should allow for the creative involvement of the team members in the game-play development process.

Although the tactic of game-play has only been addressed at the team level, it can be extended to apply to higher levels of organisation such as a ‘team’ of ‘organisational units’ that share a common goal.

Drawing on the ideas developed through the application of constraints in the netball model, the following five-step approach is proposed for application of game-plays in a business environment:

1. **Define the team goal.** Involve team members in the definition process to encourage creative involvement and ownership of the outcome.
2. **Analyse the existing team operating system.** Use information and data gathering techniques to describe the extant operating system and evaluate its performance in relation to the team-defined goal.
3. **Design the constraints that constitute the game-play.** These must be goal-directed and maximize internal (current and immediate future) system knowledge for all individuals. Ensure that the design acknowledges the ascriptive constraints that operate for each individual. Where possible, involve the team members in this creative design process.
4. **Constrain the individuals according to the game-play,** and
5. **Support ongoing creativity** within the game-play environment.

This approach to the application of constraints in a business environment is termed ‘The Game-Play Methodology’ (Figure 2.15).
1. Define the team goal

6. Support ongoing creativity within the game-play environment

2. Analyse the existing operating system in relation to the goal

5. Constrain the individuals according to the designed play

3. Design a game-play that is goal-directed & increases system state knowledge for all

4. Match the play to the abilities of the individuals

Figure 2.15 Diagrammatic Representation of The Game-Play Methodology
Chapter 3  Business Lessons from the Netball Analysis

One of the strengths of the game of netball as a model of business activity is its operational simplicity. The netball model avoids the complexity that typifies business and provides a clear framework for examining player relationships, and system outcomes. The preceding analysis of the decision-making process in netball has provided some key lessons for business – lessons that contribute to the platform for balancing freedom and constraint for the individual in support of team goals.

This chapter highlights points from the netball analysis of the previous chapter, and draws out the business lessons. Each netball lesson appears directly from the text of Chapter 2, before being placed in a business context and ultimately framed as a business lesson.

3.1 Lesson 1 – Team Roles

**Netball Lesson 1**  The rules of netball ensure that at least two of the seven players must be involved in passing the ball from the centre circle before a goal is scored. Typically, four or five players are involved, while the other players work off-the-ball, using positional tactics, to support their team play. (p. 20)

The openness of a netball court affords each player an uninterrupted view of play and the actions of team-mates. Irrespective of a player’s direct involvement with the ball, she is aware of the cumulative efforts of the team in that regard and will organise her play in support of the current or planned team tactic. Her role within the operation of the team is not diminished by a lack of participation with the ball. Her efforts in support of the team goal – to move the ball to a position for shot at goal – are recognised (and visible) as critical to the overall team performance.

In business an individual’s view of the rest of the operation is often interrupted. Organizational design and the physical location of people, coupled with the communication / information infrastructure of the organisation, place constraints on an individual’s view of operations. An inability to ‘see’ the effect of an individual’s role
within an organization can lead to misdirected effort and a misunderstanding of the impact of individual efforts. Individuals who are geographically isolated or isolated by a lack of system knowledge, must have their view augmented by updated information on both the operation of the system and the impact of their efforts on system outcomes. The role of the individual must be placed in context for all members of the business team. Supportive roles must likewise be matched for content and timing to the overriding goals of the operation.

**Business Lesson 1** The actions of individuals within a business team must be visible to others within that team, so that both the direct and supportive roles of the workers can be coordinated and recognised for their impact on operations.

### 3.2 Lesson 2 – Decision-Making

**Netball Lesson 2** At elite levels, intimate knowledge of all aspects of the game and the governing rules (constraints) is essential. (p. 20)

The distinguishing factor between standard competition and elite-level netball is the pace of the game and the ability of players to rapidly gather, assimilate and make decisions on current information. At the core of successful rapid decision-making is an intimate understanding of the game and the rules that govern it. It is not sufficient for the coach to have this level of knowledge – the pace of the game does not allow players to garner this information from others on an ‘as-required’ basis. The moment for action will have passed while the information gathering was in progress. Each player owes a responsibility to the team to have complete knowledge and understanding of the game and its imposed constraints.

As business hierarchies become delayered, groups and individuals become increasingly autonomous, and the extent of the individuals’ knowledge of the business, its environment and its policies must also increase. The quality of business decision-making, especially as the time available reduces, is directly related to the extent of knowledge and quality of information available to the decision-maker – its currency, accuracy and completeness. Just as the organisation is responsible to its decision-makers for the timely dissemination of information, the individual is responsible to the
organisation for ensuring that his or her understanding of the business and its environment is current, accurate and complete.

**Business Lesson 2** The individual decision-maker within an organisation must endeavour to have current, accurate and complete knowledge of his or her operating environment.

### 3.3 Lesson 3 – The Impact of Constraints

*Netball Lesson 3* A hierarchy of constraints – in terms of consequence, scope and intent— ... observed in netball, ... suggested three categories of constraints on the individuals – defined here as *prescriptive, descriptive and ascriptive*. (p. 21)

Those who impose constraints within an organisation must understand both the *direct impact of the control and its indirect influence on other aspects of the system.* (p. 22)

The constraints that operate upon the individual in netball can be considered in three categories. Ascriptive constraints are set and controlled (within limits) by the individual; descriptive constraints are the constraints placed upon the individual by the netball environment (physical state of play, player interactions, team goals etc.); prescriptive constraints are the universal and local competition rules of the game. This is a useful categorisation for considering the decision-making process in netball since it provides a framework in which the coach or manager can consider both the direct and indirect effects of any further constraints placed on the individual. Failure to appreciate the indirect impact of constraints can undermine the management process.

Constraints that operate on the individual in business can be similarly categorised. Laws of the business environment, policies of the business, and local rules of the business group comprise the prescriptive constraints. Although established in broad terms, these constraints impact upon the working environment of the individual. Descriptive constraints within the business context establish the local environment: physical constraints such as resource availability, access to information, and geographical layout; constraints created by the behaviour of others within the system; and the overriding constraint of the perceived goal of the business. Apart from the
physical constraints, other aspects of the descriptive category are often the least conspicuous as constraints, and therefore the most easily overlooked in terms of their impact on the individual. The final set of constraints, the ascriptive, relates to the individual and his or her attributes in relation to the requirements of the business.

In netball the effect on other categories of imposing a constraint in one category, is often transparent. The process of categorising constraints simply highlights the areas of which the coach should be aware in assessing the indirect effects of constraints. In business, indirect effects can easily be overlooked within a complex system. The process of categorising constraints forces managers to identify the constraints on the individual and aids the process of monitoring the indirect impact of any changes in control.

**Business Lesson 3** Those who impose constraints within an organisation must understand both the direct impact of the control and its indirect influence on other aspects of the system. The ability to identify and categorise constraints is important to this process.

### 3.4 Lesson 4 – Individual Performance within a Team

**Netball Lesson 4** *In netball the performance of individual players is impeded by a lack of knowledge about the behaviours of team players.* (p. 24)

Netball coaches have many stories of ‘remarkable’ players being extracted from a team, placed in another team to bolster its performance and failing to shine in that new role. The player’s skills in the game have not been diminished by the team transition but a lack of knowledge about her new team-mates, and their style of play, impedes the player’s ability to utilise her skills to best advantage. In particular, the player’s ability to predict has been reduced – she must work within the standard domain of plays that should be common to all players. Similarly she is unaware of the skill levels of other
players, so must rely on simpler, less demanding tactics in her passing game\textsuperscript{1} until she has some knowledge in this regard. Typically a coach would recognise the difficulties for a player new to the team and arrange for off-court training to fill in some of the gaps in the new player’s knowledge of the team.

In business, the opportunities for ‘off-court’ practice are limited. A new worker generally learns about the behaviour of co-workers and his or her role within the organisation, on the job. This can be a difficult and lengthy process, given the geographic, communication and structural barriers that separate workers in business. Managers can either accept that there will be a delay before a ‘remarkable’ individual shines as part of the new organisation, or find ways to accelerate the acquisition of local knowledge for the new worker. The processes that will allow a new worker to quickly assimilate within an organisation should also ensure that all current workers are kept up-to-date with operational changes. A worker’s individual performance relies on this broader knowledge of co-workers.

\begin{center}
\textbf{Business Lesson 4} The individual performance of a worker is enhanced by knowledge about the operational behaviour of co-workers. Avenues that allow for the sharing and updating of such knowledge will serve to accelerate the assimilation process for new workers.
\end{center}

\subsection*{3.5 Lesson 5 – The Need for Constraints}

\begin{center}
\textbf{Netball Lesson 5} Constraints are necessary to support a range of individual freedoms. (p. 24)

[And] The imposition of strict controls on the behaviour of each player in the team allows each player to excel within her own domain, in support of the team. Confidence in the behaviour of others on her team allows a player to creatively explore the boundaries of her performance. (p. 24)
\end{center}

\textsuperscript{1} A player’s passing game refers to the way in which she passes the ball. Some player’s have a strong short, sharp style of play while others can throw long yet accurate passes. A simpler passing game would rely on standard passes that are easily received; a more advanced style of passing game would stretch the skills of the receiver, in turn making it more difficult for the opposition to interfere with the pass.
Appropriate constraints on a netball player support the team coordination process, and allow a team of seven players to interact and support one another with the security that comes from confident prediction. A player who operates within an environment of predictability is confident in creatively exploring the boundaries of her own performance – she is free to develop her own behaviour within the confines of the team constraints. In this way she has the supported freedom to develop her own abilities without undermining the performance of the team. Without the broader team constraints, a player might still develop her own abilities, but the level of team performance will be lower and have a constraining effect on the level of performance achievable by the individual. Imposed constraints support a higher level of individual freedom.

Constraints that ensure the business direction is maintained should also support an individual’s freedom to creatively improve his or her performance within the organization. Constraints designed to coordinate the efforts of the team provide a boundary for the individual’s creative freedom, ensuring that it is directed rather than limited.

**Business Lesson 5** The imposition of controls on the behaviour of workers within an organisation allows each individual to excel within his or her own domain (in support of the organisation). Confidence in the imposed constraints allows a worker to creatively explore the boundaries of his or her performance.

### 3.6 Lesson 6 – Decision-Making

**Netball Lesson 6** Each time a player has the ball in netball is a decision-point for every player on the team. (p. 25)

The point of this lesson is that decision-making within a netball team is not restricted to the player with the ball. Each pass of the ball is a state transition for the team, so that each time a player has the ball is a decision-point, not just for the player with the ball, but also for every member on the team. The player with the ball must select the next receiver and the rest of the team must decide how to organise their play to provide a
receiver for this and subsequent passes. The inter-relationship of their decision-making is paramount to the success of the team.

Decision-making in business must also be viewed as a coordinated process. Decisions made in isolation are likely to be suboptimal. If others within the organisation are unaware of the decision-making, they are unable to offer support for the decision-making process or to organise their efforts to improve the outcome from a chosen decision. Decision-making should take a systems view of operations and recognise the contribution of all parts of the system to the business operation. Decisions that lead to optimisation of one part of an organisation are often not consistent with optimisation of the overall organisation. Recognising the impact of local decisions on the broader organisational community is important in designing the decision-making process.

**Business Lesson 6.** Decision-making within a business organisation should not be an isolated process. All areas affected by the decision should be involved in the decision-making process so that the final decision is supported, and supportive of the organisational endeavour.

### 3.7 Lesson 7 – Duplication of Effort within a Team

**Netball Lesson 7** For each pass where constraints are not imposed, considerable team effort is duplicated without adding value to the process. The probability of the pass being successful is also reduced when both the thrower and potential receiver are attempting to rapidly assimilate current information, forecast outcomes, make decisions and act on those decisions. (p. 34)

When no constraints are placed on a pass in netball, each player is acting in isolation, and all potential receivers will make an effort to lead for a successful pass. This will involve up to four players working to be clear and available for that pass. Since the thrower can only select one of these options, once the pass has been made the other three have added no value to the process and find themselves badly placed for subsequent passes. This duplication of effort can weary a team and exhaust their individual energy reserves before the end of the game. Further, the thrower often selects poorly when choosing a receiver, since her decision-making is forced rather than
considered (she has to throw the ball within three seconds or forfeit it to the opposition) and she has no team plan available to aid prediction.

Lack of planning, information sharing and coordination can lead to duplication of efforts in business. This is part of the 'Pink Work' classification identified by Meredith Belbin (2000) and described as 'a work activity that is not work … [that] contributed nothing but [was] time-consuming' (Belbin, p. 57). The same lack of information sharing and planning that leads to wasted effort also impedes the decision-making process - 'Decisions made in isolation are likely to be suboptimal.' (Lesson 6)

**Business Lesson 7** Duplication of effort is easily hidden within a large organisation and is both wasteful and costly. It derives from lack of information sharing and coordinated planning within (and between) organisational groups.

3.8 **Lesson 8 - Individual Performance within a Team**

**Netball Lesson 8** Players cannot 'hide' within a team that operates at the game-play level. The contribution of all members of the team becomes clear in the game-play process. (p. 38 & 39)

A game-play in netball imposes designed constraints on every player of the team. Each player is aware of the team expectations on not only herself but also all other players in the team. The performance of each player is therefore open to scrutiny by all other players – players cannot 'hide' within a team that operates at the game-play level. The same is true within a business organisation. In an environment in which each member of a business group is bound by coordinated, goal-directed constraints, the contribution of each worker is evident. A well-designed business game-play will draw on the efforts of all team members for its success – the failure of an individual to contribute or comply undermines the play and is self-evident.

**Business Lesson 8.** Individuals cannot 'hide' within an organisation that operates at the game-play level. The contribution of each worker becomes clear in the game-play process.
Chapter 4  Over-the-Counter Service within the Banking Industry

4.1 The Changing ‘Face’ of the Banking Industry

Forty years ago banks enjoyed a softer, friendlier image than they do today. On her fortnightly visits to the bank my mother would be greeted by name by the manager and several of the tellers. There were none of the ‘horrendous’ queues that she talks of today and no dreading of the routine business of banking. Despite being a minor customer in monetary terms, she felt valued and in return offered the bank her loyalty for over 40 years. She set up accounts for all of her children at that bank and envisaged the close working relationship continuing into the next generation.

The concept of a partnership with a banking organization has diminished during the past forty years and the public image of banks is now one of remote, wealthy corporations that put the making of profits before the interests of their clientele. Two significant issues of complaint have been exposed in the last decade: the fees that are being charged for the offered banking services and the quality of that service.

![Figure 4.1 Noninterest Banking Incomes – 1999](Data sourced from Corbelli & Ryan 2001)

The price of banking has become front-page news as fee income becomes a significant portion of the banks’ revenue source. (Figure 4.1) Industry predictions suggest that by
2005, nearly 60% of banks' revenue will come from non-interest sources (Varki & Colgate 2001). The response from consumers has been to shop around for their banking services, and select the banking institution that offers minimum costs on their particular needs (Ogilvie 2000). Old-fashioned loyalty to banks has weakened in line with the perceived drop in the loyalty of banks to their customers — at a huge cost to the banking companies (Reichheld 1996). Varki and Colgate (p. 232) point to research that 'has shown that increases in customer retention result in increased profitability for firms that compete in mature, competitive markets ... like banking ...'. In this regard, the quality of service offered by banks will become a major competitive factor, and the most visible expression of this is the over-the-counter (OTC) service offered in the banking chamber.

### 4.2 Operations Research in OTC Services

The growth in customer complaints has heralded an increase in research into the delivery of face-to-face customer service and more particularly the issue of time spent in queues for OTC service. Research into ways of reducing customer dissatisfaction with the wait in queues has been approached on two fronts: through operations management and through perception management. The applications of queueing theory and queue psychology to the OTC service industry are burgeoning fields of research. This chapter will review the recent literature on research into both operations and perception management of OTC service, focusing particularly on works based in the banking industry. The aim is to provide a platform for discussion of the banking case studies (Chapters 5 and 7) that demonstrate application of the game-play methodology, and to illustrate how the misuse of limited or incomplete data has hampered the advancement of a deeper understanding in these areas. This lack of understanding has seen lengthy queues survive the influence of fifty years of research.

### 4.3 The Contributors to Queue-Frustration

Queueing has become a frustrating fact of life for customers seeking over-the-counter (OTC) service. For those who are uncomfortable with the alternate service channels offered by the industry, have no ready access to them or whose business cannot be satisfied electronically, the waiting in line can seem interminable. We queue to do our banking, to pay our rates, to renew our license, to register our dog, to ask a question, to
purchase groceries. With little understanding of the system, we feel elated if there are only two customers ahead of us in the queue and disappointed if the queue is already ten long when we join it. We are grateful if the wait is short and resignedly annoyed if it is long.

Time has become a treasured resource in the frantic pace of the technological age. High quality, custom-fit products have become the norm and there is now a growing expectation of instant delivery on these products. A home-loan approved over the phone; overnight mail delivery; same-day dry-cleaning; one-hour processing of photographs; drive-through takeaways; 'instant' pasta, etc. The competitive edge now rests with the timeliness of the quality service being offered.

While the time constraints of life are contributing to customers' discontent with waiting for service, the service providers are exacerbating the problem in their drive for higher operational efficiencies. Staffing caps based on service models that promote minimum idle time (maximum utility) ensure the preservation of customer perceived, 'lengthy' waits in queues (Figure 4.2).

![Combined Effect on the Perception of Service Quality](image)

Figure 4.2 The Combined Effect on the Perceived Level of Service of (a) a reduction in staffing levels (in real terms), and (b) a decline in customer patience with queueing
Chapter 4 - Over-the-Counter Service within the Banking Industry

4.4 Queueing Theory and Industry Models: Queue Length as the System State Indicator

Queue-length is the current service industry indicator that more servers are required on the counter. Once a queue of customers has reached a certain length, and has been noticed, an additional server will be called (if capacity allows). In situations where the workload per customer is visible or the service time is fixed, this type of assessment may be valid. For example, in a supermarket, where the quantity and type of goods to be processed for a given customer is visible, the manager can make a reasonable assessment of the workload on the system. In a theme park where the rides are of fixed duration and capacity, the number in the queue is a measure of the system load. In most over-the-counter service institutions, however, workload for a customer is not known until the customer reaches the counter. A queue of two could hold 40 minutes worth of work while a queue of ten holds only 20 minutes. Further, if all servers are busy with lengthy transactions and there is a long break before the arrival of more customers, the queue of two may not grow to trigger the response mechanism and those two queued customers will have a long wait for service within an unresponsive system.

Clearly for OTC banking service, which is driven by random customer arrivals and a variety of transaction workloads, queue-length is a poor indicator of current system workload or system state. Yet it persists as the state descriptor, both in practice and in the academic literature (Donnelly 1996, Hammond and Mahesh 1995, Van Dijk 1997, Varki and Colgate 2001, Whitt 1999), and is one of the few commonalities between theory and practice. Academia is engrossed in deeper and more specific analysis of the service operations process to provide ever more complex solutions to less practical, hypothetical problems (Donnelly 1996; Larson 1987; Van Dijk 1997; Varki and Colgate 2001; Whitt 1999). The translation between these complex mathematical solutions and the real-world has not been forthcoming and industry has been loath (or unable) to pursue options that they cannot readily understand. Those works that transcend the specialized mathematics and present models that are recognizable in a real-world context, suffer from the other extreme - attempts to make the problems and their solutions too simplistic (Brewston 1989, Donnelly 1996, Ogilvie 2000).

1 The state variable in queueing theory is $N[t]$ - a 'random variable describing the number of customers in the system at time $t$.'

$$N[t] = N_q[t] + N_s[t]$$

Where $N_q[t]$ is a random variable describing the number of customers in the queue at time $t$, and $N_s[t]$ is a random variable describing the number of customers receiving service at time $t$. (Allen, 1990)
Both of these issues – oversimplification and incomprehensible detail – are important surface concerns, and the gulf between the two requires researchers with a complete grasp of both 'languages' (mathematics and business) to develop the bridge. But the bridge will be of little value unless researchers and policy-makers acknowledge and address the core issues of collection of incomplete data and its misuse.

4.5 Data Collection Methods

4.5.1 High Quantity, Low Quality Data

During the last decade it has become common for the collection of service data to be automated. Data capture takes place in real time as the service operators deal with customer transactions on their networked computer terminals. Information on the type of transaction being processed, when it was started, and how long it took, is generally recorded and collected at a central processing unit. On the face of it, this system is tamper-proof, not prone to the forgetfulness of operators in recording the data and provides a detailed picture of the workload on an operator throughout the day. A large proportion of researchers appear to favour this form of data for their modelling work, because it provides a significant sample of the customer base at relatively low collection costs.

In the banking industry data are drawn from the terminals at which the tellers process the OTC transactions. This records the type of transaction and the time that the teller spends on the terminal for each transaction. In analysing the data, standard workstudy practices ensure allowances are made for wrap-time\(^2\) to arrive at an average transaction time. Standardized wrap times allow this data to be used industry wide to provide national standards (Hammond and Mahesh, 1995). A bank may then compare its performance against industry 'standards'. Although the process is precise in its application and accumulates a significant volume of data, the results achieved are rarely accurate.

There are a number of problems with this form of information collection. Prominent among the causes of these problems are the data that are overlooked. Non-terminal work (other than wrap-time) does not figure in the analysis. In a bank this may include

\(^2\) Wrap-time is the time taken after the customer has departed to “wrap-up” (complete) the transaction - accounting, marshalling monies, collating and processing forms, and filing.
locating and opening safety deposit boxes, making up temporary deposit books, collecting pin numbers and cards for customers, selling travellers’ cheques, buying and selling overseas currency. The countless non-terminal tasks skew the results of the electronic data capture, but the policy makers in the industry and many researchers fail to recognize this shortcoming. Hammond and Mahesh (1995, p. 1077) quote USA banking industry national standards as “1.65 min (of service) per customer, 1.5 min per transaction; an average of 1.1 transactions per customer”. The precision implied by these figures is at variance with the capabilities of the method of data collection.

A further aspect of the OTC service process that is overlooked in this method of information collection is the behaviour of the queue. Terminal data can only recognise continuity or breaks in the flow of a queue (when the queue-length drops to zero for a period), but can give no information on the length of queues or the wait time experienced by customers. This feature is vitally important in the determination of staffing levels to ensure a desired level of service quality.

4.5.2 High Quality, Low Quantity Data

The other form of information gathering used in researching OTC banking service is direct observation and recording. When performed with care, this method provides a complete picture of the service operator’s work and the conduct of the queue. Direct observation and recording allows anecdotal evidence to be gleaned alongside the empirical data on transaction length, queue length and wait in queue. The disadvantages of this method of data collection stem from the cost of collection. The industry rarely participates in data collection by this method, trusting instead the picture created from the vastness of information that can be electronically generated. Researchers appear to appreciate the completeness of information gained by direct observation, but rarely collect enough data to form a significant sample. Katz and co-researchers (Katz et al 1991) base their recommendations in queue psychology on a study of 277 customers of a bank, performed over several days. Without information on the volume of customers served during the collection period it is impossible to ascertain the significance of this sample. For example Katz’ summary statistics indicate that only 3% of the survey population waited in excess of 12 minutes, but this amounts to only eight customers. There is no way of knowing if 3% would be an average over the entire survey period, or whether the researchers had, by accident or design, chosen busier or
quieter times than usual. Given that the site of the study was a large bank branch in 'downtown Boston', the significance of a survey population of 277 customers taken over a number of days is questionable.

4.5.3 High Quality, High Quantity Data

Operations management in the OTC service area of the banking industry is hampered by its reliance on statistically insignificant or biased information. Accruing significant quantities of complete information is a costly business but it would serve the industry well in an era when high quality and timeliness of customer service are impacting strongly on business profitability (Varki and Colgate 2001; Reichheld 1996). Policy makers must insist on completeness and significance in the data collected, if they are to have a level of confidence in the outcomes of their decisions based on the research.

4.5.4 The Case Studies in this Thesis

Data collection for the case studies presented in this thesis (Chapters 5 and 7) took place over prolonged periods and involved the recording of both empirical and anecdotal evidence. An observer/recorder sat in the banking chamber (in full view of both tellers and customers) to record the time at which each customer became a member of the queue, the time when they left the queue and the time when their transaction with the bank was complete. Information on reneging and baulking was also recorded, as were the behaviours of the tellers and customers in the queue.

A simple macro on a laptop computer allowed the time to be recorded with an accuracy of ± 1 second. On eighteen of the twenty days that comprised the survey periods, data were recorded on every customer during the bank’s opening hours. On the other two days the survey was taken in time blocks (half days), not random selections of hours. Statistics on 8277 customers were collected for the two case studies presented in this work. Information on the behaviour of staff and customers when confronted with queues was also gathered, initially as necessary input in the development of the state descriptors (see §5.3.4). Observation of the reactions of customers to waiting in queues led to the hypothesis of a patience threshold that impacted on the time allowances for

3 'Patience Threshold' is defined as the greatest amount of time that a customer will amicably queue, i.e. the amount of time that a customer will queue without the queue-time adversely affecting customer perception of service.
the state descriptors. Very early in the first data gathering process it became evident that the importance of the non-empirical data was not limited to its influence on state knowledge in the game-play application of constraints. Understanding the psychology of queues provides a powerful tool in influencing customer perceptions of service.

4.6 Queue Psychology in regard to Waiting Times

Factors such as perceived social injustice\(^4\) (Larson 1987), and environmental conditions will play a part, alongside queue time, in determining customer satisfaction with OTC service. This review will focus on the psychology of wait time with regard to queueing, illustrating some of the valuable outcomes of research in this area, the commonalities of the work and the oversights.

4.6.1 How long will customers wait?

Observations of customer tolerance with waiting in the queue contributed to the hypothesis of a patience threshold of around three minutes in the banking environments studied for this thesis. This analysis was carried out prior to consulting the literature in this area so as to avoid a biased perception of queue behaviour. Customers' signs of impatience began around the three-minute wait mark – disappointed, disgruntled body language replaced the easy mannerisms; clock-watching became more noticeable; the intensity with which customers followed the tellers' actions increased; paper shuffling / reorganization began; and occasionally the inconvenience became a topic of conversation. Perhaps not surprisingly, the three-minute mark is a recurring performance target in much of the research material in this area. Hammond and Mahesh (1995, p. 1078) created a simulated staffing model based around the benchmark set by the New Orleans banking institution:

"The bank's central management wanted a benchmark manning model to give to each branch manager. The model was to demonstrate the ideal teller staffing required to deal with actual customer arrivals and to begin service within three minutes 95% of the time." (emphasis added)

\(^4\) Defined by Larson (1987, p. 895) as "violation of first in, first out" queueing.
No justification is given for this empirical statement but it doubtless reflects the bank's interpretation of customer tolerance. Donnelly (1996) studied the reception service of a local council in the UK where a waiting time of less than 3 minutes was the 'target level set by management' (Donnelly 1996, p. 63). Some studies suggest that the patience threshold might be closer to four minutes. For example, Katz (1991) categorized customer wait times in the group's bank study as 0-4 minutes, 4-12 minutes and greater than 12 minutes – perhaps on the recommendation of the bank or from their own observations. Their study determined that:

"On average, customers thought that 5.9 minutes was a reasonable amount of time to wait. However, as with perceived waiting time responses, descriptions of what constitutes a reasonable waiting time tended to anchor around five-minute intervals. More than 40 percent of respondents specified exactly five minutes." (Katz 1991, p. 47)

Katz recognised the 'five-minute anchor points' but failed to make allowance for the natural tendency of respondents to round their approximations. The survey participants were unlikely to specify a reasonable wait to a fraction of a minute (as the researchers do), and were much more likely to round their estimation to the nearest five minutes (as happened in the study). If the timeframe were larger – a matter of hours – respondents would most likely round to the nearest quarter or half an hour. The other error that calls into question the validity of the '5.9 minute average, reasonable wait', is a failure by the researchers to apply their own findings on 'perceived waiting times'.

"As we had expected, people tended to overestimate the amount of time they spent waiting in line. Differences between perceived and actual waiting times were approximately normally distributed with a mean overestimation of just under one minute and a standard deviation of 2.5 minutes. Waits of less than one minute typically were not perceived to be waits at all." (p. 47)

If customers display a tendency to overestimate actual waiting time, then their responses in relation to a 'reasonable wait' are doubtless tainted by the same misconceptions.
In the present study it is observed that three minutes represents a reasonable estimate of the patience threshold of OTC banking customers.

There are three other aspects to "How long will customers wait?" that do not appear directly in the literature:

1. The effect, on a customer's tolerance for waiting, of being accompanied in the queue;
2. The relationship between the length of the queue joined and a customer's patience tolerance; and
3. The relationship between the amount of work (required service time) the customer is carrying and his/her patience tolerance.

The first of these three falls under the umbrella of 'eliminating empty time' or 'entertaining' the customers, as they are distracted from the wait by conversation / interaction with their companion(s). In the case study of Chapter 5, the queue-manager became a stand-in companion during her time in the chamber, effectively distracting customers from their singular concentration on the queueing process. This in turn had a positive affect on the customers' perceptions regarding the wait.

Customers' unscientific expectations about short queues — that the wait will also be short — appear to have an influence in lengthening the customers' tolerances for waiting. As anticipated, long queues have a negative effect on tolerance. Customers exhibit intolerant behaviour immediately they join a perceived 'long' queue (around eight or more in the bank studies conducted for this thesis). Clearly there is a need to keep queue lengths short to maximize the patience threshold. (See §5.3.4 for supporting evidence of this statement, from the first case study.)

The final observation regarding patience tolerance for OTC service also relates to expectations. Customers who have come to the bank with a large quantity of work have envisaged a lengthy period of transaction. They have planned and organized other aspects of their life to allow for the protracted banking business and therefore do not feel greatly inconvenienced if they are forced to wait for service. The customer who

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5 Larson (1987, p.897) contends that "filled time appears to pass more quickly than empty time."
carries less than 90 seconds worth of work has rationally envisaged a short stay at the bank and planned accordingly. Quite often this type of work arrives at the bank during morning and afternoon tea breaks or at lunchtime. The inconvenience of waiting for service is sorely felt since it contravenes the self-made prophecy of the customer. Katz observed that many customers (of the 277) declared ‘their concept of “reasonable” wait varied based on when they came into the bank; for example, they were willing to wait longest during lunchtime or on payday’ (p. 47). The case studies in this thesis (with over 8000 customers) point to behaviour in direct contradiction to this finding. Customers certainly seemed more resigned to the wait during these peak periods but were vocal about the bank needing to address the problem of increased workload and ‘ridiculous queues’ during such times.

4.6.2 Ways to alter Customer Perceptions of The Wait

The title of Katz’s paper (1991) provides a neat summary of the methods used in perceptions management to make transactions seem brief:

*Prescription for the Waiting-in-Line Blues: Entertain, Enlighten, and Engage*

The influence of ‘entertaining’ and ‘engaging’ the customers has been discussed briefly above. The aim is to distract the customers from the wait. Enlighten refers to the process of informing customers about the predicted length of wait, a concept that has mixed support amongst researchers. Larson (1987, p. 900) contends that from his observations,

"customers usually "feel better" about queueing when they are provided with information that allows them to estimate in advance their waiting time in queue."

To test this observation, Katz’s group in their study at a bank installed a digital display that gave an estimate of how long the next customer to join the queue would have to wait for service. The electronic board was placed at the entrance to the queue line, but did not achieve the process improvements the group had anticipated.
"Informing customers of their expected waiting time backfired. The clock made people more aware of the waiting time. It also appeared to increase balking rates." (p. 520)

Katz further observed that customers appeared content when the predicted wait on the digital display matched or exceeded their actual wait, but became ‘quite annoyed’ when the technology underestimated the time they really spent in the queue.

The lesson from the work in this area is that the form of information offered to customers by management must be suited to the situation. Since customers generally have little appreciation for the uncertainty of prediction and will tend to treat such information as accurate, it is perhaps better when posting estimates of wait to err on the side of exaggeration than to inadvertently compound the social injustice felt by customers. Better still, service managers could adopt the game-play approach described in this thesis to improve the quality of state-knowledge for the staff and the state information offered to customers.

4.7 A Better Way to Serve – The Game-Play Methodology

Generally OTC servers work in isolation. It has become common to refer to a group of servers as a team but this misrepresents the concept. A true team (§ 2.1) shares internal knowledge that unites them in their endeavours. A group of servers within the OTC service system of a bank simply shares a customer base. Server 1 has no knowledge of the current status of server 2, and vice versa. Each is managing his or her current customer in isolation from the rest of the ‘team’. This is fine while customers arrive with no more than the average transaction and space their arrivals to match the service requirements for those transactions. This rarely happens.

To pre-empt the growth of queues, the team needs to know when the servers are blocked (serving customers with lengthy transactions) and have a response plan that maximizes remaining capacity and matches it to the needs of the current queued customers. The traditional response to a growing queue has been to add another server to the system; then another; and another ... until capacity is reached. This is certainly a superior approach to no response at all, but it may not be the best approach. Queue management
systems that are designed to respond to queue-length suffer feedback delays that ensure the system under-performs in terms of minimizing queue time. The game-play methodology provides comprehensive, updated state knowledge that allows the system to respond in a more timely fashion, and to tailor that response to the current demands on the system.

4.8 Summary

Research in the area of OTC service operations is hampered by its reliance on queue-length as the state descriptor. Academia is offering business practitioners little support in their battle to minimize the wait experienced by OTC customers, largely because of inadequate theory and a lack of shared language, but also because of a practical dependence on limited or incomplete data.

Queue psychology addresses the second management avenue for improving the level of customer satisfaction with OTC service – perception management. The work in this area offers positive methodologies for increasing the patience threshold of customers, thereby increasing their overall satisfaction with service.

The queue-line persists amid the misconceptions and frustrations of the current service systems. Application of the game-play methodology to increase system state knowledge and provide a technique for continual monitoring and updating of state information, may provide a new approach that addresses shortcomings in both areas of OTC service management – operations and perceptions.
Chapter 5 Case Study 1– OTC Services in Branch A

Prior to undertaking these case studies I trained and worked as a teller. After two days spent with an experienced teller while I observed and served intermittently, I began work as an independent teller. At this stage I had very little back-office responsibility – this was to build up as my level of knowledge increased and I accumulated back-office work from my dealings with customers. I spent five weeks at the initial training branch – a small but busy branch in a suburban business and commercial centre. Towards the end of this period I was largely operating on my own, handling transactions that ranged from the simple (payments, deposits, withdrawals) to the more difficult (overseas bills purchases, currency buying and selling). I then spent three weeks working in the larger branch that was to be the focus of my first case study. Working alongside the tellers in this branch allowed me to understand the nature of the work environment and the expectations placed on the tellers. It also provided insights into the attitudes and abilities of the people in the branch.

The aim of this study was to prove the applicability of the game-play methodology developed in the netball case, to a business environment. In the business case the team was the over-the-counter (OTC) service staff (tellers) of a city bank. A designed set of local constraints comprised the game-play.

The use of game-play tactics in the banking chamber was highly successful. It provided a mechanism for designing constraints that addressed issues of the incomplete and inaccurate system state knowledge usually held by team members. Further, the process promoted the development of a team ethos among the tellers, and this change in attitudes had positive repercussions on the overall working environment. In addition, the case study provided insights into the psychology of queues, and gave a realistic picture of the workload experienced by the telling staff.

5.1 Profile of Branch A

The branch in this study was selected for its size and a history of poor performance in terms of customer satisfaction. The bank contracts an independent organization to perform random surveys of OTC customer satisfaction. A strong correlation has been
established between a satisfied customer base and a survey score of over 75 (on a scale to 100). Scores in this vicinity also indicate high performing branches in terms of sales and growth. Results for Branch A ranged from 49 to 53. A further measure of the branch's performance in this area was the number of customer complaints received by the area manager. Around ten written complaints were fielded each month and many more phone calls of complaint.

The branch’s reputation with customers was mirrored in its reputation with tellers, who had dubbed it the “Branch from Hell”. Tellers did not want to be sent there, and the branch had a poor record of staff retention. Turnovers were high and permanent positions remained vacant. There was a common feeling of being ‘hard done by’ in being sent to this branch – ‘overworked, under-staffed, and having to pay for parking!’ The unstable workforce meant that a team culture had not developed at Branch A.

Branch A was situated in the business/commercial centre of a major city. A prominent corner position, adjacent to large areas of pay-parking and two blocks from the transport interchange, ensured accessibility for both local business customers and visitors to the commercial sector. Residential clients would find this branch less easy to access than suburban branches.

5.1.1 Layout

Situated on a prominent city corner, Branch A had customer access on both street-frontages and a large, open chamber area with counter capacity for 13 tellers – 10 in view of the queue-line, and three at the recently closed commercial telling counter. (Figure 5.1) In line with the introduction of express business banking (the alternative to queueing for commercial customers), a ‘One-minute Teller’ had been introduced, to dispense pre-ordered change for business customers only.

The operating queue system prior to implementation of the game-play was a first-in first-out (FIFO) arrangement, with the queue forming parallel to the larger serving counter. A rectangular structural pillar obscured the queueing customers’ views of the smaller counter. The ‘back-office’ area, where bank work other than OTC telling was carried out, is open-plan. Generally non-telling staff worked in full-view of the queued customers.
Figure 5.1 Layout of Branch A  The banking chamber provides the largest direct interface between a bank and its customers. Branch A was situated on a corner and had entrances on both street frontages. Although the branch had physical capacity for thirteen tellers, staff restrictions limited the nominal service capacity to six.

5.1.2 Staffing Levels

Teller levels varied across the week in response to the predicted load. Six tellers were allocated on Mondays, Thursdays and Fridays; four on Tuesdays; and three on Wednesdays. In addition to dedicated tellers, the branch had a Service Advisor (SA) responsible for teller activities; and three Sales and Service Advisors (SSA) responsible for all other branch activities. The most senior SSA managed the branch but was given no distinguishing title within the organizational structure. At the customer interface there were three fixed OTC tellers on each of the days observed (two on Wednesdays) and up to a maximum of six tellers who were brought on-line in response to the queue length.

5.1.3 Customers

Branch A served the commercial businesses of the area and their customers. Business banking was disproportionately high in this branch, but a dedicated ‘Business Banking’ set-up ensured that these customers did not directly contribute to the OTC service problems. Registered business customers were able to drop off deposits and pre-order change so that processing did not require customers to wait and very few business customers queued for service. Overseas transactions (money exchanges, bill purchases
— labour intensive transactions) were high at this branch, in line with it being the major city branch.

Non-business customers to this branch comprised ‘white collar’ workers and casual customers (shopping in the precinct). These two groups had differing expectations of the branch, with time being the defining factor. Casual customers were less easily frustrated with the queueing process than the workers who were attempting to transact their business during a work-break (morning or afternoon tea; lunch; flexi-time). The service demands of this latter group were much higher, and in general they were more impatient.

5.2 Nature of this Study – Five Stages

This case study was planned to proceed in five stages. The first and last stages involved system performance evaluation, before and after the introduction of the game-play methodology (Stages 2 to 4).

Stage 1  Assessment of the Extant System

*Information and data collecting to describe the operation of the original system, and provide input for the design of the game-play*

Two types of data were collected to establish the state of the system before the implementation of a game-play: namely empirical data and system observations. The collection of empirical data (Table 5.1) involved recording the:

- Time at which the customer entered the bank queue,
- Time at which the customer exited the queue; and
- Time at which the customer’s business with the teller was complete.

A computer was used to log and hold the time of occurrence of the three events in a spreadsheet. The teller number information was recorded to allow tracking of the customers. System observations involved recording patterns, behaviours, incidents, and anecdotes that assisted in describing the system.
Table 5.1  Sample of Empirical Data Collected

<table>
<thead>
<tr>
<th>Customer No.</th>
<th>Enter Q (Time)</th>
<th>Exit Q (Time)</th>
<th>Teller No.</th>
<th>End Transaction (Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9:41:56</td>
<td>9:42:00</td>
<td>6</td>
<td>9:44:03</td>
</tr>
<tr>
<td>3</td>
<td>9:44:03</td>
<td>9:44:10</td>
<td>6</td>
<td>9:45:32</td>
</tr>
</tbody>
</table>

Stage 2  Application of the Game-Play Methodology

*Application of the step-wise methodology including design of the game-play*

Tellers at Branch A operated within boundaries set by the organization. Their behaviours and performances were typical of tellers at other branches - each teller was trained to independently carry out a range of functions. Their individual understandings of the organization’s goal were vague – most could articulate it as “to satisfy the customers” – and there was varied commitment to, and interpretation of, the best way to achieve this goal. For a game-play to be designed and implemented well, there needed to be a shared team goal, that would provide direction in the design process. Goal definition for the teller team was the first step in design of the game-play.

The game-play introduced in this study was developed to address issues identified in the initial data as impeding the achievement of the goal. Tellers received instruction in their role within the game-play and were supported through the learning phase of the play, until they were able to operate the imposed system ‘automatically’. In the sporting case it is rare for a player to be able to execute a game-play perfectly at the first trial and it was anticipated that the tellers would achieve their individual levels of competency after a few weeks of practice.

Stage 3  System Reassessment

*Assessment of the effectiveness of the game-play in achieving the team-defined goal, and identification of any related problems that have been exposed through the application of constraints*

Monitoring of the impact of imposed constraints on the system is an essential part of the game-play methodology. In this study one cycle of the feedback loop was performed before secondary data collection.
A week after the introduction of the initial stage of the game-play it became apparent that a second area of incomplete or inaccurate system knowledge was undermining team performance. Tellers now shared knowledge regarding the current and predicted status of substantive tellers\(^1\), but had no knowledge of the operational states of other tellers in the system.

**Stage 4  Modification (or Redesign) of The Game-Play**

*Modification of the initial game-play to reflect the findings of the system reassessment (Stage 3)*

A modification to the play was designed to augment the lack of system knowledge that was identified in the reassessment stage. Tellers required a means of knowing not just the service state of the substantive tellers, but also the operational state of each teller. Introduction of a teller schedule imposed further constraints on the team members.

**Stage 5  Follow-up Assessment of the Game-Play Operating System**

*Evaluation of the performance of the game-play operating team in relation to the defined goal*

The data collection process was repeated four weeks after application of the game-play methodology to allow direct comparison of the data.

**Data Collection Dates**

The initial extant system was observed over 5.8 days between 11\(^{th}\) and 20\(^{th}\) April 2000. Data collection took place only during the bank’s open hours – 9:30 am to 4:00 pm Mondays to Thursday, 9:30 am to 5:00 pm Fridays. Follow-up data were collected over 5 days from 19\(^{th}\) to 23\(^{rd}\) June 2000.

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\(^1\) Although the branch employs six tellers, not all tellers are allocated to the counter at all times. Their duties include back-office work and training, as well as the OTC service function. A number of tellers are designated as counter servers at different times throughout the day, and these are the substantive tellers. The role of substantive tellers is to serve the OTC customers.
Chapter 5  Case-Study 1 – OTC Banking Services in Branch A

5.3  Stage 1 - Assessment of the Extant System

5.3.1  Workload

Before the introduction of the game-play the bank handled an average of 360 OTC transactions per day, with an average transaction length of approximately 3 minutes. The average daily workload on the tellers was 19.5 hours. A daily breakdown for the study is given in Table 5.2.

Table 5.2  Daily Workload on the Tellers

\[(during \ the \ initial \ observation \ period – before \ the \ introduction \ of \ the \ game-play)\]

<table>
<thead>
<tr>
<th>Tuesday 11 April</th>
<th>Wednesday 12 April</th>
<th>Monday 17 April</th>
<th>Tuesday 18 April</th>
<th>Wednesday 19 April</th>
<th>Thursday 20 April</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.8 hrs</td>
<td>20.3 hrs</td>
<td>19.8 hrs</td>
<td>18.3 hrs</td>
<td>20.6 hrs</td>
<td>21.9 hrs</td>
<td>19.5 hrs</td>
</tr>
</tbody>
</table>

In addition to OTC transactions, deposits to the Flexi-Deposit Box (FDB) (cheque deposits only) and Express Business Deposits (EBD) had to be processed by the tellers before close of business. On all but one day (when the box was cleared mid afternoon), the FDB was cleared after closing of the bank each day. Express business work was handled throughout the day, but EBD deposits that arrived late in the day were cleared of cash and held over for processing the next day. Daily back-office work that could not be postponed was also part of the ongoing teller workload.

5.3.2  Length of Transaction

OTC transactions ranged in length from six seconds to 48 minutes. 72% of all transactions were completed within three minutes. Figure 5.2 displays the frequency of transaction times and illustrates the spread of times greater than three minutes. Throughout this first stage of the study, customers spent a total of 279 hours either in the queue or being served. The workload they carried totalled 99 hours, or 35% of their total dealings with the bank.

No information was collected on the type of banking being transacted. Duration was the only variable recorded regarding the actual transactions. This measure only includes the time while the customer was at the counter. Time spent by the teller to complete the
transaction after the customer has departed (wrap-time) did not contribute to the transaction times recorded in this study.

![Graph showing distribution of transaction times](image)

**Figure 5.2 Distribution of Transaction Times during the Initial Study.** 72% of transactions were completed in less than 3 minutes. 4.5% of transactions took longer than 10 minutes and are not displayed on this graph.

### 5.3.3 The Original Queueing System

Customers queued according to a first-in; first-out (FIFO) system. No sorting took place so that transactions with a variety of work-content were randomly distributed throughout the queue, throughout the day. The overall time that a customer spent in the bank was therefore not only dependent on the time taken to process their own transaction, but also the times to process the transactions of persons ahead of them in the queue. For the express customer, this system makes it likely that a one-minute transaction will require a prolonged visit to the bank. Figure 5.3 highlights the results of this problem. Each column on the graph shows the percentage of customers each day, who spent more time in the queue, than they did at the counter, being served.

Figure 5.3 then, is about perception, the perception of having been kept waiting longer than the transaction warranted. A 1.2 minutes wait to transact one minute of business may not dissatisfy a customer; yet a six minute wait to transact five minutes of business
may seem interminable. Time perception is an individual concept, dependent on a myriad of factors.

![Figure 5.3 Percentage of customers who spent more time in the queue than they did at the counter, on each day of observation before implementation of the game-play](image)

5.3.4 The ‘Reality’ of Perception

Two examples of the frailty of perception were observed in this study: tellers believing that a short queue did not require immediate attention; and customers believing that the wait in a short queue would be briefer than the wait in a long queue. Re-educating staff in this regard was possible but attempting to re-educate the customers would have been much more difficult. A range of customer perceptions shapes attitudes and determines levels of satisfaction with service, and it is these perceptions that must be addressed:

- The perception that a teller who is not serving at the counter is ‘not working’;
- The perception that tellers ‘always go for lunch during the busiest times’;
- The perception that tellers ‘take their time’ to do things;
- The perception that ‘I’ve been in this queue for twenty minutes.’ (The measured time on this occasion was just over seven minutes.)
- The perception that ‘The bank just needs to employ more staff!’
During the assessment period, it was observed that if the queue was short, say two persons long, the new queue member would cheerfully wait for three to five minutes, however, if the queue was long, say eight or more members, the new addition would exhibit impatient behaviour almost immediately. The number of reneges\(^2\) (see § 5.3.5 below for further discussion on reneging) increases as the length of the queue increases. There is a need to keep queue lengths short in order to maximize the customer patience threshold. The game-play developed in this case was not directed towards this objective, but had an immediate impact in this regard. Observation suggests that three minutes is the average patience threshold for customers in this banking environment. (See discussion in § 4.7.)

Figure 5.4 shows the percentage of customers (on each day of observation) who queued for less than this average patience threshold of three minutes.

![Figure 5.4 Daily percentages of customers who queued for less than three minutes](image)

This graph provides a direct picture of how well the telling team was performing in relation to their goal (§ 5.4.1) of serving as many customers as possible within three minutes of them entering the queue.

\(^2\) Reneging in the context of data collection for this study involved abandoning current business with the bank. Customers who left the queue to use an alternate channel available on site (ATM, telephone banking, flexi-drop box) did not contribute to the number of reneges.
Chapter 5  Case-Study 1 – OTC Banking Services in Branch A

5.3.5  Phantom Customers – Reneges

Customers who renege do not appear in any of the customer satisfaction surveys solicited by the bank, but their actions provide an immediate indication of dissatisfaction with the branch’s level of service. Table 5.3 provides the number of reneges observed on each day of the initial data taking.\(^3\)

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of Reneges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
</tr>
</tbody>
</table>

Seventy-one customers (3.4% of the total survey number) abandoned their business with Branch A and the anecdotal evidence suggested that in all cases this action was the result of dissatisfaction with the length of wait.

5.3.6  Original Teller Response Process

Each morning two or three tellers would be allocated to the counter to serve the queued customers waiting for the doors to open. Other tellers would be occupied with back-office or business banking work. If the length of the queue grew to around six, and this was noticed by one of the back-office workers\(^4\), an additional teller would begin to serve. If the queue continued to grow and reached around ten, a further teller would begin serving. This process of calling on additional staff in response to the length of the queue would continue until available capacity was exhausted.

5.3.7  Queue Length Propaganda

The indicator to staff that more tellers were required was queue-length. Once a queue of around five or six customers had formed (and been noticed), an additional teller would come into OTC service. This response system assumes that queue-length reflects

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\(^3\) A more detailed results table developed from initial data is presented in Appendix B.

\(^4\) Observations regarding the length of the queue were carried out in an ad-hoc manner, so that at times the Service Advisor would notice the growing queue; at times a teller who had just finished with a customer would look up and notice the length of the formed queue; and at times, no one noticed.
the load on the telling system in the branch. In the worst example of queue 'blow-out'\(^5\) during the initial observation period, a line of over twenty customers accumulated; but was cleared relatively quickly with full application of staff and the fortunate circumstance of a large proportion of express transactions. At another time, an inconsequential queue of two stood for over six minutes, with no additions to the queue to alert the staff that all tellers were busy with lengthy and prolonged transactions. The message is that queue-length is a poor indicator of workload and expected wait-time for customers.

### 5.4 Stage 2 - Application of the Game-Play Methodology

#### 5.4.1 Defining the Goal

The staff at Branch A discussed their individual understandings of the role of tellers within the bank to arrive at this definition of their team goal:

*To achieve and maintain outstanding levels of (over-the-counter)\(^6\) customer service.*

The observation during the initial study was that each teller provided professional, courteous, timely and appropriate service (to the best of their individual abilities) once customers were at the counter. Historically, complaints about the quality of teller service were rare. Customer complaints overwhelmingly related to waiting time – time spent in the queue-line. Addressing this issue was to be the aim of the game-play at this branch. The performance measure chosen for evaluating the success or otherwise of the play was *'percentage of customers who queue for less than three minutes'.* This objective was non-ambiguous, quantitative and addressed the recognized impediment to achievement of the goal. The designed game-play needed to ensure that the customer experience with the bank recalled the high quality of service, not the lengthy wait for service. To this end Branch A staff would endeavour

*To maximize the percentage of OTC customers who queued for less than three minutes*

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\(^5\) Queue ‘blow-out’ is a term used by the tellers to describe the situation in which the queue length reaches a size that could not be contained within the chamber – the queue extending into the entrance way. Queue ‘blow-out’ generally caused both staff and customers to feel stressed and dissatisfied.

\(^6\) The addition of the qualification (over-the-counter) recognises the distinct customer base at which the tellers’ efforts are directed.
5.4.2 Designing the Game-Play

5.4.2.1 Primary Design Considerations

The design criteria of a game-play are to increase current and immediate future state knowledge for all members of the team and to achieve the team goal. Considered design according to the first criterion will support the second criterion.

Initial observations at the branch highlighted two problem areas: system state knowledge for the operators was limited to a broad, daily view (there was no current, updated knowledge and indeed no mechanism for achieving current or predictive knowledge), and the response mechanism that was used in times of system overload was slow to react and slow to restore queue flow. The design of the game-play in this case study needed to address these areas.

5.4.2.2 Design Solution

To provide tellers with knowledge of their current and immediate future operating state a process was devised whereby individual tellers would assess and flag their workload state, each time they received a new customer. The flagging allowed them to share their individual state knowledge to create overall state knowledge for the team.

The next step in the design process was to determine an appropriate structure for flagging the teller workload states. A limited, discrete set of states based around time-intervals was considered appropriate as this caused minimal intrusion on the tellers’ service commitments while providing the information necessary to provide current and immediate future state knowledge of the overall system. Transactions were categorized as illustrated in Table 5.4.

<table>
<thead>
<tr>
<th>Table 5.4 Categorization of Transactions by their Service Time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged Transaction</td>
</tr>
<tr>
<td>Lengthy Transaction</td>
</tr>
<tr>
<td>Express Transaction</td>
</tr>
</tbody>
</table>
This categorization was developed from analysis of arrival and transaction data on Branch A's customer base, and the direction given by the team determined goal (§ 5.4.1). Approximately half (48%) of all OTC transactions were express transactions, i.e. half of Branch A's daily customers had business with the bank that could be completed in less than 1.5 minutes. In effect, 50% of the potential customer survey base contributed only 14% of the daily workload. (Figure 5.5)

**Figure 5.5** Composition of the days' transactions before the introduction of the game-play  Express Transactions (the top portion of each bar), requiring less than 90 seconds to complete, are carried by approximately 50% of the daily customer load.

Tellers used one of these three categories (ET, LT, PT) to describe the workload of their current transaction. In making this self-assessment the teller is providing a state measure with a higher level of accuracy than could be achieved by other means. Most industry efforts to categorise transactions consider the type of transaction (for example making up a bank cheque, cash deposit, cash withdrawal, bankcard payment) and assign an average time to complete that type of transaction. Such categorisation ignores individual teller performance and ability differences and the variation in workload of tasks within a category. Teller self-assessment acknowledges both of these.

Having established a means of continually collecting and updating system state knowledge, the next step in the design process was to determine an appropriate response to this new information, based around the intent of the team goal. The flagging system
provided the important information regarding service ‘blockage’ – the service state in which all tellers are involved in LT or PT transactions. When this situation occurred it was impossible to achieve the goal of maximising the number of customers who queue for less than three minutes. A response needed to be initiated the instant that the system was aware of the blockage – i.e. as soon as the last person flagged an LT or PT transaction.

By monitoring the state of each substantive teller (and thus the overall service system), a reduction of queue progression7 was recognizable before it occurred, rather than several minutes later when the queue had lengthened. Immediately a blockage was recognized, indicating that reduced progression was imminent, an express telling lane was opened and a queue-manager brought on line to select and direct the customers with express transactions from the queue. The queue-manager would also monitor the state of the overall system from the chamber, calling on more staff to serve LT and PT customers (to the staffing cap) as required while continuing to satisfy express customers until the teller blockage was cleared and progression had been re-established.

In this case study tellers displayed coloured flags (green, orange and red) to indicate the type of transaction being worked on (ET, LT or PT, respectively). As each teller displayed a new flag for the current transaction, he or she was required to monitor the state of all flags and assess the overall system state. If no green flags were showing, the queue-manager/express teller (QMET) pair was brought on-line. The four system states that trigger action within the game-play are illustrated in Figure 5.6.

This manual monitoring system was used in both case studies. An electronic monitoring system, as outlined in Appendix C, would be less intrusive on the primary role of the tellers. The proposed system could track the tellers’ flagged states, update the status if the flagging proved inaccurate, signal the need for responsive action and record statistical data for feedback and control.

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7 Queue ‘progression’ describes the rate of movement of customers through the queue. A reduction in progression occurs when all tellers are working on lengthy or prolonged transactions – all tellers are effectively ‘blocked’ and the queue stops ‘flowing’ for a period. Progression evaluation is subject to the same problems of perception that plague queue time. A customer who is in a hurry may feel that a queue is ‘stagnant’ if a customer is exiting each minute, while another customer who is not so pressed for time may be satisfied that a queue is progressing if a customer leaves every two minutes.
Figure 5.6 System States Identified in the Game-Play  State 1 is the most common operating state in Branch A – the three substantive tellers are on the counter and the random distribution of transactions has resulted in at least one teller serving an ET customer, at any given time. The team’s current knowledge is that teller 2 should take no longer than 90 seconds before she is available to take the next customer. During this time tellers 1 or 3 may also become available, but irrespective of this occurring, the system is still able to maintain flow through teller 2. State 2 describes the circumstance of all substantive tellers being occupied with either lengthy or prolonged transactions. The instant that the last of the substantive tellers flags on red or orange (i.e. no tellers working on express transactions), a bell is rung to signal system blockage. A response mechanism is then initiated – in this case an in-chamber queue-manager and an express teller (State 3). The queue-manager directs the first ET customer from the queue, to the express teller, and ascertains the composition of workload in the remainder of the queue. If there are two or more customers with lengthy or prolonged work in the queue, an additional teller is brought on line (State 4). The presence in the queue of three or more customers with LT or PT work indicates that two additional tellers should be brought on line. The server system is now at full capability (State 4) and remains in operation until there are no queued customers.
5.4.2.3 Description of Game-Play Operation

When a substantive teller greets a new customer, an assessment is made of the workload in the transaction. If the transaction will be a ‘quick one’ – up to approximately 1.5 minutes – a green flag is displayed and no further action is required. There is no need to assess the overall state of the system (check other tellers’ flags) since only one green flag is necessary for the system to continue to operate in the substantive state (just the substantive tellers serving). If the transaction will take a few minutes – but not more than about four, the teller displays an orange flag and checks that at least one teller is displaying a green flag. For transactions that will take "forever" – a red flag is displayed and the system state is checked. The substantive tellers are indicating to each other the status of their current workload. When a teller changes the state of the flag display, he or she scans the other displays to establish the current overall system status. If no green flags are showing, a bell is rung to alert the queue-manager, express teller pair. The responsiveness of the queue-manager and the flexible express teller to blockage of the substantive tellers is critical and the aim is for zero lead-time.

While only one teller is operating in the express mode, a queue may develop – but it will be a moving queue and, based on data from the initial study, should be manageable. If all substantive tellers become blocked (PT or LT), then ET capacity is reduced to nil and the response will be initiated. The queue-management response system remains in operation until the queue is reduced to zero and the system is returned to the substantive state. While queue-management is operating, the tellers continue to assess and flag transactions, since this provides the queue-manager with a high level of state knowledge.

Analysis of the workload and rate of loading for the branch indicated that staff levels were consistent with the requirements for implementation of the proposed game-play and a planned response that included an in-chamber queue-manager and an express teller. No extra personnel were required. A minimum of three substantive tellers were required at all times on Mondays, Thursdays and Fridays, with a fourth substantive teller during peak periods on these days. Tuesdays and Wednesdays required a minimum of two substantive tellers. Two Additional LT & PT tellers could be called into service by the queue-manager based on assessment of the workload in the queue, not the length of queue. For example, if all tellers were flagged on red (PT), it was
inappropriate to allow a customer with lengthy work to continue to wait while express customers were drawn from the queue and served. Similarly if some tellers were on orange (LT), but there were two or three PT or LT customers in the queue, there was a need for increased capacity in that area and tellers 4 and 5 would be called. If the gameplay was executed well the branch would rarely ‘build queues’.

5.4.2.4 State Based Management – The Game-Play for Branch A

This game-play required more team coordination than staff had previously experienced and involved continual monitoring and flagging of the state of the teller system. The play was challenging but staff could envisage immediate improvements from its introduction so there was interest in, and commitment to, its application. Updated knowledge of the system state allowed the team to pre-empt and avoid the growth of queues by initiating a response that matched the service capacity to the known workload. This part of the play was sensitive to the performance of every player and highlighted the value of a cooperative, cohesive team over an equally dedicated group of uncoordinated individuals. This form of game-play has potential for application in any single queue, multi server system that is characterised by random customer interarrivals and service times, and has been termed State Based Management (SBM). SBM addressed the two issues that were highlighted in the primary design considerations (§5.4.2.1)

5.5 Stage 3 – System Reassessment

A problem observed during the first week of operation of the game-play was that unplanned fluctuations in the number of substantive tellers caused major fluctuations in capacity to serve. Tellers leaving their station (to clear their drawer, complete accumulated work or other off-line tasks) quite often reduced the substantive number of servers by a third. Less often the number was reduced by two-thirds and occasionally by 100 percent as all designated substantive tellers were otherwise occupied.

The game-play required three substantive tellers (two on Wednesdays) to be at the counter at all times, but tellers were uncomfortable with standing at the counter while

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8 The random nature of interarrivals and transaction types still allows for the arrival of six or more PT customers in quick succession and this event is not served substantially better by the game-play, but it is statistically rare. (In a comparative simulation of the original system and the game-play, this event occurred less than 1% of the time during a 4-year period. See §6.4)
there were no queued customers, so they would busy themselves off the counter with other work. One teller created a large amount of non-available times for herself, simply flagging herself as red (prolonged transaction) and leaving the counter to do other business. This resulted in the queue-management aspect being initiated more frequently than should have been required. To compound the problem, the Service Advisor (SA) (supervisor of tellers) would randomly assign lunch breaks, training sessions and back-office work. The pace of activity in the branch often caused her to misallocate, so that available capacity was at a minimum during times of greatest load.

The inability of the teller team to maintain a substantive number of servers on the counter at all times highlighted the need for a modification to the game-play. The change (increased constraints) was introduced in the second week of implementation.

5.6 Stage 4 - Modification of The Game-Play

A Teller Schedule (Table 5.5) was introduced to support the constraints of the original play and to address the problem identified in §5.5. The schedule allocated staff to one of four activities – serving on the counter (allocation to Bays); back-office duties; training; and lunch break. All tellers had one hour of training each week, which was organised during the quieter times for the branch. Similarly allocation of back-office work avoided the busy periods over lunch and just before closing. Once again the aim with this modification was to increase current and future system state knowledge for all team members. As soon as the schedule was distributed, the issue of the inability of the team to maintain substantive teller numbers disappeared.

While the implementation of this second phase placed further constraints on tellers' behaviours, it also increased their freedom (§ 2.3.1). Having a set lunch break meant that it was now possible to organize personal appointments during that time, and the knowledge that the counter was adequately manned allowed tellers on back-office work to concentrate their efforts in that area rather than ‘keeping one eye’ on the counter. Tellers were also comfortable in swapping elements of the schedule to suit their personal needs, secure in the knowledge that the intent of the schedule would be maintained.

<table>
<thead>
<tr>
<th>Table 5.5 A Portion of the Teller Schedule for Mondays (using generic titles)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mondays</strong> (using generic titles)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>94</td>
</tr>
</tbody>
</table>
5.7 Stage 5 - Follow-up Assessment of the Game-Play Operating System

A month after the introduction of the game-play the data collection process that had been used initially, was repeated. Staff was aware of the work-study analysis but had become quite ambivalent towards the data recorder observing from the chamber and there was no visible extra effort to affect a favourable result for the game-play.

The follow-up data was recorded over five days – Monday to Friday- 19th to 23rd June 2000. The QMET pair was required for a total of only 4.5 hours during the data collection period (33.5 hours duration). For the other 86.6% of the time, the substantive tellers were able to handle the load. Table 5.6 provides a comparison of the load on the operating system, before and after the introduction of the game-play.

The distribution of service times was ostensibly the same for both periods of observation (Figure 5.7), but a larger workload was handled in a shorter period in the follow-up analysis, resulting in increased pressure on the teller system (Table 5.6). In addition, one of the tellers was absent on sick leave for 1.5 days without replacement, further increasing the pressure on the serving system. The overall load to capacity ratio for the branch increased from 0.6 to 0.8. Consequently the conditions were more demanding during the game-play period and so any bias in the results will be against the game-play.
Figure 5.7. Distribution of Service Times for the OTC operation at Branch A, with and without the game-play. Service time remained unchanged after the implementation of the game-play.

Table 5.6 Comparisons of Loads on the Teller System before and after the implementation of the game-play

<table>
<thead>
<tr>
<th>Property</th>
<th>Before the Game-Play (April 2000)</th>
<th>After the Game-Play (June 2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days in the Study</td>
<td>5.8 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Total Number of OTC Transactions</td>
<td>2079</td>
<td>2122</td>
</tr>
<tr>
<td>Total Load (hours of OTC work)</td>
<td>86 hours</td>
<td>96 hours</td>
</tr>
<tr>
<td>Express Transactions – ET</td>
<td>47%</td>
<td>51%</td>
</tr>
<tr>
<td>Lengthy Transactions - LT</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>Prolonged Transactions – PT</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>Load / Capacity&lt;sup&gt;9&lt;/sup&gt;</td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

<sup>9</sup> The ratio (Load / Capacity) is the term $p$ in queueing theory, where $p = \frac{\lambda \cdot W s}{c} = \frac{\text{average rate of customer arrival} \times \text{average service time}}{\text{Number of staff}}$.
The results taken during the follow-up work-study showed a marked improvement on those of the pilot study. The number of reneges fell from 71 to four (three of whom were frustrated with waiting; one of whom objected to the selection of an express customer from further back in the queue, ahead of him). The maximum wait in the queue was halved – from 24 minutes to 12 minutes – still well outside the desired maximum wait of three minutes. 85% of customers however, enjoyed the 'less than three minutes wait' under the new game-play, compared with only 34% under the old operating system (Table 5.7).

### Table 5.7 Performance Measure Comparisons – Before and After the Introduction of the Game-Play

<table>
<thead>
<tr>
<th>Property</th>
<th>Without the Game-Play</th>
<th>With the Game-Play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Reneges</td>
<td>71</td>
<td>4</td>
</tr>
<tr>
<td>Percentage of customers who queued for less than 3 minutes</td>
<td>34%</td>
<td>85%</td>
</tr>
<tr>
<td>Longest wait in the queue(^{11})</td>
<td>24 minutes</td>
<td>12 minutes</td>
</tr>
</tbody>
</table>

Customer written complaints to the area manager fell from an average of 10 per month, to zero in the period immediately following the implementation of the play. This may have been due in part to the 'Hawthorne Effect'\(^{12}\) – *the customers were pleased with any form of activity that appeared to be addressing their waiting problem* – but was a welcome side effect. There were other positive side effects of introducing this game-play, which were not anticipated at the outset:

- The queue-manager was able to satisfy several customers without them having to see a teller (20 OTC customers during the follow-up study).
- The implementation of SBM and the role of the queue-manager served to entertain the customers in the queue and reduce their perception of the wait - effectively increasing their patience threshold.
- Tellers' appreciation of the time taken to complete a transaction became more accurate. Initially the tellers were consistently underestimating how long a

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\(^{10}\) A complete table of results is given in Appendix B.

\(^{11}\) The longest wait in the queue considers the entire study. For a daily breakdown, see Appendix B.

\(^{12}\) The Hawthorne Effect is a term coined by Elton Mayo who carried out work-studies in Chicago in the 1930's. Mayo suggested that showing some concern for people's work welfare is enough to improve their performance – irrespective of the form of the concern.
transaction would take them to complete. Tellers operate in ‘busy-time’ – a level of relative perception in which time passes very quickly. Realizing that tasks were taking them much longer than they thought gave them a better appreciation of how long customers were waiting.

5.8 Notes on The Game-Play Methodology at Branch A

The following compilation of notes is based on observations made throughout the case study.

5.8.1 Determining the Scope of the Play

Initially the game-play that was designed for Branch A included a number of related components. For example – one aspect placed constraints on the Senior Advisor to empty the flexi-deposit box hourly and distribute the work throughout the day rather than holding it over for bulk processing after the bank had closed for the day, and another aspect constrained Teller 1 to regularly clear the draws of substantive tellers rather than have them leaving their service position to do this. Six components of the proposed game-play were initially presented to the teller team but this proved to be overly ambitious. The tellers baulked at what appeared to be a complex play and of the six components that comprised the original game-play proposal, only State Based Management (SBM) was introduced and evaluated. This aspect was most easily rationalised by staff as directly linked to achievement of the goal. The tellers gradually included other aspects of the original play without the need for rigid constraints. For example, the queue-manager began emptying the flexi-deposit box after each session of queue-management and distributing the work. The process of arriving at the scope for the initial game-play reinforced the idea that more is learnt from mastering a simple play than is learnt from inept application of a complex play.

5.8.2 Staff Motivation for the Play

While the tellers were involved in the development of the goal for the team, they had little input into the form of the play. Both phases of the play were largely thrust upon

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13 Tellers were given confidential feedback in regard to the accuracy of their flagging. Generally two sessions of monitoring and feedback were enough to improve the accuracy of teller evaluation of workload to over 95%.
14 Other aspects were designed to support SBM, but the link to the goal was less obvious to the tellers.
them. Senior area management supported the trial and lent authority to its introduction, but for staff the game-play had the potential to be an added burden in an already over-worked day. Further, although dealing with disgruntled customers was unpleasant, it was 'part and parcel' of the job and something that the tellers had learned to cope with over the years. Overall the motivation for implementation of the play was limited. The tellers' attitude could perhaps best be summarized by the statement "If management want this game-play, then we'll give it a go". There were no attempts by staff to undermine the implementation of the game-play.

5.8.3 The Non-Intuitive Nature of the Game-Play

For both customers and tellers, the most intuitive response to a blockage of all substantive tellers, is simply to apply more tellers to the counter. On Day 2 of the follow-up study the tellers illustrated a clear lack of understanding of the virtues of the game-play. Rather than implement the game-play response to a blockage, the designated queue-manager simply came on as an extra substantive teller. She became blocked and called for an additional teller, who came on, cleared a couple of customers and became blocked also. This continued until full capacity was reached (in terms of staff and telling bays) and still there was a growing stationary queue. For that period (33 minutes to clear), only 35% of customers queued for less than 3 minutes while the satisfaction rate for the remainder of that day was 87%. (The overall rate for the day was 83%.)

5.8.4 Performance of the Queue-Manager/ Express Teller Pair

In the implementation phase of the game play, the point was stressed that the QMET pair must aim for a response time\textsuperscript{15} of zero. No pretence was made that this was achievable, only that it should be a permanent local goal within the overall expectations of the game. In general, response times were such that massive improvements in customer queueing times were achieved – but they could certainly have been better. (Table 5.8) Most often there was no evidence of increased pace of activities to satisfy the immediate demand. The 'old' attitude of 'customers in the queue will just have to wait – there isn't much we can do about it,' carried over into the 'new' approach

\textsuperscript{15} Response time was the time between the teller's signal for the implementation of the response mechanism, and its actual introduction.
(despite the mounting evidence that something could be done about it). Tellers appeared to have immunity to the queue-frustrations of customers. Efforts to steel themselves against the abuse from customers who had queued for ‘ages’ had been successful. A reversal of this attitude would not be easy or instantaneous.

Table 5.8 Performance of Queue-Manager/ Express Teller Pair in responding to a signal that the substantive tellers system was blocked

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Response Time</td>
<td>2.4 minutes</td>
</tr>
<tr>
<td>Max Response Time</td>
<td>16.5 minutes</td>
</tr>
<tr>
<td>Min Response Time</td>
<td>3 seconds</td>
</tr>
<tr>
<td>Percentage of responses in under 1 minute</td>
<td>55%</td>
</tr>
<tr>
<td>Instances of no response</td>
<td>22 (over 5 days)</td>
</tr>
</tbody>
</table>

5.8.5 The Queue-Manager’s Queue-Frustration

From behind the counter, it is relatively easy to ignore the frustrations of the customers in the queue. For the tellers the time is passing in ‘busy-time’ i.e. they are busy with the customer in front of them so the time passes unnoticed. For the customers in the queue, time is passing in slow motion, in ‘q-time’, with every second magnified by the exposure it is given when the customer has nothing else to focus on but the inconvenience. Tellers do not seem to fully appreciate this difference in perceptions … until they join the queue as queue-manager.

It was interesting to watch the level of frustration build in the queue-manager, as her choices for express business proved incorrect, or the express customer changed his or her workload from ET to LT or PT. Suddenly the queue-manager became agitated and keenly watched all tellers for a break that would allow resumption of the express process. Quite often the feeling that the express bay had ground to a halt was a false one, but the transaction was closer to 90 seconds than 30 seconds. The perception was that the transaction had become lengthy – the reality was that it had not. The queue-manager was experiencing the same q-time that affects customers. In this regard, the role of queue-manager was an educational one and should perhaps be mandatory for all tellers. The teller schedule (as used in the modified version of the game-play) could be altered to ensure that each teller has a couple of hours each week in the stand-by role of
queue-manager. Not only would tellers gain some appreciation of the frustration which can build in queueing customers, they would also be cross-training to handle the role as queue-manager and expanding their interface skills with customers.

5.8.6 Queue-Manager Performance

For the most part, queue-managers performed well. With one exception the queue-managers seemed comfortable in the role and were able to improve their task assessment abilities over the course of the trial. They quickly learned that it was wise to solicit as much information as possible before assessing the time a transaction was likely to take. Too often allocation of customers was made on insufficient information and the express bay would also become blocked.

An area of the play that was done poorly by the queue-managers was that of bringing on extra capacity when the queue comprised a disproportionate number of LT or PT customers. This was a rare occurrence but little effort was made to increase service capacity when it did happen.

5.8.7 Queue-Manager Entertains the Queue

Once the last teller to become blocked rang the bell, the customers in the queue generally took on a ‘different face’. Gone were the looks of resigned boredom, to be replaced with expressions of expectation, especially for those who had experienced the SBM before. They would keenly watch for the response in back-office, watch the Express Telling Bay come on line, and study the queue-manager’s interaction with the first couple of customers in the queue. Suddenly the customers in the queue were transported from q-time to real-time and the impatience threshold was extended. Part of this may also have been because the queueing customers were witnessing a concerted response to their predicament, as opposed to an apparent indifference to their existence. This blindness to the plight of the queueing customer has been developed as a defence mechanism – part of the tellers’ immunity system required to survive a day of disgruntled customers. The belief that “I can’t do more than I am doing; so they’ll just have to wait” has promoted this feeling. Some history of an ability to satisfy the queue will be required before any permanent ‘cultural’ change takes place.
5.8.8 Queue-Manager Serves the Customers

Several times the queue-manager was able to assist customers in the queue so that they no longer needed to proceed to a teller. Twenty customers were removed from the queue and satisfied by the queue-manager in the 4.5 hours that queue-management was in operation. Some of these customers wanted forms (applications for cards, personal loans); information on interest rates; to open new accounts - a lot of valuable business that was given the personal touch by the queue-manager. Some were customers the branch was unable to satisfy, and the queue-manager was able to save them a wait in the queue before discovering this. Customers in this last category, for example, included those wanting safety deposit boxes (which the bank will hold in safe custody, but doesn’t supply) or those wanting foreign currencies that the bank didn’t have on hand at that time.

5.8.9 Customers’ Response

Customers’ response to the implementation of the game-play was positive. Several customers, who had witnessed the pilot study and follow-up work with the bank, took the time to comment that “It seems to be working”. Quite a few suggested that ‘the “bank across the road” could do with this’. Customers also seemed quite keen to understand the process and the education of customers often happened in the queue with discussion between customers or at the counter. In the first couple of weeks of the training trial, tellers spent some of their time explaining the system to interested customers. Regular customers certainly seemed to notice the difference and recognized the importance of flagging. Educated customers even began advising the tellers on how they should flag for a particular transaction.

During their random sojourns into the chamber, the Sales and Service Advisors (SSA) would hand out surveys for customers to fill in, after their transaction was complete. Without exception written comments on the game-play were favourable. Negative comments (seven customers of over 4000) all had a central theme – “The solution is simple – you just need more staff on the other side of the counter.”
5.8.10 Customer Education

Regular customers became comfortable with the system very quickly. Only on one occasion did a customer object to being ‘passed over’ in favour of ET customers. In this instance the customer had waited for an inordinate amount of time, and the queue-manager should have made efforts to bring on another PT or LT teller.

Customers also became proficient in managing the queue when a queue-manager could not be brought on concurrently with the express teller. In fact, there were no instances of deceptive behaviour in an attempt to head the queue, during these periods. Occasionally though customers became too well educated. It was not uncommon in the early stages for the queue-manager to misread the workload of an “express” customer and temporarily block the express teller with lengthy work. This could also happen when the customer ‘remembered one more thing they wanted to ask’, and the transaction would become lengthy. There were however, three occasions on which the business of a customer who had been directed to the express teller, went from express to prolonged and in each of these cases, the customer had been deceptive in order to get to the express teller. One customer hid the majority of her work in her coat pockets and only showed the queue-manager a fraction of her business. Another simply assessed his own work and proceeded to the express bay, knowing full well his work was not express. There is little that can be done when this happens, but to wait for the first available teller to become free and then designate that teller as express and start to clear the queue that has invariably formed.

5.8.11 Difficulties in Developing a Team in the Banking Environment

To discuss the game-play, two special branch meetings were called at 8:30 am. Staff were paid overtime to come in at that hour on the two occasions and for several tellers this was a major inconvenience. They have chosen their work role to fit in with school hours and the needs of their children. Throughout the study there were no other group conferences and all feedback was given individually, most often in written form. The banking environment makes it difficult to reflect as a team. There are no group lunch-breaks, no common time before or after work - some tellers come in at 9 am, some at 9:30, some at 10 am; and departures are also staggered.
It is difficult to build a team play under such conditions. For at least some of the staff, their first exposure to the play was putting it into practice. To their credit, these people generally accepted this without question. But there was certainly no opportunity for a constructionist approach in the game-play methodology. The lack of common time also meant that suggestions for improvements to the system came from individuals who had the courage to float their ideas. There were no opportunities for prior group discussion and analysis of ideas.

5.8.12 Cultural Conflicts

Before the introduction of the play, the tellers appeared to be a tight band of workers. But the solidarity was a façade - a shield against external criticism. There was little cohesion or team ethos in this group. They felt they were doing it hard and no one had the right to criticize them since this branch was one of the designated 'hell-holes' in the bank. People spoke of having 'done time here', as if it was a penalty that should be shared around. The surface solidarity masked a lot of 'civilized' conflict that took weeks to recognize and understand.

5.8.13 Emergent Behaviour

The game-play's introduction did not create the branch culture that was exhibited, but it threw a stronger light upon it. Initially all other tellers expressed 'polite' animosity towards T2 because of her 'always off the counter' behaviour. They generally felt that she considered herself above the rest of them and 'entitled' to more time off the counter. She was also seen as the senior officer's 'pet'. The study showed that this broad assessment was incorrect. T2 was certainly reserved and not as likely to join in social banter, as were the others. She was conservative to the point of being negative, but very competent in what she did and a consistent worker. Branch A's senior officer certainly gave T2 more of the back-office work because she was more able than other tellers to complete the work without the senior officer having to check it. Initially she appeared to be the most difficult member to convert to the new game-play but her apparent reluctance stemmed more from 22 years of routine and the difficulties she faced in stepping out of her rut. She 'forgot' to play, rather than 'refused' to play. She embraced the new teller schedule without question and was the first to advocate changes

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16 T2 = Teller 2, as described in Appendix D.
to improve its application. Her behaviour in working away from the counter was not motivated by self-importance - she was just getting on with the job, as she had in the past.

The constraints of the game-play and the focus on the goal also seemed to highlight the level of dedication of staff to their work. Suddenly there was a fixed process that allowed measures as simple as “adheres or does not adhere” to become evident. There was no room for grey areas – either a player was with the team or not – and while this was indeed evident, there was no team-initiated retribution for non-adherence. The civilized approach prevailed.

After six weeks of being forced to work as a team in support of the play, stronger relationships had developed between some of the tellers. Other interactions had become more strained, to the point that within a month of completion of the study, the teller who exhibited the poorest performance (stretching the limits of the teller schedule, proving inconsistent in the flagging, vocally denouncing the process) left her job and the banking industry. ‘T2 became less reserved within the team and took on a more relaxed, mentoring role with two of the newer tellers. Her adherence to the teller schedule dispelled lingering doubts about favouritism.

5.8.14 Estimating the Length of a Transaction

One of the most important contributors to the success of the game-play is the accuracy with which the tellers assess the time that tasks will take. Since the play aimed to satisfy as many customers as possible within the shortest possible time, it would have been better for tellers to overestimate the time a task would take rather than to underestimate it. Such action would have forced the queue-management system to operate more often than was needed, but would be consistent with the defined goal. In practice, the reverse was more common in the early stages. Transactions were being flagged as ET when they were LT\textsuperscript{17}, or LT when they were PT. Generally prolonged tasks were correctly flagged. Underestimating transaction times reduced the ability of the team to achieve their goal. Ideally, the estimations would be accurate – supporting the goal without compromising other aspects of tellers’ duties in the branch.

\textsuperscript{17} This is distinct from the tasks that the customers changed partway through a transaction.
Tellers were given regular confidential feedback on the accuracy of their flagging. Data were recorded on the state of their flagging and compared against the actual outcome in terms of transaction time. Early on the tendency was to underestimate the length of time a transaction would take. Once again perception was a major influence. While q-time is monotonously slow, busy-time is rapid because it is engaging and concentrated. Real-time is somewhere between the two. Another common error made by the tellers was to mistake a simple transaction for a quick one. Simplicity and speed of execution are only loosely related in OTC banking work.

Achieving accuracy in the flagging process directly improves the quality of the play. Persistently underestimating the length of a transaction delays the onset of queue-management and reduces its effectiveness. Continually overestimating will see the system called into operation more often than it needs – which will certainly promote the quality of service to customers, but will play havoc with the other commitments of the queue-manager and express teller, thus reducing their overall capacity in the bank. 100% accuracy should be the goal and could be approached with practice. However without accurate feedback (in real-time), perception will be the only guideline and self-improvement on this basis is likely to be slow.

The experience of this study was that only two feedback sessions were required to ensure that tellers were flagging correctly more than 95% of the time. Errors after training related more to forgetting to flag than to mis-flagging.

5.9 Performance of The Game-Play Methodology in Case Study 1

This first attempt at the application of a game-play within a business environment provided significant support for the methodology. Prior to the introduction of the game-play, a divisive group of tellers struggled with a disgruntled customer base to provide a level of service that provided rapid response (less than three minutes of queueing), to only 35% of customers. Four weeks later this same group of tellers demonstrated that even under an increased load they could meet their defined goal for over 85% of customers – an increase in goal-directed performance of 140%.

Moreover the group was showing signs of becoming a team, united in their efforts to achieve their goal. The backlog of back-office work that was evident at the outset of the
case study had disappeared and staff were leaving work earlier than they had previously. The application of the teller schedule had allowed for concerted efforts on back-office work during assigned periods, reducing the amount of stop / start and duplication work. The flexi-drop box (for non-cash deposits or payments) was being cleared each time the queue-manager completed a session, so that the work associated with this task was distributed throughout the day rather than being accumulated for processing after bank closure. Changes of this nature were initiated by the individuals and although they did not seem significant in isolation, contributed to a positive workplace attitude and improved overall performance for the team.
Chapter 6  Game-Play Simulation – OTC Service

"Queueing theory originated as a very practical subject, but much of the literature up to the middle 1980s was of little direct practical value. .... The emphasis in the literature on the exact solution of queueing problems with clever mathematical tricks is now becoming secondary to model building and the direct use of these techniques in management decision-making. Most real problems do not correspond exactly to a mathematical model, ...” [Gross and Harris 1998, p. 3]

Gross and Harris’ statement regarding the application of queueing theory is timely. In the absence of better techniques, mathematical modelling has provided a scientific approach to understanding and managing complex human activity systems. By narrowing the applicability of the queueing solutions, these sophisticated mathematical approaches have been able to limit the number of assumptions that are necessary for tractability. Nevertheless, the assumptions remain and the focus in the process of finding solutions has often been more on mathematical tractability rather than system applicability. Advances in simulation technology have provided an alternate approach to queue-server analysis that allows the analyst to focus on the system and its players without being drawn to the preconceptions of a theory limited by assumptions.

Computer simulation involves designing a dynamic model of a system – a model that closely describes the real-world activities. In its virtual environment the model can be altered to test hypotheses in a fraction of the time that actual process testing would take, if process testing can be done at all. A commercial simulation package, Extend™, was used to model the game-play used in the first case study in order to provide insights into the success of the game-play, and to design and develop the second game-play that was introduced in Branch B (see Chapter 7).

6.1 The Modelling Process

In each banking case study the modelling was developed in a staged process, beginning with the existing queue-server systems and focussing on the state variables identified as significant to the achievement of the goal. The first model developed for each study provided important insights into the cause of the current service problems and a visual representation of the results of such practices.
6.2 Modelling in Case Study One – Branch A

Figure 6.1 The Original Server System in Case Study 1 – Branch A (Extend™ model) The original operating system had up to three substantive tellers, with capacity for three additional tellers to be brought on in response to queue-length. A queue-length of 6 triggers a demand for the fourth teller; a queue-length of 12 triggers the fifth teller and a queue-length of 15 brings the system to its service cap of six.

The model of the original operating system at Branch A (Figure 6.1) was straightforward to create since the standard building blocks of the simulation package allow for the typical industry queue-length response (§ 4.4). This basic model reflects well the intent of the response system, however there are no delays in the response mechanisms of the model and no allowance for complete failure, on the part of the tellers, to recognise the growth of the queue. In practice the tellers’ response to queue-length was spasmodic, more often requiring a significant growth in the queue (to ten or more customers) before action was taken to increase the serving capacity. By comparison, the model instantly adds a server once the queue-length targets are reached and provides a hysteresis effect to retain tellers on the counter until the queue-length has

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1 A description of the modelling blocks used in this chapter is given in Appendix E.
2 The standard industry response to increases in queue-length is to bring on more tellers.
dropped below a threshold. If the queue-length dropped to three, the sixth teller would leave; to two and the fifth teller would leave; to one and the fourth teller would leave the counter. These are quite generous thresholds for this branch—the additional tellers would often leave well before these reductions in queue-length were reached. Overall the model shows a 'rosier' picture than would be expected at the branch, but the simulated results were startling enough to demonstrate to staff the effect on customer service quality of random arrivals of jobs of randomly distributed sizes. (Figure 6.2)

**Figure 6.2 Distribution of queue-lengths and wait times for a simulated day before the introduction of the game-play** The left vertical axis is the number of customers in the queue; the right vertical axis is wait-time in seconds. The horizontal axis is time in seconds—23400 seconds corresponding to a standard 6.5-hour day in the bank (Monday to Thursday). The maximum wait experienced on this virtual day was just under 13 minutes and the queue-length peaked at 16 customers around lunchtime. Notice that at one stage (just after 3900 s) although the queue-length never exceeded 3, a customer experienced a wait of over 8 minutes—a clear example of queue-length also being a poor indicator of service quality.

### 6.1.1 Input Data

The models created to simulate service at the branch had three input distributions: Transaction Times, The Mean of Interarrival Times, and The Standard Deviation of Interarrival Times. Data on 2052 customers was used to describe the system that was operating before the introduction of the game-play. The distribution of transaction times is given in Figure 6.3 and was approximated in the model by a lognormal distribution with a mean of 178 seconds and a standard deviation of 220 seconds.
Figure 6.3 Distribution of transaction times taken from the data recorded prior to the introduction of the game-play. The x-axis is the length of transactions measured in seconds and the y-axis is the frequency of those transaction lengths as a percentage of the total.

The distribution of interarrivals followed a similar pattern to that of the transaction times with the majority of customers arriving in quick succession. (Figure 6.4)

Figure 6.4 Distribution of Interarrival Times taken from the data recorded prior to the introduction of the game-play. Interarrival times in seconds are given on the x-axis and the frequency of occurrence of those interarrival times is given on the y-axis.
Figure 6.5 Distribution of mean and standard deviation of interarrival times taken from the data recorded prior to the introduction of the game-play. The y-axis is both the mean and standard deviation, while the x-axis is the time of day (24-hour clock). Results were averaged in half-hour blocks to create this graph.

A lognormal distribution was used to model interarrival time (IAT) since it more closely matched the collected data on arrivals than did a Poisson distribution that is commonly used for IAT in queueing work.

Figure 6.6 Distribution of IAT mean and standard deviation as used in the modelling process. The y-axis is both the mean and the standard deviation, while the x-axis is the time of day according to the 24-hour clock.
Both the mean and standard deviation of IATs dropped markedly during the lunchtime period between midday and 2 pm (Figure 6.5). These straight-line approximations to the mean and standard deviation distributions were input to the model (Figure 6.6).

### 6.2.2 The Original Model - Limitations and Opportunities

Since no empirical data were collected on the delays encountered in bringing additional tellers on line or the instances of failure to respond to the growth of the queue, these aspects of the existing operating system were not reflected in the original model. A delay (and perhaps a random delay) could be included to more closely model the reality, however, since these issues became redundant with the introduction of the game-play there was little to be gained by their inclusion in this analysis. The model adequately demonstrated the problem of matching server capacity to a random pattern of customer arrivals with customers carrying a random selection of jobs.

### 6.2.3 The Game-Play

The first game-play that was tested at the bank was developed without the aid of simulation. The logic for its design was based on system observation and analysis of the empirical data that was collected. Both of these aspects are vital in understanding the causal components of a problem. It is difficult to recognise within a mass of data that a queue of two was stationary for six minutes in an unresponsive system although this was obvious to the casual observer. The game-play endeavoured, in the first instance, to provide a mechanism for recognizing the onset of a blockage in workflow and then provide a response that would avert the growth of queues, thus minimizing customer-waiting time.

### 6.2.4 Staged Development of the Model

Unlike the original model that simulated decision-making based on queue-length, the model of the game-play required several levels of decision-making and multifaceted customer selection procedures. Simulating the level of complex decision-making that humans routinely handle is not so straightforward. The game-play model was developed in stages with the introduction of new server states at each level. The starting point was a model that defined the inputs to a three substantive tellers, non-responsive system. The logic of the first partial model is given in Figure 6.7.
The second model (Figure 6.8) considered the length of transactions and assigned attributes to customers according to the ET, LT and PT descriptors. This allowed decisions to be made in regard to channelling customers if the substantive system was blocked. The first-in first-out priority of customers was maintained in this next model unless the substantive servers became blocked. Then the first ET customer in the queue became first priority for service by the express teller that was brought on line to handle ‘express only’ work when all other tellers were busy with LT or PT work. The substantive tellers continue to serve all types of customer on a first-in first out basis. Immediately the model recognises a blockage of the substantive tellers (i.e. all tellers handling ‘not ET’ work), the express teller is brought on line and draws the first express customer from the queue. This additional teller operates in this manner until the length of the queue is reduced to zero.
Figure 6.8 Logic Diagram for Second Partial Model in the Development of the Game-Play Model for Case Study 1  Three substantive tellers, plus an express teller. The latter is brought on to serve express only customers when the substantive tellers are ‘blocked’. See text for discussion.

The final model (Figure 6.9) incorporates not only the express teller but also allows for additional substantive tellers to be brought online in response to the number of queued customers with LT or PT work. When there are two customers in the queue with LT or PT work, an additional substantive teller is brought on line. Three LT or PT customers in the queue will bring the service system to capacity as another substantive teller comes on line bringing the total number of substantive tellers to five. The service system continues to operate in this mode until the queue is reduced to zero.
Figure 6.9  The Game-Play Model for Case Study 1  Three substantive tellers, an express teller who is brought on in response to a blockage of the substantive tellers, and two additional tellers who are brought on to handle all customers. The first of these additional tellers is brought on line when there are two LT or PT customers in the queue, and the second comes on line when there are three LT or PT queued customers.
6.2.5 The Game-Play Model – Limitations and Opportunities

The final model of the game-play used in the first case study (Figure 6.9) simulates the basic components of the play: three substantive tellers on the counter at all times, a queue-manager and express teller brought on line in response to a blockage of the substantive tellers, decision-making by the queue-manager in regard to the composition of the workloads in the queue and the allocation of additional substantive tellers if necessary.

Once again, the model does not incorporate delays in the response of the tellers to state signals. Data were recorded on the response time of the queue-manager / express teller pair (see § 5.8.2) and could be used to update the model in this regard. A comparison of the model with and without the delays could be used to illustrate to staff the importance of aiming for zero lag time in initiating the response.

Implementation of the teller schedule in the second phase of the game-play allowed for scheduling of four substantive tellers on the counter during peak periods (lunchtimes and the hour before closing) without disrupting the amount of back-office work that was completed. The benefits of increasing the substantive serving capacity by one third during busy periods could be demonstrated by the addition of activity schedule blocks to reflect the teller schedule.

6.3 Case Study 1 – Before and After Comparisons

Since the game-play used in the first case study was designed and developed without the aid of simulations, the models prepared as part of the study were intended as validation and demonstration tools. An additional model was created to allow comparison of the model of the operating system before the introduction of the game-play with the final model of the game-play operating system, by inputting identical data to both models. The outputs from this model (Figure 6.10) provided visual impetus to the arguments in support of the game-play.
6.1 Modelling for Long-Term Results – Branch A

Extend™ was used to model (a) the original system, and (b) the game-play operating system. Simulation was carried out for a virtual 1000 days, with identical customers input to both models. This timeframe simulates approximately four years of operation in the branch. Figure 6.11 illustrates the frequency of average daily waits during that period. The service system that was initially running in the branch confirms the overall average of 180 seconds (3 minutes). But while the peak frequency is sitting around the target of 3 minutes, the percentage of customers queueing for less than this average is under 35%. A much higher frequency peak at 1 minute for the system based around the game-play correlates well with the improvement that was observed in this study. The
spread of averages is also reduced with the application of the play. Under the 'old' operating system the $3\sigma$ spread of averages covers about 3 minutes (90 to 280 seconds) while the 'new' system has compressed the spread by half to about 1.5 minutes.

![Graph showing frequency of daily average wait for two operating systems](image)

**Figure 6.11** Comparison of the frequency of daily average wait for the two operating systems, before and after the introduction of the game-play  The time of wait, in seconds, is given on the x-axis, and the frequency of occurrence of those wait times is given on the y-axis. 1000 days were simulated to provide data for this graph.

The maximum wait on each virtual day was also plotted for both operating systems and is shown in Figure 6.12. In this simulation the improvement after the application of the game-play is clearly evident. On the majority of days, the maximum wait made by a customer is less than 8 minutes. The old operating system would create maximum waits ranging from 8 to 13 minutes.

An interesting feature of the plot in Figure 6.12 is the residual hump on the 'After' curve which appears as a smaller version of the 'Before' curve. Both systems involve a maximum of six servers at the counter, however the new operating system has one of these designated as express transactions only. The old system placed no such designation on any of their tellers. On the infrequent occasions when a number of lengthy and prolonged customers arrived in succession, the new system reverts to the
old system, with one less teller. Instead of having six tellers blocked with LT and PT work, the new system has five tellers blocked and one held in reserve to handle ET arrivals. Since the game-play was devised around the knowledge that 50% of customers carry express business, the likelihood of the queue being composed of only LT and PT is not high. This residual effect could be addressed by increasing the number of servers during these periods. For Branch A, SSA’s could offer support during these times, with additional servers operating from the commercial telling bays.

![Graph showing comparison of maximum daily wait for two operating systems](image)

**Figure 6.12 Comparison of the maximum daily wait for the two operating systems – before and after the introduction of the game-play** The maximum time of wait on any day, is given on the x-axis, (in seconds) and the frequency of occurrence of those maximum wait times is given on the y-axis. 1000 days were simulated to provide data for this graph.

### 6.5 Modelling for Change (Case Study 2 – Branch B)

The models prepared in case study 2 (discussed in Chapter 7) were used not only to justify the proposed process changes but also to educate the tellers. Branch B was originally operating with four substantive tellers and this capacity dropped when tellers took lunch or training breaks, or left the counter to deal with back-office work. The other two tellers employed at this branch worked constantly away from the counter and there was no response mechanism in place to deal with rapid arrival of customers or
excessive waiting by customers. Since Branch B mostly had a third greater serving capacity for a similar number of customers than did Branch A, and less intense peak periods, the performance of Branch B staff in maximizing the number of customers who queued for less than three minutes was already considerably better than that of the team at Branch A. (63% in the second case study, compared to 35% in the first study)

The layout of the second branch, the abilities of the staff, and the operation of their business banking section ruled out the implementation of a play identical to the one used in Branch A (although this had been the original intention). This branch and its people required a slightly different game-play.

The form of game-play that was eventually adopted for Branch B recognized the range of constraints on the system (prescriptive, descriptive and ascriptive) and gave the team a play that they believed was sustainable. Prior to implementation of their game-play, the tellers were shown a comparison of outputs from three different models:

• In the first model, four substantive tellers served without break, but there was no response mechanism to deal with system blockages. This model roughly simulated the existing practice, however no allowance was made for reduction in serving capacity due to lunchbreaks, training etc. In effect this model illustrated a superior performance by comparison with the original operating system.

• In the second model, two additional tellers were brought on-line in response to the length of queue. Once the queue-length reached six, the two additional tellers would begin serving.

• In the third model, two additional tellers were brought on line in response to a system blockage, alerted by the state based management system used in the original case study.

6.5.1 First Model Shown to Tellers: The ‘No Response Mechanism’ Model

The original operating system had a capped counter-staff level of four. Irrespective of the demands on the system, the service level remained ostensibly constant (it fell as staff left for lunch or training breaks, but it did not increase).
A random customer base, based on Branch B’s customer profile, produced the simulation plot given in Figure 6.13. On a typical weekday (other than Friday) the bank is open for 6.5 hours (23400 s) with the peak interarrivals in the last hour of the day. The maximum wait on this artificial day was 15.4 minutes and the maximum queue length was 18 – a typical day at Branch B prior to application of the game-play.

Figure 6.13  The ‘No Response’ - Graph of time- wait-time for customers throughout a simulated day at Branch B: four substantive tellers and no response mechanism. The x-axis of the graph is time (in seconds) throughout the day. The y-axis is the time that customers spend queuing, again in seconds. (See text for discussion.)

6.5.2 Second Model Shown to Tellers: The ‘Queue-length Response’ Model

While a ‘queue-length response’ approach (commonly used throughout the OTC service industry, although generally with staggered additions to staffing levels) is inferior to the play based on state based management, it is considerably better than the ‘No Response’ approach. Two additional tellers could be brought on to serve in response to queue-length (an ‘after the event’ indicator). The tellers need not flag and the bell would be rung once the queue had grown to around six. In reality this system would not perform quite as well as the model suggests. The model simulates an instantaneous response by the additional staff when the sixth customer enters the queue, however the serving staff are unlikely (or unable) to be monitoring the queue-length that closely and in reality their response will be delayed. Figure 6.14 illustrates the system performance given by the queue-length response model. The same customer base was used as in the previous
model. The maximum wait experienced under this system was 6.4 minutes and the maximum queue length was 10 – a significant improvement over the ‘no response mechanism’ system.

![Figure 6.14](image)

**Figure 6.14** The ‘Queue-length Response’ - Graph of wait-time for customers throughout a simulated day at Branch B: Two additional tellers brought on in response to queue-length \((L=6)\) (Time in seconds on the x-axis; length of wait in seconds on the y-axis)

### 6.5.3 Third Model Shown to Tellers: The ‘SBM Response’ Model

The game-play that featured in this study was based on response to the operating state of the system- a state based management (SBM) response. Flagging by tellers provided information about the current service state and allowed additional tellers to be brought on before a blockage caused queue growth and excessive waiting. The same customers used in the ‘No Response’ and ‘Queue-length Response’ simulations were input to the game-play model. (Figure 6.15)

On the day of this simulation, the maximum customer wait experienced was 3.4 minutes and queue length peaked at 5 – an even better result. A summary of the results for the three simulations is given in Table 6.1.
## Table 6.1 Summary of Results - Simulation Models

<table>
<thead>
<tr>
<th></th>
<th>‘No response mechanism’</th>
<th>‘Queue length response’</th>
<th>‘SBM response’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum customer wait (minutes)</td>
<td>15.4</td>
<td>6.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Maximum queue length</td>
<td>18</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 6.15 The ‘State Based Response’ - Graph of wait-time for customers throughout a simulated day at Branch B: Two additional tellers brought on in response to the length of the queue (L=6) (Time in seconds on the x-axis; length of wait in seconds on the y-axis)

### 6.6 Visual Comparison of the Three Models

The output from each run consistently supported the use of the game-play illustrated by the third model and there was overwhelming agreement from the tellers for the implementation of this play.

A sample output from a comparison run - a single banking day of 6.5 hours or 23400 seconds – is given in Figure 6.16. On this simulated day no customers queued beyond the target of three minutes, however, not every day is as accommodating. Figure 6.17 provides output on a second day, once again illustrating the superiority of the chosen game-play over the alternatives.
Figure 6.16  Output from a single run (one bank day of 6.5 hrs) of the three models prepared for case study two  The highest wait times are experienced under the existing operating system; a queue length response provides moderate relief from excessive customer waiting; and a SBM response limits all waits, on this day, to less than three minutes. (c.f. Figure 6.17) (x-axis is time in seconds; y-axis is wait time in seconds)

Figure 6.17  Output from a second single run (one bank day of 6.5 hrs) of the three models prepared for case study two  Once again the SBM system outperforms the other two systems in terms of customer service, however on this day not all customer waits are restricted to less than three minutes. (x-axis is time in seconds; y-axis is wait time in seconds)
6.7 Modelling for Long-term Results – Branch B

Running the model simulations over 100 days (100 runs) provides a vivid comparison of the performance possible with each operating state.

The raw data are displayed in Figures 6.18 and 6.19. The figures show the maximum wait and the maximum queue length experienced on each day of simulation. There are instances in which an operating system with no response mechanism appears to perform as well as one that responds to queue-length – i.e. when the queue-length fails to reach the trigger of six. The dominating trends, however, suggest that a queue-length response is superior to no response, while pre-empting the growth of queues by recognizing a blockage as it occurs (State Based Management response) is the most effective.

**Figure 6.18** Maximum wait on each of 100 simulated days, with the three operating systems. The x-axis is the sequential days during the simulation and the y-axis is the maximum time that a customer spent in the queue on each of those days.
Figure 6.19 Maximum queue-length on each of the 100 days of simulation, under the three different operating systems. The x-axis is the sequential days during the simulation and the y-axis is the maximum time that a customer spent in the queue on each of those days.

The raw data, from the 100-day simulations, were assembled into frequency functions of maximum wait and maximum queue-length. Figure 6.20 shows the performance that can be expected under the three operating systems. Long waits are inevitable for customers within a non-responsive system. An increase in server capacity by 50% in response to queue-length provides improvement, limiting and condensing the spread of waits, but still ensuring that the majority of customers experience 'unacceptable' periods of waiting. In the third scenario, employing the game-play methodology, a majority of maximum waits are less than 6 minutes.

Figure 6.21 provides visual representation of the distribution of queue-lengths during the simulation period. As expected, lengthy-queues result from the non-responsive system, while the game-play based on SBM limits the frequency of lengthy queues.
Figure 6.20 The frequency of maximum waits experienced over the 100 days of simulation, under the three different operating systems. The maximum waits are given on the x-axis in minutes and the frequency of occurrence of these waits during the 100 days period is given on the y-axis.

Figure 6.21 The frequency of maximum queue-lengths experienced over the 100 days of simulation, under the three different operating systems. The maximum queue-lengths are given on the x-axis in minutes and the frequency of occurrence of these queue-lengths during the 100 days period is given on the y-axis.
6.8 Summary

Simulation packages provide a tractable alternative to mathematical modelling of queue-server systems. The ability to model and test hypotheses in a fraction of the real time required for process testing gives managers a powerful decision tool. Modelling was initially used in this research to demonstrate the process improvement that resulted from the implementation of the game-play of the first case study. In the second case study the modelling process was used for education, design, development and justification of the game-play.

While mathematical models are difficult to ‘sell’ in the workplace, the visual aspects of computer simulation make it a user-friendly medium in the education process. The teller team in case study two were effectively ‘sold’ on the success of the proposed game-play before its introduction, and this made the task of implementation easier. Nonetheless it was disturbing to witness the complete faith of the tellers in the ‘evidence’ presented by computer simulation - no-one questioned the accuracy of the models. The simulation tool must be used judiciously in its roles of informing and educating.
Chapter 7 Case Study 2 – Application of a Game-Play to a Second Banking Teller ‘Team’ – Branch B

This study was to be a repeat of the first case study, although in a different branch, with a different teller team. Since the business environments were similar, the intention was to apply the game-play that was so successful in the first case and attempt to confirm that the performance improvements at Branch A were repeatable. The original case study had applied the game-play methodology and case study 2, at Branch B was to follow the same process. Since the only anticipated change was the location of the branch, the form of game-play was expected to be the same in both studies.

Nevertheless, while there were commonalities between the two businesses, there were also differences and these differences were significant enough to make the original game-play unworkable in Branch B. This was to be the most significant lesson from the second case study – a lesson that reinforced one of the primary tenets of the game-play methodology. Namely, that matching the play to the abilities of individual players, and to the prescriptive and descriptive constraints that affect their ability to perform, is a crucial part of game-play design. The team goal must drive the design in the first instance, but the final game-play must also consider team and individual abilities in the context of the working environment. This aspect of game-play design is often overlooked in the team sports environment, and was similarly overlooked in the enthusiasm to ‘prove’ that the excellent results of the study at Branch A were repeatable. The original form of the game-play methodology was amended to include a step that would focus on matching the play to other individual and system constraints (besides those that would be required to achieve the team goal).

The updated version of the game-play methodology is:

1. Define the team goal. Involve team members in the definition process to encourage creative involvement and ownership of the outcome.
2. Analyse the existing team operating system. Use information and data gathering techniques to describe the extant operating system and evaluate its performance in relation to the team-defined goal.
3. Design the constraints that constitute the game-play. These must be goal-directed and maximize internal (current and immediate future) system knowledge.
for all individuals. Consider the ascriptive constraints that operate for each individual in the design process. Where possible, involve the team members in this creative design process.

4. **Examine the requirements of the game-play** in relation to the abilities of the players and the unalterable constraints of the working environment, and assign or modify roles accordingly. Redesign the play if necessary to match the abilities of the players. While it is valid to extend a player in the design of a game-play, such extension must be realistically achievable.

5. **Constrain the individuals according to the game-play.**

6. **Support ongoing creativity** within the game-play environment.

### 7.1 Branch B - A Different Branch

The first case study was carried out in a large inner-city branch that had a high proportion of business and professional customers. Peak service times at Branch A occurred during tea and lunch breaks, and the last half hour before bank closing. The branch involved in the second study was located in a major shopping complex and although it was on par with the first branch in terms of OTC customer volume, the clientele was different. A constant flow of transient shoppers typified the customers in this branch, with a single peak after 3 pm (school closing time) each day. Further, the layout of the second branch made it difficult to implement the QMET response that was so successful in the first study. A recent renovation had created an open-plan layout that gave the branch an uncluttered, modern appeal (Figure 7.1). The redesign had located the doorways between the back-office and the chamber at the remote corners of the space. Several doorways and security obstacles had to be navigated for a queue-manager to move between the chamber and the back-office. This was the subject of overt complaints from the two tellers who were trialled as queue-managers, but it was not the real issue. Neither of the tellers was comfortable working in the chamber with the customers, and their efforts to avoid queue-management increased until SBM was not operating at all. They would simply ignore the signal to initiate a response to a recognised blockage. Further, this branch was burdened with a teller who had no motivation for her work beyond the earning of a wage. She had no interest in her work or workmates beyond what was absolutely necessary to continue her employment. Once again lessons drawn from the sporting environment were to provide a solution to
this human management issue. Branch B demanded (and deserved) a unique game-play designed with its profile in mind.

![Figure 7.1 Branch B Layout](See text for discussion)

7.2 Branch Profile

Branch B was suggested by the bank as a candidate for this second study because it was renowned for having queues that extended ‘out-the-door’ into the open space of the shopping centre. Branch B handled comparable volumes of customers to the branch in the original study, but unlike Branch A it performed well in most other banking performance areas. The dedication and motivation of the staff was, with one exception, very good. The branch was consistently in the top five in the state for sales – an outstanding result, given its unremarkable location. The kudos associated with this level of sales performance was enormous and shared by all staff at this branch. The sales team, however, was distinct from the OTC service team. Three sales and service advisors (SSAs) dealt exclusively with sales, occasionally acting on referrals from the telling staff. While the external praise and reward system offered to the branch was generalized to include everyone, internally there was no confusion about which team deserved the credit. The only black spot on the report card for Branch B was the length of its queues and the significant number of customer service complaints in this regard.
For much of the time the queues were manageable, but on occasion the notorious 'out-the-door' queues were experienced, and this was the situation that customers remembered and took the trouble to complain about. The tellers were keen to remedy this.

Under the supervision of the service advisor (SA) there were six tellers who were responsible for OTC service, maintenance of the ATMs, and the counting and processing of business banking. This number was reduced to five on Tuesdays. The ATM and business banking consumed a great deal of the daily load of the SA and two tellers, leaving four tellers to handle OTC work. Two queues operated in Branch B – a standard customer queue and an express business queue, allegedly dedicated to collection of pre-ordered change for business customers. Sales and enquiries were handled by SSAs at an open counter at the front of the banking chamber. This portion of the business did not feature in this study – only OTC teller work was considered.

The existing service plan at Branch B was simple and the roles were largely exclusive:
- The SA handled most back-office work;
- A teller was dedicated to preparing faxed-through change orders, serving the second queue (change collection), maintaining the ATMs and managing cash holding 1 (the primary cash holding for the branch);
- A second teller processed express business deposits (EBD’s) full-time; and
- The remaining four tellers were responsible for OTC business.

Irrespective of the length of the queue, these four tellers (three on Tuesdays and during lunch and training breaks) simply continued to serve. On rare occasions the change collection teller would assist if she was not busy elsewhere and had noticed the length of the queue, and on a single observed occasion during the initial data collection, when the queue extended outside the bank entrance and customers had difficulty entering or exiting the bank, the SA came on as an additional teller.

7.3 Data Collection

The state of the operating system prior to the introduction of the game-play was assessed via direct data collection in early September 2000. 2192 customers, in both queues, were observed in the initial survey that took place over five days (Monday –
Information on reneges, customer behaviour with respect to queue length, teller performance and relationships, modes of supervision and other anecdotal incidents was also recorded.

### 7.4 Service Status Prior to the Implementation of the Game-play

The operating system was observed over five days from 9:30 am to 4:00 pm Monday to Thursday and 9:30 am to 5:00 pm on Friday. During the initial study, Branch B handled an average of 438 OTC transactions per day, with an average transaction length of approximately three minutes. Thus, the average workload on the tellers was around 19 hours per day. A daily breakdown for the study is given in Table 7.1.

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Average:</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.5 hrs</td>
<td>15.5 hrs</td>
<td>16.1 hrs</td>
<td>18.6 hrs</td>
<td>23.0 hrs</td>
<td>19.1 hrs</td>
</tr>
</tbody>
</table>

#### 7.4.1 Transactions

OTC transactions ranged in length from seven seconds to 42 minutes. 74% of all transactions were completed within three minutes. Figure 7.2 displays the frequency of transaction times and illustrates the spread of times greater than three minutes.

Throughout this first stage of the study, customers spent a total of 220 hours either in the queue or being served. The workload they carried during the five days totalled 96 hours – only 44% of their total time in the bank.
Chapter 7 – Case Study 2 – Application of a Game-play to a Second Banking Teller Team – Branch B

Figure 7.2 Distribution of transaction times at Branch B prior to implementation of the game-play. The x-axis is the time of transactions in seconds, and the y-axis is the frequency of occurrence of those transactions times during the initial data recording period. 3.2% of results fall outside the range of the graph i.e. have transaction times greater than 10 minutes.

Based on observations regarding the impact of transaction time on wait time the categorization of transactions that was used in the first case study was again considered appropriate (Table 7.2).

<table>
<thead>
<tr>
<th>Table 7.2 Categorization of Transactions by their Service Time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Express Transaction</td>
</tr>
<tr>
<td>Lengthy Transaction</td>
</tr>
<tr>
<td>Prolonged Transaction</td>
</tr>
</tbody>
</table>

48% of all OTC customers carried express transactions yet contributed only 16% of the branch’s daily workload. The daily occurrence of these defined transaction types is given in Figure 7.3. The relative proportions of each transaction type are similar to those of the first case study. (Table 7.3)
Figure 7.3 Composition of each day’s transactions during the initial data recording period at Branch B, according to the defined categories: ET, LT or PT.

Table 7.3 Percentage occurrence of the defined transaction types during both case studies, before and after the introduction of the game-plays.

<table>
<thead>
<tr>
<th></th>
<th>Branch A (CS1)</th>
<th>Branch B (CS2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td></td>
<td>The Game-play</td>
<td>The Game-play</td>
</tr>
<tr>
<td>ET</td>
<td>47%</td>
<td>51%</td>
</tr>
<tr>
<td>LT</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>PT</td>
<td>22%</td>
<td>19%</td>
</tr>
</tbody>
</table>

7.4.2 The Original Queueing System

Customers queued according to a first-in-first-out (FIFO) system, in two separate queues. The main queue, served by the substantive tellers for the branch, was available to all customers. The second, a designated express change collection service, was only available to express business customers (those who had registered for express business deposit bags), who had faxed through their change requests.
No sorting took place in either queue, so that in the main queue ET, LT and PT were randomly distributed, while the express queue should comprise only ET (pre-ordered change collection).

### 7.4.3 The ‘Express’ Queue

There were only 78 customers (3.6% of the total of 2192 OTC customers) in the express change queue during the week of data collection, but they had a significant impact on the operating system. A sign in front of the express change teller notified customers that only change orders that had been faxed through would be available at this telling bay so that this queue should only have handled express transactions i.e. ones that take less than 90 seconds to complete. In practice, however, the express queue had a smaller proportion of ETs than the main queue (Table 7.4).

| Table 7.4 Comparison of the composition of the two queues operating at Branch B prior to the introduction of the game-play |
|---|---|---|
| | Main queue | Express change queue |
| ET | 48% | 33% |
| LT | 34% | 51% |
| PT | 18% | 16% |

The majority of ‘express change’ customers were not faxing through their change orders and therefore should not have been expecting the offered express service. However, the express change teller was loath to enforce the criteria and customers continued to abuse the privilege. The other aspect of this weighted distribution of lengthy and prolonged transactions in the express queue was the inordinate amount of time that some customers were kept waiting for ‘express’ service. Although 82% of customers queued for less than 3 minutes, 5% waited longer than six minutes with the longest wait being 15 minutes.

There was another ramification of the failure of the express change queue to live up to its name. Both queues at Branch B were clearly visible to all customers, so that during periods of protracted queueing, the customers in the main queue could watch as ‘favoured’ customers walked directly to an express teller and received prolonged
service. The inequity of the situation became most obvious during those times of a stationary, growing queue, when the already frustrated customers (who had queued excessively, in their opinions) became increasingly disenchanted with the level of service offered by the bank. The reactions of customers in the main queue were not dissimilar to those of customers who feel they are victims of queue-jumping.1

7.4.4 Summary of Initial Operating System

Branch B handled a comparable number of customers to Branch A, but enjoyed a more evenly distributed pattern of inter-arrivals. Branch B also operated with one more substantive teller (33% higher staffing level), so that in general, system blockages (typified by long waits) were less frequent. The lack of a formal response to such a predicament, however, meant that the impact of blockages was more severe in this second branch.

7.5 The Goal

The tellers at Branch B were keen to adopt the team goal defined by those at Branch A since it would directly address their dilemma in relation to customer service: To maximize the number of customers who queue for less than three minutes, while maintaining the quality of OTC service. The initial performance of the teller team in relation to this goal is given in Table 7.5. Data given in italics comprised the performance measures for this study.

An overall average of 63% of customers enjoyed the ‘less than three minutes’ wait, suggesting that Branch B had a head start over Branch A (average 35%). However lengthy periods of high performance (close to 100%) masked the poor performance during the less frequent but devastating periods when performance hovered around 0% of customers queueing for less than three minutes. Consistent high performance became a codicil to the original goal:

To consistently maximize the number of customers who queue for
less than three minutes, while maintaining the quality of OTC service.

1 For an excellent discussion on this issue see Larson, 1987.
Table 7.5 The operating system before the introduction of the game-play.

<table>
<thead>
<tr>
<th>Property</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Express Transactions</td>
<td>47.0</td>
<td>47.1</td>
<td>44.6</td>
<td>52.7</td>
<td>50.8</td>
<td>48</td>
</tr>
<tr>
<td>% Lengthy Transactions</td>
<td>34.5</td>
<td>38.5</td>
<td>31.8</td>
<td>31.6</td>
<td>33.0</td>
<td>34</td>
</tr>
<tr>
<td>% Prolonged Transactions</td>
<td>18.5</td>
<td>14.4</td>
<td>23.5</td>
<td>15.7</td>
<td>16.2</td>
<td>18</td>
</tr>
<tr>
<td>Total No. of Customers</td>
<td>487</td>
<td>374</td>
<td>336</td>
<td>471</td>
<td>524</td>
<td>438</td>
</tr>
</tbody>
</table>

| No. of Reneges            | 7      | 0       | 1         | 2        | 22     | 6       |
| % Customers who queued    | 67%    | 84%     | 85%       | 55%      | 26%    | 63%     |
| < 3 minutes               |        |         |           |          |        |         |
| Longest Wait (minutes)    | 10.5   | 6.6     | 9.1       | 9.9      | 18.1   | 11      |

7.6 Game-Play Design and Implementation

Game-plays are designed to increase the level of internal system state knowledge for the players, but they must also take into account the abilities, strengths and weaknesses, of the players (ascriptive constraints) and the influence of external system constraints (both prescriptive and descriptive). This requirement was ignored when a play identical to that of the original study (§ 5.4.5) was implemented at Branch B (modified simply for the increased substantive staff loading). Substantive tellers provided OTC service; the SA was to act as queue-manager, and teller one would double as the express teller. A decision was made to enforce the “No fax; no privileged change collection” rule, after a week of customer re-education. Fax sheets were prepared and offered to business customers who had neglected to fax ahead their order, with the gentle reminder that next week only prepared change orders would be distributed through Teller 1. This change would ensure that Teller 1 was not caught with lengthy or prolonged work at any stage during the day.

After the first week of the game-play implementation, it became clear that this team was struggling with the play. Four members of the team were performing well, but their
efforts were being undermined by the inability of the SA to cope in the role of queue-manager, the delays in her moving between the back-office and the chamber, and the failure of Teller 5 to flag her status. It transpired that the SA was so uncomfortable in the chamber, talking with customers about their needs, that she was further delaying the onset of the QMET response, in the hope that queue pressure would abate of its own accord. When Teller 5 was queried regarding her failure to flag, she claimed simply to have forgotten.

Training and support were offered to the SA over the next week, but with little improvement in her performance as queue-manager. Her tentative approach to the customers ensured that she misread the workload they carried and more often than not, caused the express teller to become blocked. Continual reminders to Teller 5 saw a slight improvement in her system awareness, and it was hoped that flagging would eventually become second nature to her, as it had to the other tellers. Data was collected on the accuracy and timeliness of teller flagging so that feedback would assist in their assessment of transaction workload. As in Case Study 1, the tellers tended to underestimate the workloads in the first instance, but after a fortnight of intermittent individual feedback, their assessments were generally accurate.

7.6.1 The Modified Game-Play

By week three the team was disappointed with the lack of visible improvement since the implementation of the game-play – particularly those members who felt their performance within the team was exemplary (three of the substantive tellers). A modification to the original play, more in line with the capabilities of this team of players and the specific demands of their layout and environment was needed.

Models were prepared to illustrate the possibilities for process improvement using the game-play methodology in the hope of re-enthusing the staff. (See § 6.4) The models showed two levels of improvement over the 'no response mechanism' of the original operating system – a 'queue-length response' and a 'state based management (SBM) response'. In this instance the planned SBM response did not require queue management. All players felt more comfortable with the proposed changes which still relied on flagging by the substantive tellers to monitor the overall service state of the system. Instead of initiating a QMET response when the tellers flagged a blockage, the
SA and Teller 1 would immediately come on as additional tellers. The risk was still there that both of these tellers could become blocked with lengthy or prolonged work, but it was a slight risk given that almost half of all customers carried express work, so that the 50% increase in service capacity should have an immediate impact on queue times. The two additional tellers were to continue serving until queue-length had been reduced to zero. The SA was much more comfortable with this response mechanism and the system improvement was evident from the first day of implementation.

The only glitch in team performance with the new game-play was that Teller 5 was still regularly neglecting to flag. Initially she was given extra education on the value of flagging when all tellers participate. Models were created to illustrate how failure to flag by a single teller could sabotage the efforts of the entire team. When this failed to exact the desired response the senior SA counselled her and reminded her that flagging was now a requirement of her job. In moments of frustration, the other team members also pointed out to Teller 5 that they were ‘wasting their time’ if she wouldn’t flag. Her verbal response was always one of acquiescence but her poor performance did not change, creating continued frustration and discord for the rest of the team. This was not how the game-play was supposed to operate, but was an excellent lesson in the obstacles that exist in a normal human activity system.

7.6.2 Further Modification to the Game-Play (Teller 5 – Playing on the Wing)

In netball a balanced team has seven dedicated and equally proficient players – but this balance is uncommon. Often one or two players are less capable than the other players on the team, and the coaching response will be to relegate those players to the wing while their skill-level is addressed. The strengths of the other players may allow the team to succeed despite a deficiency in a wing position, although the same type of deficiency in any of the other five positions would adversely affect the entire team performance. A further modification of the game-play at Branch B involved a decision not unlike that taken in netball. Teller 5 was moved “onto the wing” and the main play was designed around her.

Teller 5’s general behaviour had served to alienate her from the rest of the banking staff, well before the introduction of the play. The bank’s security policy dictated that the branch doors could not be opened within the last five minutes before customers arrive.
At the designated opening time, tellers were to be prepared for the initial influx of customers and have their cash holdings and the safe secured. Teller 5 regularly entered the bank with the first of the day’s customers as she arrived within the five minutes before or after opening and could not be let into the branch before the customers. She was therefore unavailable to serve for the first few minutes while she organised her serving bay. Her lunch breaks were always longer than her allocation, which caused other tellers to have to wait, and she refused to wait for the teller who had previously gone to lunch to return, before she left on her break. This regularly left only two tellers on the counter during the changeover. Teller 5 was also notorious for not serving in the last ten minutes before closing, so that she could marshal her cash and leave shortly after the last customer of the day.

On the Monday when the change to the game-play was made, the other players were advised to ignore any flagging from Teller 5, so that the new 'system' being monitored involved only three tellers. The two extra tellers were called on when a blockage occurred in this newly defined system. This change was easily instigated without her knowledge since it was Teller 5’s habit to arrive at the bank with, or after, the first customers. Her flagging continued to be very poor and she never rang the bell to call on the extra tellers. Indeed, she may have wondered at times why the other tellers were calling on the system when she was still flagged on green (express). More often though, the ringing of the bell would recall her to the fact that she hadn’t been flagging and she would change a green flag to red or orange. In spite of her poor play, the system was responding.

7.6.3 The Final Form of the Game-Play at Branch B

After four weeks of adapting the original play to suit the environment and players of Branch B, the final form of the game-play appeared to be addressing the goal. The components of the play are listed below:

- Tellers 2, 3, 4, and 5 are substantive tellers. The division of their time within the bank (serving, back-office, lunch breaks and training) is dictated in a Teller Schedule, so that a minimum of three tellers is on the counter at all times. (There are four substantive tellers unless tellers are on back-office, lunch or training.)
- Tellers 2, 3 and 4 flag the workload of each transaction.
If all flags are red or orange (LT or PT), a bell is rung and the SA and Teller 1 (express change teller) come on the counter as additional tellers. They continue to serve until there are no queued customers (queue length of zero).

7.6.4 The Game-Play is Adaptive

The flagging system proved its adaptability when a novice teller was introduced to the bank for training.

Teller training initially involves on-the-job experience in a larger branch:
- A few days of watching a proficient teller,
- A few days of supervised telling, and
- Several weeks of telling as an additional server within the bank.

After this period the teller is given a position at another branch and on-going training involves a designated block of time each week with a mentor – usually an SSA. A novice teller was assigned to Branch B shortly after the study began. She was able to immediately participate in the flagging process and became proficient at assessment and flagging very quickly. Initially she flagged solely on red and orange, since all tasks took her much longer than the experienced tellers. As the weeks progressed she was flagging more frequently on green.

The flagging system allows for individual assessment of capability, and adapts to changes in capability. The accuracy of the system state information depends on this form of assessment. It is important that the system can allow for the evolving competence of the players.

7.7 System Performance with the Game-Play

A month after the introduction of the original game-play (Phase 1) the data collection process was repeated. The follow-up data was recorded over 4.5 days in November 2000 and 1,884 customers were observed in the study. On the first day of the follow-up study (Monday), both of the branch’s ATMs malfunctioned and the SA and teller 1 spent the day trying to bring the machines back on line and deal with the most pressing
of their back-office work. This 30% reduction in teller staff meant that the game-play could not be used on this day. Tellers continued to flag and ring the bell but there was no response to their signals of blockage. Further, there was no-one to manage faxed-through change orders. Queue 2 customers were simply combined with queue 1 customers, apologies were made for the inability to prepare change orders for express pickup and tellers made up the change orders on request. In effect, application of the play began on day 2.

The results for the follow-up study are given in Table 7.6. Data given in italics comprised the performance measures for this study.

Table 7.6  The operating system after the introduction of the game-play

<table>
<thead>
<tr>
<th>Property</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday (1/2 day)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Express Transactions</td>
<td>48.3</td>
<td>44.0</td>
<td>43.8</td>
<td>47.7</td>
<td>47.2</td>
<td>45.2</td>
</tr>
<tr>
<td>% Lengthy Transactions</td>
<td>30.5</td>
<td>34.6</td>
<td>35.8</td>
<td>35.9</td>
<td>37.3</td>
<td>35.4</td>
</tr>
<tr>
<td>% Prolonged Transactions</td>
<td>21.2</td>
<td>21.4</td>
<td>20.4</td>
<td>16.4</td>
<td>15.5</td>
<td>19.4</td>
</tr>
<tr>
<td>Total No. of Customers</td>
<td>425</td>
<td>408</td>
<td>397</td>
<td>493</td>
<td>161</td>
<td>433</td>
</tr>
</tbody>
</table>

| Number of Reneges                 | 6*     | 1       | 0         | 0        | 0                | 0.3     |
| % Customers queued < 3 minutes    | 40%*   | 78%     | 96%       | 86%      | 87%              | 87%     |
| Longest Wait (minutes)            | 14.5*  | 11      | 5.2       | 8.3      | 5.7              | 8.2     |
| SA time on counter (mins)         | -      | 72      | 21        | 62       | 44               | 50      |
| Teller 1 time on counter (mins)   | -      | 48      | 29        | 86       | 42               | 51      |

2 Tables of data collected before and after the implementation of the game-play at Branch B are presented in Appendix F.
3 No game-play was possible on this first day. Averages are calculated on the Tuesday to Friday results only.
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The SA and Teller 1 spent (on average) 50 minutes a day on the counter in response to system blockages. This equates to just under a sixth of their working day. This additional load (still well below the requirements for OTC telling work as listed on their duty statements) did not appear to interfere with the completion of their other duties during the study. Back-office work was now more evenly shared as dictated by the teller schedule.

A summary of the performance outcomes before and after the introduction of the game-play is provided in Table 7.7.

<table>
<thead>
<tr>
<th></th>
<th>Without the Game-play</th>
<th>With the Game-play</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Reneges</strong></td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td><strong>% Customers who queued for less than 3 mins</strong></td>
<td>63%</td>
<td>87%</td>
</tr>
<tr>
<td><strong>Longest Wait (minutes)</strong></td>
<td>11</td>
<td>8.2</td>
</tr>
</tbody>
</table>

The level of improvement against the goal of maximizing the number of customers who queue for less than three minutes, was not as numerically dramatic in this second case study as in the first at Branch A, but there were some other significant outcomes that are not reflected in the figures of Table 7.7.

The perception of improvement was as clear for the telling staff in this study as it was for the customers. In the first case study, those involved were amazed at the level of improvement achieved and relied heavily on the data collected to provide this feedback. In this second case, the participants were surprised that the improvement was not greater – “it felt so much better” as one teller commented. There were no more queues ‘out-the-door’, so that regular customers remarked the change. The reduction in number of reneges confirmed the improvement in customer perception for the branch. Reneges generally occur when customers become frustrated with the wait or judge that the wait
Chapter 7 - Case Study 2 - Application of a Game-play to a Second Banking Teller Team - Branch B

will be too long, so recoil at joining the queue\(^4\) (called baulking in queueing studies). This ceased to be a problem for the branch during the follow-up study.

While the overall study probably served to alienate Teller 5 more than she was already, for the rest of the team it provided a positive boost to their cohesiveness and appreciation of the inter-relatedness of their roles in satisfying customers.

7.8 Summary

The application of a game-play to a second bank teller team once again demonstrated the effectiveness of this approach to the achievement of team-defined goals. The percentage of customers who queued for less than three minutes increased from 63% without the game-play to 87% with the game-play, and the consistency of this performance was evident. The adaptive nature of the game-play was demonstrated when a novice teller joined the team without undermining its performance. Once again a welcome by-product of the approach was the development of team values – cohesion, support, understanding, appreciation, work ethic, and responsibility – among the players. In this case though, one player refused to be part of the team and her subversive actions threatened the overall success of the team. The netball themes again provided a way of dealing with this behaviour (i.e. the uncooperative player was ‘sided-lined’) so the team could function and experience the success warranted by their efforts.

A feature of this second case study was the demonstrated importance of tailoring a game-play to the particular team of players and their unique environment. Lessons borrowed from an allied business environment must be carefully tested for their applicability within a new human activity system. This means that game-play designers must carefully analyse the system, going beyond the direct implications of imposing prescriptive constraints. The impact on other constraints being managed by the team (descriptive, ascriptive or other prescriptive) must also be considered in the analysis.

\(^4\) Both customers who left the queue after joining, and those who baulked at joining the queue were included in the figures on reneges.
Chapter 8  Summary, Conclusion and Areas for Further Study

8.1  Summary

The research topic, *Application of Constraints in a Human-Activity System*, with its focus on business systems, spanned a range of scientific management fields – organisational theory and behaviour, organisational structure as a decision-making framework, business strategy and resource management, empowerment and job design, and teams. Ideas from each of these areas played their part in the process of developing an understanding of the issue of control in business. The core question was how to apply constraints within a human-activity system such that the endeavours of the team are coordinated and the creative freedoms of the individuals are supported.

Three hypotheses framed the problem:

**Hypothesis 1:** That new freedoms for the team and the individual will emerge once the appropriate constraints have been designed for the individual.

**Hypothesis 2:** That a set of constraints may be designed to support simultaneously the goals of the organisation and the creative freedom of the individual.

**Hypothesis 3:** That the probability of success of the constraints so designed will be greater in a working environment that not only embraces, but also ‘teaches’ creativity.

The first hurdle in addressing the problem was the complexity of the business environment. A breakthrough came with recognition of the parallels between business and some team sports. Netball provided a tractable model in which to examine the application of constraints and develop a theory that supported the use of the game-play methodology in both the sporting and business environment.

The game-play methodology was developed from an analysis of the decision-making process in netball, in particular the effects on decision-making of different levels of constraint. A trial of the game-play approach in a business environment led to improvements in the methodology. The updated version of the game-play methodology
acknowledged the need to match constraints to the abilities of the individuals and the demands of the environment.

The Game-Play Methodology is summarised as follows:

1. **Define the team goal.** Involve team members in the definition process to encourage creative involvement and ownership of the outcome.
2. **Analyse the existing team operating system.** Use information and data gathering techniques to describe the extant operating system and evaluate its performance in relation to the team-defined goal.
3. **Design the constraints that constitute the game-play.** These must be goal-directed and maximize internal (current and immediate future) system knowledge for all individuals. Consider the ascriptive constraints that operate for each individual in the design process. Where possible, involve the team members in this creative design process.
4. **Examine the requirements of the game-play** in relation to the abilities of the players and the unalterable constraints of the working environment, and assign or modify roles accordingly. Redesign the play if necessary to match the abilities of the players. While it is valid to extend a player in the design of a game-play, such extension must be realistically achievable.
5. **Constrain the individuals according to the game-play.**
6. **Support ongoing creativity** within the game-play environment.

The analysis also exposed several management practices in netball that are important in business management. Eight lessons that address some of the fundamental issues in business management were formulated.

1. The actions of individuals within a business team must be visible to others within that team, so that both the direct and supportive roles of the workers can be coordinated and recognised for their impact on operations.
2. The individual decision-maker within an organisation must endeavour to have current, accurate and complete knowledge of his or her business field.
3. Those who impose constraints within an organisation must understand both the direct impact of the control and its indirect influence on other aspects of the
system. The ability to identify and categorise constraints is important to this process.

4. The individual performance of a worker is enhanced by knowledge about the operational behaviour of co-workers. Avenues that allow for the sharing and updating of such knowledge will serve to accelerate the assimilation process for new workers.

5. The imposition of controls on the behaviour of workers within an organisation allows each individual to excel within his or her own domain (in support of the organisation). Confidence in the imposed constraints allows a worker to creatively explore the boundaries of his or her performance.

6. Decision-making within a business organisation should not be an isolated process. All areas affected by the decision should be involved in the decision-making process so that the final decision is supported, and supportive of the organisational endeavour.

7. Duplication of effort is easily hidden within a large organisation and is both wasteful and costly. It derives from lack of information sharing and coordinated planning within (and between) organisational groups.

8. Individuals cannot 'hide' within an organisation that operates at the game-play level. The contribution of each worker becomes clear in the game-play process.

The game-play methodology was tested with teller teams in two bank branches. The results were excellent. In both cases the approach provided process improvement tactics that allowed staff to improve, not only their performance in regard to a team-defined goal: 'maximising the number of over-the-counter (OTC) customers who queue for less than three minutes', but also their efficiency and productivity in related areas.

In the first case study (Branch A) the improvement was dramatic – four weeks after the introduction of a tailored game-play, the team at this branch affected a 143% improvement measured against the goal (35% of customers queued for less than three minutes prior to the introduction of the game-play, while 85% enjoyed that level of service after the operation of the play). In the second case study (Branch B) the baseline performance was much higher (63%) so that the improvement was less spectacular (to 87%) but it was nonetheless significant – 38% improvement within two weeks of application of their game-play. Reneges at Branch A dropped from 71 in the
pre-game-play week to 4 in the follow-up period, while the maximum waiting time experienced by a customer during the case study fell from 24 minutes (without the play) to 12 minutes (with the play). Improvements in allied process efficiencies were also noted, leading to earlier end-of-day departure times for tellers, and less back-office work held over for the following day. But perhaps the most distinguishing feature of the game-play methodology was its ability to transform a group of dedicated but divisive players into a cohesive, supportive, goal-driven team.

The aim of the case studies was to investigate the effectiveness of the game-play methodology in a business environment, and in this regard the studies were successful. But the studies delivered much more than was originally envisaged. They provided insights into OTC operations and the difficulties for service systems that are prone to random customer arrivals and randomly distributed workloads. System variation makes the allocation of appropriate staffing levels difficult. One key dilemma is whether to have fewer staff operating at high usage rates or more staff at low utilization. The first situation invariably leads to lengthy queues, long customer waits and reduced customer and server satisfaction. The second situation involves increased costs, service staff standing idle for periods of time, and greater customer satisfaction. The trade-off is clear – the cost of increased staff levels, versus to cost of customer dissatisfaction. The application of the game-play methodology led to the development of State Based Management (SBM), a game-play whereby service operators share internal system state knowledge so that the state of the overall service system can be monitored. This process allowed the banking staff to match the number of servers to the current and predicted load on the system. SBM has application in any single-queue, multi-server system that is characterised by randomly distributed customer interarrivals and transaction times.

The banking case studies also prompted research into queueing theory and queue psychology as applied in OTC services. Current queueing theory provides limited assistance in queue management because of its reliance on queue-length as the state descriptor. Queue-length is a poor indicator of system load, but persists in the absence of another analytically tractable measure. OTC service managers are further hampered by the poor standard of customer service data that is collected in the industry. Insignificant amounts of high quality data or massive amounts of low quality data are
generally used to describe the system, and form the basis for management decisions with regard to service. Queue psychology addresses a second management avenue for improving the level of customer satisfaction with OTC service and might more aptly be described as perception management. The work in this area offers positive methodologies for increasing the patience threshold of customers, thereby increasing their overall satisfaction with service. The game-play methodology, and in particular, SBM, allowed both aspects of queue-management to be targeted, reducing the real-time wait for the customers and increasing their patience threshold for waiting.

8.2 Conclusion

The application of constraints in human-activity systems is not a straightforward problem. A broad approach to applying constraints may serve the team well but fails the individuals. A narrow approach that serves the individuals within an organisation, invariably fails at the team level. The game-play methodology provides a balance for both the team and the individuals in the team.

The game-play methodology acknowledges the unique contribution of each individual within a team, and its application in business trials proved that 'new freedoms for the team and the individual will emerge once the appropriate constraints have been designed for the individual.' (Hypothesis 1) The secondary aspect of game-play design is the focus on the self-defined goal of the team. This directs the design process that appropriates roles according to the abilities of the individual. The set of constraints are 'designed to support simultaneously the corporate goals and the creative freedom of the individual.' (Hypothesis 2)

Game-play design is a creative process. It looks beyond the range of standard practices, to create a new process approach, and in doing so, establishes a framework for creative design within the team. Challenging players to think creatively is an intrinsic part of the game-play methodology and the early stages of play design lead the innovative change by example. Indeed, 'the probability of success of the constraints so designed will be greater in a working environment that not only embraces, but also 'teaches' creativity.' (Hypothesis 3) This was clearly evidenced in the netball case, but also recognized in the banking cases. Tellers began to explore opportunities for process improvement that augmented the initial game-play tactic.
In testing the game-play methodology in a business environment, a game-play was designed that was able to address a long-standing problem in queue-management. This game-play was termed State Based Management (SBM). OTC operations are generally single queue, multi-server systems in which customer arrivals and the workload carried by customers are both randomly distributed. Allocating a fixed number of service staff in a system of this nature generally results in either poor customer service (too few staff) or high overheads (too many staff). SBM offers a method of matching service staff numbers to the current (and immediate future) workload on the system. The shared system knowledge for all players, which is promoted by the game-play methodology, led to the development of SBM. SBM can be applied in any single queue, multi-server system.

8.3 Areas for Further Study

8.3.1 An Electronic SBM and Monitoring System for OTC Servers

The manual monitoring system that was used in the banking case studies served its purpose well – the flags indicated the serving state of each server and thus the overall system status. It was a rudimentary scheme requiring the tellers to change coloured cardboard flags in response to their assessment of the workload in their current transaction. The proposed electronic monitoring system would not remove the requirement for servers to assess and ‘flag’ the current state, since that is one of the strengths of the SBM system – each server is assessing workload against their own (known) performance level and not against some predetermined average or standard. An electronic version would offer advantages in other areas:

• Ease of usage - A push button system as opposed to a manual card replacement system. The service operator would push a button to ‘flag’ the type of transaction.

• Update facility – The electronic system could track the servers’ flagged states and update the status if the flagging underestimates the transaction time for whatever reason (the server forgets to flag; the server underestimates the workload; or the customer increases the workload requirements partway through a transaction).

• Automatic signalling – The system could recognise a system blockage according to predetermined criteria and signal the need for the response mechanism to come
into operation. The signal could continue to sound at intervals until the response was initiated.

- Feedback – The system could provide instantaneous feedback directly to servers in regard to the accuracy of their assessment of transactions so that they can continually improve the accuracy of their estimates.
- Data capture – Information on the frequency of blockages; length of time that additional servers spend on the counter (i.e. the time that the response mechanism is in operation); ratios of transaction types experienced throughout the day or week; time distribution of transaction types; etc. could all be recorded electronically.

This proposed level of technological aid would simplify the operation for the servers and provide both the operators and the managers with a level of knowledge about the system performance. Flagging signals that were visible in the chamber could also provide the educated customers with a degree of state knowledge (and entertainment) and allow them to better assess their position within the queueing system.

The suggested technology though, does not provide the goal-defined measure of performance – percentage of customers who queue for less than three minutes. This aspect is not an explicit part of the operating system – it is a by-product of the operating process – and to measure queue-length for each customer would require a dedicated data capture system. Knowing the percentage of customers who queue for less than three minutes has no direct impact on performance, but it may have implicit effects. Being able to measure (and acknowledge and reward) high performance is a valuable management tool. Being able to monitor performance allows for design and testing of process improvements with a degree of confidence. The system developed for this level of data capture need not be a permanent fixture but could be shared on a week-around rotational basis with several OTC branches. Its development should give full recognition to the outcomes of research on the psychology of queues and could incorporate the aspects of ‘engagement, entertainment and enlightenment’ (Katz et al 1991).
8.3.2 State Based Management – Models for Selection of the State Criteria

The selection of the flagging states used in the two banking case studies was based on a study of the empirical data and an understanding of the system developed through first-hand telling experience and observation. The breakdown of the workload transition times into the chosen three categories was a result of examining the daily transaction times and recognizing the patience threshold of customers observed in that environment. Once a model was developed of the SBM system, the appropriateness of the chosen transaction categories was tested, in 30-second blocks (i.e. ET of 60 sec; 90 sec, and 120 sec). This method of testing relies on first establishing the system model.

An alternate mathematical approach to determining the state categories (given the customer volume, IAT and transaction time distributions, and the observed patience threshold of customers or allowable wait as determined by management) would provide an excellent baseline for decision-making and allow for rapid update of states to reflect changes in the input data. It would formalise the categorization process and alleviate some of the onus on the observer to accurately describe the system. For example, if data were collected to provide the following summary: 600 customers per day; Exponential distribution of interarrivals with a mean of 65 seconds; lognormal distribution of transaction times with a mean of 120 seconds and standard deviation of 110 seconds; defined goal of maximizing the number of customers who wait less than two minutes for service and a total of 5 servers available on an as-required basis, the mathematical formulae could determine: (a) How many workload states would be required, (b) What flagging states would be required, and (c) How many substantive servers would be required, for this system to achieve the defined goal?

A computer-based management system, based on a mathematical queueing model that could capture the given data and deliver the required process parameters could act, in some instances, in place of an observer. Data capture from the service-side of the system would be straightforward and reliable, but data capture from the customer-side would not. Data capture systems that require action by the customers (such as taking a time-coded ticket on entry to the queue, and feeding it to a second ticketing machine on

---

1 Requiring operators to estimate time intervals to a greater degree of accuracy than 30-second blocks would be unrealistic. The selection of the number of system states and the range of states that are appropriate in describing a system must recognise human limitations in terms of estimation.
 Exiting the queue, so that wait-time in the queue can be determined) are notoriously unreliable. Transferring the data collection process from an observer to a remote means must not reduce the quality of data obtained.

The mathematical queueing model could be allied to the data capture system to create a monitoring system that identified changes to the customer base and triggered the appropriate adjustment to the process parameters.

### 8.3.3 Strategies for Introducing a Game-Play within a Business Environment

Two factors contributed to the less than ideal method of game-play introduction that was used in the banking case studies: a lack of time (largely imposed by the bank in wanting to minimise the ‘disruption’) and an inability to have team meetings. The first constraint meant that it was impossible to lead the players through a constructionist approach to discovering the game-play that would best suit them and their situation. The game-play was designed externally and imposed on the team of tellers. Ownership is poor when processes are imposed on the recipients and this reality was compounded by an inability to work effectively on team-building strategies, beyond the influence of the game-play.

Tellers' working hours involved staggered starts and finishes and individual lunch and tea breaks, to maximise the number of staff available during peak hours. There was therefore no time during working hours for the team to come together as a whole. Information for the team was always disseminated second-hand in written form.

The banking environment is not the only one that experiences these restrictions – many business environments have operating practices that make team strategies difficult to implement. An allied area of study to the game-play methodology, could be the techniques / strategies for its development and implementation.

- Is there scope for involving the workers in development of the game-play, or can ownership be effectively promoted within the constrained environment of the play? What would a constructionist approach involve? How could it be facilitated?
- What do the designers of the play sacrifice by limiting the input of the workers?
Chapter 8 - Summary, Conclusion and Areas for Further Study

- If a game-play must be imposed, rather than developed with the team – what strategies should be used to instil ownership and pride in the process?
- How can team values be promoted when the players have little one-to-one and team interaction? What other avenues can be utilised to instil these values? How can team values be monitored and supported in this environment?

8.3.4 Evaluation and Testing of the Transition Matrix Method

The Transition Matrix Method (TMM) (Appendix A) was devised to deal with a specific problem that was encountered in the netball case study for this thesis. A lack of knowledge about the players delayed the design and implementation of game-plays for the team and the TMM was an attempt at the directed use of historical player data. *(In the netball case the 'historical data' was gathered in parallel with the application of game-plays and used to confirm the chosen designs.)*

At the elite levels in team sports individual player statistics are constantly updated and readily available to new coaches. Statistics on player interrelationships are generally not kept other than on an anecdotal level – “Tom and Harry play well together” – but would provide increased opportunity for applying the TMM at this level. The TMM can only provide accuracy to the level that the chosen performance measures reflect the team goal. There is scope for testing the TMM in different team sports and business environments. The business example of selecting a banking loans team could be well employed in the sporting domain to select a team or team/coach partnership that would mesh well on the field, and contribute the attributes considered necessary in a winning combination.

8.3.5 Queueing Models – A Compromise

Academia offers two approaches to queueing issues. The first has its roots in queueing theory and has led to the development of ever more complex mathematical models that describe some highly constrained hypothetical queue-server problems. The relevance of this work to industry practitioners is severely limited by its constrained nature and mathematical complexity. The second body of work recognises the need for practical solutions and has therefore been restricted to simplistic applications of queueing theory that can at best describe only a small portion of the overall system. Both of these
approaches – the generalists’ oversimplification and the specialists’ incomprehensible
detail – contribute to the body of knowledge on queue systems. But they contribute in
isolation. There is a need to bridge the gulf between the two, so that the detail of the
mathematical models can enhance the applicability of the practical models. Computer
simulation may be the tool that allows this to be accomplished, with its ability to
perform complex analysis to reveal usable approximations.
Appendix A  Transition Matrices – A Tool in the Development of Game-Plays

A.1 Development of the Ability Matrix from Thrower to Catcher in Netball.

The idea around which this method was devised is drawn from the work of Ross Ashby (Ashby 1956, p163). Ashby develops matrices to describe multi-faceted transition or change in a system. These sets of transitions, or transition matrices portray more closely the transformation of a system, than does unitary change analysis. Ashby’s form of matrix, with the operands in a row across the top, and the possible transforms in a column down the side, is in transposition with the common form found in most literature, but is used here for consistency. The body of the matrix, the intersection of column \( i \) and row \( j \), is the probability of a successful transition of the system from \( i \) to \( j \).

\[
\begin{array}{cccc}
\downarrow & A & B & C & D \\
1 & \frac{1}{2} & \frac{1}{2} & 1 & 0 \\
2 & \frac{1}{2} & 1 & 0 & \frac{1}{2} \\
3 & 0 & 1 & \frac{1}{2} & 0 \\
\end{array}
\]

Matrix of Transition Probabilities (Ashby 1956)

The analysis begins with a generic matrix, drawn from the universal rules of netball, and transforms these to reflect the abilities of the seven particular players in this study. An overriding assumption in this analysis is that forward play of the ball is preferable to playing the ball ‘back’ (away from the goal-scoring end). Valid instances arise in netball in which backward play supports the ambition of goal scoring. If no forward leads present within the three seconds available to the thrower, a backward pass is preferable to losing possession of the ball for infringing the three-second-rule. On balance however, playing the ball backwards is a rare occurrence in the game, and most often a ‘last-resort’ option to avoid losing possession.
The staged process of the analysis illustrates the inclusion of prescriptive constraints (laws, rules, orders, commands) and ascriptive constraints (self), in the first instance. Descriptive (causal) are included, to a degree, later in the analysis. Table A.1 below lists the player abbreviations used in the analysis.

Table A.1 Abbreviations used in this analysis

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Played by</th>
<th>Player</th>
</tr>
</thead>
<tbody>
<tr>
<td>GK</td>
<td>Goal Keeper</td>
<td>played by Alpha</td>
<td>A</td>
</tr>
<tr>
<td>GD</td>
<td>Goal Defence</td>
<td>played by Beta</td>
<td>B</td>
</tr>
<tr>
<td>WD</td>
<td>Wing Defence</td>
<td>played by Gamma</td>
<td>G</td>
</tr>
<tr>
<td>C</td>
<td>Centre</td>
<td>played by Delta</td>
<td>D</td>
</tr>
<tr>
<td>WA</td>
<td>Wing Attack</td>
<td>played by Epsilon</td>
<td>E</td>
</tr>
<tr>
<td>GA</td>
<td>Goal Attack</td>
<td>played by Zeta</td>
<td>Z</td>
</tr>
<tr>
<td>GS</td>
<td>Goal Shooter</td>
<td>played by Theta</td>
<td>T</td>
</tr>
</tbody>
</table>

Table A.2 summarises the matrices and weightings that comprise the body of the analysis. A superscript applied to the bolded identification for each matrix or weighting describes the governing type of constraint - a for ascriptive; d for descriptive; and p for prescriptive. Subscripts used throughout the analysis refer to the transition states:

- \( t \) refers to the general 'thrower';
- \( c \) refers to the general 'catcher';
- positional subscripts (eg. GD, WD, C ...) refer to generic positional players; and
- individual player abbreviations (eg. A, B, G, D, E, Z, or T) refer to the particular players observed in this study and defined in Table 1.
Table A.2: Descriptions of the transition matrices and weighting information used in this analysis

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F^p )</td>
<td>Matrix of Probabilities of catchers being Forward of a thrower given their relative playing positions.</td>
</tr>
<tr>
<td>( P^d )</td>
<td>Player weightings reflecting their individual efforts to Position forward of the thrower.</td>
</tr>
<tr>
<td>( C^{ad} )</td>
<td>Matrix of Probabilities of a particular player Catching a pass thrown by another designated player</td>
</tr>
<tr>
<td>( I^{op} )</td>
<td>Player weightings reflecting their individual probabilities of not Infringing with the ball: based on knowledge of &amp; competency in, the rules of netball.</td>
</tr>
<tr>
<td>( D^{ad} )</td>
<td>Matrix of Probabilities of a particular player throwing the required Distance to make a successful pass to the designated catcher.</td>
</tr>
</tbody>
</table>

\( T^1 \) Transition Matrix of probabilities of a particular player being forward of the generic positional player with the ball – Based on \( F^p \) and \( P^d \).

\( T^2 \) Transition Matrix of probabilities of a successful transition of the ball from the Thrower to the Catcher. – Based on \( T^1 \) (\( F^p \) and \( P^d \)), \( I^{op} \) and \( C^{ad} \).

\( T^3 \) Transition Matrix derived by combining two aspects of "success": the likelihood of the pass going forward (Matrix \( T^1 \)); and the probability of it being a 'without loss' transition, \( (T^2) \).

\( T^4 \) Ability Matrix \( T^4 \) further refines transition matrix \( T^3 \) to include the constraints given in matrix \( D^{ad} \).

A.2 Positional Analysis

Matrix \( F^p \) shows the probabilities of a positional player being forward of the thrower, based on the prescriptive constraints (rules) for the game. The entries in this initial matrix are estimates based on knowledge of the game structure and the physical positional restrictions imposed by the official rules of netball. It is clear from Matrix \( F^p \) that all players are generally forward of the goal keeper (GK), while most players are rarely forward of the goal shooter (GS). Although the WA and GA have the same two-thirds of the court in which to play, the WA is excluded from the shooting circle, while the GA spends a significant proportion of her play in the circle, hence the higher probability of the GA being forward of the WA, rather than the reverse. This matrix gives no consideration to particular players and the efforts they may make to secure front position on the ball; it simply reflects the constraints of the positional playing rules as set down by Netball Australia. For example the goalkeeper has only a small possibility of being forward of the other two defences; practically zero chance of being forward of the centre; and no chance whatsoever of legally being forward of the other
attacks. Similarly, the goal shooter is forward of most people on the court, most of the
time, but is unable to receive a legal pass from the goalkeeper as their playing zones are
exclusive, hence the zero probability.

\[
\begin{array}{ccccccc}
\text{Thrower} & & & & & & \\
\downarrow & & & & & & \\
\text{GK} & \text{GD} & \text{WD} & \text{C} & \text{WA} & \text{GA} & \text{GS} \\
\text{GK} & 0.00 & 0.10 & 0.10 & 0.00 & 0.00 & 0.00 \\
\text{GD} & 0.90 & 0.00 & 0.50 & 0.40 & 0.10 & 0.10 & 0.00 \\
\text{WD} & 0.90 & 0.50 & 0.00 & 0.40 & 0.10 & 0.10 & 0.00 \\
\text{C} & 1.00 & 0.90 & 0.90 & 0.00 & 0.80 & 0.50 & 0.10 \\
\text{WA} & 1.00 & 0.90 & 0.90 & 0.70 & 0.00 & 0.50 & 0.10 \\
\text{GA} & 1.00 & 0.90 & 0.90 & 0.80 & 0.80 & 0.00 & 0.30 \\
\text{GS} & 0.00 & 1.00 & 1.00 & 1.00 & 0.90 & 0.80 & 0.00 \\
\end{array}
\]

\textbf{Matrix }P^g\text{: Probabilities of 'generic' players being forward of the thrower
given the positional restrictions of the game of netball}

To transform Matrix }P^g\text{ from a generic to a specific matrix of the probabilities of the
particular team players positioning themselves forward of the thrower, statistics were
required in this regard for the seven players that comprised the observed team. Most
players made an effort in this regard, as reflected in Table }P^g\text{.

\[
\text{Probability of a Specific Player being forward of the thrower} = \frac{\text{Opportunities taken to be forward of the thrower}}{\text{Opportunities available to be forward}}
\]

[Rounded to the nearest 5%]

\[
\begin{array}{cccccccc}
\text{Alpha} & \text{Beta} & \text{Gamma} & \text{Delta} & \text{Epsilon} & \text{Zeta} & \text{Theta} \\
0.90 & 0.90 & 0.70 & 0.90 & 0.90 & 0.95 & 0.95 \\
\end{array}
\]

\textbf{Matrix }P^g\text{: Positional weightings for individual players (probabilities of being forward
of the thrower.)}
Appendix A – Transition Matrices

The alternate approach to deriving the transition matrix for forward positional probabilities is to record the percentage of the game time in which particular players are forward of the thrower. While this approach makes data-collection simpler it biases the data towards the information in the generic matrix and poorly reflects the player individual efforts to make forward play – important information in assessing player abilities.

Transition Matrix $T^1$ applies the generic positional restrictions and players' self-restrictions (the weightings from Matrix $P^a$) to derive probabilities of a particular player (catcher) being forward of the generic positional player with the ball (thrower).

This matrix is derived by adjusting the probabilities of a generic positional player being forward of the thrower (Matrix $F^p$) by introducing the specific player probabilities of taking action to be forward when the opportunity arises (from Matrix $P^p$), and is calculated by multiplying each row of Matrix $F^p$ by the corresponding value of Matrix $P^a$, i.e., Row 1 of Matrix $T_1 = 0.9 \times \{0.0 \ 0.1 \ 0.0 \ 0.0 \ 0.0 \ 0.0 \}$ – Equation (1).

$$T_{t,c}^1 = F_{c}^p \times P_{t,c}^a$$

(1)

<table>
<thead>
<tr>
<th>Thrower</th>
<th>GK</th>
<th>GD</th>
<th>WD</th>
<th>C</th>
<th>WA</th>
<th>GA</th>
<th>GS</th>
<th>Row Average</th>
<th>Generic Row Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.00</td>
<td>0.09</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>B</td>
<td>0.81</td>
<td>0.00</td>
<td>0.45</td>
<td>0.36</td>
<td>0.09</td>
<td>0.09</td>
<td>0.00</td>
<td>0.30</td>
<td>0.34</td>
</tr>
<tr>
<td>G</td>
<td>0.63</td>
<td>0.35</td>
<td>0.00</td>
<td>0.28</td>
<td>0.07</td>
<td>0.07</td>
<td>0.00</td>
<td>0.24</td>
<td>0.34</td>
</tr>
<tr>
<td>D</td>
<td>0.90</td>
<td>0.81</td>
<td>0.81</td>
<td>0.00</td>
<td>0.72</td>
<td>0.45</td>
<td>0.09</td>
<td>0.63</td>
<td>0.70</td>
</tr>
<tr>
<td>E</td>
<td>0.90</td>
<td>0.81</td>
<td>0.81</td>
<td>0.63</td>
<td>0.00</td>
<td>0.45</td>
<td>0.09</td>
<td>0.62</td>
<td>0.68</td>
</tr>
<tr>
<td>Z</td>
<td>0.95</td>
<td>0.86</td>
<td>0.86</td>
<td>0.76</td>
<td>0.76</td>
<td>0.00</td>
<td>0.29</td>
<td>0.74</td>
<td>0.78</td>
</tr>
<tr>
<td>T</td>
<td>0.00</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.86</td>
<td>0.76</td>
<td>0.00</td>
<td>0.74</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Matrix $T^1$: The probabilities that team players will be forward of the thrower to receive a pass.
A.2.1 Summary of the Information in Matrix $T^{1}$.

The generic row averages summarise a particular player’s probability of being forward of throwers to receive (by the current definition) a successful pass. As expected, players whose playing area is largely in the 'attacking' end of the court have a greater probability of being forward. Matrix $T^{1}$ has included specific information (ascriptive constraints) that is lacking in Matrix $F^{p}$. Information on particular player performance in this regard (being forward for a pass) is also considered to provide the probabilities for a successful transition from a particular position to a particular player. Notice that the row averages for this table reflect the inclusion of ascribed constraints to the prescribed constraints of matrix $F^{p}$.

Two other internal factors\(^1\) impinge on the success rate in passing the ball down the court in netball – the players' abilities to catch and throw a variety of passes (in terms of pass style, speed, and degree of difficulty), and the players' abilities to participate in the play without infringing the prescriptive rules of the game. To this point in the analysis, only positional factors have been considered under the assumption that a forward pass is optimum. Since the goal is to transition the ball to the goal circle for a successful shot at goal, this is not an unrealistic assumption and on balance a team must surely make more forward than backward passes to achieve this ambition. Once again, however, this reasoning ignores the weight of creativity and the advantages of variety in the play. The occasional backward play – for tactical reasons – can be used to support the team and its goals.

A.3 Inclusion of Player Catching Ability in the Analysis.

The probabilities of the particular players in this team catching passes thrown by other designated players are described in Matrix $C^{a}$. As the superscript suggests, only ascriptive constraints are applied here and no consideration is given to the likelihood of the passes taking place in a game.\(^2\)

\(^{1}\) This analysis attempts to omit the influence of the opposition. Information was gathered over a four-week period to allow assessment of players against a variety of opposition to reduce the impact of external effects on the analysis.

\(^{2}\) Although this study was able to include catching ability based on receipt of passes from particular players, in the case when a new team is being assembled, this information would revert to the more general data on catching success rate of players, based on their historic performances.
Appendix A – Transition Matrices

Data was recorded on the success rate of each player throwing to each other player, i.e. Zeta catching passes from Alpha, Beta, Delta, etc. In effect, this information takes account of both the skills of the thrower and the catcher, since a skilful player will often be able to modify the type of pass to suit the catching abilities of the receiver. The statistics on all players’ success in catching passes from Gamma are lower than their general catching statistics on passes from other players. This reflects Gamma’s passing ability more than it does the catching skills of the receivers. In general the players seemed to be aware of this problem and put extra effort into making the pass an easy one for Gamma to execute, doubtless improving the probabilities of her passes being successful to the levels shown in matrix $C^e$. In a different team environment Gamma may not perform as well in the role of Thrower. Throwing and catching (or receiving) are tightly related activities in ball sports.

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
<th>Zeta</th>
<th>Theta</th>
<th>Row Average $^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>0.00</td>
<td>0.80</td>
<td>0.50</td>
<td>0.75</td>
<td>0.70</td>
<td>0.70</td>
<td>0.00</td>
<td>0.70</td>
</tr>
<tr>
<td>Beta</td>
<td>0.85</td>
<td>0.00</td>
<td>0.70</td>
<td>0.85</td>
<td>0.80</td>
<td>0.85</td>
<td>0.75</td>
<td>0.80</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.20</td>
<td>0.30</td>
<td>0.00</td>
<td>0.30</td>
<td>0.25</td>
<td>0.30</td>
<td>0.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Delta</td>
<td>0.70</td>
<td>0.75</td>
<td>0.65</td>
<td>0.00</td>
<td>0.70</td>
<td>0.80</td>
<td>0.75</td>
<td>0.73</td>
</tr>
<tr>
<td>Epsilon</td>
<td>0.55</td>
<td>0.65</td>
<td>0.45</td>
<td>0.60</td>
<td>0.00</td>
<td>0.60</td>
<td>0.60</td>
<td>0.58</td>
</tr>
<tr>
<td>Zeta</td>
<td>0.80</td>
<td>0.85</td>
<td>0.50</td>
<td>0.80</td>
<td>0.70</td>
<td>0.00</td>
<td>0.85</td>
<td>0.75</td>
</tr>
<tr>
<td>Theta</td>
<td>0.00</td>
<td>0.55</td>
<td>0.20</td>
<td>0.40</td>
<td>0.60</td>
<td>0.65</td>
<td>0.00</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Matrix $C^e$: The probabilities of particular players being able to successfully catch a pass delivered by another particular team player.

Matrix $C^e$ reflects the statistical analysis of historical data on the catching ability of each player, relative to the thrower. Gamma is considered to have ‘soft hands’ - a propensity to ‘drop the ball’, irrespective of the thrower. (The higher probability given for a pass

$^3$ Averages are calculated only on legitimate passes (five legal options for GS & GK; six for the other positions)
from Theta reflects more the infrequency of the event\(^4\) than an increased proficiency in catching Theta’s passes.) Statistically, Theta is also relatively weak at catching, managing to secure less than 50% of passes. What the figure fails to indicate is Theta’s inconsistency in her catching ability i.e. She will ‘stick’ a hard pass, only to ‘drop’ the next easy pass. Despite the unpredictability for any given pass, the probability remains consistent – in 50% of the events she will catch passes from most of the girls (40% from Delta -a rapid passer; and 20% from Gamma - a poor passer who is unable to be geographically close to Theta because of their exclusive, playing zones).

A.4 Inclusion of Players’ Abilities to Abide by the Rules (*Prescriptive Constraints*)

Table \(I^{op}\) provides particular player probabilities of not infringing with the ball, a skill based on knowledge of and competency in, the rules. Alpha, Beta and Zeta are well acquainted with the rules and their application to match play and are largely able to conform to the rules in most situations that arise in netball. Errors in this regard in their play are generally externally generated, e.g. being forced offside by a poor pass; no clean leads available for passing off during the three seconds of possession, or subjective conflict between player and umpire in assessing 3 feet (the allowable distance for defending a player with the ball).

Zeta and Theta have a basic general knowledge of the rules but are less uniform and less controlled in their application of the rules. Both players have learned habits that contravene the rules and result in their infringing in spite of their rule knowledge. Gamma and Epsilon have poorer understanding of the rules and less experience and skill in their application.

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.95</td>
<td>0.95</td>
<td>0.50</td>
<td>0.80</td>
<td>0.70</td>
<td>0.95</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Matrix \(I^{op}\): Probabilities of individual players not infringing with the ball: based on their knowledge of and competency in, the rules.

\(^4\) During the four-week period of observation, Theta only passed back to Gamma on two occasions and Gamma caught 50% of those passes.
A.5 Transition Matrix of Probabilities of a Successful Transition of the Ball.

Transition Matrix $T^2$ combines information on the particular players' catching abilities (Matrix $C^a$) and their skills in not infringing while in possession of the ball (Matrix $I^p$) to arrive at the probabilities of a successful transition of the ball from the Thrower to the Catcher. A transition of the ball in play is considered as the process from the time the ball leaves the Thrower's hands until the ball leaves the Catcher's hands (i.e. the catcher has become the thrower).

The weightings of Matrix $I^p$ are used to modify the probabilities of Matrix $C^a$ according to the equation -

$$T^2_{t,c} = I^p_{t,c} \times C^a_{t,c} \quad (2)$$

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
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<th>Epsilon</th>
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<td>0.76</td>
<td>0.81</td>
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<td><strong>Zeta</strong></td>
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<td><strong>Theta</strong></td>
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<td>0.36</td>
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<td>0.00</td>
</tr>
</tbody>
</table>

**Matrix $T^2$:** Probabilities of a successful transition of the ball – based on players' skill levels.

A.5.1 Summary of the Information in Matrix $T^2$.

Although it is only inclusive of two factors of play (an isolated part of the overall system) Matrix $T^2$ provides important information for the coach in the design of a game-play. The Matrix suggests the most successful path for the ball (irrespective of
Appendix A – Transition Matrices

direction of play) given knowledge of the player with the ball. If Gamma is currently in possession of the ball, the highest probability of a successful transition of the ball is achieved if she passes to Beta. Notice that in all cases, a pass to Beta has the highest probability of success. No consideration is given in this matrix of the likelihood of a forward transition taking place, as per the information in Matrix $T^1$. For example, when Zeta is the thrower, the probabilities of this matrix would suggest that passing to Beta is the best option for success. However, Beta cannot always position forward of Zeta, and quite often a pass from Zeta to Beta would be contrary to achievement of the initial assumed team goal - to move the ball closer to the scoring end. The information contained in both Matrices $T^1$ and $T^2$ needs to be considered, to better understand the system.

A.6 Probabilities of a Successful Transition - Positional and Skill Aspects

Transition Matrix $T^3$ is derived by combining the two aspects of "success" as defined by the initial assumption and the overriding requirement to score goals (maintain possession of the ball): firstly the likelihood of the pass going forward, from Matrix $T^1$; and secondly the probability of it being a 'without loss' transition, from Matrix $T^2$.

<table>
<thead>
<tr>
<th>Thrower</th>
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<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
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<tr>
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<tr>
<td>Theta</td>
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<td>0.30</td>
<td>0.00</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Matrix $T^3$: Probabilities of a successful transition of the ball – based on positional information and skill levels.

---

5 The information in this Matrix $T^2$ may be used in isolation, if the assumption of a forward path being preferable is not made, and further qualifications are not considered. Certainly the outcomes of this matrix supported the suitability of included a backward throw in the first of the game-plays that were designed for this study.
\[ T^3_{t,c} = T^1_{t,c} \ast T^2_{t,c} \]  

(Note that this is not matrix multiplication in the normal mathematical sense – each \(ij\) entry of the transition matrix \(T^1\) is multiplied by the corresponding \(ij\) entry of the transition matrix \(T^2\) to create the \(ij\) entry of the transition matrix \(T^3\).)

Matrix \(T^3\) comes much closer than the previous two transition matrices to providing assistance with decision-making. For example, if Theta has the ball, her first choice of catcher should be Zeta. If Alpha has the ball, her best option is to pass to Beta. A further aspect is missing in this matrix of transitions, and it is one that will ultimately dictate whether a pass between two players is a rational possibility - that of player ability to throw the required distance. This is an easily measured performance measure and can be assessed in pre-season training sessions.

A.7 Inclusion of Distance-Throwing Abilities

The constraint described as ‘distance-throwing ability’ is a combination of descriptive and ascriptive constraints and is demonstrated in matrix \(D_{ad}\). The individual probabilities are based on the relationships between players' areas of play and their ability to cover the required distances with a pass. Matrix \(D_{ad}\) shows the probability of a particular player throwing the distance to make a successful pass to the designated catcher (given the catcher's playing zone relative to that of the thrower).

The data in Matrix \(D_{ad}\) suggest that there is a slim possibility of Gamma having the ball in her playing zone, and being able to throw to Theta in her standard playing zone. Although their playing areas are adjacent and the players could stand within a metre of each other across the transverse line, this area is not generally part of their standard play, and such an occurrence would be extremely rare. Theta as GS would spend the majority of her time in and around the goal circle and Gamma as WD would play predominantly towards the back half – defensive end - of the court. Note that this matrix does not consider direction in terms of achievement of the goal, so while there is a 0.8 probability of Zeta being able to pass to Alpha (given Zeta's position with the ball and Alpha's allowed zone), it is unlikely that Zeta will make such a pass in the course of a game. To pass so far back to Alpha would be contra to achieving the goal of scoring.)
Appendix A – Transition Matrices

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
<th>Zeta</th>
<th>Theta</th>
</tr>
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<td>1.00</td>
<td>1.00</td>
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</tr>
</tbody>
</table>

**Matrix D_{ad}:** Probabilities of players being able to cover the distance required of a pass to another designated player.

Modification of Transition Matrix $T_3$ to include this final factor as described in $D_{ad}$ should provide a comprehensive picture of players’ abilities in the successful transition of the ball from one end of the court (or centre court, from the centre pass) to the goal-scoring end.

**A.8 The Ability Matrix**

Ability Matrix $T_4$ further refines transition Matrix $T_3$ to include the constraints given in matrix $D_{ad}$ and provides information regarding players’ overall skills with the ball and positioning possibilities. Careful ‘reading’ of the information in this matrix should allow the coach to recognise the players who should be involved in transition of the ball for the highest probability of success. Statistical analysis of this type is very clinical though and gives no acknowledgment of the vital aspect of team building. In this regard, a game-play built solely on statistical data will be less than optimal, but is a good starting point for early season work. Ultimately no players need be overlooked in the overall format of a game-play – some will work with the ball, others will work to decoy or shepherd the opposition from interference with the play, and each player can have a recognised role within the play.
Appendix A – Transition Matrices

<table>
<thead>
<tr>
<th>Thrower</th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
<th>Zeta</th>
<th>Theta</th>
</tr>
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<tbody>
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<td>0.07</td>
<td>0.00</td>
</tr>
<tr>
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<td>0.06</td>
<td>0.00</td>
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<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
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<td>0.05</td>
</tr>
<tr>
<td>Epsilon</td>
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<td>0.35</td>
<td>0.10</td>
<td>0.26</td>
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<td>0.04</td>
</tr>
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<td>0.21</td>
<td>0.31</td>
<td>0.30</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Matrix T₄:** The Ability Matrix.

This third iteration of the original transition Matrix $T^1$ provides a solid representation of the probabilities of success for different actions in the (attacking) transition of the ball in netball, for this team. According to the final transition matrix – the Ability Matrix - the solid first-option for most players is a pass to Zeta, who plays in the middle and attacking thirds of the court and is relatively strong in terms of personal skills with the ball. Beta remains the first choice for back-court players but has been relegated to third option overall because of her position on court.

The body of Matrix $T^i$ provides individual decision-making information. For example, if Delta has the ball, her best option is to throw to Zeta. If Zeta is unavailable or out of range, then any of Beta, Theta or Epsilon would be acceptable second options. If Theta has the ball, she is best to limit her passing to Zeta, Epsilon or Delta - the other three attacking players. Alpha, who plays Theta's counterpart down the other end of the court, has many more options. The data for Alpha as thrower may seem unusual, given that Zeta is her second-best option, although she is positioned well down the back end of the court. This reflects two realities - Alpha has a strong passing arm and can easily cover the distance to Zeta; and Zeta is a strong attacking player, well able to position forward and catch most balls that are thrown to her. Another seeming anomaly is that Alpha and Gamma are never the catchers of choice, irrespective of the thrower. This
would suggest that they are not really of much use in attacking plays. In Gamma's case this reflects her level of competence as a player (weaknesses in ability to move forward, catch and throw); in Alpha's it reflects her position on the court. As Goal Keeper Alpha will take a minimum of passes in attack and hopefully a maximum of passes in defence.

If the team was restricted to the advice of Matrix $T^4$ and thereby barred from throwing to Gamma (subconsciously this happened - the players being fully aware of Gamma's poor statistical success rate with the ball, without the aid of data recording), then Gamma's game improvement would be hampered and the gulf between her playing ability and that of the rest of the team would simply widen. Strategies to counteract this can include the use of game-plays coupled with increased practice for Gamma in her role within the play.

A.9 Use of the Ability Matrix in Game-Play Design

The information contained in Matrix $T^4$ provided no surprises. After observing the team for several weeks, I could concur with the outcomes of the transition matrix process. The players had naturally made individual assessments of other players and adjusted their inter-play accordingly. The quantity of statistics on Gamma and Epsilon was less than the quantity gathered on the other five players since the solid players had more consistent play with the ball. Without it ever being discussed, the players had reduced the likelihood of failure by reducing the involvement of the weaker players. A different type of play also evolved to support Gamma's weaknesses, when she was involved in the game. Shorter, more direct and open leads (with less risk attached) were made by all players when Gamma had the ball, to improve the probability of a successful transition. The other players also over-enthused about Gamma's successes to ensure that she felt valued within the team. The combined affect of increased success and praise led to an overall improvement in Gamma's involvements throughout the season.

The four game-plays implemented during the season were designed around both the strengths and weaknesses of the team, but always with the aim of developing and supporting the entire team. Gamma and Epsilon had key roles with the ball in only one play, but had supportive roles in other plays. The play designed for these girls was simpler in both movement and ball skill requirements and complimented the higher-
energy, more skilful aspects of the other game-plays to balance the limited repertoire. Throughout the learning process, the importance of off-the-ball roles to the success of the overall play was stressed (and reinforced when Beta and Zeta were also given these supportive roles in a designed play):

The Ability Matrix then, should preferably only be used as a guide to the early development of game-plays. In isolation, the matrix information could not fully support the dynamics of the team and the developmental requirements for a team. As a tool in the design of the first plays for an unsighted, newly amalgamated team however, the transition matrix method neatly packages a large quantity of statistical information about players and their roles within the team.

A.10 Business Application of the Transition Matrix Method

Application of the Transition Matrix Method (TMM) to the netball environment was somewhat simplified by the chosen framework already having a defined goal and specified positional roles for all players in pursuit of that goal. The rules of play were fixed and the structure of the operation well described within those constraints. The challenge then for the netball case was to identify the performance measures that were significant to the process of achieving the goal, evaluating the individuals against those measures and sequentially performing the transition iterations to arrive at the Ability Matrix.

In the netball case four player ‘properties’ were considered as determinants of the probability matrix for a successful transition of the ball: the catcher positioning forward of the thrower; the thrower being able to pass the ball the required distance to the catcher; the catcher being able to receive the pass; and the catcher not infringing the universal rules of the game while in receipt of the ball. Certainly there are a myriad of other factors that will impinge on the successful transition of the ball, but they are either minor by comparison with the chosen properties or external to the operating system (the team). The quality of the chosen parameters in describing the goal of the team will ultimately determine the quality of the Ability Matrix, and its appropriateness as a tool in the design of game-plays for the operating system.
The process for applying the TMM, in any environment, is an iterative application of contributing performance measures to arrive at an overall weighting of performance for all players within the defined organisation. The information provided in the final transition matrix, (and earlier transition matrices) may be judiciously used in game-play design for that team. The flowchart of Figure A.1 illustrates the TMM process.

**Figure A.1: Flowchart of the Transition Matrix Method (TMM)**
Establishing the Starting Matrix is possibly the most difficult aspect of the TMM. Once again, the netball case provided a simple platform with specific rules for process application and a tightly defined goal. The business environment is seemingly more complex by lack of definition. Developing the descriptions required of the TMM will clarify the business paradigm to a level comparable with the netball analogy.

To exemplify this process in a business environment and highlight some of the nuances of particular environments, two standard banking systems are examined. In this research case studies involving the application of a game-play within a business organisation were undertaken in a banking environment, so it is an appropriate framework for further explanation of the TMM.

A.10.1 A Series Workflow Example

Operations involving a series flow of work are more closely aligned to the netball case than those that involve largely independent parallel workflows. The roles of banking tellers in over-the-counter service are consistent with parallel workflows and will be discussed in the next example. Processing of a home loan application is an example of series work within a banking environment. From the initial customer enquiry about a home loan, the paperwork (ball) must pass through a number of hands (as illustrated below) before the loan is drawn-down (a goal is scored).

Sales Advisor (at the Bank):

- Assesses Customer Needs
- Prepares Mortgage Application
- Sights, Verifies & Copies Customer documents
- Checks Approval Authority Requirements for completeness
- Forwards document to Lending Services

Loans Officer (at Lending Service Centre)

- Checks documents for completeness
- Checks re affordability & reference information
- Prepares legal documents
- Forwards pre-contractual documents to customer
Evaluation Officer (at Lending Service Centre) \hspace{1cm} (EO)

*Performs evaluation on proposed home purchase*

*Forwards evaluation to Loans Officer*

Authorising Officer \hspace{1cm} (AO)

*Checks returned documents for completeness*

*Execute contract between bank & customer*

*Draw-down of the loan*

In this case the goal for the bank may be to furnish the customer with approval (or the loan) within a three-day period. While loan rate may entice customers in the first instance, turn-around time on loan approvals is an important selling point in the banking sector. The choice of game-play for the Bank Manager (coach) in this example may involve selecting the sales advisor, loans officer, evaluation officer and loan authority officer team that can best deliver on the promised goal. Notice that in this example it is a choice between combinations, not routing decisions – i.e. the sequence of passes must follow SA to LO to EO to AO. The game-play decision may involve who will play those roles and how they may be altered to increase system state knowledge for the team. Studying the creative ideas in this regard, from a 'top team' may provide fuel for improving overall procedures in this domain.

Performance measures may include *first run yield (the probability of the application proceeding at each stage without requiring 're-runs' to amend inaccurate or incomplete documentation); processing time for each stage; ability to handle several applications simultaneously (several balls); and the ratio of time spent with the customer to processing time (commonly termed touch time: flow time ratio).*

The generic matrix by virtue of the strict flow pattern is the unit matrix.

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<thead>
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<th>SA3</th>
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<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
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<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Generic matrix for the first stage of loans processing
Appendix A – Transition Matrices

The probability of each sales advisor forwarding the application to a loans officer is 1.0. Different loans officers may have different procedures and requirements regarding how and when the documentation is processed and this will be reflected in subsequent transition matrices to determine the best SA – LO pairing for the first stage of loans processing.

Data collected on the processing between the various pairings might be as shown in the matrices below.

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<thead>
<tr>
<th></th>
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<th>SA2</th>
<th>SA3</th>
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Probabilities of no returns on 'first run' documentation

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<th>SA3</th>
<th>SA4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO1</td>
<td>0.30</td>
<td>0.80</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>LO2</td>
<td>0.20</td>
<td>0.80</td>
<td>0.60</td>
<td>1.00</td>
</tr>
<tr>
<td>LO3</td>
<td>0.30</td>
<td>0.80</td>
<td>0.70</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Probabilities of processing time being less than 1 day (Note that this reflects the ability to handle several application simultaneously.)

<table>
<thead>
<tr>
<th></th>
<th>SA1</th>
<th>SA2</th>
<th>SA3</th>
<th>SA4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO1</td>
<td>1.00</td>
<td>0.60</td>
<td>0.30</td>
<td>0.20</td>
</tr>
<tr>
<td>LO2</td>
<td>0.90</td>
<td>0.60</td>
<td>0.30</td>
<td>0.20</td>
</tr>
<tr>
<td>LO3</td>
<td>1.00</td>
<td>0.60</td>
<td>0.30</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Probabilities of touch time: flow time ratio being greater than 0.2.

The individual matrices provide their own degree of information on the players within the system. SA1 can rarely be relied upon to complete her component of the loan
process in less than one day but her accuracy in processing and customer ‘touch time’ are high, and in these two areas she may have valuable advice to offer. Alternately, her approach in both areas may simply be slow and methodical and a source of frustration for customers. SA₄ is always able to submit her documentation to the loans officer within one day but scores poorly in terms of customer relations as defined for this analysis. Do the customers appreciate her efficiency or feel hurried and neglected in the process? (See § A.11 for further discussion on the limitations of the TMM.)

Sequential application of these performance matrices determines the ability matrix.

<table>
<thead>
<tr>
<th></th>
<th>SA₁</th>
<th>SA₂</th>
<th>SA₃</th>
<th>SA₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO₁</td>
<td>0.27</td>
<td>0.34</td>
<td>0.17</td>
<td>0.12</td>
</tr>
<tr>
<td>LO₂</td>
<td>0.11</td>
<td>0.14</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>LO₃</td>
<td>0.27</td>
<td>0.34</td>
<td>0.13</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Ability Matrix – AM₁

The Ability Matrix for this contrived case suggests that the combination of SA₂ with either LO₁ or LO₃ would be the best choice of pairing for the performance parameters chosen in this analysis. A different combination of parameters (or removal or weighting of some or all of the parameters) may result in a different indication from the Ability Matrix. In the design of the initial game-play in the netball case the requirement that the ball move forward for a successful transition was ignored in favour of using the exceptional strengths of a defensive player (Beta) to support the attacking players and the team goal. A second ability matrix illustrates the outcome when only the first two parameters, which focus on time constraints rather than customer relation constraints, are considered.

<table>
<thead>
<tr>
<th></th>
<th>SA₁</th>
<th>SA₂</th>
<th>SA₃</th>
<th>SA₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO₁</td>
<td>0.27</td>
<td>0.56</td>
<td>0.56</td>
<td>0.60</td>
</tr>
<tr>
<td>LO₂</td>
<td>0.12</td>
<td>0.24</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>LO₃</td>
<td>0.27</td>
<td>0.56</td>
<td>0.42</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Ability Matrix – AM₂
The new direction of the performance parameters results in an ability matrix that suggests the combination of SA4 and either LO1 or LO2 as the best pairing. The TMM can only provide applicable results to the extent that the input information is reliable and well-matched to the goal.

A.10.2 A Parallel Workflow Example

The second case study undertaken in the banking environment [Chapter 7] was intended to be a repeat of the first, a confirmation of the initial successful application of the game-play methodology within a business setting. With blind faith that the system environmental similarities rather than the player differences would dominate the play, the same game-play was introduced to the second branch. After several weeks of frustrated efforts to implement the play and affect the improvement predicted by simulation, the play was redesigned to recognize the abilities of the players. Application of the TMM at the outset\(^6\) would have provided player performance information to suggest the second form of game-play that was ultimately adopted. The worked example that is illustrated here describes players (and their skills relative to the play), who were involved in the second case study for this research.

Key performance parameters in the execution of the game-play that was termed State Based Management (SMB) were an ability to accurately assess the workload in the transaction being proffered by the customer\(^7\); the level of consistency of the operator in flagging the type of transaction being actioned; the level of consistency of the operator in alerting the queue-manager of an imminent blockage.

\(^6\) In this instance there would have been no historical data on some of the players' skills in the necessary components of the play, since to my knowledge this form of system knowledge enhancement had not been trialled in the service industry (and certainly not with these players), other than at the branch that featured in the original study. After the study, data is now available on the players who took part, so that should they transfer to another branch where the game-play concept was implemented, the designer could pre-empt the problems experienced in the second case study.

\(^7\) The assessment of workload was in relation to time taken to complete the transaction. Individual assessments were made with cognition of their own abilities – a transaction that may take one teller 2 minutes to complete may only require 1 minute from a more experienced teller.
<table>
<thead>
<tr>
<th></th>
<th>Teller₁</th>
<th>Teller₂</th>
<th>Teller₃</th>
<th>Teller₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of accurately assessing the transaction workload</td>
<td>0.50</td>
<td>0.70</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Probability of flagging the type of transaction being actioned</td>
<td>0.90</td>
<td>0.10</td>
<td>0.95</td>
<td>0.80</td>
</tr>
<tr>
<td>Probability of accurately signalling an imminent blockage</td>
<td>0.60</td>
<td>0.00</td>
<td>0.90</td>
<td>0.90</td>
</tr>
</tbody>
</table>

No further action on the performance measures is required in this parallel workload case since the work flows simultaneously through all players – rather than from player to player as in the series and netball cases. The ability of Teller 2 within the play was dismal and since increased system knowledge relied on a level of proficiency from all players, there were only two options available: to increase Teller 2’s performance or to design the play around her (as was largely done with Gamma and Epsilon in the netball case). The preference was to improve her performance within the team but after a period of instruction, encouragement, supervision, and ‘hand-holding’ through the process, Teller₂ had shown no measurable improvement. The second option – operating without the direct input of Teller 2 (she continued to work ‘off-the-ball’) - was successful and significant improvement was affected.

A.11 A Word of Caution on the Application of the Ability Matrix

The Ability Matrix is a compact, tractable summary of information that may be useful in the development of a game-play for the team (organisation). It is not the game-play. Many non-numeric factors are pertinent in the design of a game-play. The value of a team extends beyond the individual abilities of the players and even the individual interactions of any two players. Observation and experience in the operation of a team will provide a higher quality of information than can the TMM. The downside of this process is the time it requires. If data is available on the players in similar environments, the TMM allows for early design (albeit less than optimal) of game-plays while data in the immediate context is gathered.
Appendix B  Summary of Results from Banking Case Study 1 – Branch A

B.1  Summary of Data and Results without the Game-Play

<table>
<thead>
<tr>
<th>Property</th>
<th>Monday 11 April</th>
<th>Tuesday 12 April</th>
<th>Monday 17 April</th>
<th>Tuesday 18 April</th>
<th>Wednesday 19 April</th>
<th>Thursday 20 April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Transactions</td>
<td>341</td>
<td>232</td>
<td>369</td>
<td>396</td>
<td>349</td>
<td>392</td>
</tr>
<tr>
<td>Express Transactions - ET</td>
<td>49%</td>
<td>41%</td>
<td>47%</td>
<td>51%</td>
<td>45%</td>
<td>50%</td>
</tr>
<tr>
<td>Lengthy Transactions - LT</td>
<td>33%</td>
<td>29%</td>
<td>32%</td>
<td>31%</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>Prolonged Transactions - PT</td>
<td>18%</td>
<td>30%</td>
<td>21%</td>
<td>18%</td>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td>Reneges</td>
<td>11</td>
<td>13</td>
<td>14</td>
<td>11</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Customers who queue for less than 3 minutes</td>
<td>64%</td>
<td>30%</td>
<td>19%</td>
<td>41%</td>
<td>27%</td>
<td>27%</td>
</tr>
<tr>
<td>Customers who spend more time on their transaction than in the queue</td>
<td>42%</td>
<td>31%</td>
<td>14%</td>
<td>33%</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Longest wait in the queue (minutes)</td>
<td>12</td>
<td>15</td>
<td>16.6</td>
<td>18.4</td>
<td>18.7</td>
<td>24</td>
</tr>
<tr>
<td>Daily workload (minutes)</td>
<td>907</td>
<td>766</td>
<td>1090</td>
<td>1051</td>
<td>1077</td>
<td>1035</td>
</tr>
<tr>
<td>Number of tellers</td>
<td>4</td>
<td>PART DAY ONLY</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Load per teller</td>
<td>227</td>
<td>218</td>
<td>350</td>
<td>270</td>
<td>207</td>
<td></td>
</tr>
<tr>
<td>(Load / capacity)</td>
<td>0.63</td>
<td>0.60</td>
<td>0.97</td>
<td>0.75</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>
### B.2 Summary of Data and Results with the Game-Play

<table>
<thead>
<tr>
<th>Property</th>
<th>Monday 19 June</th>
<th>Tuesday 20 June</th>
<th>Wednesday 21 June</th>
<th>Thursday 22 June</th>
<th>Friday 23 June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Transactions</td>
<td>378</td>
<td>354</td>
<td>369</td>
<td>456</td>
<td>582</td>
</tr>
<tr>
<td>Express Transactions - ET</td>
<td>53%</td>
<td>55%</td>
<td>45%</td>
<td>52%</td>
<td>52%</td>
</tr>
<tr>
<td>Lengthy Transactions - LT</td>
<td>24%</td>
<td>27%</td>
<td>35%</td>
<td>34%</td>
<td>31%</td>
</tr>
<tr>
<td>Prolonged Transactions - PT</td>
<td>23%</td>
<td>18%</td>
<td>22%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>Reneges</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Customers who queue for less than 3 minutes</td>
<td>88%</td>
<td>83%</td>
<td>88%</td>
<td>91%</td>
<td>77%</td>
</tr>
<tr>
<td>Customers who queue for less than 1 minute</td>
<td>36%</td>
<td>38%</td>
<td>28%</td>
<td>35%</td>
<td>31%</td>
</tr>
<tr>
<td>Customers who spend more time on their transaction than in the queue</td>
<td>62%</td>
<td>55%</td>
<td>67%</td>
<td>64%</td>
<td>46%</td>
</tr>
<tr>
<td>Longest wait in the queue (minutes)</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Daily workload (minutes)</td>
<td>1188</td>
<td>924</td>
<td>1078</td>
<td>1090</td>
<td>1471</td>
</tr>
<tr>
<td>Daily workload (hours)</td>
<td>19.8</td>
<td>15.4</td>
<td>17.9</td>
<td>18.2</td>
<td>24.5</td>
</tr>
<tr>
<td>Number of tellers on counter</td>
<td>4.5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>Load per teller (minutes)</td>
<td>264</td>
<td>308</td>
<td>270</td>
<td>218</td>
<td>420</td>
</tr>
<tr>
<td>(Load / capacity)</td>
<td>0.73</td>
<td>0.85</td>
<td>0.75</td>
<td>0.61</td>
<td>1.00</td>
</tr>
<tr>
<td>Time spent on response (mins / day)</td>
<td>47</td>
<td>76</td>
<td>39</td>
<td>45</td>
<td>67</td>
</tr>
<tr>
<td>With no Q-man and Teller 2 managing from the express bay (12:50 to 1:04 pm) - Percentage served in less than 3 minutes</td>
<td>86%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>With no Q-man and 2 extra tellers brought on (3:16 to 3:50 pm) - Percentage served in less than 3 minutes</td>
<td>35%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Appendix C Preliminary Design Proposal for an SBM system

Proposal 1. – Data Capture for Monitoring and Evaluation of SBM Performance

A data capture and recording system to capture the following data in an over-the-counter (OTC) service system –

- The time when a customer enters the queue – \( T_1 \).
- The time when the customer leaves the queue – \( T_2 \).
- The time when the customer completes the transaction with the teller – \( T_3 \).

Means for evaluating \( T_2 - T_1 \), which is the customer wait time.

Discrete event updating (customer leaving the queue) of the percentage of customers who queue for less than a predetermined period of time (the set performance measure in terms of customer service).

Proposal 2. – Flagging System for Monitoring Overall System State

A flagging and monitoring device with the following properties:

- The device must have a workload status console available to each service operator in the system. The individual operator must be able to register his or her transaction workload status in one of a predetermined number of states (For example, State 1 for transactions less than 90 seconds; State 2 for those of 90 seconds to 4 minutes; state 3 for those greater than 4 minutes.)
- The state entered by an operator must be reflected in a coded readout above the service bay (For example, by use of coloured lights - green for express work; orange for lengthy and red for prolonged; or the words express; lengthy or prolonged may be illuminated.)
- If the duration for the state that the teller has input is exceeded, the monitoring system must update the state and the coded display.
- When a minimum number of operators are on the shortest time-interval allowed for queue progression to be maintained, the monitoring system rings an alarm. It should continue to ring at 30-second intervals until a response is triggered.
- Information to be fed-back to operators to indicate their accuracy in assessing the workload of transaction.

Proposal 3.

Software to collate and analyse the data recorded by the flagging and monitoring system.
Appendix D  Structural Organization at Branch A – Case Study 1

The organizational structure within the branch is given in Figure D.1. In practice Teller 1 was naturally afforded an elevated status similar to the SA (Service Advisor) and other tellers deferred to her as an authority on a range of matters. She was also delegated work that demanded higher personal responsibility than were the other tellers.

Figure D.1 Organizational Structure in Branch A. SSA1 (Sales and Service Advisor 1) was responsible for running local aspects of this branch. Her immediate supervisor was the Area Manager who was responsible for over 20 banks in his area. The other two SSAs had similar operational duties to SSA1, but without the management component. The SA (Service Advisor) was directly responsible for the performance of the teller team. See text for descriptions of each of the people in these roles.

D.1 Staff at The Branch

SSA (Sales and Service Advisor)1 was very much the mother of the branch. She was protective, defensive and eager to please everyone. Her spasmodic attempts at authoritarian rule were given cursory attention only. She would allocate specific tasks throughout the branch and when they were ignored, there would be no follow-up on the matter.

SSA2 replaced an SSA who went on maternity leave within 2 days of the implementation of the game-play. While she presented as competent and strong-willed, she was very uncomfortable in the role of queue-manager, which she only had to assume on a couple of occasions. She intimated that she was much more comfortable with the counter between herself and the customers.
SSA3 was extremely ambition, not only personally but also for the branch. Her sales figures were amongst the best in the Bank. Nothing overwhelmed her and she prepared to work hard and long to achieve self-determined goals. Competent in any role within the bank (and the game-play), she tendered her resignation on week 2 of the trial. She was moving to a “job with better prospects for promotion and advancement” (her words) within a Government Department. Casual staff filled her position (most days) during the remainder of the study.

SA (Service Advisor) had a measure of authority more from her position than her approach to the job. She was certainly knowledgeable enough to be an SA – broader knowledge than the tellers – but was a new SA and still finding her niche. Teller 1 (an ex-branch manager) and Teller 2 (22 years experience as a teller) were both knowledgeable and proficient and considerably older than the SA. She deferred to them quite often, as did other tellers, making her role less obvious in the branch. The SA’s insecurities about her new management role were highlighted with the introduction of the game-play.

Teller 1 had run a branch many years ago – left: ‘because of the politics and a desire to deal with customers, not paperwork’ – worked in real-estate and become totally disillusioned with that – and returned to the bank as a teller, with no intention of being promoted further. She worked ‘like a Trojan’ and handled the EBD side of things as well as being Teller 1 (responsible for the major cash holding in the branch). An excellent employee – worth much more to the branch than was reflected in the station she filled.

Teller 2 had been with the bank for 22 years. Her knowledge of procedural rules was complete and she was totally inflexible in her application of them. Despite the fact that tellers are asked to ‘go that extra mile’ for the customers, she could not see past the rules. She had a loyal following of customers who appreciated her professionalism and courteous manner – she also managed to offend more customers than most, always in a highly professional manner. Initially Teller 2 spent a lot of time ‘off the counter’ doing back-office work. Her behaviour was the catalyst for development of the Teller
Schedules. However, her desire to always 'do the right thing' led to her being the staunchest (and most proficient) player in the game.

**Teller 3** (SA's cousin) presented extremely well, and was steady and consistent in her work approach, but showed no ambition to achieve more and was not motivated beyond earning a pay packet. She had no compunction about leaving her station to have a cigarette, even while customers were queued. She did no more than was strictly required and her lunch-breaks were always on the long side of 30 minutes.

**Teller 4** was less experienced than Teller 3 but had already surpassed her in performance, largely because of her attitude. Dress-wise she did not present as well, but her dedication to the job and her attitude to customers and the game-play were far superior. Teller 4 had a vision of a long-term career with the bank.

**Teller 5** worked from 9:30 to 2:30 with enthusiasm, and energy. She was customer focused and self-motivated—not the sort who would ever do a second-rate job. She had 3 young sons and her ambition was to work at home as a child-carer so that she could spend more time with her boys. Her efforts towards the game-play were good.

**Teller 6** was a new teller. He had been with the bank for less than 4 months when the play was introduced - very keen, very biddable, but at the time of the study, very insecure about his work.

Tellers 3 and 6 provided added challenges during the implementation of the play. Teller 3 was not a team player and she had no interest in the performance of the branch (which all other tellers did.) She was coerced to 'play the game' by her cousin, the SA, but her performance was always poor. Her attitude annoyed others in the team, but they allowed the SA to deal with her, because of the family connection. Teller 3 left the bank shortly after the conclusion of the study. Teller 6 was a steady learner but still lacking in confidence after 4 months with the bank. This nervousness undermined his performance in the team, but his genuine efforts to play well saw the other tellers support rather than condemn him.
## Appendix E  Extend Modelling Blocks used in Chapter 6

**Note:** All information in this appendix is taken from the Extend™ Simulation Package (version 4) (1997)

<table>
<thead>
<tr>
<th>Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Executive Block</strong></td>
<td>This block allows the duration of the simulation to be controlled by the end time or by another number specified in the dialog.</td>
</tr>
<tr>
<td><strong>Generator Block</strong></td>
<td>Provides items for a discrete event simulation at specified interarrival times.</td>
</tr>
<tr>
<td><strong>Input Function Block</strong></td>
<td>Generates a function over time.</td>
</tr>
<tr>
<td><strong>Count Items Block</strong></td>
<td>Passes items through and reports the total number of items passed in its dialog and at the # connector.</td>
</tr>
<tr>
<td><strong>Set Priority Block</strong></td>
<td>Assigns a priority to items that pass through.</td>
</tr>
<tr>
<td><strong>Set Attribute Block</strong></td>
<td>Sets the attributes of items passing through the block.</td>
</tr>
<tr>
<td><strong>Get Attribute Block</strong></td>
<td>Displays and/or removes attributes on items, then passes the items through.</td>
</tr>
<tr>
<td><strong>Input Random Number Block</strong></td>
<td>Generates random integers or real numbers based on the selected distribution.</td>
</tr>
<tr>
<td><strong>Decision Block</strong></td>
<td>This block makes a decision based on the inputs and internal logic that can be defined.</td>
</tr>
<tr>
<td>Block</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>DE Equation</td>
<td>Calculates an equation when an item passes through.</td>
</tr>
<tr>
<td>Add Block</td>
<td>This block adds the three inputs on the left of the block and outputs the total.</td>
</tr>
<tr>
<td>Select DE Output Block</td>
<td>Selects the input item to be output at one of two output connectors based on a decision.</td>
</tr>
<tr>
<td>Buffer Block</td>
<td>Simulates a first-in-first-out (FIFO) queue for buffering items needed by machines, conveyors, or batching operations.</td>
</tr>
<tr>
<td>Combine Block</td>
<td>Combines the items from two different sources into a single stream of items.</td>
</tr>
<tr>
<td>Activity (Attributes) Delay Block</td>
<td>Works the same as the Activity Delay block, which holds an item for a specified amount of delay time, then releases it, except it interacts with an item's attributes.</td>
</tr>
<tr>
<td>Exit Block</td>
<td>Passes items out of the simulation from many inputs.</td>
</tr>
<tr>
<td>Plotter Discrete Event Block</td>
<td>Graphs model outputs</td>
</tr>
<tr>
<td>Queue, FIFO Block</td>
<td>A first-in-first-out (FIFO) queue.</td>
</tr>
</tbody>
</table>
### Appendix F  Summary of Results from Banking Case Study 2 – Branch B

#### F.1  Summary of Data and Results without the Game-Play

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Transactions</td>
<td>487</td>
<td>374</td>
<td>336</td>
<td>471</td>
<td>524</td>
</tr>
<tr>
<td>Express Transactions - ET</td>
<td>47.0%</td>
<td>47.1%</td>
<td>44.6%</td>
<td>52.7%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Lengthy Transactions - LT</td>
<td>34.5%</td>
<td>38.5%</td>
<td>31.8%</td>
<td>31.6%</td>
<td>33.0%</td>
</tr>
<tr>
<td>Prolonged Transactions - PT</td>
<td>18.5%</td>
<td>14.4%</td>
<td>23.5%</td>
<td>15.7%</td>
<td>16.2%</td>
</tr>
<tr>
<td>Reneges</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Customers who queue for less than 3 minutes</td>
<td>67%</td>
<td>84%</td>
<td>85%</td>
<td>55%</td>
<td>26%</td>
</tr>
<tr>
<td>Longest wait in the queue (minutes)</td>
<td>10.5</td>
<td>6.6</td>
<td>9.1</td>
<td>9.9</td>
<td>18.1</td>
</tr>
<tr>
<td>Daily workload (minutes)</td>
<td>1349</td>
<td>929</td>
<td>967</td>
<td>1113</td>
<td>1383</td>
</tr>
<tr>
<td>Number of tellers</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Load per teller</td>
<td>337</td>
<td>232</td>
<td>242</td>
<td>278</td>
<td>346</td>
</tr>
<tr>
<td>(Load / capacity)</td>
<td>0.9</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>1.0</td>
</tr>
</tbody>
</table>
## F.2 Summary of Data and Results with the Game-Play

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Total Transactions</td>
<td>442</td>
<td>408</td>
<td>397</td>
<td>493</td>
<td>161</td>
</tr>
<tr>
<td>Express Transactions - ET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40.7%</td>
<td>44.0%</td>
<td>43.8%</td>
<td>47.7%</td>
<td>47.2%</td>
</tr>
<tr>
<td>Lengthy Transactions - LT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>34.5%</td>
<td>34.6%</td>
<td>35.8%</td>
<td>35.9%</td>
<td>37.3%</td>
</tr>
<tr>
<td>Prolonged Transactions - PT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.8%</td>
<td>21.4%</td>
<td>20.4%</td>
<td>16.4%</td>
<td>15.5%</td>
</tr>
<tr>
<td>Reneges</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Customers who queue for less than 3 minutes</td>
<td>60%</td>
<td>96%</td>
<td>86%</td>
<td>87%</td>
<td>60%</td>
</tr>
<tr>
<td>Customers who queue for less than 1 minute</td>
<td>28%</td>
<td>42%</td>
<td>81%</td>
<td>46%</td>
<td>51%</td>
</tr>
<tr>
<td>Longest wait in the queue (minutes)</td>
<td>12.4</td>
<td>11 mins</td>
<td>5.2 mins</td>
<td>8.3 mins</td>
<td>5.7 mins</td>
</tr>
<tr>
<td>Daily workload (minutes)</td>
<td>1391</td>
<td>1232</td>
<td>1157</td>
<td>1298</td>
<td>455</td>
</tr>
<tr>
<td>(half-day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of tellers on counter</td>
<td>4</td>
<td>4.3(^1)</td>
<td>4.1</td>
<td>4.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Load per teller (minutes)</td>
<td>348</td>
<td>287</td>
<td>282</td>
<td>295</td>
<td>206</td>
</tr>
<tr>
<td>(Load / capacity)</td>
<td>1.0</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Time that Extra Teller 1 is on the counter (minutes)</td>
<td>0</td>
<td>72</td>
<td>21</td>
<td>62</td>
<td>44</td>
</tr>
<tr>
<td>Time that Extra Teller 2 is on the counter (minutes)</td>
<td>0</td>
<td>48</td>
<td>29</td>
<td>86</td>
<td>42</td>
</tr>
</tbody>
</table>

\(^1\) The 120 minutes that the extra tellers were on the counter equates to 0.33 of a total teller, who would be available for 6 hours each day.
References


Cranston, Maurice, (1953) Freedom, a New Analysis, Longmans, Green & Co, UK.
references


References


References


References


References


