# 18

# Systems Engineering: Intelligent Systems

*Tax not the royal Saint with vain expense,*
*With ill-matched aims the Architect who planned —*
*Albeit labouring for a scanty band*
*Of white robed Scholars only — this immense*
*And glorious work of fine intelligence*!
*Give all thou canst; high Heaven rejects the lore*
*Of nicely-calculated less or more.*

(*Of King's College Chapel, Cambridge*)
William Wordsworth – 1770–1850

## Introduction

There is considerable business management interest in businesses and enterprise as entities with the potential to learn and to behave intelligently. Concepts such as the Learning Organization (Senge, 1990) and the Intelligent Enterprise (Quinn, 1992) have entered the business management psyche. The ideas, broadly, were that the people working within an enterprise could learn together, develop intellectual capital, could manage their knowledge in such a way as to enhance their achievement of objectives.

Peter Senge wrote about the Fifth Discipline, which he identified as Systems Thinking (see page 17), where the system was the enterprise, and the thinkers were the employees who came together to understand and address problems, and develop ways of overcoming them. Warfield's interpretive structural modeling (ISM) (on page 191) and interactive management (IM) (Warfield, 1973, 1989) were significant methods for exploring issues and developing understanding, cooperation and consensus. Major international organizations rose to the challenge and converted themselves into learning organizations, often with surprisingly swift and effective results. In some instances, group learning became the norm; in others, the experiment made a significant difference in the short term,

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but there was subsequent reversion to previous practices. Some managers and accountants saw little merit in employees 'spending time learning about the business, which was really none of their concern,' when they could be 'getting on with their proper work.' Essentially, too, accountants saw little return in the short term — their principal interest — from group learning and group problem solving.

Although Peter Senge in particular popularized the notion of corporate systems thinking, it was not new. The systems houses of the 1950s, 1960s and 1970s had been centers of systems thinking (see Preface). In at least one well known systems house of the period, the systems engineering paradigm (see Systems Methodology: conceptual model on page 172) was used extensively to address virtually any problem that arose. An *ad hoc* group would form: members would outline a problem, identify the criteria for a good solution, and generate a range of possible solutions. The group would then trade off the potential solutions against the criteria, arriving at a 'best fit' solution. The result was a solution to which all who had participated were committed: it not only worked, it worked well.

The result of this extensive use of a systems thinking/problem solving approach was a vibrant, creative organization populated with intelligent, articulate, highly motivated people: yet, the systems houses were largely driven out of business by the large aerospace and defense companies. Systems thinking, it seems, was not at a premium

## What is an Intelligent System?

Rather than situate the idea of learning and intelligence in enterprise and business, it is useful initially to abstract the concept, and to consider any open system existing, flourishing and trying to survive in its dynamically changing environment, where it interacts with and adapts to, other systems.

Employing the classic systems approach, then, the image is of an entity (open system) that experiences inflow and outflow of energy, materials and information, yet maintains dynamic stability, seeking to survive and flourish in a complex of other, open, interacting, adapting entities, all similarly engaged in trying to survive and flourish. The entity does work and expends energy in processing the flowthrough: the entity may also extract material and energy from the flow through. The entity, although interacting with, and adapting to, other entities, maintains a level of dynamic stability (homeostasis), such that inflow rates and outflow rates are balanced and, if disturbed, a new point of balance may be reached (in accordance with Le Chatelier's Principle). The entity constantly maintains its internal processing facilities. The entity, as an open system, stabilizes dynamically at a high energy level, reinforcing the appropriateness of the organic, as opposed to the mechanistic metaphor — where stability would be consistent with a low energy state — (see The Concept of the Open System on page 11: this book addresses open systems; although some manmade systems may be more open than others, all are essentially open. If a system were truly closed, we would be unable to detect it and would be unaware of its existence.)

Examples of open systems that fit this description abound, of course. A cell in the human body is an archetypal open system. So, too, are individuals, families, communities, societies, gangs, teams, businesses, enterprises, platoons, sociotechnical systems, civilizations, economies, governments, organizations/organisms, etc., etc.

So, are some open systems intelligent, and how would we know? In posing the question, we are asking a wider question than that posed and answered by the pundits mentioned in the opening paragraph: they presumed that any prospective intelligence was to be found in the people of the organization; our question allows that intelligence could be emergent, i.e., a property of the whole not exclusively attributable to any of its logically separable parts.

# Defining Intelligence

## Kinds of intelligence

If we consider the open system as (being like) an organism, we may reconsider the question: are any organisms intelligent, and how would we know?

It is not easy to define intelligence. Some like to define it as an ability to learn facts and skills, and to apply them. For others, intelligence is the capacities to reason, plan, solve problems, think abstractly, comprehend ideas and language, and learn. Yet again, the terms ‘smart,’ and ‘quick-witted’ often indicate situational and behavioral intelligence.

There seem to be two contradictory threads:

1. Intelligence is seen as ‘deep think;’ reasoning, learning, planning, problem solving, abstract thinking, etc.
2. Intelligence is the ability to ‘think on one’s feet,’ to be aware of what is going on around you, and to respond in a decisive, effective manner.

Intelligence seems to be related to the ability to unravel problems and make decisions. Jacques Cousteau, the French naturalist, filmed an octopus in a water-filled glass tank on a table, on the deck of his yacht, the Calypso. The octopus climbed out of the tank, slithered to the corner of the table, felt with its tentacles for a table leg that it could not see, slid down the table leg, dragged itself across the deck and dropped to the safety of the sea below. In so doing, it put itself at great risk: it has no skeleton to sustain its weight when out of water, nor could it breathe; yet it was prepared to go to great risks to escape.

Was this intelligent behavior? Most people might think so: the animal faced a problem, saw an opportunity, formulated an escape strategy and a plan, executed the plan at great risk to life, and succeeded. So, the octopus was brave, as well as smart and decisive. This might be classified as situational and behavioral intelligence. Of course, as it dropped over the side of the yacht, the octopus may have fallen into the open jaws of some waiting shark — we will never know: what price intelligence then?

## Intelligence and survival

Are intelligent organisms better suited to survive than nonintelligent ones? There does not seem to be much evidence for such a hypothesis. Starfish (echinoderms) may not be classified as intelligent — they have no central brain — yet they has survived in harsh environments for hundreds of millions of years: longer than the dinosaurs, apparently. But, is survival in this context related to intelligence? The starfish survives, not as an individual, but as a species by reproducing (sexually and asexually) many offspring — a strategy that recognizes that most offspring will fall victim to predation. (Recently, time-lapse photography has revealed echinoderms as having unexpectedly complex interaction behavior: such behavior occurs so slowly in relation to that of other creatures that we humans have been unaware of it, making the phylum’s survival all the more remarkable.

Is this very slow behavior something to do, perhaps, with the echinoderms' apparent absence of lifecycle: starfish apparently do not age? We have much to learn, it seems, about organisms — natural as well as man-made.)

Some organizations operate in a not-dissimilar manner, comprising a variety of relatively small, viable companies each of which is aimed directly at different market targets within the same market segment (e.g. consumer electronics, defense avionics). Market dynamics favor growth in some areas, shrinkage in others, and the constant introduction of innovative products. As the market shifts, some companies expand; some shrink, some fold and new ones start up. The organization as a whole, however, is dynamically stable, maintaining broadly the same number of companies, while there is a continual turnover of those companies, with the resources of those that fold being transferred to start-up replacements.

Is this intelligent behavior: not at individual company level, it seems, but at organizational level? Certainly, the organization as a whole is open and continually adapting to its environment and certainly, the strategy promotes survival and longevity of the organization, if not of its parts. Perhaps this is intelligence in the sense of the whole being smart in situational and behavioral terms.

Consider too the Japanese technique of Heijunka, flow smoothing — see The Open System Viewpoint on page 149, part of Case A: Japanese Lean Volume Supply Systems. It can be shown that WIP can be minimized if the flow of a product through a lean volume supply system is steady, as opposed to rising and falling, or batching.

Heijunka operates by sensing the sales rate for the product and either increasing marketing and introducing 'special offers' if the rate starts to fall, or conversely reducing marketing if the sales rate starts to rise. When the rate looks set to fall irretrievably, Heijunka triggers a switchover from the current product, soon to be obsolescent, to a new product in such a way that the flow through rate is maintained.

To an observer, this might appear as intelligent organic behavior: the organism/organization is continually manipulating the market to smooth out demand peaks and troughs, which in turn minimizes WIP, which in turn keeps unit production costs down so that products remain affordable while profits rise. This might be seen as intelligence more in the mould of reasoning, learning, planning and problem solving. And Heijunka is a philosophy, leading to a strategy, leading to an execution of a plan by the organism, as much as by any individuals. So, is Heijunka 'institutional intelligence?'

Once the system for Heijunka is in place, the individual actors have no particular need to show intelligence — the 'smarts' are in the way the system is conceived, set up and organized. . . . So, is this intelligence promoting survival? Or is this simply a human-powered, rate-feedback servomechanism? In either event, Heijunka adapts the environment to the open system, rather than the other way around — and that is neat.

## Predicting the future

There is an interesting dilemma here: the variability of the environment, both business and natural world, militates against the idea of making 'intelligent decisions' about the future. For an organism to make intelligent decisions concerning future actions presupposes that it has some knowledge of how things are going to turn out in the future: in that way, the organism can pursue advantageous situations as they develop and opportunities as they arise, while at the same time it can avoid, absorb, or protect itself against risks, threats and attacks. But, can it know the future?

Our environment, and the various interacting systems within it, seem to vary chaotically — not in a deterministically chaotic sense, but more in the way of *Weak chaos*: see page 27 *et seq*. Weakly chaotic behavior, unlike random or chaotic behavior, is consequential, in the sense that conditions in following time periods are dependent on conditions in previous time periods. The weather is weakly chaotic: tomorrow's weather stands a (slightly) better than even chance of being the same as today's, which would not be true of weather were random. However, the weather ten days from now is not knowable, at least not in any detail. Ask any meteorologist.

This means that for most things there is a Horizon of Knowability — a period in our immediate future during which we have a reasonable prospect of knowing what is going to happen. Beyond that time-horizon, things become increasing unknown and unknowable.

Humans, and possibly other organisms too, seem to ignore this fact. Humans predict the weather, the outcome of some future situation, the way the stock market is going to move, the fashions for next summer, etc. The predictions are invariably, wrong. We ignore the fact that they are wrong and we make more predictions — and they are wrong too. Humans are hooked on making predictions and basing long-term decisions on them. And humans are in full denial, clinging firmly to the belief that they can, after all, predict the future. It seems that we humans are driven by our intelligence to believe that we can predict the future, and no amount of contrary evidence will convince us otherwise.

(A classic example of this curious propensity is our formulation of project and program plans, stretching five, ten or even twenty years into the future. Such plans are often out of date before the ink dries, yet we continue to make them, consider them sagely, and base major investment decisions upon them. We even go so far a to create project plans, using Program Evaluation and Review Technique (PERT), that are designed to change from week to week, from month to month. So, we know in our hearts that we lack the ability to predict what is going to happen in the weeks and months ahead, yet we still insist on making predictions about outturn, outcome, end costs, timescales, performance, cost effectiveness, etc., etc., years ahead of the events.)

So, does that mean that intelligence is of little value to an organism? Not really, but it does limit the prospects for intelligent decision-making to result in favorable outcomes.

## About Making Decisions

Part of intelligent behavior seems to be about acting decisively. Which involves making decisions. One way to understand decision-making is to study it in the military context, where two opponents face each other. Each wishes to impose his or her will on the other. Each has only imperfect, incomplete knowledge (Intel) about the other. Moreover, when either party acts, the results of that action are uncertain since the opposing party may parry, defend, evade, or be acting simultaneously, so changing the assumptions on which plans were made, as well as the outcome.

Interactions between protagonists are therefore generally nonlinear, and the results of actions taken by either party are seldom going to turn out as planned. In other words, cause and effect do not correspond as in a simple linear model. Commanders may adopt 'empathic reasoning': 'if I do this, then he is likely to respond by doing that: but if I do something else, instead, he will be obliged to respond in a different way.' Sometimes, as in a game of chess, protagonists may think several moves ahead. Empathic reasoning only works, of course, if commanders have some understanding of situation and opponent: and then, there is always the 'double bluff. . . .'

Opposing commanders have to make decisions. Circumstances dictate that sometimes those decisions must be virtually instantaneous: at other times, there may be an opportunity to strategize, plan and coordinate action. So, the military become interested in 'what is a good decision.'

Figure 18.1 is an intent structure showing aspects of a good decision in an adversarial military

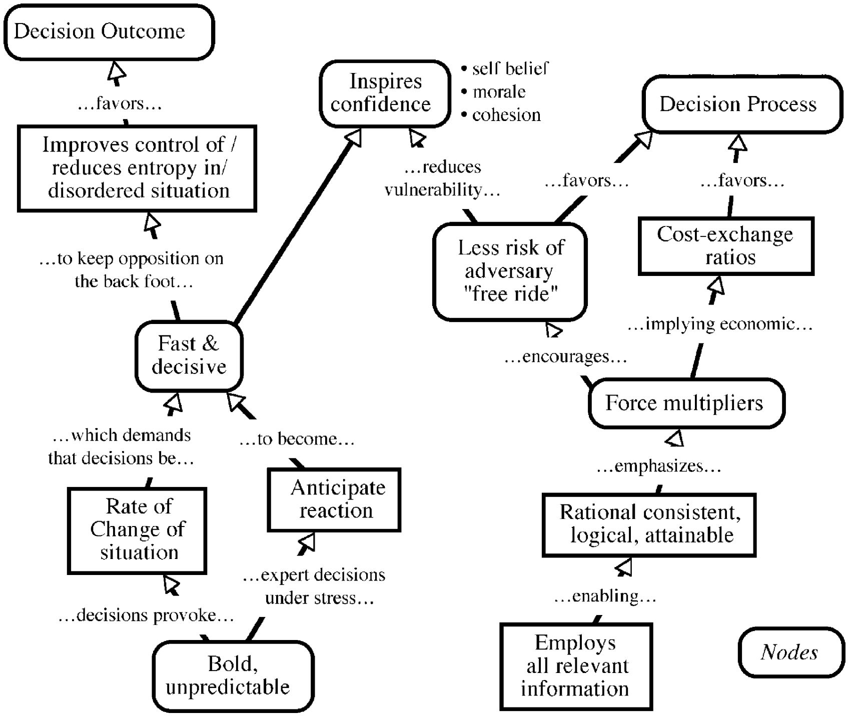


**Figure 18.1** Decision-making in command and control. What makes a good decision? At left, factors favor decision outcome. At right, factors favor decision process. Both strands inspire confidence. Force multiplier is a concept, similar to 'leverage,' in which some forces may be seen as having more effect than might be expected, often due to agility and the ability to adopt more than one role. A 'free ride' may occur when all aspects of an adversary's offensive capabilities are not parried.

situation. As with intelligence above, there seem to be two contradictory threads: one thread favors the comprehensive, systematic decision-making process as defining a good decision — this is the process view. The second thread is concerned with outcome — never mind how the decision was reached, did it result in the right outcome? This is the outcome view. Both kinds of decision inspire confidence in others, although probably under different circumstances. The process view is acceptable when time is not pressing, and where the decision maker may be inexperienced. The outcome view is acceptable when under pressure, but generally requires an experienced leader to take the initiative.

Conflict within a military command and control HQ may arise when the commander's staff systematically develop a strategy and a plan and present it to the commander, who then uses his experience and 'instinct' to do something quite different. Similarly, conflict can arise in a boardroom when the chairman overrides the well planned, well structured, carefully thought out proposals of board members . . . .

Are military decision models relevant to enterprises? Military formations (platoons, brigades, etc.) are enterprises, of course, but are often considered, as in this instance, to be in direct confrontation with an adversary. In the west, we tend not to think of enterprises as being at war. Some

Japanese commercial enterprises, on the other hand, follow bushido ('the way of the warrior') and the teachings of Sun Tzu (Wee Chow Hou, 1991): for them, business is warfare; and, they seem to be doing quite well . . . .

## What Characterizes a Learning Organization/Intelligent Enterprise ...?

We may deduce that an organism/organization may be deemed intelligent:

- by virtue of its behavior in context, and that. . .
- . . . said behavior may be an emergent property of the whole, or . . .
- . . . it may be vested in the ability of parts within the organization to make 'good decisions,' and for . . .
- . . . other parts to act cooperatively and cohesively upon those decisions,
- so making the whole decisive,
- such that intelligence may again be perceived as an emergent property of the whole.

All of which amounts to intelligence being perceived as a property of the whole: one that may emerge, like any other emergent property, from coherent, cooperative, coordinated and complementary behavior of the parts.

What does this suggest about enterprises, learning, intelligence, adaptation and evolution?

- An enterprise may be deemed intelligent in context by virtue of its organization and configuration, if it adapts (evolves?) to changes and perturbations in its environment such that it can both survive and flourish: this without any apparent discrete focus of 'intelligence' within the enterprise
- Individuals, teams and groups comprising an enterprise can learn, be aware, of changes and perturbations in their environment such that they can anticipate and respond to change quickly and coherently as a social group or groups. Such group learning enables swift adaptation to change and opportunity, which will favor survival and sustained flow through.' Such an enterprise would appear intelligent by virtue of its ability to adapt swiftly to changing circumstances
- An enterprise may set out to be intelligent, may seek to understand its context, to anticipate change and perturbation, and to act decisively to take advantage of opportunities/avoid threats. Such an enterprise would be deemed intelligent if it made good decisions, ones in which the outcome favored the enterprise both surviving and flourishing. In a turbulent environment, 'good decisions' would be bold and innovative, to accommodate foreshortened timescales, rather than process driven.

It is reasonable to conclude that the learning organization gains survival advantage not from what it learns, *per se*, but from the shared group motivation, social cohesion and coordinated behavior that such learning encourages. People in a learning organization become aware of their respective positions, roles and tasks, but also of the 'bigger picture:' of their situation and objectives as a group, rather than as individuals; and, of how they may cooperate to achieve those objectives. Through the continual exercise of learning in groups, teams, etc., the various parts/groups, etc., become more closely coupled, more responsive, and better able to react together as a unified whole. A key property of the learning organization, then, is that it is reactive.

The intelligent enterprise seeks survival advantage through anticipating changes in situation, environment, etc., and through perception of opportunities and avoidance of risks. As such, it attempts to 'look ahead' to determine the best course of action to take. Making such intelligent choices depends on the ability to perceive the future, which is not practicable beyond a time horizon, the distance ahead being a function of situational and environmental turbulence: the intelligent enterprise will gather Intel to help it identify threats, and opportunities, and to anticipate trends. A key property of the intelligent enterprise, then, is that it is proactive.

## Situation Facing Intelligent Enterprises

A commercial enterprise may be visualized as a node within a complex network of interconnected nodes — see Figure 18.2, which shows a notional Intelligent Enterprise (IE) existing, like any other, in a complex multidimensional network of systems, exchanges, markets, etc. In a free market economy, the network is continually shifting, with enterprises coming and going: linkages, shown as arrows in the figure, may be transitory, and may flip from one enterprise to another. Enterprises will have many inflow sources, and many outflow sinks: none need be permanent. The figure, then, represents a snapshot: another snapshot, taken earlier or later, may look quite different. Despite this, the whole may be dynamically stable. . .

In this turbulent environment, the goal of the enterprise in the first instance is to survive — not, as some would have it, to make a profit. It will prove necessary to make a profit in order to survive, but profitability is a means to survival, not the goal. As with any organism in a hostile, competitive environment, the enterprise needs sustenance. It extracts sustenance from 'flowthrough:' that proportion of the flow of energy, materials and information through the network that can be 'persuaded' to flow through the enterprise. Flowthrough can be processed to create products and services for sale to downstream enterprises and markets: flow-through depends, of course, on downstream wants, needs and ability to pay. Similarly, flow-through depends upon sufficient and appropriate inflow: an enterprise's sources are as important as its markets. (There is an obvious analogy here with anabolism, catabolism and metabolism.)

Figure 18.3 shows a 'homeostatic' view of an (intelligent) enterprise, with resource levels of manpower, machinery, materials, money and information/intelligence ($M^4I$) being kept in dynamic balance so that together they may support flow-through. Changes in flowthrough rate may be 'followed' by changes in any or all of $M^4I$. Ideally, as the figure suggests, a steady flowthrough enables $M^4I$ stability, which potentially enhances economy, efficiency and effectiveness. Where flowthrough either dips or rises, there may be a concomitant need for an IE to adjust $M^4I$ inflow/outflow rates to achieve a new point of dynamic balance. Some IEs achieve this adjustment by outsourcing, subcontracting, etc.

Flowthrough can be encouraged by stimulating downstream demand, through publicity, advertising, marketing and selling practices. Creating innovative products and services, ones that do not exist in the marketplace at present, and which afford benefits to the owner, also stimulate demand.

One way to go about innovating is to undertake market analyses, often examining trends, to suggest what kind of product would sell well. An alternative approach, favored by some Japanese entrepreneurs, is to make a variety of innovative products 'on spec,' not knowing whether they will sell well or not, and finding out by putting them on the market. Those that do not sell are discontinued, while those that do sell spark off new products ranges.

So, is it intelligent to analyze the market and to predict what will sell? Or, is it intelligent to 'throw' a variety of innovative products at the market and 'see which ones stick?' This 'suck it and

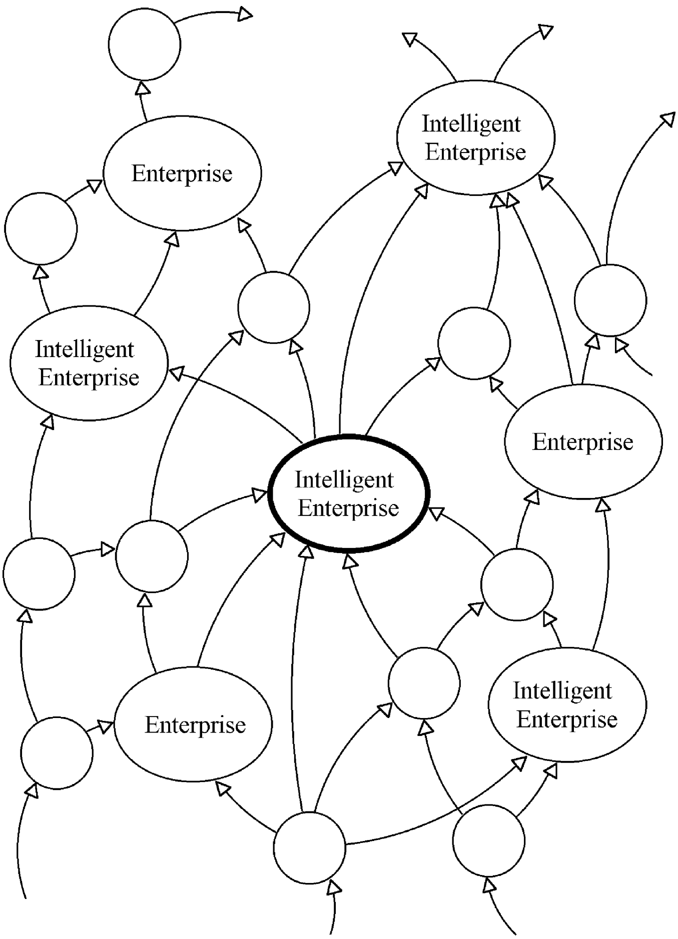


**Figure 18.2** The Intelligent Enterprise (IE) as a business in a dynamic, turbulent context. The IE will be one of many enterprises, operating in an extensive, multi-dimensional market economy. Its primary goal is to survive. Prospects for survival are enhanced by establishing, sustaining and enhancing 'flowthrough:' the proportion of material, energy and information flowing through the net that passes through the IE. The IE flourishes if it able to process flowthrough to produce goods and services that downstream enterprises need, want and are willing and able to pay for. Intelligence can be seen as manipulating the network in such a way as to sustain and enhance flowthrough as opportunities and threats appear and develop in the network, and as variations occur in the total flowthrough.

see' approach has revealed holes in the ability to analyze the market and to predict what innovative products will be needed and will sell. 'Suck it and see' has come up with many products that have appealed to the public, but which sober analysis would have rejected out of hand as unworthy of investment. On the other hand, not to analyze the market would seem foolish. . . so, perhaps taking both approaches in parallel might be the intelligent thing to do!

## Making intelligent choices — intelligent enterprise model

It may be possible to create a model of an intelligent enterprise — see Figure 18.4. The model is based on the layered Generic Reference Model (see The Generic Reference Model (GRM) Concept on page 125), but with specific features highlighted:

- Mission Management shows Intel being fed from sensors to enable Situation Assessment. Good Intel may allow anticipation of threats and exploitation of opportunities.
- Mission Management shows two different kinds of decision making: naïve decision-making (methodical/systematic) and Recognition-primed Decision-making (RPD); see Instantiated layered GRM on page 138.
- Mission Management is moderated throughout by Behavior, which is founded on Cognition such that situations are interpreted on the basis of Belief: perceptions of threats, opportunities and decisions are colored by Belief.

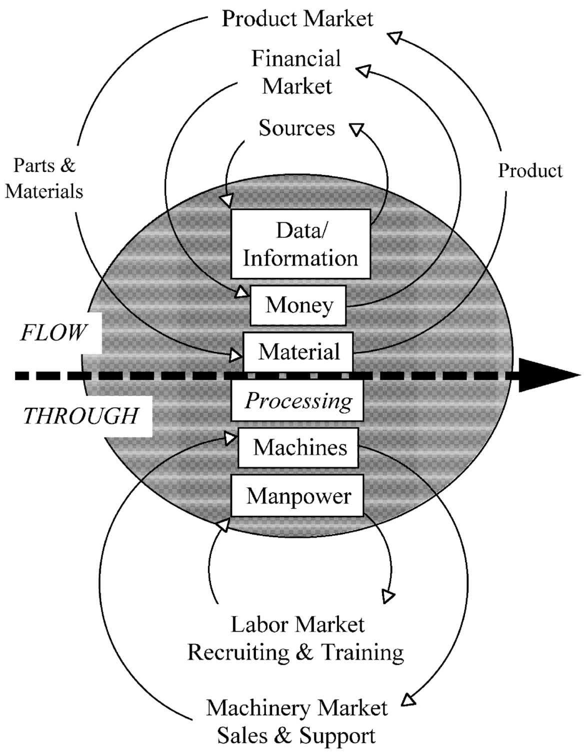


**Figure 18.3** Despite existing in a dynamic environment, the intelligent enterprise will seek to maintain homeostasis — local dynamic stability. The figure shows 'homeostatic loops' for $M^4I$: Men, Machines, Material, Money and Information/Intelligence. So, although there will be a variable turnover of manpower, for instance, recruiting and training rates are adjusted to keep the manpower level and skills as needed to support flow-through.

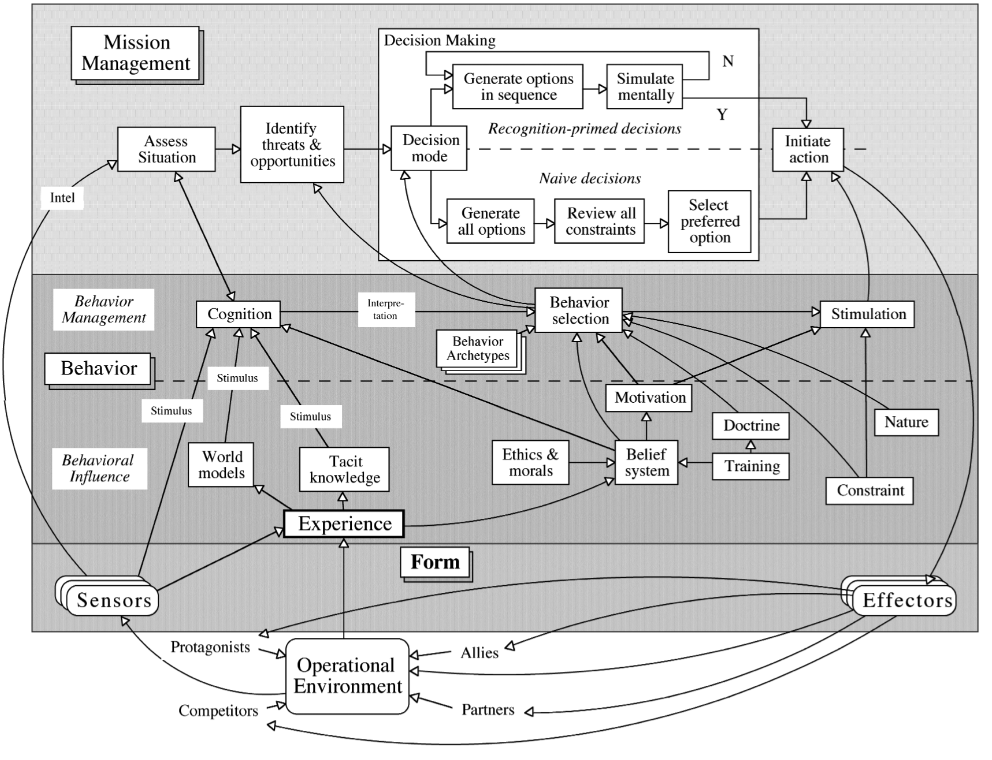


**Figure 18.4** Intelligent enterprise: layered generic reference model (LGRM). Mission Management shows alternative models of decision-making: Naïve and Recognition Primed, for methodical and expert decisions respectively. Note how Experience of what has happened in the operational environment can modify World Models, Tacit Knowledge and, importantly, Belief System, which can in turn moderate Cognition, Behavior Selection, Motivation, and Stimulation. This is situational learning — learning what works and what does not — leading to Behavior modification. Operational Environment in this context will depend upon the kind of enterprise. For a commercial business, it would encompass the market, conferences, trade associations, etc., where intelligence might be picked up. For a gang, it might be the street, or a gang hideout.

- The whole appears to represent a control loop, with Mission Management decisions being made about what actions to take, the actions occurring, and sensors feeding the results of the actions back to Mission Management. However, competitors, protagonists and even allies and partners may confound this simple control notion by taking contrary actions such that cause does not result in the expected effect.

## Innovative decision-making model

A typical decision-making process, outlined in the Intelligent Enterprise LGRM, is shown in more detail in Figure 18.5. A situation, indicated at the top of the diagram, generates complex input stimuli to those seeking to understand the situation and make decisions relating to it.

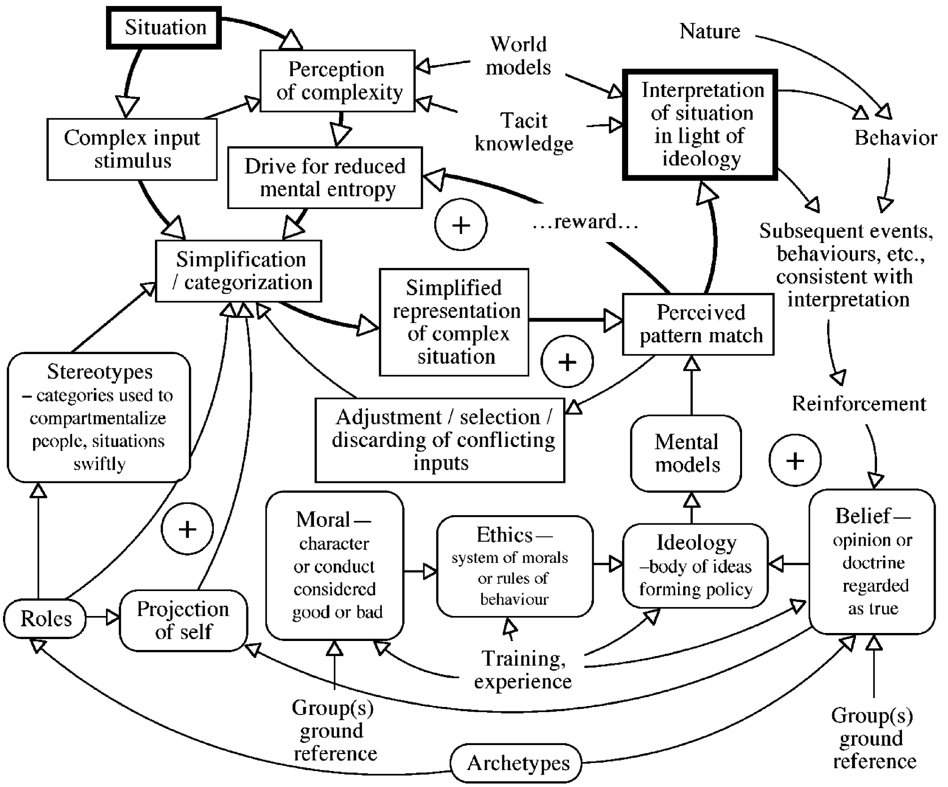


**Figure 18.5** Making innovative decisions — process model for continual situation assessment and decision-making. N.B. Behavior occurs as a result of making decisions.

People categorize entities and features perceived in a situation as a means of reducing and managing the otherwise overwhelming degree of disorder/perceived complexity: this allows them to develop a simplified representation of the complex situation, one that is simple enough to accommodate mentally. In driving towards this simplified representation, they may adjust, select, or discard conflicting pieces of information. They employ stereotypes of people, places and 'things,' perhaps subconsciously, to categorize and to reduce mental entropy. This may be unavoidable: humans may have developed this capability as a means of survival, where it was vital to identify friend from foe, safety from danger, etc., and where instantaneous reaction meant the difference between life or death.

Successive representations of the situation are compared with stored mental models to find a fit that is deemed 'close enough,' i.e., one that reduces mental entropy — giving that familiar sense of the 'penny dropping.' As the process model shows, stored mental models are largely founded in belief systems, which have been developed over time through training, experience, and through individual psyches.

A perceived pattern match will provide an interpretation of the situation based on belief, ideology, training, etc. Using this interpretation of the real world situation, people will make decisions and take actions (Behavior in the figure) that, if they turn out as expected, will reinforce their belief system which underlay the decision. If not, then, they will either put it down to 'bad luck,' or they might, just might, question the basis for their judgment. Rational decision-making may not be quite as rational as we might like to think. . . and one person's rationale may be quite different to another's.

If this model of decision-making is accepted, then where does that leave innovative decision-making? Interestingly, it suggests that innovation is less likely to emerge from a group of people who share the same culture, beliefs and training, project similar mental models, and possess similar world models and tacit knowledge — all of which are functions of nurture. Variety may be the basis for innovative decisions; variety in terms of culture, education, training, experience, character, personality, etc., brought together in an unconstrained, accommodating and supportive environment.

## Learning and Intelligent Behavior

The foregoing sections have suggested that intelligent enterprises (IEs) and learning organizations may not be the same thing. A graphic comparison between the two concepts is drawn in Figure 18.6. The two concepts are represented left and right respectively. Their common goal, survival, is shown in the center in the context of a dynamic environment.

At left, the proactive IE is seen as gathering intelligence about markets, suppliers, competitors, allies, with a view to anticipating some impending change, opportunity or threat. Perceiving some future change stimulates the IE to adapt in some way so as to be able to take advantage of the opportunity as soon as it arises, or even, perhaps, to assist in its arising. . . . The IE is hampered by system inertia, the resistance to change that systems/organizations all exhibit to a greater or lesser degree. So, the IE invests in changing the enterprise, allowing for the time it may take to effect the necessary change. In the ideal world, the IE has, then, adapted to the impending change just as it arises, enabling the IE to capitalize on the new opportunity for flow-through.

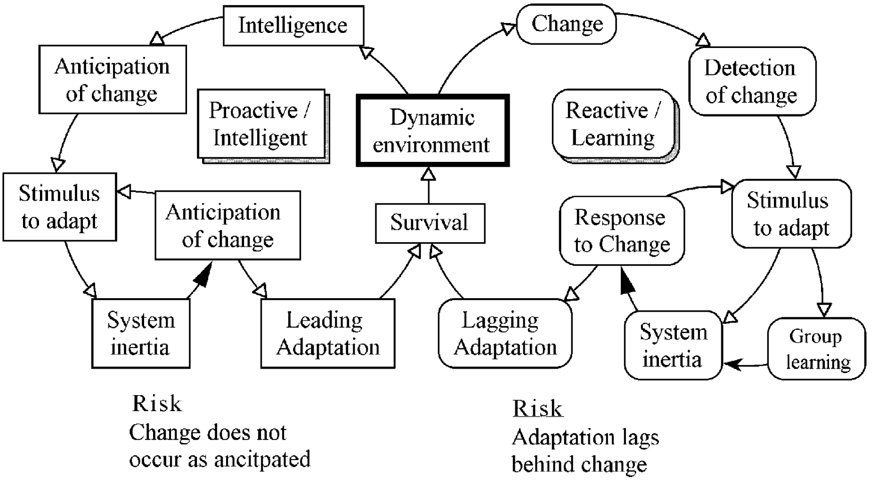


**Figure 18.6** Proactive intelligent behavior vs reactive learning behavior.

As the figure suggests, there is some degree of exposure in this. The greater the period of anticipation, the greater the exposure: the greater the corporate inertia, the longer to achieve the necessary change, and, again, the greater the exposure. However, the potential rewards of being first are enticing: first in the market often dominates that market.

At right, the learning organization is reactive: observing and detecting changes stimulates it to adapt. The learning organization has inertia, too, but the process of learning may reduce this such that all the players are 'singing from the same hymn sheet,' all are motivated, all pursue the same — or at least consistent — goals. Inevitably, the learning organization's adaptation to change will lag behind that change, but the learning process will minimize that lag, and hence reduce the risk that adaptation comes too late to save the organization. Essentially, the learning organization invests up front in its people to reduce inertia and resistance to change; instead, they may learn to embrace change.

Should the concepts combine: should an IE also be a learning organization? If the analysis above is valid, then the issue is one of speed of adaptation to change, with corporate inertia being the crucial factor. There may be several ways to address corporate inertia other than group learning. Group inertia rises with the size of the group. (Informal experiments suggest that the time taken to reach a consensus rises broadly as the square of the number of participants — based on using Warfield's interactive management and ISM to develop consensus within different sized groups of military officers, across a range of subjects.)

This suggests that one strategy might be to organize in many small groups, rather than few large groups, although that then raises the issue of coordinating the many small groups. Another strategy employs competition between teams, coupled with immediate reward for success. Competition motivates and creates its own dynamic.

A third, intelligence-led strategy is to establish a separate small team to find and address prospective opportunities. If the search team becomes the nucleus of a group dedicated to seizing the new opportunity, then inertia is principally associated with recruiting additional team members. This inertia may be limited, since each new member is imprinted, as he or she joins, with the culture already existing in the team. This third strategy is similar to earlier examples of institutional intelligence, rather than of intelligent individuals, per se.

# Keeping the Enterprise Intelligent

There is a tendency for any enterprise to mature and become set in its ways — see the Social Genotype on page 50. In many ways this is a good thing, indicating as it does that social bonds have been formed, that routines have developed, processes established, etc. It also suggests that groups have formed (nascent organizations often lack any formal group structure), and that group barriers are likely to be rising.

Group barriers, which impede group-to-group interaction and cooperation, are a potential source of social inertia within an enterprise. However, groups will form naturally, if not by design, probably because we humans are anthropologically more comfortable working in family-size groups; we will form such groups willy-nilly, at parties, dances, meetings, etc. Teams of people greater than about seven and less than about fourteen in number will divide into two groups, perhaps three. Psychologists suggest that there are different conceptual group sizes: 'natural' group size populations might be of some 50 people, and there is another natural group size of about 300 people, or so. These may have to do with instincts related to nuclear family, extended family and tribal populations. . . .

Be that as it may, groups proffer psychological comfort of belonging, and they develop their own in-group cultures — all of which can lead to social cohesion and social inertia — two sides, perhaps, of the same coin. The way in which an intelligent enterprise is organized into groups is of importance in this context, since social cohesion is desirable for cooperative and coordinated behavior, while social inertia resists change.

## Continual redesign – reprise

One approach to keeping the enterprise intelligent is continual redesign — see page 436. Sensibly, for the IE, this would be supported by a dynamic simulation of the environment, of interacting systems, of markets, etc., essentially of Figures 18.2 and 18.3. The usual approach (see The GRM and the Systems Approach on page 135) would be augmented by the inclusion of markets, sources, sinks and many competitors, to create the necessary complex dynamic simulation – see Evolving Adaptive Systems on page 25; see also Create an intelligent, auto-adaptive, evolving solution system? on page 179.

The simulation would be of the behavior of each of the many interacting entities: developing such a simulation is not as daunting as it might appear, since the behavior of an enterprise is less diverse, more predictable and much slower than, say, of individuals comprising that enterprise. For many enterprises competing and cooperating in a complex market simulation, it would be necessary only to represent their emergent behavior. . . for the IE, however, more detail would be appropriate, as indicated in Figure 18.4. Additionally, the IE simulacrum would show interacting functional groups and would represent their dynamics, synergies, homeostatic influences, etc.

Such a simulation would enable the IE to experiment with different organizational configurations, pose situations and different strategies to exploit them, all without risk. Of course, the simulation could not predict the future either, but it would be possible to posit a variety of futures, and hence to make a well-educated guess (SWAG) at the best course of action. (In marketing jargon, SWAG means a scientific wild-ass guess — a deliberate oxymoron to indicate limited credibility: cf., WAG, which has no credibility.)

# Summary

The concept and identification of intelligent behavior is considered, in both the natural and manmade systems worlds. The relationship, if any, between intelligence and survival is also considered, where survival is seen as the ultimate goal of both organism and organization. No firm connection is identified: there are examples of intelligence aiding survival, but then again there are examples of intelligence defeating itself.

For IEs, intelligence is seen as either an emergent property of the whole, or as a property of people who form (part of) the enterprise, and who condition its behavior — making intelligence again an emergent property. It may be that some organizations and enterprises may behave intelligently by virtue of their adaptable configurations.

An attempt is made to define intelligence, but it seems to mean different things to different people. Similarly, making 'good decisions' means different things to different people For some, a good decision is one with a favorable outcome: for others, a good decision is one that was reached carefully and comprehensively, taking all relevant factors into account. One characteristic of a good decision is that it inspires confidence in others.

Decision-making is explored, both naïve and recognition-primed decision-making: they are seen as alternatives rather than complementary, with RPD being employed by experts of long-standing, such that they believe their decisions to be 'instinctive.'

A distinction is drawn between learning organizations and intelligent enterprises. The learning organization is seen as reacting to changes in its environment, with the speed of response being enhanced by group and corporate learning. In contrast, intelligent enterprises may be proactive, seeking to look ahead for opportunities and threats, and to anticipate them by preparing and configuring itself in advance. If the intelligence is accurate, the intelligent enterprise is potentially able to avoid delay and exploit the opportunity/avoid the threat directly. By anticipating events, situations or changes, the IE may increase its exposure. Taking the risk may reap the benefit; on the other hand, it may not.

Ways in which an IE might be designed and structured are considered, together with how such organizations can be kept intelligent, in view of the general tendencies of many enterprises to mature to the point of petrifaction. Since intelligent behavior consists, not only of making good decisions, but also of acting swiftly upon those decisions, if follows that system inertia should be minimized. The learning organization achieves this through group learning, developing shared motivation and consistent goals. Another factor seems to be group size within the enterprise, where smaller groups can be more cohesive and can reach consensus views and act more quickly. On the other hand, reorganization of an existing enterprise into small groups implies more groups, all of which may then need to be coordinated. It is likely that there is an optimum group size, between the large and few, and the small and many. . . that favors best motivation, cooperation, coordination and synergy.

# Assignment

You are the project systems architect for a human-like robot that is being developed for prospective use as a Peace Officer — a policeman whose role is the maintenance of peace, as opposed to crime fighting — see Case E: The Police Command and Control System on page 405, for background. You are required to endow the robot with 'intelligence,' although the 'specification of concept' is far from clear about what robot intelligence is supposed to mean.

1. Consider and outline the emergent properties, capabilities and behaviors of the proposed police robot that you would consider identified it as behaving intelligently. You should consider not only one robot Peace Officer operating, but also squads of Police Officers, some robot, some human, some mixed robot and human.

Police operating together as a team in potentially hostile conditions would constitute an intelligent enterprise. Confrontational policing has developed a standard tactic in recent years of 'tit-for-tat.' In other words, responses in crowd situations are always proportionate, never 'over the top (OTT), and hopefully never 'undercooked,' either: OTT draws others into the conflict in support of the underdog; undercooked risks the police being outnumbered and overpowered.

2. How, if at all, would you consider that the police might employ the intelligent police robot, supposing it to have been successfully developed, tested and employed as a Peace Officer, in a

tit-for-tat, many-on-many conflict situation. . . (e.g. a riot at a football game, or similar). You should consider the psychological impact of the robot on the crowd, as well as on associated human policemen.

3. Can you envisage a situation where such an intelligent, robotic Peace Officer might be equipped with: (a) nonlethal weapons to temporarily incapacitate miscreants; or (b) lethal weapons for robot self-defense; or (c) lethal weapons for the defense of human police, other robotic police, or innocent people caught up in a situation? Discuss the pros and cons in each case. Justify your viewpoints.