The Pac-Man model of total quality management: Strategy lessons for change agents

Øgland, Petter
Department of Informatics, University of Oslo, Norway

Abstract

Organizational development frameworks like total quality management (TQM) can create conflicts between change agents and managers. Some researchers believe that playing video games has an impact on how people make decisions and handle conflicts. The purpose of this paper is to identify and investigate a Pac-Man model for aiding change agents in developing optimal TQM strategies. An empirical study of a five year TQM development project is analysed by using the Pac-Man video game as a theoretical lens. The results are presented as simulations of game play, suggesting four implications on how Pac-Man strategies can be used as TQM strategies. The four strategies consist of (1) never stop “eating dots” in terms of continuous quality auditing, (2) find and follow the “patterns” in the organizational maze that can be audited without upsetting management by understanding “ghost” psychology, (3) eat “power pellets”, getting management commitment when the organization is in a receptive mode, and (4) eat “bonus fruits” of management appreciation whenever it appears. In conclusion the study suggests elaboration of critical systems theory (CST) by applying ideas and concepts from game theory.

Key words: Total quality management, Pac-Man, game theory, critical systems theory

Introduction

In his analysis of management science (operational research, OR) in business use, Beer (1968, pp. 22-23) describes the conflict between managers and scientists as a conflict between “natural enemies”. Scientists want to use a scientific approach for solving business problems, but know less about business from a practical perspective. Managers, on the other hand, see a threat to dominion in the shape of the scientists. As a response to this problem, management science has expanded beyond the positivist framework of operational research and systems analysis in applying theories from psychology, sociology and philosophy for improving the ways of analyzing political conflicts (Checkland, 1981; Jackson, 2000; Mingers, 2006). In order to succeed with OR frameworks like total quality management (TQM), a technical education in OR is not sufficient, it is also necessary to develop political skills.

Game theory has since its conception been seen as an integrated part of operational research and systems theory, providing systems models for modelling conflict situations (Churchman et al, 1957; von Bertalanffy, 1968; Rapoport, 1986). While game theory has made impact on the type of systems thinking that is sometimes
referred to as problem structuring methods (PSM) (e.g. Bennett et al, 2001), other PSMs dealing specifically with politics, such as critical systems thinking (CST) (Ulrich, 1994; Flood & Jackson, 1991; Flood, 1993; Jackson, 2000), have, perhaps somewhat surprisingly, no references to game theory. Beck and Wade (2006) argue that people growing up with computers and video games have developed certain political skills and ways of seeing the world that is radically different from that of an older generation.

While game theory is only one of many theoretical perspectives used by game designers, game theory is used for analysing strategies for serious and non-serious games (Salen & Zimmerman, 2004). Abt (1969, p. 9) defines serious games as games that “have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement”. As observed by Axelrod (2002), also non-serious games, like the Monopoly board game, can be interpreted as a serious game by viewing it as a model of the real world, and then see, for instance, whether optimal strategies for winning at Monopoly carry over into the world of real estate speculations or business in general. Expanding on the research carried out by Beck and Wade (2006), the idea of using the non-serious Pac-Man video game as a serious game and a model for understanding the politics of implementing TQM is the purpose of this paper.

The hypothesis of the study is that the Pac-Man model produces optimal TQM implementation strategies (“quality plans”) in complex organizations.

In order to investigate this, the remains of the paper have been structured in five parts. First there is a literature review bringing more detail to the hypothesis in terms of explaining what is meant by complex organizations in the context of TQM, some comments on game theory and a short explanation of the Pac-Man video game and what is meant by a Pac-Man model of organizational conflict. Next there is a methodology section explaining how the Pac-Man model has been used for interpreting the dynamics and results of a five year long TQM project within a Scandinavian public sector organization. The methodology section is followed by a results section narrated in the style of game simulation. Then there is a discussion section using the simulation results for evaluating the Pac-Man model and the strategies developed through the model. The final section concludes the paper by summarizing how the Pac-Man model is an effective model for capturing certain core dynamics of the TQM game, providing simple strategies on how change agents should play to maximize payoff. Concerning the debate of how systems theory can learn from the past and prepare for the future, the position articulated through this paper is that game theory should be more explicitly used and further developed within systems research domains like PSM and CST.

**Literature review**

The literature review is written with the aim of clarifying the hypothesis in terms of first reviewing literature on the game of TQM in complex organizations, as this is the context of the moderator variable in the hypothesis. This is followed by reviewing the literature on TQM assessment methods, as the hypothesis states that the Pac-Man
model is able to produce optimal TQM strategies. The final part of the section consists of reviewing literature used for formulating the Pac-Man model.

The game of total quality management (TQM)

Use of game metaphors in TQM literature

Crosby, one of the gurus of the quality movement in the 1980s, had been active in sports and used metaphors from games and sports extensively in his writing (Crosby, 1979; 1984; 1999), "quality is ballet, not hockey" being a typical example. In his final interview before his death in 1993, Deming, the most well-known TQM guru, told the interviewer that "the legacy he wanted to leave was systems thinking and win-win" (Schultz, 1995, p. 152), a reference to the theory of positive-sum games.

While Berry (1991) uses metaphors about baseball and golf for giving inside suggestions on how to implement TQM, Cole (1999) gives and outside analysis of the quality movement in terms of how a series of different "quality fads" changed the quality game but helped the industry grasping key insights from different ideas as they were highlighted through each fad.

The political game of TQM is indirectly pointed out by Beckford (2002, p. 311) when he says "management commitment is the single most critical issue in the pursuit of quality. Without it, the program will fail – as so many do." Legge (2002) interprets statements like these to mean that the TQM practitioner is recommended to play the game of persuading management into buying some TQM framework and then continue manipulating and persuading them into staying committed to the framework. What is not touched upon in this account of the political TQM game, is what Beer (1968) describes as managers and scientists (TQM practitioners) being "natural enemies", meaning that persuasion and manipulation can sometimes be a never-ending process.

The idea of the Pac-Man model is to take all these game aspects into consideration when using the Pac-Man game as a model for learning about TQM implementation in practice ("serious game"). Within the literature on TQM, there are serious games focused on role playing, simulations and different types of serious games used as part of training (e.g. Caroselli, 1995), but no serious games for training TQM practitioners on handling the ongoing conflict with management.

Concerning the point in systems theory where this paper aims to make a contribution, the award winning book "Beyond TQM" (Flood, 1993) articulated a mixed methods approach towards designing TQM founded in critical systems theory (CST) without referring to game theory. The Pac-Man model aims at showing how this approach can be elaborated further through explicit use of game theory.

Action research and scientific management – the game of science

Some anthropologists and sociologists contributing to the theory of science and technology studies (STS) describe science more or less like a game of scholars developing strategies for convincing other scholars (e.g. Latour 1979, 1987; Sismondo, 2004), emphasizing the role of power and politics in such games.
Contrasting the descriptions of the scientific process from the outside, Sindermann (2001) uses the game metaphors for giving inside advice on how to "win the game of science", stressing the importance of understanding the rules and ethics of the game. Although he mentions game theory in the introduction of his book, the advice is given in conventional prose. Bonilla (2006), on the other hand, shows how game theory can be explicitly used for describing the social aspects of doing scientific research, both from the inside and the outside.

Action research (Reason & Bradbury, 2004; Collis & Hussey, 2002) is a methodology used in organizational science for investigating how various socio-technical parameters can have an impact on organizational performance. For epistemological reasons, knowledge is sometimes defined through the researcher’s ability to understand his research subjects in being able to identify with their beliefs. This kind of research has to be explicitly political, and can in this sense be seen not only as a scientific game of convincing others but also a political game of trying to influence decisions and actions.

When stressing the technological parameters rather than the social parameters for the purpose of researching how to improve organizational performance, the research design is sometimes called design science (Simon, 1996; Cross, 2008). In such cases, the research is often less politically explicit, but, following the reasoning of STS, it is can still be seen as a political game. Scientific management (Taylor, 1911), quality control (Shewhart, 1938), operational research (Beer, 1968), total quality management (Deming, 1986) etc., are all variations of the same theme, what Cole (1999) would call different game variations within the total game of management science.

**TQM and game theory**

Reyniers and Tapiero (1995) explain how game theory can be used for developing audit strategies for supplier-producer contracts. If the situation is quality sensitive, game theory may highlight how each party is developing strategies for maximizing profits and minimizing quality control costs.

This same approach could be used for analyzing the scenario described by Beer (1968) with scientists and managers being natural enemies. In this context, the strategies are not formulated in an audit contract but in the quality plans developed by the quality department. To elaborate on Beer’s concept of "natural enemies", the conflict can be seen to consist of managers and quality coordinators playing two different types of games. While the managers may find it useful to hide knowledge, being able to use bluff as a strategy for maintaining and building power (a game of imperfect information, like Poker), the nature of quality improvement is to make knowledge explicit and visible through use of measurements, graphs and feedback in order to stimulate process improvement (a game of perfect information, like Chess).

Being involved in two different games, the scientists and managers become "natural enemies". As it is the managers who are formally in power, the TQM game challenge for the scientist is to try to stimulate process improvement by auditing processes and present results, speculating on when to present the results, to whom, knowing when to keep silent, and when the organization may respond positively to being audited.
In addition to chase and scatter behaviour in management, due to the relationship between knowledge and power, it is important not to forget the importance of management commitment (Beckford, 2002; Legge, 2002), meaning that whenever it should happen that the scientist's "natural enemy" in management should actually be happy or thankful for work well done, something that happens rarely and lasts only for short intervals, this is a moment to celebrate.

In game theoretic terms (von Neumann & Morgenstern, 1953, pp. 48-60), the game of TQM politics can be thought of as a n+1 player game consisting of one scientist and n managers. The allowed moves of the scientist consists of auditing the organization, but having to avoid management until a series of audits relevant to some particular quality control practice that involves management happens. While management would normally be sceptical of the auditing process making knowledge and sources of power visible, at the time of formal decision making such knowledge is needed. Credit is given to the scientist when submitting quality reports for the right people at the right time. The more managers the scientist manages to commit to process improvement at such times, the better.

**Evaluating TQM strategies through payoff functions**

In wanting to investigate the effect of applying Pac-Man strategies in the real world of total quality management, it is necessary to have a somewhat precise mapping between the payoff function \( f(s) \) for playing strategy \( s \) in a game of Pac-Man and the payoff \( f'(s') \) when we interpret the Pac-Man strategy \( s \) as the TQM strategy \( s' \) and the Pac-Man payoff \( f \) as TQM payoff \( f' \).

There are many ways of measuring the TQM level of a given organization, with different assessment methods and models for different industries. In the software development industry, for instance, organizations can be measured on a level from 1 to 5 according to the CMM model (Humphrey, 1989) or on a continuous scale from 0 to 5 according to the ISO 15504 model (Zahran, 1998). The assessment model ISO 9004:2000 uses a similar five level model, making it possible to start the journey towards TQM by first developing a quality management system that complies with the requirements of ISO 9001:2008 and then improve this system step by step as it rises up the five step ladder.

For organizations participating in the international game of TQM, however, there are annual TQM competitions and TQM awards based on three regional standards. In Japan they have the Deming Award, in the United States they have the Malcolm Baldrige Award and in Europe we have the EFQM Excellence Award, based on the results of the EFQM assessment model, where an organization can score between 0 and 1000 points (0.0 to 100.0%). In this context, one aspect of the hypothesis means that a Pac-Man strategy \( s \) producing the maximum Pac-Man score of 3,333,360 points should correspond with a TQM strategy \( s' \) that produces an EFQM score of 1,000 points.

While the Pac-Man score is fairly easy to calculate, as will be explained later, the EFQM assessment model is highly complex. When applying for the EFQM Excellence Award, an application report has to be written and a team of experts are
brought in for doing the evaluations. Although it is possible to use the EFQM model for doing self-assessments, it is costly and as much of the assessments depend on subjective judgements, the score is not as precise as that of eating dots, ghosts and bonus fruits.

![Diagram showing the EFQM Excellence Model]

**Figure 1: The EFQM Excellence Model**

At the most abstract level, the EFQM Excellence Model divides organizational excellence into nine categories (figure 1); four categories for evaluating the excellence in terms of results indicating excellence and five categories implying that excellence has to be enabled in a certain way. Each of these nine boxes is evaluated by going through questions and checkpoints on a deeper level.

Due to the complexity of the model, a simplified version Common Assessment Framework (CAF) has been developed for the public sector, primarily as a motivational tool for getting started with EFQM-like self-assessments and improvements. The EFQM model can be used for the whole organization or for a single department. One way of developing excellence within the quality department might be to do annual self-assessment by use of models like the EFQM model or the CAF model.

**The Pac-Man model**

The video game Pac-Man was developed and released in Japan in 1979 and became a surprise success when released in the US in 1980, now being considered among scholars of game studies as one of the most important games in the history of video games (Loquidice & Barton, 2009).

Pac-Man can be played as a single-player game ("puzzle") against the computer, or it can be played as a two-player game as two people can compare scores in trying to solve their own Pac-Man puzzles (figure 2). In this two-player version, the game can be described in game theoretic terms as a two-player positive-sum game of perfect
information. However, when using the Pac-Man game for modelling the politics of TQM, the game theoretic interpretation of the single-player version of Pac-Man is to see it as a five-player game (Pac-Man and the four ghosts Blinky, Inky, Pinky and Clyde) of imperfect information as the novice player does not know all details of the artificial intelligence running the behaviour of the ghosts.

![Pac-Man Title Screen and Start of Game](image)

*Figure 2: Title screen (left) and start of game (right)*

As pointed out by Salen & Zimmerman (2004, p. 245), in order to apply the game theoretic approach, it is necessary that (1) time in the game takes place in turns or other discrete units, (2) players make a finite number of clear decisions that have knowable outcomes, and (3) the game is finite in terms of not being able to go on forever.

Although the Pac-Man game appears to be running in continuous time, by conceptualizing the game as if it were running at a very slow pace, it can be seen to meet the first requirement. Requirement number three represents a potential challenge in the way that Pac-Man was not intentionally designed to be a finite game. When one board has been completed, a new board is prepared at a slightly more difficult level, and so it goes on level after level. However, due to a technical malfunction in the original software, after 255 levels the board structure breaks down. It is a finite game. The second requirement, about players making a finite number of clear decisions that have knowable outcomes, is a consequence of requirements one and three having been met.

In game theory, each strategy (sum of all choices defining a game play) is associated with a payoff function. In the case of Pac-Man this translates to the total score reached at the end of the game. The score is updated as the game progresses, as Pac-Man eats dots, power pellets, ghosts and bonus fruits, some of the scoring mechanisms described on the left side of figure 2, with a more detailed score board to be presented later. A perfect Pac-Man game occurs when the player achieves the maximum possible score on the first 255 levels (by eating every possible dot, power
pellet, fruit, and ghost) without losing a single life. The maximum possible score is 3,333,360 points.

The first contributions for developing a theory of Pac-Man consisted of describing strategies for winning the game (e.g. Zavisca & Beltowski, 1982; Editors of Consumer Guide, 1982). Although more recently (e.g. Thompson et al, 2008), simulation studies by use of the theory of complex adaptive system (CAS) has been used for finding strategies for achieving perfect game, the strategies described in the books written in the early 1980s were developed by endless hours of human game play.

In order to find an optimal strategy for Pac-Man, it is necessary to understand how the ghosts operate. The behaviour of the ghosts is defined through algorithms of artificial intelligence (AI), each ghost behaving in its own characteristic manner.

<table>
<thead>
<tr>
<th>Ghost</th>
<th>Behaviour (AI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shadow</td>
<td>When the ghosts are not patrolling their home corners, Blinky will attempt to shorten the distance between Pac-Man and himself. If he has to choose between shortening the horizontal or vertical distance, he will choose to shorten whichever is greatest. For example, if Pac-Man is 4 grid spaces to the left, and 7 grid space above Blinky, Blinky will try to move up before he moves to the left.</td>
</tr>
<tr>
<td>Speedy</td>
<td>When the ghosts are not patrolling their home corners, Pinky wants to go to the place that is four grid spaces ahead of Pac-Man in the direction that Pac-Man is facing. If Pac-Man is facing up, Pinky wants to go to the location exactly four spaces above Pac-Man. He does this following the same logic that Blinky uses to find Pac-Man's exact location.</td>
</tr>
<tr>
<td>Bashful</td>
<td>Bashful has the most complicated AI of all. When the ghosts are not patrolling their home corners, Bashful considers two things: Shadow's location, and the location two grid spaces ahead of Pac-Man. Bashful draws a line from Shadow to the spot two squares in front of Pac-Man, and extends that line twice as far. Therefore, if Bashful is alongside Shadow when they are behind Pac-Man, Bashful will usually follow Shadow the whole time. But if Bashful is in front of Pac-Man when Shadow is behind him, Bashful tends to want to move away from Pac-Man (in reality, to a point very far ahead of Pac-Man).</td>
</tr>
<tr>
<td>Pokey</td>
<td>Pokey has two basic AIs, one for when he's far from Pac-Man, and one for when he is near to Pac-Man. When the ghosts are not patrolling their home corners, and Pokey is far away from Pac-Man (beyond 8 grid spaces), Pokey behaves very much like Blinky, trying to move to Pac-Man's exact location. However, when Pokey gets within 8 grid spaces of Pac-Man, he changes his behaviour and goes to his home corner in the bottom left of the maze.</td>
</tr>
</tbody>
</table>

*Table I. Verbal description of the ghosts' behavioural patterns (StrateWiki, 2009)*
As the ghosts represent managers when using the Pac-Man model for understanding the politics of TQM, it could be interesting to place each of the ghosts within a managerial grid model (Blake & Mouton, 1964) as the managerial grid model has served as inspiration for conflict management style inventories such as the Thomas-Kilmann inventory (Womack, 1988).

As Blinky is aggressively seeking Pac-Man, his behaviour could be described as high concern for people and high concern for production, the upper right ("team leader") on the grid in figure 3. Pinky has a similar concern for production, but as he aims four steps ahead of Pac-Man rather than straight at Pac-Man, one could say that he represents the "produce or perish"-type manager at the bottom right of the grid. Clyde is the least dangerous, always avoiding direct confrontation, and seems to fit in the "impoverished" category of the grid, while Inky is clearly the most social of the ghosts in having a strategy that focuses on the behaviour of the others, the "country club" manager.

![Managerial Grid Model](image)

*Figure 3: Placing the ghosts on the managerial grid model (Blake & Mouton, 1964)*

Due to the fact that the AI algorithms for the ghosts do not include elements of random behaviour, it is possible to find patterns for Pac-Man to move within each board that makes it possible to eat all the dots without being chased down by the ghosts. Although some of the best Pac-Man players in the world prefer to play the game in a more intuitive manner, manipulating the ghosts around the maze, identifying and utilizing the patterns makes it possible for less experienced players to achieve high scores. However, when eating power pellets, it is useful to have all the ghosts within short reach as long as they are in scared mode, meaning that manipulating them into a cluster at the right moments is also an important skill.
Methodology

In order to investigate the Pac-Man model in an empirical TQM setting, the idea has been to make the author reflect upon his own five year experience as a quality manager within the IT-function of a Scandinavian public sector organization, using the Pac-Man model as a device for narrating the story in a way that emphasizes some of the political aspects.

The TQM implementation was extensively documented through plans, progress reports, assessment reports and other documents (table II). When using the Pac-Man model in order to search for TQM strategies, not all aspects of the video game are equally simple to convert into an organizational setting. For instance, when playing Pac-Man the move from one level to another happens when all 244 dots have been eaten. A new board is then prepared, looking exactly like the previous, with a few game-play parameters changed in order to make the new level more challenging. Each level in the organizational setting, on the other hand, is defined by the annual budget cycles and production cycles. This means that it is not necessary to eat a given number of dots (e.g. do a given number of audits or verifications) in order to move from one level to another, as the change of level is time driven rather than event driven.

<table>
<thead>
<tr>
<th>Pac-Man phase</th>
<th>Period</th>
<th>Administrative</th>
<th>TQM documents</th>
<th>Other documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insert coin</td>
<td>November 1999</td>
<td>1st</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 1</td>
<td>2000</td>
<td>6</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Level 2</td>
<td>2001</td>
<td>15</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Level 3</td>
<td>2002</td>
<td>16</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Level 4</td>
<td>2003</td>
<td>13</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Level 5</td>
<td>2004</td>
<td>10</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Game over</td>
<td>January 2005</td>
<td>25th</td>
<td>-</td>
<td>4</td>
</tr>
</tbody>
</table>

Table II. Count of documents produced during each year of the TQM process

In order to tell the story of TQM politics in the language of the Pac-Man model, table III assigns the Pac-Man scoring mechanisms onto TQM activities. As it is already shown in table II that the particular Pac-Man simulation studied here only lasted five levels, only bonus fruits for the first five levels are included in table III.

What happens when Pac-Man eats a power pellet is that the ghosts turn from aggressive chasing into scarred scattering, and Pac-Man can chase them down and eat them, producing scores as shown in table III. In a TQM context, the translation done in this study is to define the power pellets as quality reports that are aligned with the parts of the quality management system that is already institutionalized, using the
reports as input for decision processes where managers are already committed to making signatures and thus using the report as a “management review” (ISO 9001, chapter 5.6; Hoyle, 2006) for trapping them into taking responsibility for defects and make sure process improvement is commenced or sustained.

Although document verification is a simpler task that a quality audit (which may typically include document verifications), for the purpose of keeping as close as possible to the rules of Pac-Man, both these activities give the same amount of points.

In Pac-Man, the bonus fruits (cherry, strawberry, lemon and apple) appear randomly and quite seldom. A TQM change agent getting positive feedback for work well-done is perhaps even more rare and random, especially as the game levels rise, and conflict levels rise accordingly, but it is an important event that should be given proper score.

<table>
<thead>
<tr>
<th>Pac-Man food</th>
<th>Level</th>
<th>Points</th>
<th>TQM activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dot</td>
<td>All</td>
<td>10</td>
<td>Document verification</td>
</tr>
<tr>
<td>Dot</td>
<td>All</td>
<td>10</td>
<td>Quality audit</td>
</tr>
<tr>
<td>Dot</td>
<td>All</td>
<td>10</td>
<td>Quality report not part of a management decision process</td>
</tr>
<tr>
<td>Power pellet</td>
<td>All</td>
<td>50</td>
<td>Quality report as part of management decision process</td>
</tr>
<tr>
<td>1st Ghost</td>
<td>All</td>
<td>200</td>
<td>Impact on manager</td>
</tr>
<tr>
<td>2nd Ghost</td>
<td>All</td>
<td>400</td>
<td>Also impact on a second manager</td>
</tr>
<tr>
<td>3rd Ghost</td>
<td>All</td>
<td>800</td>
<td>Also impact on a third manager</td>
</tr>
<tr>
<td>4th Ghost</td>
<td>All</td>
<td>1600</td>
<td>Impact on four managers or more</td>
</tr>
<tr>
<td>Cherry</td>
<td>1</td>
<td>100</td>
<td>Positive feedback</td>
</tr>
<tr>
<td>Strawberry</td>
<td>2</td>
<td>300</td>
<td>Positive feedback</td>
</tr>
<tr>
<td>Lemon</td>
<td>3+4</td>
<td>500</td>
<td>Positive feedback</td>
</tr>
<tr>
<td>Apple</td>
<td>5</td>
<td>700</td>
<td>Positive feedback</td>
</tr>
</tbody>
</table>

*Table III. Assigning the Pac-Man score board onto TQM practice*

**Case study presented as a simulation experiment**

**Insert coin**

Describing the quality management experience in the IT-function of a Scandinavian public sector organization as a Pac-Man simulation, the starting point was as the author entered the organization in November 1999. The first months consisted of being handed over a large document (“game manual”) explaining the strategies, policies and standards of quality management of the organization. These documents were written as a part of the strategies, policies and standards for information security
(i.e. the opposite of conventional ISO 9001 practice where security management, environment management etc are defined as special cases of quality management).

Furthermore, the author was also given instructions in game play, primarily focusing on the principle of formal authority overruling competence authority, and then having this illustrated by the head of information security stating he had no competence in TQM but nevertheless wanted it implemented in a such-and-such way. This resulted in quality being managed consistently with how information security was managed, although conflicting with basic ideas and principles of TQM such as continuous improvements, customer satisfaction, process approach etc.

To the author, these first few months provided good learning experiences in terms of understanding the organizational culture and the explicit conflict between a managerial approach (doing things in order to maintain and increase power) and a scientific approach (doing things in order to learn and improve).

**First two levels of game play**

In February 2000, after the head of the Information Security Department left the organization, the author was appointed director of quality management, and the real game was ready to commence. Consistent with the logic of Pac-Man, the author started running through the maze, eating dots in terms of doing document verifications and quality audits, working as closely as possible with the IT professionals in order to avoid stepping into the political schemes of the managers. However, as verifications consist of measuring products and processes against the standards set by the organization, it quickly became visible that there was close to no focus on compliance with standards, and as the managers were being reminded of this the chase was on.

Several strategies were used for traversing this first level of the game, few of them resulting in documents that generated scores according to table III. The most important idea was to start some kind of repeatable activity that would result in demonstrating the principle of continuous improvement, producing a success project that could be used as an example for starting more and more ambitious improvement projects. As a cause of a near accident, due to lack of standardization in the COBOL software development process having created some management attention, a measurement system for monitoring compliance between existing software and organizational standards was designed and implemented. However, as the final report (“management review”) was presented early next year, this process did not contribute to the first level score, but generated 10 Pac-Man points at the beginning of level two. Unfortunately, no ghosts were caught as the COBOL process was not integrated with any of the institutionalized routines that required management signatures.

The second result in 2001, according to the counting in table III, was an initial attempt at describing parts of the existing quality management system within the framework of ISO 9000, as ISO 9000 was mentioned in both the information security policies and the IT strategy document. This was an attempt to go for the strawberry bonus fruit, hoping to get positive management feedback and commitment to a TQM
strategy that would allow for a more systematic approach. As no such response was achieved, this resulted in zero score.

A better result was achieved when publishing articles about TQM and progress on the TQM project in the internal journal. By writing the articles in a way that made the IT function seem professional, focused on standards and continuous improvement, the initiative was acknowledged by the head of the IT function as a positive signal, regardless of the less convincing results produced by actual verifications and audits. The author was given positive feedback on all four journal publications (table II), corresponding to eating four bonus strawberries, increasing the score with 1200 points.

**Level three**

With a total score of 1,210 at the beginning of level three, it seemed like a good idea to continue writing articles. Of the four articles written in 2002, the first three resulted in positive feedback, producing 1,500 points of eating lemons, but in the case of the forth article, the author was told that some manager had taken offence, and the strategy of writing articles was effectively terminated for good.

On the other hand, writing journal articles was time-consuming, and even though they were aligned with IT management politics and could perhaps have some minor cultural impact, a better way to impact real organizational improvement would probably be do to the usual things that TQM professionals do, such as introduce ISO 9000, EFQM assessments, statistical quality control, audits, measurement feedback, improvement projects etc.

During the course of 2002, nine quality reports were written. Three of these were aligned with institutionalized practice, thus making them into power pellets and producing a score of 150 points. The first of the “management reviews” involved only one manager (200 points), but with the two others involved two managers each (400 points x 2 = 800 points). Among the other reports, there was one TQM evaluation of the IT function, using the CAF public sector quality assessment model. This report did not create any signatures (10 points), but the author was asked to give a TQM presentation at a management meeting which resulted in positive feedback (bonus fruit = lemon, 500 points).

Another report showed results from TQM assessments using the CMM model and the ISO 15504 model, resulting in 30 points of dot-eating. Each of the assessment were carried out by external experts, resulting in management presentations, but not resulting in positive feedback that could be used for using either of the models for general TQM implementation frameworks. A new COBOL evaluation report produced 10 points.

As a part of the TQM process, the author had been collaborating with the Internal Audit, and the Internal Audit was interested in trying out the CobiT audit model for auditing the IT function. The author was invited by the Internal Audit to participate in the national CobiT forum, for discussing best practices in applying CobiT audits. As a first approach for trying out the model, the author wrote a quality report focused on the M4 audit process, evaluating the process of doing quality audits and internal
audits. This, however, resulted in turning a friendship into conflict as the manager of the audit team got upset by being audited and started chasing the scientist in the style of the “Clyde” ghost (i.e. keeping distance). As the report included a total of five audits, the total dot-score for the report was 60 points.

Another report was politically motivated by an IT manager who wanted to exercise power over a unit outside the IT domain, and the author was asked to write a quality report. As the author was not invited to explain the report, it is unclear whether it was used as part of a decision process (although a decision was made), but at least the report included four audits, producing a score of 50 points.

As a part of the success so far, the author was granted an extra life in terms of having an industrial engineering student working for him during summer. The student helped out in conducting quality audits, and quality report evaluating project management according to the CobiT standard was produced, including results from seven audits (8 x 10 points = 80 points). A “Pinky”-type manager (aggressive and manipulative) tried to convince the “Blinky” top-manager (aggressive and confrontational) to prevent more interference from students doing quality audits.

As seen in table II, a part of the strategy for preventing management into interfering with TQM was to produce annual plans, monthly status report and annual self-evaluations. Although this was a Herculean task, it seemed to work in terms of preventing the managers in interfering. In the case of the 2002 evaluation report, the Balanced Score Card (BSC) assessment method was used, something that triggered positive feedback, as there had been some discussion on the top management level concerning BSC, and the report fitted with the political argument the IT department was trying to make (lemon = 500 points).

**Level four**

Having now been playing Pac-Man for some levels, a certain feeling for what were the best patterns for running through the maze, eating dots and ghosts started to emerge. Although not scoring many political points, focusing on the real problems of the organization and trying to contribute input at the time when the organization was ready to discuss (eating power pellets when the ghosts were close and close together) was a sustainable way of getting points. This approach resulted in another two lives in terms of having two students helping out with audits during summer and also being allowed to hire two quality coordinators to help out on a permanent basis.

Among the ten quality reports produced in 2003, six of them were “management reviews” (power pellets, 50 points each) that each resulted in four management signatures or more (3,000 points x 4 = 12,000 points), and where each report included an average six document verifications or quality audits (10 points x 6 x 4 = 240 points).

In an attempt to make the TQM implementation strategy more risk driven, a series of CobiT-PO9 quality audits were carried out. This process did not align with any institutionalized quality control practice, and no management signatures, but it resulted in 7 x 10 = 70 points of dot eating. As the department was later visited by the National Audit, wanting to do a total evaluation of the organization according to the
CobiT audit standard, the PO9, PO10 and M4 reports were used as input for producing our own CobiT self-assessment report just ahead of the National Audit report. This resulted in another 30 points of dot eating.

The most important event this year, however, was that one of the quality coordinators, that we managed to get on a permanent basis, happened to have a “Inky” personality, meaning mediocre technical TQM skills but highly developed social skills. This resulted in creative tension within the quality department proving highly efficient in terms of stimulation for self-improvement. A self-evaluation report was written, 4 x 10 = 40 points.

**Level five**

What started out as creative tension on level four quickly evolved into aggression on level five. The quality coordinator “Inky” managed to manipulate and coordinate the managers “Blinky”, “Pinky” and “Clyde”. The author was chased down, in October 2004 there were obvious indications of “game over”, and in January 2005 the author was formally removed from the position.

Despite quality coordinators following their own private agendas rather than working together as a unit, the measurable results of 2005 turned out to be better than ever. A total of seven power pellets were eaten, each time managing to capture more than four ghosts, resulted in a score of 7 x 3,050 = 21,350 points.

A COBOL evaluation resulted in 10 points. A revision of the total CobiT self-assessment resulted in 10 points. A long series of document verifications as input for a CobiT-AI4 audit resulted in 120 points.

Despite political turbulence within the quality department, a new EFQM self-assessment produced another 20 points. The year also consisted of establishing international network of quality management, the author being elected member on a national board of quality management, and more useful collaboration with the National Audit.

**Game over**

Due to the impetus created during the previous years, the first four weeks of 2005 resulted in eating two power pellets and a maximum number of ghosts, 2 x 3,050 = 6,100. A new COBOL report was written (10 points), and a CobiT-M2 audit was also completed (10 points).

**Final reflections**

The evolution of the Pac-Man score is plotted on the left side diagram in figure 4, the diagram on the right side presenting the results of the quality department doing EFQM Excellence self-assessments. Theoretically both the Pac-Man score and the EFQM assessments should be monotonously increasing curves. In practice, however, the EFQM score is seen to be increasing from 2001 to 2002, and then decreasing from 2001 to 2003 due to calibrations and difficulties in finding out how to measure in an exact way, until a baseline is found in 2003 and there is a slight increase in 2004.
Figure 4: Pac-Man payoff from Pac-Man strategy (left) and EFQM payoff for same strategy (right)

The payoff from strategy used for five years of organizational play resulted in a score of 38,770 points. Although this only amounts to 1.2% of the score from performing perfect play, it is significantly better than the high score of 2,230 points achieved by a comparable Pac-Man simulation carried out in the streets of New York (Pac-Manhattan, 2004).

Discussion

Applying Pac-Man philosophy in the real world

Table IV summarizes three strategic insights that seem specific for Pac-Man, and that also seemed to work well as TQM strategies when working in a politically turbulent environment.

In order to answer whether optimal Pac-Man strategies also work as optimal TQM strategies, the literature review suggested that the performance of the quality department could be monitored by use of the EFQM Excellence model. When doing this in the empirical case, the points in the literature review about the model being complex and difficult to use is illustrated in figure 4, showing several years of adjustments before the TQM baseline is established and measurements of continuous improvements can commence.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Pac-Man</th>
<th>TQM politics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle 1</td>
<td>Keep eating, and reflect in action (or between games). For each board level, there are behavioural survival patterns (Zavisca &amp; Beltowski, 1982).</td>
<td>Keep auditing, measuring, analyzing and making improvements. Data collection, analysis, action and progress must never stop.</td>
</tr>
<tr>
<td>Principle 2</td>
<td>Understand ghost psychology, both on individual level and how they act as a swarm (Kelly, 1994; Holland, 1995).</td>
<td>Expect conflict, study management psychology and avoid irritating people unnecessarily.</td>
</tr>
<tr>
<td>Principle 3</td>
<td>Get energized and attack when the ghosts are clustered, before they manage to scatter in all directions.</td>
<td>Design “management review” (Hoyle, 2006) to fit with institutionalized quality control practice (annual budget process, annual production cycles etc.), get as much management commitment as possible.</td>
</tr>
</tbody>
</table>

**Table IV. Transfer of insights that are specific to Pac-Man**

Although this calibration phenomenon makes it difficult to perform statistical comparisons between the Pac-Man payoff function and the TQM payoff function, if the game had not been terminated at level five, there is reason to believe that both payoff functions would continue to rise as the baseline for the EFQM measurements was identified in 2003.

A major difference between the two payoff functions, however, is that the Pac-Man model insists on a conflict of interest between the scientists and managers while the module that is given the highest weight in the EFQM model is the module marked “customer satisfaction” (figure 4), in this case meaning management satisfaction. As illustrated at the beginning of the game, doing what is needed in order to improve processes (“eating dots”) and doing what results in management satisfaction (“bonus fruits”) may not necessarily be the same thing. In fact, trying to keep management satisfied without doing what is substantially needed for improving the organization can lead to the organization getting imprisoned into a mental state of “fake quality” (Øgland, 2009a).

Although not a problem with Pac-Man per se, a significant amount of TQM work needs to be done (244 dots eaten) before exiting one level and stepping up to the next, but the way the model was implemented in this empirical case, going through a level by just eating bonus fruits could be a highly successful approach for producing game score, while being a totally unsatisfactory approach from a TQM perspective.

Nevertheless, although it is difficult to say whether the resulting TQM strategies are optimal or not, the results of viewing the TQM politics from the Pac-Man perspective produces TQM strategies that fit with an energetic, fact oriented and generally sceptical and disillusioned approach that reflect values inherent in scientific work.

**Evaluation of the Pac-Man model**

While conventional TQM advice would be to get management commitment and measure, analyze and improve the organization on behalf of management, the Pac-Man model suggests a completely different reality based on the assumption assume that there is a constant conflict between the “natural enemies” of managers and
scientists (Beer, 1968). In the case study, several conflict situations were presented, providing context for illustrating various reasons why conflict between scientists and managers may sometimes be the default scenario.

In figure 3, there was an attempt to create a mapping between the behaviour of the four Pac-Man ghosts and the five management styles defined by the managerial grid (Blake & Mouton, 1964). The case study illustrated challenges due to the scientist being chased by a swarm of managers. Although conventional wisdom might suggest handling one manager at a time, by looking at the conflict from the perspective of a Pac-Man game, the managers are applying a “swarm logic” (Kelly, 1994) in attacking the scientist, a tactic that is based on the managers partly acting in an individual manner and partly coordinating their behaviour with other managers.

Like Pac-Man gamers say they develop gaming skills through long periods of intense trial and error, the CAS-method of genetic algorithms (GA) has been used for developing strategies for winning the game of Pac-Man (Thompson et al, 2008). This approach can be carried over to quality management, using CAS-inspired rules and principles for handling the turbulent situation (Øgland, 2008) or, more ambitiously, designing quality control and continuous improvement as GA (Øgland, 2009b).

<table>
<thead>
<tr>
<th>Game theory concepts</th>
<th>Pac-Man</th>
<th>Science</th>
<th>TQM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Players</td>
<td>Pac-Man, Blinky, Inky, Pinky, Clyde</td>
<td>Scientists</td>
<td>Change agent, managers, workers</td>
</tr>
<tr>
<td>Rules</td>
<td>Maze, scoring mechanism, framework defined by the computer</td>
<td>Methods and behaviour accepted by the community of practice</td>
<td>TQM standards and methods, rules and behaviour accepted by the organization.</td>
</tr>
<tr>
<td>Strategies</td>
<td>Food, flight, fight.</td>
<td>Argumentation through theory and experimentation</td>
<td>Improve organizational performance by measurements, analysis and redesign.</td>
</tr>
<tr>
<td>Payoff</td>
<td>Score at end of game</td>
<td>Established facts, strengthening theories, impact factors on publications</td>
<td>Significant findings, successful improvements, results from TQM assessments</td>
</tr>
</tbody>
</table>

*Table V. Comparison of Pac-Man, science and TQM by use of game theory concepts*

When using Pac-Man as a model for understanding the conflict between scientists and managers when implementing TQM, one way of making sense out of the game is to
think of it in terms of food, fight and flight within an organizational labyrinth. The scientist Pac-Man eating dots can be seen as researching the organization, making trivial findings and continuously upsetting the four managers living within the main office at the centre of the labyrinth. Each according to his own psychology tries to track down the scientist in order to have him eliminated, while the scientist must learn the skills of manoeuvring efficiently around the organization while reading, interpreting and discovering patterns of psychological behaviour among the managers in order to avoid them.

If the scientist makes a substantial scientific finding (eats a power pellet), then the managers become scared and scatter. During this short period of confusion, the scientist can attack the managers and scores points for each manager he gets. This only works for a period of time, however, because soon the organizational climate returns to normal and the managers start preying on the scientist again.

If the scientist manages to audit the whole organization, he is promoted to the next management level where he meets the same managers behaving slightly more aggressively and intelligently, as they have learned from previous encounter with the scientist and are now even more concerned with not having management issues cluttered with objective facts and scientific rationality.

Comparing the serious game of Pac-Man with Axelrod’s (2002) comment about Monopoly modelling business as a zero-sum game, winning the game of Monopoly being equivalent to making all others loose, in Pac-Man there is no way for the scientist to win. Payoff (score) is being measured by how long the scientist is able to survive in the organization. With each set of managers he gets to outsmart or track down, they will always re-emerge on a new and fiercer game level.

While the case study supports the Pac-Man model for understanding action research-driven TQM (table V), the least successful aspect of the model is probably the score board. It would be nice to maintain the score board exactly as it was in the video game version of Pac-Man, but the way some types of rather costly work is identified as a single dot, only producing 10 points, while a relatively more simple tasks may result in thousands of points, makes a challenge. If one should not tamper with the score board, then there is at least need for rethinking the relationship between TQM activities and Pac-Man scores (table III).

Conclusion

The Pac-Man model is a simplistic model. As a model for quality management and organizational change, the only quality improvement and changes in behaviour that are created by the Pac-Man game is the behaviour of the Pac-Man player. It is played like a game of survival, not a game about creating change. Nevertheless, by defining the maze in a way that paves way for performance improvement, the survival game may be sufficient for generating the behaviour that is needed for the quality manager (change agent) to operate effectively. This is the message of the case study.

The world of Pac-Man is non-stop action of instinct behaviour driven by impulses of food, fight and flight. Although the TQM strategies implied by the Pac-Man model
are contrary to common wisdom about management commitment, quality awareness, quality culture, motivated workers etc., often such key premises are not present in organizations, and the quality manager has to choose whether to give up the TQM project or to try it anyway. The Pac-Man model suggests strategies for succeeding in conflictual, complex and unpredictable environments, implying strategies that comply with what Dooley et al. (1985) have described as a complex adaptive systems approach to TQM.

Looking at what may be interpreted as a systems debate within the field of problem structuring methods (PSM) on which systems frameworks to include and how to mix them (e.g. Flood & Jackson, 1991; Rosenhead & Mingers, 2001), this paper can be seen as an argument, along with Bennett et al. (2001), that game theory can and should be more explicitly used in PSM, for instance as a part of TQM-oriented critical systems thinking (CST) (Flood, 1993; Jackson, 2000).

References


