### Knowledge Research Institute, Inc. Case Stories and Vignettes from Many Sources

<table>
<thead>
<tr>
<th>Type of Situation</th>
<th>Example Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Competitive Enterprise Example</td>
<td>Jones Development &amp; Engineering, Inc</td>
<td>3</td>
</tr>
<tr>
<td>The Proactive and Decisive Company Example</td>
<td>Steel minimill (Chaparral)</td>
<td>4</td>
</tr>
<tr>
<td>The Personal Reasoning Example</td>
<td>Unnamed industrial heat exchanger.</td>
<td>6</td>
</tr>
<tr>
<td>The Personal Memory Example</td>
<td>ChemCo</td>
<td>6</td>
</tr>
<tr>
<td>A class in paper making for operator trainees</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Personal Situation Handling: A Customer Service Example</td>
<td>Unnamed Susan Stark, a CS manager</td>
<td>7</td>
</tr>
<tr>
<td>The Enterprise Situation-Handling Example</td>
<td>Asterix Consolidated’s large trucks</td>
<td>9</td>
</tr>
<tr>
<td>New Successful Services Strategy Made Possible by Costly Education</td>
<td>Financo (Schwab)</td>
<td>11</td>
</tr>
<tr>
<td>R&amp;D and Marketing Leadership Find New Markets for New Products</td>
<td>Argis</td>
<td>13</td>
</tr>
<tr>
<td>Production Line Investigation Finds Reasons for Cost and Delivery Problems</td>
<td>Morrison Co</td>
<td>14</td>
</tr>
<tr>
<td>Chief Engineer and Company Management Do Not Acknowledge Emerging Staffing Problems</td>
<td>AeroCo</td>
<td>15</td>
</tr>
<tr>
<td>How Shall We Utilize Our Retained Earnings for Best Long-Term Success?</td>
<td>Parity Corp</td>
<td>16</td>
</tr>
<tr>
<td>Business Expansion Requires Hiring of Competent Staff</td>
<td>Holly Corp</td>
<td>18</td>
</tr>
<tr>
<td>Repairing Relations with Unhappy Clients</td>
<td>Parity Customer Solutions</td>
<td>19</td>
</tr>
<tr>
<td>Restructure Sales and Operations to Increase Profits by Action Space Expansion</td>
<td>LearnSys Inc</td>
<td>20</td>
</tr>
<tr>
<td>New In-House Technology Make Possible Significant Cost Reductions</td>
<td>Potter Industries</td>
<td>22</td>
</tr>
<tr>
<td>The Strategy Is Not Being Implemented by Rank-and-File!</td>
<td>Stubb Corp</td>
<td>24</td>
</tr>
<tr>
<td>Implement Strategic Partnerships to Make the Enterprise Stronger</td>
<td>Stihlo Corporation</td>
<td>25</td>
</tr>
<tr>
<td>The Project Is Late and Will Cost More Than Projected - Working Hard Instead of Working Smart Does Not Always Work</td>
<td>Prego Systems</td>
<td>26</td>
</tr>
<tr>
<td>Company Works to Meet Societal Responsibilities</td>
<td>Atlee Chemical Corporation</td>
<td>27</td>
</tr>
<tr>
<td>Our People Do Not Make Balanced Decisions! They Focus on One Factor Only</td>
<td>Bromley Corp</td>
<td>29</td>
</tr>
<tr>
<td>Execute Effective Damage Control after Product Failure in the Marketplace</td>
<td>Fancy Foods</td>
<td>31</td>
</tr>
<tr>
<td>The Vigilant Knowledge Company</td>
<td>Palmera Corporation</td>
<td>32</td>
</tr>
<tr>
<td>The Global Leader Example</td>
<td>Solitus, Inc.</td>
<td>33</td>
</tr>
<tr>
<td>Find and Manage the Most Important Knowledge Areas</td>
<td>high-tech engineering and manufacturing</td>
<td>37</td>
</tr>
<tr>
<td>Conduct Strategic Knowledge Audit to Change Corporate Direction</td>
<td>large process company</td>
<td>38</td>
</tr>
<tr>
<td>Build Knowledge-Based System to Exploit the Value of Proprietary Knowledge</td>
<td>medium-sized financial institution</td>
<td>39</td>
</tr>
<tr>
<td>A new line of merchandise</td>
<td>Value-Buy</td>
<td>39</td>
</tr>
<tr>
<td>Illustration of How Knowledge May Be Held. (Table 2-4)</td>
<td>A metals company</td>
<td>40</td>
</tr>
<tr>
<td>Illustration of How Knowledge Can Be Pooled. (Table 2-5)</td>
<td>a large bank</td>
<td>40</td>
</tr>
<tr>
<td>Illustration of Applying Knowledge. (Table 2-6)</td>
<td>expert mechanic</td>
<td>40</td>
</tr>
<tr>
<td>Example of an Aggressive Learning Organization</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>Deductive Reasoning</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>Inductive Reasoning;</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Abductive Reasoning Creative People Use It to Get Better Insights Fast!</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Analogical Reasoning</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Associative Reasoning</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Reasoning with Patterns -- Pattern Recognition</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Metaphoric Reasoning</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Spatial Reasoning</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Reasoning With Uncertainty</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Case-Based Reasoning</td>
<td>- AltCo’s senior Application Engineer</td>
<td>49</td>
</tr>
<tr>
<td>Model-Based Reasoning</td>
<td>- Henry Paulsen, ConLoCorp’s</td>
<td>51</td>
</tr>
<tr>
<td>Qualitative, Fuzzy or Approximate Reasoning</td>
<td>- Peter Harrow, product manager PRATCO</td>
<td>52</td>
</tr>
<tr>
<td>How Do We Cope with Complex Reasoning Situations?</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>Dominant-Hypothesis Reasoning</td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>Most-Important Factor Reasoning</td>
<td>Faxco</td>
<td>56</td>
</tr>
<tr>
<td>Complex Reasoning Approaches</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Temporal Or Dynamic Reasoning</td>
<td>- Mary Paw, product manager for ASCO’s</td>
<td>56</td>
</tr>
<tr>
<td>Reasoning with Causal Event Chains</td>
<td>Men’s Department</td>
<td>58</td>
</tr>
</tbody>
</table>
Nonmonotonic Reasoning - Mary McAllister at Enigma Insurance 59
Reasoning by Default - Joe Palmer at Point of Sales 59
Planning - "Blackboards" - Dick Morse 60
Reasoning with Multiple Hypotheses - Frank Hauser, Oxxo’s 62
We Create "Proxy Beliefs" With Our Mental Models - George Sweany 62
Goal-Directed Reasoning, Proxy Beliefs, and Developing Judgments - Mary Merriweather 64
Leisurely or Unfocused Exploration -- “Give Some Thought to It” - Tom Hagan 65
Crisis Problem-Solving -- “Avert Disaster!” - Kristi Long short-term cash for Sigma. 65
Systematic Problem-Solving -- “Find Quality Approaches to Special Challenges” - Delta Inc 65
Decision-Making -- “Generate, Select, and Implement an Approach to Handle the Challenge!” - Zumak Corporation 67
Evolutionary Incremental Problem-Solving “Let Me Tackle That Problem When I Get to It!” - Susan Hammer 67
Exploratory Problem-Solving -- “Find out What Goes on and See If Anything Can -- or Should -- Be Done About It!” - Bundin Inc. 67
Innovating or Creative Exploration -- “Make What You Are Doing Better!” - June Hanson 68
Script for Personal On-the-Job Problem-Solving - Karen Jones 69
Reframe -- Change the Paradigm - Hydro Corp’s strategy director 69
Automatic or Intuitive Decision-Making -- Decisions by Rote - Zumak Corporation, Broad Street Bank 71
Snap, or “Seat-of-the-Pants” Decision-Making - DCO’s cement plant 71
Fixed-Idea Decision-Making - PaxCo’s president 72
Arbitrary-Alternatives Decision-Making - Tangent Corp 72
Dominant-Factor Decision-Making - Appie Corp Maggie Hogan product manager 73
Dominant-Hypothesis Decision-Making - ApCo’s regional sales managers 74
Incremental “Muddling-Through” Decision-Making - Info Systems Division at Bolac Industries 75
Mixed-Scanning Decision-Making - Hollis Crocker VP Dapper Engineering 76
Satisficing Decision-Making - Hattie Post, Hull Corp’s plant engineer 78
Vigilant Decisions - Core Corporation’s management committee 80
It Takes Conviction to Make Decisions! - Chet Hawkins, PotCo’s customer service 81
Collaboration by Equals - Star’s oil refinery 83
What Is the Meaning behind the Information? - Alice Carpenter CS director at Apex Corp 83
Budget Cutting May Lead to Detrimental Knowledge Gaps - Silicone Valley semiconductor company 84
Do Not Transfer Work to the Field without the Accompanying Knowledge! - large chemical firm 85
Automating without Adding Knowledge Can Be Costly - large producer of consumer goods 85
Dangers of Technology Transfer without Underlying Knowledge - large technology company 86
KM Approaches from Nine Different Perspectives

1. Knowledge Transfer Mode
2. Knowledge Asset Building
3. Knowledge Asset Management
4. Intelligent-Acting Operation
5. Reengineering
6. Learning Organization
7. Total Quality
8. Core Competence
9. Knowledge Culture

Knowledge Management Focus Is Driven by Needs
A service company
A high-technology company
A heavy equipment manufacturer
A financial company
The Learning Organization - A service company
Transfer Knowledge from Expert Areas to Points-of-Action -- A Challenging Scenario - Alta Co
Organizations Forget – and Miss Learning Opportunities - A medium-sized engineering company
New product strategy and introduction – Argyll
Forrex Uses KM in Customer Service – Forrex
The Competitive Enterprise Example

For 25 years Jones Development & Engineering, Inc. has provided advanced technology services to industrial customers in many industries. Jones assists customers in creating prototypes of complex high performance products that utilize advanced technologies and materials. Jones’ staff collaborates with customers to conceptualize, design and engineer products that must perform well in very demanding applications. They also work with customers’ customers to understand their problems to properly address the issues that they have. Most often, Jones starts work with customers in the initial conceptual stages of new product development followed by pilot production and product introduction. Later, Jones’ staff assists by handing over production to customers’ operations, often working for months in customer facilities to achieve full technology and expertise transfer.

During its existence, Jones has grown steadily to become the international leader in its niche and works hard to maintain its leadership position. The company is very profitable with a large and faithful customer base. In many ways, Jones operates like many of its competitors, yet pursues practices that are proactive and deliberate and therefore quite effective and sets them apart. Some examples of these practices include:

- **Provide superior customer value** – Jones’ management emphasizes the need to provide the best matches to the individual customers’ needs and requirements thereby providing the highest possible value to customers.
- **Understand customers** – Jones’ employees accept that it is absolutely necessary to understand their customers’ business purpose, direction, objectives, their marketplace and Jones’ products and services contribute to the customers’ value creation and how to help customers succeed.
- **Understand technology opportunities** – Jones’ employees work to understand how and why customers, and the customers’ customers, benefit and are affected by different technology solutions.
- **Collaborate with customers to maximize value of assistance** – Jones’ teams collaborate with customers to conceptualize and engineer new products. The teams consist of a mix of researchers, design engineers and crafts people to allow immediate incorporation of insights into advanced solutions and practical assessments of how solutions can be built in the factory.
- **Develop relationships** – Jones’ management emphasizes the need for employees to network and develop good relationships with customers, suppliers and coworkers. They rely on these relationships to understand what is needed and what they can provide. Internal relationships are crucial for frictionless and effective operations and to support work force morale.
- **Understand the universe of product opportunities** – Jones’ management and employees – professionals and crafts people – are continually provided with opportunities such as participating in professional meetings to understand the importance of utilizing and benefiting from advanced technologies and materials.
- **Ascertain that the company has command of State-of-the-Art technology** – Jones invests in advanced technology expertise early – through benchmarking or acquisition of licenses and equipment – and experiments with promising technology in the factory for trials and familiarization before they are needed for customer work.
- **Prepare employees to implement corporate strategy** – Through company-wide information, education, discussion and feedback programs, Jones’ employees build understanding of corporate thrusts, direction and strategy and of how they as individuals can assist in implementing the company’s goals. Employees also understand how their own future depends on their own performance and the company’s long-term and durable success.
- **Innovate faster than competitors** – Jones’ management believes that to keep their leadership position they need to learn quickly and innovate faster than their competitors – in technology, in management and operational practices, and in strategy.
Support personal learning – By understanding why it is to their personal benefit, Jones’ employees take upon themselves to discover and identify – to learn about – advances in every field they think will be important for their work. They are recognized and rewarded as a group for practical curiosity, innovations and for how they collaborate and share insights. Jones’ culture fosters agility, versatility and flexibility in a noncompetitive, safe environment.

Foster knowledge-focused mentality and culture – Jones’ senior management believes that each employee must understand, as second nature, how better knowledge is built and leveraged – through personal and company investments, through collaboration and through deeply entrenched and practiced trade-offs between short-term facilitation and long-term strength.

As a result of pursuing such practices, Jones Development & Engineering, Inc. has been able to maintain its global leadership position. In addition, it has become a role model for other proactive organizations who also work to become leaders in their market niches.

The Proactive and Decisive Company Example

A steel minimill has practiced systematic and comprehensive knowledge management (KM) since its start-up in 1975. The Company’s senior managers do not think of their management philosophy and operating practices as KM, only as the most effective and appropriate approach to secure durable exceptional performance. Their business results, which they attribute to their knowledge- and people-focused approach, validate their beliefs. The company’s business and operational successes are exceptional and we wish to consider some characteristics of their approach:

Management Philosophy

- The Company’s management pursues the ‘hologram’ philosophy where each employee is a replica of the whole and understands management’s visions and the company’s daily business situation and long-term strategy. That allows employees to make independent decisions to corporate strategy while taking into account short-term trade-offs, broad business implications and other consequences.
- The management recognizes that people are “incredibly smart and innovative” and perform to succeed when: a. Given the opportunity to perform; b. Having sufficient job-related and general knowledge; c. Being provided with detailed up-to-date information on the plant’s and company’s performance and constraints; and d. Being accountable for their actions.
- The management believes that their employees must be better educated and have better understanding of operational, technical and business aspects of operations than competitors. This is their basis for distributing decision making and enabling employees to act on their own.
- Collaboration is essential and reinforced. Employees are not judged on their individual performance. Instead, they are judged on the performance of the whole team and the company as a whole.

Management Choices

- Decisions are delegated to the point-of-use to permit each operator to act immediately.
- The Company’s employees are salaried and divided into teams. Team leaders are rotated.
- There are no individual department bonuses. Twice yearly profit sharing is distributed to all based on the total company’s performance.
- There are no production quotas – only a stated desire to produce as much as possible at the highest quality required by the present market.
- Operations are closely integrated to break down barriers between departments.
- Adjacent operations report to the same general manager to strengthen integration.
“Everyone participates in research.” The Company has no separate R&D function but is still performing extensive R&D. Senior operators and engineers collaborate on research and development of new operations methods, new designs, etc. Teams are allowed to experiment with different operating conditions to test improvements.

The Company does not have a maintenance department per se. Operators are educated and expected to diagnose, troubleshoot and repair the equipment. Maintenance people with special knowledge in electronics, computers, etc., are part of operations.

The Company’s plants are controlled by sophisticated process computers to reduce dependence on personnel for routine work and to achieve uniformity of operations.

**Knowledge-Related Practices and Actions**

- All employees are provided with competence to act independently, intelligently and quickly – although collaboration is widely encouraged.
- Deliberate educational and knowledge distribution efforts ascertain that employees have access to the best possible knowledge available to handle situations.
- The Company uses outside experts whenever possible and frequently surveys world-wide what others do. “Not Invented Here” syndromes are not prevalent. “We are not large enough to have in-house experts in most of the areas where we need expertise.”
- Information on operating and technical performance is shared widely. Competitively sensitive information is controlled but technical and operating information is made available to everyone. The performance of operations and potentials for improving performance (quality, throughput, energy consumption, etc.) are constant topics for discussion among operators at all levels.
- The Company places extensive emphasis on education and provides education for high school equivalency for those without diploma. Education is provided for all in metallurgy, steel chemistry, metals processing, control, electronics and other relevant technical areas as well as in basic business principles, customer requirements, people skills, team-work and other subjects.

**Resulting Behavioral and Cultural Traits**

- All employees have a “can-do” mentality based on needs to pursue competence and innovation.
- Individuals are not afraid to ask others for inputs and expertise – The Company maintains a “safe environment” culture.
- Peer pressure is very important to identify and weed out unwanted behavior.
- Management is careful to not blame individuals. Operating problems are examined to find what can be learned – if it is technical or human. If technical, solutions are sought and corrections implemented. If human, management explores how it can change the situation through its own behavior, education, staffing, or perhaps by changing the operation itself.

**The Company’s Business Results**

Unless significant business results can be traced back to the way the company is managed, the management principles, corresponding practices and actions would be without merit. However, for this Company the results are significant.

- It is able to produce higher quality steel at lower costs than its competitors and it is a preferred supplier for many very large customers.
- It uses less energy and time to melt and process steel than its competitors.
- Its plants are operated with fewer operators than their competitors.
- The company is very profitable.
The Personal Reasoning Example

Peter Jones, an experienced design engineer was drawing up the specifications for an industrial heat exchanger. The problem was complicated with information describing physical space constraints and close exit temperature requirements over a wide operating range. Peter had designed similar exchangers before and knew immediately that the best solution would involve counter-current flow with a particular geometric arrangement. Without thinking explicitly about it, he knew precisely how to go about all detailing calculations and how to use the computer analysis programs. In fact, he performed all initial specification tasks without giving conscious thought to how to do it or what to do next. He had a well established script in his mind that he operationalized and activated nonconsciously once given the information describing the situation.

The technical specifications were easily done and while working alone, Peter completed them in a few hours. Then came the complicated part – to design the specified capacity into a physical shape that would fit into the available space. This was a new challenge and Peter and two collaborators struggled for several days to solve the problem by trying different geometric configurations. At first, none seemed to work properly. The ones they could fit into the space posed impossible manufacturing problems. After several attempts they remembered having seen an unusually shaped exchanger using uncommon materials which had the needed manufacturing flexibility while also having the required thermal and physical properties. By obtaining more information on the materials, the team finalized the design and submitted it to the shop to be built. After completing this project, Peter realized that using these materials would allow his company to make a new line of heat exchangers for uses that they previously had not been able to serve.

In performing his work, Peter drew on a wealth of personal knowledge. He possessed mental reference models as automatized tacit knowledge about creating heat exchanger specifications. Such work had over time become routine for him. He reasoned rapidly, intuitively and accurately with concepts, scripts and facts that represented his tacit understanding of the detailed scientific principles and engineering methods pertaining to heat exchanger design. In addition, Peter and his team used other, less automatized knowledge to explore design options for the physical configuration of the device. Part of this knowledge involved methodological metaknowledge to guide collaborative problem solving and the search for a workable solution.

The Personal Memory Example

Shawn is an experienced shipping dispatcher for ChemCo, a bulk chemical producer. She has recently been transferred from Dispatching to Shipment Planning where she generates the Short-Term Shipping Schedule. Much of what she knows from dispatching is of direct use to her in the new position. However, there are new considerations and requirements with which she is unfamiliar and that she needs to learn – and learn quickly.

A week into her new position, after Shawn has generated her first short-term schedule, a large high-priority order comes in and requires that she reschedules immediately to get that shipment out as early as possible. The material is in inventory but the trucks needed are already committed for other shipments. Although the problem is similar to dispatch situations with which she is very familiar, short-term scheduling introduces additional considerations. Shawn must identify which other shipments would be candidates for delays if she were to free up the trucks needed. She works with sales to determine problems and relative priorities of potentially delayed shipments. She works with production to explore possible manufacturing impacts. As she does this, she also searches for possibilities for subcontracting shipments to outside truckers.

While she assesses ChemCo’s options, Shawn with help of her manager and colleagues in the other departments, weigh the advantages, costs and issues associated with the options of delaying shipments and buying outside trucking services. There are many factors to be considered. Delaying shipments in most cases impacts customer relations. Delaying shipments also postpones revenues and at times creates manufacturing, inventory and storage problems. It is also more costly to use outside trucking than ChemCo’s own trucks.
All of this is new territory for Shawn but she learns fast and her manager is of great help to guide her along. Sally, Shawn’s manager does not work directly with Shawn to show her in detail how to deal with the issues. Instead, Sally tells stories about how she pursued similar problems in the past. She also tells Shawn what to watch out for, which impacts the scheduling decisions might have on departments, operations, customers and on ChemCo overall. She tells Shawn with whom to network – who good friends are in Sales, Production, Marketing and Contracting. Sally tells stories that includes examples of situations and by indicating how it all fits together. Without being directly aware of it, Sally helps Shawn develop integrated understanding of how to deal with a whole range of issues from both an overall perspective and in some detail.

During this experience, Shawn automatically builds a library of mental reference models for how to tackle this kind of situations in the future.

**Paper Maker Operators**

As an example of an effective use of a story from enterprise education let us visit a class in paper making for operator trainees. The small class had learned about all the parts of the paper manufacturing process from chipper, digester, bleaching plant, refiners, the paper machine with its head box, presses, felts, dryers, calenders, spools and all other objects. The teacher covered designs, construction, individual functions and principles of operation but the trainees still had problems understanding how everything fit functionally and operationally together in detail although they understood the general flow of materials through the process. The teachers then told a “story” by following one piece of wood from the point where it entered the chipper, was transformed into pulp and fine cellulose fibers before entering the paper machine until in the end it emerged as high quality paper after calendering. As he told the story, he indicated how the piece of material that started as a wood chip was gradually transformed to paper and how it was beneficially or adversely affected by proper and improper operation of the equipment. As a result after the story had been told, each student was able to build coherent mental models of the whole process and develop a mental framework for how to operate the different areas of the paper making process.

**Personal Situation-Handling: A Customer Service Example**

Susan Stark, a customer service manager, is informed that a key customer returned a recently shipped high-technology instrument with indication that it does not work correctly. From additional information and previous experience, Susan quickly recognizes that the instrument indeed has quality problems and she needs to decide how to deal with it in a manner that is practical and provides effective support of the enterprise’s intent and strategy and also satisfies her personal performance goals.

Susan handles this situation tacitly and rapidly – she does not need to explore it extensively or consult with others. Three immediate action-options come to mind: (1) Cancel the sale and let the customer place a new purchase order when a new instrument is needed; (2) Repair the returned instrument and send it back to the customer; or (3) Manufacture and deliver a new, problem-free instrument as soon as possible. In turn, she tacitly and automatically performs quick mental simulations to explore the acceptability of each outcome. By examining what she is about to do from the perspectives of her enterprise’s intents – its strategy – and her personal attitudes for how business should be conducted she immediately rejects choices (1) and (2) and decides that the best approach for the company is to manufacture a new item as fast as possible. She implements her decision by ordering and expediting the building of the new instrument. Furthermore, she decides to inform the
customer personally of what her company will do to correct the problem. Parts of this situation-handling process is outlined in the figure.

**Situation-Handling by a manager who decides how to handle the return of a high technology instrument by a customer.**

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In light of the situation-handling model, let us examine what Susan does in our earlier example. She uses her prior knowledge which she has stored in her mind as tacit mental reference models and other types of knowledge. Using her mental Situation Recognition reference models that are part of her Situational Awareness functional proficiency to make sense of the situation, she understands the situation to be almost routine. Since she thinks she understands the situation, she applies her mental Decision-Making/Problem-Solving reference models that are part of her Action Space and Innovation Capability and makes the decision automatically and rapidly, within about six seconds – even though she needs to engage in “multi-stage Decision-Making.”

As part of the Decision-Making task she performs mental simulations guided by Monitoring and her mental Governing Approach reference models (see the Topic Domain Knowledge section below). It is this process that led her to reject the first two action options since they did not satisfy her company’s intents, nor her own criteria for how to treat clients. She implements her decision routinely by being highly familiar with corporate practices, systems and procedures and having good networking contacts with the people in manufacturing. Part of this knowledge she possesses as Execution Method reference models included in her Execution Capability.

Throughout, the manner in which Susan performs her Sensemaking, Decision-Making/Problem-Solving, and Implementation tasks is supervised by her Monitoring task and her Governance Competence and Perspectives functional proficiency – particularly her mental Governance Approach reference models. This executive function operates in the background – mostly nonconsciously and automatically – and provides objectives and guidance to influence the way she interprets information, makes decisions, chooses action-options and implements the desired actions. As a result, her overall situation-handling supported the enterprise intent for

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1 For routine and many non-routine situations decision making based on tacit mental models take on the average six seconds as discussed by Klein (1998 & 2002).
how to deal with important customers. The corporate situation-handling is rapid, routine and flexible and falls in line with implementing the enterprise strategy and satisfies Susan’s own professional values.

The Enterprise Situation-Handling Example

The Situation

Sales of Asterix Consolidated’s large trucks, its major product line and the market leader, were declining. That happened in spite of recent innovations and new product features requested by customers. The decline seemed to continue and if sales did not pick up, drastic and undesirable steps would be required. Sales and Marketing did not have a clear picture of why sales were down – and that was a real problem. Recently, Asterix had also lost two large follow-up sales to longtime fleet customers. In both cases Asterix had been short-listed and had felt that they were both price and feature competitive to the point that they expected to win. The debriefing meetings had not provided concrete reasons for why they lost. So, what was wrong? What did they need to change?

Information Gathering

Ken Haas, Asterix Chairman CEO, was frustrated that no one seemed to know, or had been willing to tell him, why such a serious situation had developed and he created a taskforce to investigate in-depth. He chose four mid-level people known for their vigilance: an outside trucking industry expert and one each from Marketing, Manufacturing and Research and Development (R&D). The team arranged to visit existing and potential customers to talk to both senior executives and rank-and-file representatives. After one week’s intensive work and travel, the team had been surprised by what they were told although other customers had earlier voiced similar opinions but that information had never been assembled into a single, coherent message. The companies they visited were quite critical of Asterix and all shared much the same opinions. Over the week-end, the team organized their findings in a brief report that summarized the situation.

Sensemaking

There were several issues:

Issue 1. Asterix customer support representatives (CSRs) did not give customers impression of being motivated and competitively responsive – many were late in returning calls and in responding to requests. Most CSRs were not proactive and would often wait to do something until problems became critical – even when they had known about them for some time.

Issue 2. The Marketing department and the sales staff and their managers appeared to be convinced that Asterix was ahead of its competition – they also seemed to think that they knew most things better than their customers and had become somewhat aloof and difficult to deal with.

Issue 3. Asterix clearly had worked hard to innovate – but mostly by focusing on perfecting existing features except when responding to customer requests. Many competitors – including the two that had won the large sales – had introduced radically new features that no customers requested from Asterix.

Issue 4. Some new features were difficult to use and had quality problems. They appeared to be designed by sophisticated engineers who had their own ideas of how the features should be implemented instead of working closely with customer drivers.

Issue 5. Customers estimated life-cycle costs of Asterix’s trucks to be higher than most competitors’ – even though acquisition costs and fuel consumption both were lower.
When Ken Haas and his executive vice presidents were presented with the findings, they were dismayed and initially did not believe that the situation could be that bad and that widespread. A heated discussion followed but the evidence was compelling. There also had been earlier indications of similar problems but they had been ignored. It was clear that Asterix had been complacent and had pursued a business-as-usual approach that now was resulting in problems.

**Understanding the Situation**

The executive team decided that Asterix needed to address all five issues and that they needed to work quickly. They decided that the situation principally was a result of senior management failure and that they, themselves including Ken Haas, were responsible. Now they needed to decide what to do. They agreed that they needed to be positively proactive instead of taking a negative reactive course.

Since time was of essence and the problems were systemic, it was decided to pursue changes vigorously – as a major shakeup – perhaps bring about a new corporate direction. They needed to determine what could be done quickly and at the same time start immediately to correct or improve what needed more time. However, they still needed to decide explicitly why and how they needed to change and started by considering the five issues but first they agreed that all signs pointed to four general problems:

1. Asterix’s intended strategy, operational mode and practices had not been understood by rank and file and were therefore not being implemented effectively.

2. Both Asterix management and its rank and file had distanced themselves too far from their customers and did not understand customer thinking and attitudes sufficiently well.

3. Customers believed that the attitudes and mentalities of Asterix employees was not “good enough” to provide the service levels customers required – partly because of a lack of a common Asterix *esprit de core* and partly because of lack of employees integrative understanding of Asterix’s business and operations.

4. Whereas Asterix executive management encouraged independence and distributed decision making, it was clear that the direction of work in many parts of the organization deviated from the enterprise’s intended strategy, operational mode and practices and much work was performed that did not contribute directly – or at all – to implement Asterix strategy and intents.

There were other issues as well but the executive team decided to narrow the focus and initiate actions as soon as possible by creating a very demanding program with highest priority that required several other activities to be postponed or cancelled.

**Decision-Making/Problem-Solving and Action-Selection**

The executive team identified how to deal with each of the five original issues. It became a long list covering numerous areas and would require extensive resources. Nevertheless, the team decided that drastic measures were required and to proceed as follows (see Chapter 6 Appendix for details on rationale, expected results and next steps of the action program):

**Issue 1.** Lack of motivation and responsiveness were caused by people’s lack of understanding how their daily work was part of implementing Asterix’s strategy.

*Immediate Action 1-1:* Help CSRs understanding how their work implements Asterix’s strategy.

*Immediate Action 1-2:* Create and implement positive incentives and control measures.

*Immediate Action 1-3:* Terminate individuals with incorrigible negative attitudes.
**Longer-Term Actions 1-1:** Help all employees understand how to implement strategy.

**Longer-Term Actions 1-2:** Create and promulgate a “Service Paradigm” for everyone.

**Issue 2.** The beliefs held by marketing and sales people that Asterix was ahead of competitors were falsely based on inadequate competitor assessments and market intelligence.

**Immediate Action 2-1:** Undertake quickly a new comprehensive marketing study.

**Immediate Action 2-2:** Marketing, sales and others to immediately share market intelligence.

**Immediate Action 2-3:** Create incentives to make it rewarding and natural to collaborate.

**Longer-Term Actions 2-1:** Change the enterprise-wide personnel evaluation system.

**Issue 3.** Asterix needed to be more innovative in introducing competitive features.

**Immediate Actions 3-1:** Review R&D projects to expedite those that support Asterix’s strategy.

**Longer-Term Actions 3-1:** Consider making available selected features at no cost on new trucks.

**Longer-Term Actions 3-2:** Revise R&D project plan for next years with new priorities.

**Longer-Term Actions 3-3:** Create a framework for a flexible forward-looking strategy.

**Issue 4.** Features needed to be created and tested in close collaboration with customers.

**Immediate Actions 4-1:** Engage customers to review and test product features.

**Longer-Term Actions 4-1:** Create strategic relationships with suppliers and customers.

**Issue 5.** Asterix sales staff had insufficient understanding of their truck’s economic performance.

**Immediate Actions 5-1:** Make life-cycle cost projections for several customer scenarios.

**Longer-Term Actions 5-1:** Re-evaluate pricing changes, cost reductions, new product offerings.

**Longer-Term Actions 5-2:** Reorganize spare parts logistics to maximize geographical availability.

As a result of this program, nine immediate actions and nine long-term actions were implemented with broad involvement of the whole Asterix enterprise.

**General Aspects**

**Situation Handling Aspects.** Asterix’s management discovered that the company faced a serious problem. Its chairman resolutely undertook high competence information gathering and Sensemaking activities to quickly make sense of the situation which had problems centered around five issues. That provided sufficient insight to understand the problem sufficiently well to identify what to do. Correcting the five issues required numerous actions (nine immediate and nine long-term) that were implemented.

**Knowledge Management Aspects.** Asterix needed to manage knowledge much more decisively and systematically. Some KM efforts are short-term while others are significantly larger long-term efforts. The objectives of these KM efforts are to transfer insights and concepts to build knowledge in Asterix employees at all levels to understand its strategy, customers, operations and to build understanding of the markets.

**New Successful Services Strategy Made Possible by Costly Education**

*People throughout Financo, a financial services firm, were following developments in the marketplace closely. They were encouraged by the executives to identify customer and competitor behaviors and*
assess trends and potential opportunities. The executives were particularly interested in new strategic directions that would support CEO Paul McTierny’s belief that they never should offer services that could be perceived to exploit customers. Instead, the firm should offer services that would provide as great value to customers as possible. The basis for this philosophy was that success would be secure when their customers were served better by the firm than by competitors.

Based on inputs from everywhere, the marketing department and executive committee identified several market opportunities that could be created and exploited. They decided to provide a new service to provide customers with advise to build their understanding to make their own investment decisions. Such a service would be competitively novel and fall in line with the desired strategic intents and the CEO’s philosophy of being of genuine help and value to customers. However, pursuing this strategy required delivery of the new services to its customers with a great deal of expertise. The new services would require customer service representatives (CSRs) to possess additional knowledge which they needed to obtain through additional costly education.

**Financo’s handling of its strategy opportunities involved all the tasks of Sensemaking, Decision-Making/Problem-Solving, Implementation and Monitoring.**

Nevertheless, the executive committee judged that the new strategic direction would be worth the risk and they proceeded with implementation by creating a pilot program by providing the new service to key customers using a small number highly experienced and specially educated CSRs. This program was highly successful and the next step was taken to create an educational program for all service representatives using the experienced CSRs as extra resources to share their approaches and deeper understandings of how to assist customers.

**Comments:** Without knowing it at the time, Financo divided their issue into the four distinct and separate situation-handling tasks as indicated in Figure 6-3. Financo’s management handled the strategic situation by considering it from a knowledge perspective that resulted in comprehensive concept transfers and education.

**The primary knowledge-related aspects** of this case were the need for CSRs to build expertise in the form of a mental library of reference models that were required to deliver the new service with the proficiency Paul McTierny considered to appropriate.

**Sensemaking and Its Situational Awareness**

Sensemaking is the initial – and perhaps the most important – area within situation-handling. However, it is often made difficult for several reasons. Information may be insufficient or contradictory. The situation may be
unfamiliar. Most situations are close-coupled, interwoven, with other aspects within or outside the enterprise. Hence it may be difficult to delineate what to include or exclude in the target situation.

**R&D and Marketing Leadership Find New Markets for New Products**

The Marketing Department of the electronic equipment manufacturer Argis wanted to explore if potential new communications products would be successful in the market place. The new products had capabilities far beyond the conventional products which primarily served logistics operations. The sales staff and most of the marketing people argued that the new products were over-engineered and that the new features would make them too expensive for the limited logistics market. Steve Hill, R&D head and Paul Rhone, Marketing vice president, agreed that the “logistics only” perspective was too narrow and that Argis would be able to drive down costs if a larger market could be found to justify larger production runs.

The Market Research Department (MRD) had little market data outside the logistics industries and were reluctant to expand their product acceptance analyses. They felt that the new devices probably had little attraction for industries other than logistics and thought it would be a waste of effort. Steve and Paul decided that the MRD were too constrained in their views and that they needed assistance and insights by someone with a broader perspective. Consequently, they created a taskforce composed of an outside group assisted by R&D and Marketing people who were convinced the new devices would be attractive to larger markets.

The taskforce returned with a wealth of information from focus groups and work meetings with operations people from several industries. They had found that no one else were offering competing devices. Many potential users were enthusiastic about how the new devices would make their jobs easier and help their companies. The information included virtual user scenarios – models – for how the devices would assist operations in practice. The taskforce also made up pro forma financial analyses to illustrate potential economic benefits. From these models it appeared that the market for the new devices easily could be double that of the logistics market. Steve and Paul were able to summarize the findings in a succinct report for Argis management team which were to decide on whether or not to pursue the new product line. They also explained the deeper reasoning behind the concepts and findings in the report in discussions with management thereby transferring the insights, not only the results.

**Comments:** Argis was faced with an interesting situation and needed to assess how it related to the potential market place. They needed to understand if it made sense to pursue the situation.

The knowledge-related aspects of this case included the many, sales, marketing and MRD people who appeared to have narrow knowledge that prevented them from perceiving opportunities. The taskforce learned to know potential new customers. Perhaps most importantly, the taskforce were able to engage in deep knowledge transfer to those who ultimately needed to use it, the management.

**Sensemaking in the Enterprise**

In unexpected, less known and more complex situations, enterprise situation-handling becomes increasingly ad-hoc. Under these conditions Sensemaking is particularly important and requires thinking of the unexpected – “thinking outside the box.” Sensemaking of what may appear as a simple matter often requires considerable effort as illustrated by the following example:
Production Line Investigation Finds Reasons for Cost and Delivery Problems

Morrison Co., an agricultural machine manufacturer experienced unacceptable rework and production delays in one of their production lines. Joe Hanson, the plant industrial engineer, investigated the problems to find out what was wrong and pursued the task from different perspectives. He assembled production statistics and information on production machine downtime and repairs. He interviewed supervisors and line personnel. For hours, he observed activities on the production line paying particular attention to trouble spots. And, he examined parts that needed rework. Joe also followed information flows and parts flows in his attempts to find discrepancies.

Joe uncovered evidence which indicated that several things appeared to be wrong. There were unaccounted interruptions of the production line work flow. There were unacceptable quality problems that were identified by the inspectors and testers at the end of the production line. The quality problems were perplexing – some appeared to be machining problems whereas others might be problematic materials. In addition, there were long down times when equipment failed. Most of these problems were new and it was uncertain what caused them. Morrison had recently completed a cost containment program and Joe suspected that some problems might be related since they seemed to have appeared after the program was implemented. That was hotly denied by those who had promoted cost cutting. Nevertheless, he explored if there were any connections. After thorough analysis and collaborating with workers and supervisors Joe identified the following issues:

The cost containment had resulted in several separate moves to reduce costs. Plant maintenance staff had been reduced, production line overcapacity had been eliminated and procurement had changed to lower cost suppliers for some materials. Whereas these changes had resulted in somewhat lower costs, they in turn had led to the observed operating problems in the following manners:

- The reduced maintenance staff led to maintenance scheduling problems and long wait times – delays – to fix equipment. Also, since teams were measured by throughput, long maintenance delays resulted in reduced productivity and a tendency to continue to operate with out of spec equipment which resulted in out-of-tolerance quality problems at the end of the line. In Joe’s mind, this could be avoided if the production line workers were allowed to perform selected maintenance on their equipment. However, that required additional education and new operating practices and supervisory functions.

- Some new, low cost suppliers delivered materials (such as high strength bolts) that failed during product tests and required repair and rework.

- The production line capacity reductions led to reduced flexibility. Morrison had always been proud to provide individualized customer service, including expediting orders from important customers. That had never caused problems since the overcapacity had absorbed the associated disturbances. Instead, the leaner production line could not absorb expediting and production delays and other disruptions resulted.

Comments: Joe Hanson was very experienced and did not always believe what he was told. In addition, he had been educated in systems dynamics and was personally interested in higher order consequences of actions. In this situation, Joe received conflicting information and opinions. However, the symptoms indicated that there were underlying factors and he was therefore motivated to uncover them.

The primary knowledge-related aspects of this case are related to the value of Joe Hanson’s own expertise. A more permanent and strategic aspect related to the needs for greater and broader knowledge for production line workers and new management and supervisor understandings to support the new practices.
Enterprise Situational Awareness

Many enterprises are caught off guard as a result of misunderstanding situations and misinterpreting perceived consequences. Their Situational Awareness has been limited – the enterprise’s reference models and the mental reference models of its employees have been limited – and therefore have become constraints in ways that lead to problems. Along the same lines, when enterprise management teams are faced with difficult situations that fall beyond their previous experiences – such as accidents or management failures – they may immediately execute self-preserving responses based on human reflex models instead of engaging in proactive Problem-Solving that examine implications from broader perspectives. Also, in many enterprises the information management function lacks the means, or have not been designed, to deal with issues beyond the expected. As a result, in these cases, the enterprise’s intelligence assets lack the capabilities to deal with unanticipated challenges, hence leaving the enterprise vulnerable.

The extent of an organization’s Situational Awareness often distinguishes a higher performing enterprise from one that only follows the industry leaders. Situational Awareness to a large extent is determined by the understanding and breadth of knowledge. When focus is narrow and understanding is limited, it may lead to significant business problems as illustrated by this example:

Chief Engineer and Company Management Do Not Acknowledge Emerging Staffing Problems

Pierre Sonne, the human resource director for AeroCo, a medium-sized aerospace company, was quite concerned. He had identified that more than half of the factory employees, including supervisors and plant engineers, were eligible for retirement within four years. Most of the remaining employees were quite new and in general, not highly experienced. In addition, some specialty departments would be almost completely without workers when the eligible staff retired. However, there were no manufacturing department plans or budgets to hire replacements, transfer expertise to younger workers or start building a new competent workforce by other means. Matters were made worse by the manufacturing management who reported to the Chief Engineer did not consider the situation to be worthy of attention.

Pierre was aware of the general shortage of a competent workforce in the general geographical area and the low supply of new engineers and people with associates degrees that could be expected from the regional colleges. He attempted to make the company management aware of the seriousness of the situation. The president and the vice presidents of operations and technology checked briefly with the Chief Engineer, Tom Jordan. Tom told them – and they believed – that he was certain the situation would resolve itself as people would not all leave at the same time and that there were more pressing issues about which to be concerned.

The company’s competitiveness was to a large extent based on the factory’s expertise involved in building sophisticated products. Hence, as personnel started to retire, 15% of the eligible group in the first year, 25% the in the second year, 40% in the third year and 20% in the fourth year the problems that Pierre had foreseen quickly became apparent. Already in the first year it was difficult to find competent replacements and during the next three years, the expertise level within the workforce was drastically reduced. As a result, the company has experienced product quality problems, lost considerable business and a new management team has been brought in to try to improve the situation.

Comments: AeroCo’s management exhibited constrained Situational Awareness which limited its ability to act in time.

The primary knowledge-related aspects of this case included the Chief Engineer’s lack of understanding the dynamics of personnel retirements, replacements and acquisition of expertise. Upper management also
exhibited a lack of understanding of the same issues. Other aspects included the knowledge building requirements to create a competent workforce, a process that required knowledge transfers from experts to novices, education and learning on-the-job.

**Decision-Making/Problem-Solving and Action Space and Innovation Capability**

The quality of the enterprise Decision-Making/Problem-Solving capability is one of the most important functions for determining the enterprise’s ability to survive and prosper. This capability may be risk seeking, daring and creative to seek new and novel business opportunities. It may be risk-balanced, proactive and innovative to support market leadership pursuit. It may be risk adverse, reactionary and conventional to support a business-as-usual direction. Clearly, within an enterprise of some size, Decision-Making/Problem-Solving capabilities will fall within all of these categories – within top management, operating divisions, departments and among individuals.

**How Shall We Utilize Our Retained Earnings for Best Long-Term Success?**

Parity Corp’s president, Joe Hammack, struggled with the question of how to expand Parity’s business. The last years had been successful and the company had accumulated cash reserves from retained earnings beyond those needed to sustain operations during difficult times. Much of their success they attributed to their advanced personnel policies and good salaries and bonuses that provided a loyal and effective workforce. In spite of present successes, market research indicated that Parity’s existing medical diagnostic products would potentially be outdated within a few years. Within Parity, updated products were being prototyped and new generation products were under development. However, all were extensions of the present product line. Market forecasts for healthcare sector growth in general were quite favorable. Under these circumstances, it would be natural to pursue business-as-usual and use Parity’s favorable situation to lower profit margins and prices to increase market share. Parity could then bank the cash reserves as insurance against future adverse conditions, or perhaps use reserves to increase dividends or otherwise reward owners and employees.

Nevertheless, Joe was not at ease. Joe, his Marketing VP and other members of the executive team believed that the present market trend would not continue for very long and together they decided that Parity needed to consider new directions while they had the financial advantages to invest in new business. The issue was: Which directions should they pursue? There were many clear options but they were still within the present market perspectives. Most would exploit Parity’s R&D and manufacturing technology strengths and they knew that direction could be managed with confidence. Then again, other firms would pursue the same options and competition could be fierce with no guarantee of successful outcomes.

Given this situation, Joe and his management team decided, given their core strengths, to explore if they could find or create a new market niche that would provide them with durable opportunities for success in years to come. They set to work by first defining from a top-down and abstract perspective which core strengths they could use as foundation for new business directions. They focused on their R&D, Engineering, Manufacturing, Marketing and Sales capabilities assuming that they would have the management strengths to deal with new markets. They decided to “think outside the box” and created scenarios for wide-ranging customer and market futures. The initial scenarios still were based too much on conventional thinking. It was decided to step back and look at general principles and plausible
scenarios for future healthcare delivery and how technology would need to develop to support new thinking, new practices, new economics and new health care-related social values. In addition they included the best thinking they could find on expected emerging technology and technological breakthroughs both within their present areas of expertise and areas that were outside their experience.

Several interesting scenarios emerged, some were isolated, others overlapped but all required some technologies beyond Parity’s present capabilities. The isolated scenarios were considered to be vulnerable and risky whereas the overlapping ones were judged to provide both flexibility and greater likelihood of being realized. In addition, all the scenarios would require that someone – most likely Parity if it proceeded – would need to build awareness and understanding in the marketplace of the improved quality of care and cost-effective opportunity associated with the new healthcare delivery practices that would rely on its new products. The priority scenarios centered around diagnostic and treatment monitoring devices that ranged from simple and inexpensive applications of sophisticated technology with large market potentials throughout the world to high cost machines with limited markets. All relied on new technologies, some of which might not be realizable and which therefore were risky.

Joe and his team agonized over the situation which truly represented a dilemma with risks on all sides. However, there was general agreement that continuing with any one of the business-as-usual alternatives would likely make Parity ultimately deplete its cash reserves to stay in business and become a mature corporation with few options for renewal. In the end, they selected to pursue a strategy that would work if several of the overlapping scenarios were realized. The strategy would be costly and risky but also quite rewarding if it could be brought about. The scenarios and the success of the strategy relied extensively on the ability of Parity to develop radically new and affordable diagnostic and treatment monitoring devices that could revolutionize selected areas of healthcare delivery. Hence, they agreed that the responsibility for success was in the hands of Joe and his management team and equally important, every employee at every level of the company.

To pursue the new strategy, Parity needed to more than double its R&D operations by bringing in senior researchers and their teams with expertise in four scientific areas. They were prepared to use considerable resources to acquire the necessary capabilities. They also needed to build greater medical expertise and develop additional strategic alliances with medical institutions, particularly with medical schools. In addition, the management team realized that they needed to rely on its rank-and-file employees to a greater degree than they previously attempted to assist in implementing the new strategy. Given evidence that greater employee satisfaction increases productivity and innovation, they decided to make Parity a more effective organization by providing employees at all levels with greater freedom to innovate and assume responsibilities. For that, management needed to create and engage in deep dialogs with each employee to make them understand how they could assist in implementing both existing and new strategies and how they would benefit, personally, from making Parity a success.

Comments: Parity’s management confronted a challenging situation familiar to many management teams. Based on their best understanding of the situation – in spite of all its uncertainties and conflicting and partial information, they decided to pursue a proactive and comprehensive approach that required innovative Problem-Solving to determine what to do. Their goal was to re-create Parity to be successful in the long term. Their management philosophy was that they needed to rely upon a loyal and effective workforce – to an even greater extent than previously. All these factors made a complex situation.

There were several knowledge-related aspects of this case. Clearly, Parity’s management team was very knowledgeable and had good understanding of its market, its capabilities and how to make the organization operate effectively. However, to pursue their aggressive strategy, they needed to build additional knowledge
capabilities. They needed to increase their R&D intellectual capital and also prepare their general workforce to understand how to participate in implementing the strategy in detail.

**Enterprise Decision-Making**

Much enterprise Decision-Making is immediate and often routine. Experienced managers respond to a myriad of varying situations, most of which are familiar – or close to familiar to them. Work performed by rank-and-file employees is often immediate and routine and consists of well-established tasks and practices. Hence, to perform such work, proficient managers and other employees are often able to operationalize and execute personal mental reference models to perform their jobs. Within the enterprise one frequently finds that much work is performed by another class of Decision-Making cases that include pre-designed responses that are embedded in automated functions such as payroll systems and in other types of systems and procedures.

**Business Expansion Requires Hiring of Competent Staff**

As a result of expanded business, Sally Struve, the human resources director of Holly Corp, a public relations (PR) firm, was spearheading the hiring of 20 experienced PR specialists, advertising professionals, copy writers and graphics designers. She assembled several hundred resumés for likely candidates. With her staff, Sally summarized the resumés and used a candidate evaluation software system to apply company criteria to screen and select about 60 candidates that she and the department heads would interview in person.

To expedite the process, standard background checks were performed in parallel with inviting candidates for interviews resulting in disqualification of a few candidates. The remaining candidates were invited in for interviews by Sally and representatives of the departments involved and 8 were such obvious hires that they were given employment offers while still present.

Sally convened meetings with the department heads to staff the remaining 12 positions. They reviewed the interview results and ranked candidates according to Holly’s proficiency, salary and personality criteria. Based on these rankings, employment offers were extended to fill the remaining positions. However, since only 17 candidates accepted the employment offers, Sally, in follow-up efforts was able to quickly extend offers to other candidates and in the end all 20 positions were filled.

**Comments:** Holly had adopted a streamlined hiring procedure with established criteria that allowed the company to make effective hiring decisions.

*The primary knowledge-related aspects* of this case included Holly’s Intellectual Capital that provided for ordered hiring procedure with established criteria and pre-formatted employment offers and contracts. These structural IC assets constituted enterprise reference models for hiring. By following the hiring procedure, Sally and her coworkers were able to perform the hiring as a routine group decision.

**Enterprise Problem-Solving**

Enterprise Problem-Solving is performed by individuals, by teams, and still very rarely, by automated means that contain embedded Problem-Solving methodologies.

Problem-Solving in the enterprise occur in widely different cases as indicated in Table 6-4. The approaches are in some cases determined by the urgency and other aspects of the nature of the situation. In other cases, the Problem-Solving approach may be determined by the capability or mentality of the decision makers.
Repairing Relations with Unhappy Clients

Parity Customer Solutions, a customer relations software provider that had grown rapidly, experienced problems with several major clients as a result of insufficient customer support made worse by a new software release that had disruptive reliability problems. Richard Posner, Parity’s President and Chief Operating Officer, led the effort to find ways to ameliorate the problems and, if possible, win back the confidence and loyalty that Parity had enjoyed in the past.

The problems were quite clear – they had not only caused clients inconveniences but in several cases also economic losses, although these were not large. Clients were unhappy but none appeared to wish to break their contracts or take drastic measures. Nevertheless, Richard and his colleagues believed that it would be inadvisable to let time heal the situation and were instead intent on finding positive ways to fix the relationships. After all, Parity’s expertise was customer relations and that needed to be reflected by its actions.

Richard pulled together a team of six top people from Marketing, Sales, Strategy, Customer Support and Software Development and Deployment. In the past, Parity had successfully repaired client relations by providing reductions in fees but there was consensus that the present situation required more drastic measures. What could they possibly do that would have sufficient impact and value to their clients to correct the present state?

In spite of Parity itself employing customer relations experts, the team decided to explore the experiences and approaches that others had with repairing customer relations. Quickly, they contacted and interviewed anyone they thought could provide insights. Three members of the group sat down to examine how they would feel if they themselves had received Parity’s treatment and how that would have affected them. They explored what they would require from Parity to set things right. In principle, the team engaged in divergent thinking to generate a spectrum of plausible approaches that might provide solutions to the dilemmas. They agreed it would be important to go to some length, particularly if the measures were of great value to clients. However, Parity could not go too far in providing compensating measures.

After discussing and evaluating the potential approaches they decided that one aspect was to provide special compensations to the affected clients. Quite another aspect – and perhaps a more important one with greater market visibility and impact – would be to strengthen its customer support and software development, testing and bug fixing capabilities. They should also publicly acknowledge the problems and explain how they were being corrected to never occur again.

The team, and subsequently Parity, selected to immediately allocate additional customer serve representatives to the affected clients and compensate those that had experienced losses. They also decided to expand both customer service and software department and explain their actions openly and truthfully to the marketplace. In addition, there were indication that most customer support representatives (CSRs) needed to be better prepared – particularly by understanding Parity’s products better and understanding how clients benefited from the products in their business. A comprehensive educational program – including knowledge sharing within the CSR community of practice – was therefore initiated. These actions were expensive but were judged to be both the best way to go and were good investments with acceptable returns.

Comments: Parity’s trouble-shooting team collaborated to find the best solution to the customer situation by pursuing systematic Problem-Solving as was illustrated in Table 6-4.
The primary knowledge-related aspects of this case included the team’s methodological Problem-Solving expertise, the knowledge sharing with the marketplace of Parity’s intents and actions and the educational program for CSRs.

**Enterprise Action Spaces**

Frequently, enterprise approaches become constrained by conventional thinking such as the “If it is not broken, don’t fix it!” mentality. Action Spaces in the enterprise are often more constraining than in the personal situation and may be subject to “group-think” and committee behavior that reduces creativity to the “least common denominator.” For these reasons, it is often helpful to bring in a different perspective, a different paradigm or problem framing in which the group members have fewer constraints.

**Restructuring Sales and Operations to Increase Profits Led to Action Space Expansion**

LearnsSys Inc. developed advanced computer-based educational materials for industry. Cecilia Cho, LearnsSys’ president was dissatisfied with the effectiveness of their sales process. She also thought that their contract work led to excessive change orders and delays. This was in spite of LearnsSys’ recent efforts to streamline their marketing-sales-proposal-contract execution-systems delivery value process which was as good as advanced thinking in the industry could make it. Nevertheless, Cecilia was positive that a better approach could be devised to improve performance.

Cecilia argued with her team – who were quite proud of the present arrangements – to help find better solutions. They thought her wish was beyond reach. They agreed that the reasons for what Cecilia considered to be a problem was that the market was limited and that LearnsSys technology was too advanced and therefore amounted to a certain amount of hard-to-sell “technology-push” instead of “demand-pull” that customers would naturally ask for. They did not see any reason for a “rethink” or change.

All the same, Cecilia brought her team together to consider the marketing-to-delivery process from new perspectives. In the past they had focused on information and work flows but Bud Norman, the innovative R&D director, who also spearheaded LearnsSys’ advanced technology, suggested that maybe they should look at what he called “understanding flow” instead. Bud felt that in executing the marketing-to-delivery process the sales people and proposal writers did not properly represent LearnsSys’ technological capabilities. Also, Sal Sanguese, head of software development thought that many change orders could be avoided if better customer specifications were included in the contracts. And, if change orders were reduced, that could lead to shorter execution times and lower execution costs.

As they argued and discussed, it became clear that most had opinions about limitations of insights at several points in the process and that these might be caused by “understanding problems.” Jane Quist, head of sales suggested that quite often, it was difficult for the sales team to explain how advanced features would benefit potential customers. She also indicated that at other times she learned later that valuable features which could be implemented quickly and inexpensively were not included in the proposed work due to lack of understanding. Others indicated additional limitations, all understanding or knowledge-related.

Initial suggestions for improving the situation (this was natural for an educational materials developer) were to provide an educational program for sales and proposal people to give them insights to represent LearnsSys capabilities better. That was quickly discarded for two reasons. First, conditions
and technology changed too fast and second, everyone already had enough to learn and keep up with. Hence, it was not possible to plan for more education.

After more discussion, a new model developed – that of placing people with relevant understandings and expertise in the various situations where they could make a difference. It was agreed that senior software and R&D people would join with the sales team to work with potential customers to conceptualize what LearnSys could do and how that would benefit the customer. The software and R&D people would only rotate in visiting roles. However, after conceptualizing a potential contract, they would next assist in writing the proposal, and if a contract was secured, the same people would participate in, or lead the contract work. In this way, there would be opportunities for a wide range of people to participate.

This model was build on the concepts that the presence of deep understanding of advanced technology and implementation in the customer situation would quickly help conceptualize the best possible customer solution. It would also build customer understanding and confidence. Next, the proposal would better reflect what was agreed with the customer and increase the probability of customer acceptance. Finally, the project work would benefit from automatic inclusion of customer understanding and agreements. This model was implemented with the results that contract scopes increased on the average, acceptance ratio increased and execution costs and delivery time were reduced. There were other benefits. R&D and software people obtained a much better understanding of customer situations and issues and they were better able to meet them in future work. By having people from different parts of the organization work together in different situations, new and valuable ideas and innovations emerged. In addition, improved customer relations increased follow-up work.

Comments: LearnSys faced a typical business situation – that of needing to restructure work to improve profitability. Initially, the team’s Action Space was constrained to business-as-usual as often is the case, particularly when a change to the better has already been implemented. For people who have been part of implementation, the psychological cost of discarding recent improvements is high. In LearnSys’ case, by introducing a new paradigm – new model and perspective – the team were able to expand their Action Space to create a new

The knowledge-related aspects in this case included the “understanding flow” within the marketing-to-delivery process as indicated in Figure 6-4. That paradigm provided the insights that allowed the LearnSys team to expand its Action Space that in turn led to their innovative knowledge bridging approach by assigning technology experts to follow each project though all its stages.
Enterprise Innovation Capabilities

Competitiveness appears to be a function of the degree to which an enterprise can innovate better and faster than its competitors. Its Innovation Capabilities provides the ability to innovate and is a result of many factors such as enterprise culture and the mentalities of its employees, the degrees to which people are free to engage in creative and innovative activities, motivational factors and incentives, exchanges of viewpoints, perspectives and knowledge within the enterprise and with the outside, and the degree to which people within the enterprise understand customers, customers’ customers and the marketplace.

Innovation is a human activity and there are many approaches to create an innovative environment within the enterprise. Among these are approaches to expose people to new ideas. Equally important are approaches to expose people to novel needs and requirements. In addition, many organizations have discovered that creating opportunities for people from different parts of the organization to meet or work together often lead to innovative collaboration with great results. Perhaps the most valuable innovations are those that are associated with totally novel ideas and opportunities – opportunities that are not yet perceived by the marketplace or by customers. At other times opportunities are created by improving operations in ways that competitors have not understood as in the following illustration:

New In-House Technology Make Possible Significant Cost Reductions

Potter Industries was a leading commodity producer in a highly competitive industry. They had remained successful by developing and applying sophisticated technologies better than its competitors. However, other producers were catching up fast.

For its size, Potter had a comparatively small but very effective Research and Development Center that had been the nucleus for technology development. But R&D did not act alone. Plant process engineers
and production teams experimented and assisted R&D in improving processes. R&D personnel visited the plants on regular rotation to work closely with plant employees for one or two weeks. As a result, the plant operators and engineers became conversant with technological matters making it possible to implement equipment and practices that required extensive competence to operate. Plant engineers and union operators also rotated into the R&D Center but for longer periods of three to six months which gave the R&D projects a practical direction that made it possible to implement many of them directly, without needs for R&D pilot plant operation.

However, most of the R&D effort had been focused on perfecting operations and making present second generation technology more efficient. Keith Esquivel, the thoughtful and broadminded R&D VP, was not satisfied. Potter already operated the present technology close to its theoretical limit and future improvements would be costly and not bring great improvements. Keith decided it was time to rethink the production process to introduce, if possible, new technology that either existed elsewhere or that Potter had to invent.

After considerable research at the R&D Center and in the plants, research that was both costly and risky, Potter was able to devise a new patentable third generation process which in pilot plant operation showed great promise for yield improvement and cost reductions. Thanks to the involvement of plant people in the initial research, pilot plant design and operation, the scaling up to full production size occurred with only minimal problems. The anticipated economic gains were achieved.

Comments: By building an ongoing Innovation Capability, Potter was able to create a proprietary third generation technology solution which by its improved yield introduced significantly lower production costs as indicated in Figure 6-5.

The knowledge-related aspects in this case included the valuable process that Potter created by rotating R&D and plant people. The continued interaction – both while working on projects and in leisure periods – formed an effective process for exchanging and creating ideas and innovation and transferring concepts between the R&D Center and the plants. In addition, the rotation created valuable networks and shared understandings and mentalities.

Potter’s experienced yield of three technology generations and the time of switchover from second to third generation.

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Implementation and Its Execution Capability

Problems with proper Implementation of good intents is perhaps the greatest problems in the world in general. Many excellent decisions and worthwhile projects and programs are derailed or even discarded because of inadequate Implementation. There are many examples of execution problems as indicated by and Matta & Ashkenas (2003) and Bossidy & Charan (2002).

Often Implementation becomes a problem because of ineffective communication of concepts and intents – bridging of purpose – from one person or functional entity to another. This is a particular area of concern in most enterprises. After a decision is made, the implementation team or department, at the same organizational level as the decision maker or at a lower level, often do not fully understand – or understand at all – the concepts or other underlying intents behind the decision. As a result, execution effectiveness suffers.

In the organizational domain Implementation may involve large and complicated efforts that require extensive supports from specialized and competent personnel, systems and other resources. However, most problems with implementation seem to originate with decision makers who do not appreciate that the implementers cannot understand what is required (Mittelstaedt 2003).

Our Strategy Is Not Being Implemented by Rank-and-File!

Stubb Corp’s president and CEO Paul Nary was appalled at how badly their strategy was implemented. Only four month’s ago, with the help of outside consultants it was determined that Stubb’s key strengths were centered around customer relations and quality leadership and their strategy should focus on attaining market leadership based on these strengths. Such a strategy was considered certain to succeed since the marketplace considered Stubb to have excellent relations and excellent products. In anticipation of increased business, Stubb proactively increased its laborforce by about ten percent across all departments to ascertain that new workers were competent when they would be needed.

However, after a few months, the strategy was not being properly implemented by lower-level managers, supervisors and rank and file. Instead of making tradeoffs in favor of quality and good customer service, they frequently focused on internal issues and minutiae such as maintaining low inventories, smoothing production line flows, minimizing scrap rates and reducing costs of supplies and consumables. There were also costly bickering and finger-pointing between maintenance and production departments.

Paul called in a consultant, Pete Storm, who specialized in strategy implementation to find what was wrong. Pete identified that several aspects worked against the strategy. Firstly, whereas people throughout Stubb read and knew the strategy slogans, they did not really understand what the strategy entailed and most did not see how their own work would help to implement the strategy. Secondly, people did not see how achieving good strategy implementation would be of value to themselves. They really were not interested in implementing the strategy. They were more interested in keeping their own work problem-free and maintaining good relations with coworkers and superiors. Pete identified internal Stubb initiatives that were counterproductive. Hence, operating cost containment efforts that dealt with inventories, scrap, consumables, etc., ended up to be of greater concerns than effective strategy implementation. In addition, current operating practice and culture did not support rank and file to make independent decisions to innovate and improvise on operational guidelines to achieve strategic benefits.

Pete recommended that a different approach be taken to communicating the strategy, its implementation, what it would mean for the company, how each job could participate in its implementation and the value it would have for each employee to succeed. It would also be important to assist people to understand how they could resolve conflicts between strategy issues and other issues
such as the cost containment efforts. These initiatives would require considerable work on part of management and people throughout the organization. Pete also emphasized to Paul that in order to achieve successful strategy implementation it would be necessary to loosen management control and give people greater decision latitude – which in turn also require building additional expertise in the workforce.

**Comments:** Stubb’s problems in implementing its strategy were created by a combination of lack of understanding, lack of interest in seeing the strategy succeed, and factors that were of greater immediate importance. In addition, many did not find it easy to establish priorities and to resolve conflicts between strategy issues and operating issues.

The knowledge-related aspects in this case included apprenticing and preparing new staff in advance of being needed for expanded business. An important knowledge problem became apparent when the actions of many employees indicated that they had not understood how to – or even that they were parties to – implement the strategy. The most important knowledge tasks were associated with communicating and transferring the insights of the strategy and enterprise intents with the associated implications to all employees. Also of importance were the knowledge flows required to build expertise sufficient for employees to assume responsibilities to handle distributed decision making.

**Implementation in the Enterprise**

A major implementation problem in the enterprise is the hand-off of the selected action-option from Decision-Making/Problem-Solving individuals and teams to the Implementation team. The typical problem is particularly associated with the transfer of concepts and intents – the conceptual knowledge and insights – behind the action-option. These aspects of the action-option are rarely communicated deeply and appropriately and are crucial for understanding how to improvise when implementation requires adaptation to the reality and details of the implementation environment. When deep understanding is missing, the action-option implementation therefore typically suffers.

**Implement Strategic Partnerships to Make the Enterprise Stronger**

Paul Foh, Stihlo Corporation’s Vice President of Marketing and Strategy had the executive committee’s agreement to expand strategic partnerships with universities, several suppliers and key customers. Stihlo provided financial analysis and backroom processing services to institutions and maintained its market position by being innovative, fast and cost effective – all key factors within its market niche. Recently, Stihlo’s competitors had been able to steal two of Stihlo’s customers by demonstrating that they provided equal performance at lower costs.

Stihlo’s management decided that they needed to improve on several fronts. They needed to become more efficient in internal operations to lower costs. That was necessary, but it would be still more important to innovate by improving, even redesigning, its products and services to provide greater value to its customers. Hence, the concept was to expand strategic partnerships to obtain new ideas and potentially co-develop proprietary solutions that would set them apart from competitors. Paul had good ideas for new partnership candidates which previously had been limited to two suppliers and three customers.

Paul needed to delegate most of the strategic partnership work to Helen Tracy, director of external relations who were to collaborate with Harry Thompson, the in-house analytical genius. But Paul was concerned that the effort could fail unless Harry, Helen and their staff understood the underlying
concepts for why the partnerships were strategically crucial, which ideas for technologies and solutions might be considered in the short term and specifically, the priorities of customer services and benefits that Paul thought should be pursued. These particulars needed to be central in the dialogs Helen, Harry and others would have with prospective partners when formulating and agreeing the nature and content of the partnerships.

In order to build the requisite understanding, Paul decided to work closely with Helen and Harry and a few people from their staff by meeting every day for two weeks in hour-long discussion and work meetings. They worked through the premises for the strategic partnerships, the potentials for benefits for the partners and for Stihlo and what might obtain in terms insights, products, and other results. The motivation was for Helen and the others to internalize the concepts and expectations and build strong mental models to the degree that the concepts and priorities would “be on the tip of their tongue” and they could steer partner explorations extemporarily and creatively. That was indeed achieved and the partnerships that were established produced both invaluable results and strong allies.

Comments: Stihlo’s management needed to ascertain that the decisions and ideas to create strategic partnerships were to be implemented creatively and to the fullest possible potential.

The knowledge-related aspects in this case was centered on the transfer of ideas, concepts, priorities and expectations behind the decision to create new partnerships. Another aspect, not made explicit in the illustration, was the need to transfer enough understanding to the partners to make them valuable and motivated supporters of Stihlo’s strategy.

Enterprise Execution Capability

Many enterprises excel by being able to execute successfully. They build internal capabilities and practices that focus on developing a “can do” mentality, The mentality is backed up with broad individual and team expertise and systems, procedures and practices to ascertain that all necessary resources are provided and that people are motivated and the enterprise is flexible and ready to assist when problems occur. Apart from providing the needed understanding as indicated in the above illustration, successful Implementation depends upon quality and sufficiency of the capabilities and resources that are made available to execute the decision – to implement the selected action option. In many instances, execution failures are caused by budget limitations, miscalculations or misunderstanding, time pressures and many other factors as indicated by the following illustration:

The Project Is Late and Will Cost More Than Projected - Working Hard Instead of Working Smart Does Not Always Work!

Leon Pavarotti, project manager in Prego Systems’ Information Services Division, was leading a new project to create the “Starburst” business system. Half-way into the project Leon started to have problems. He was an accomplished project manager but this project used a new and sophisticated technology with which both Prego and Leon lacked previous experience. The project was high priority and when fully completed, would bring considerable benefits that were central to Prego’s continued success. Hence, it was important to finish Starburst early and with all its planned features. However, now it appeared to Leon that the project would exceed both its schedule and budget. Worse, there were issues which Leon and his team did not seem to be able to overcome and Starburst might fail to meet some of its design criteria.
Frank Hayes, the Chief Information Officer, had been warned that it might be risky to perform the project with only in-house staff and that it might be wise to bring in outside expertise to at a minimum provide guidance. However, Frank had seen Leon lead difficult projects before and was confident that it would be quicker, less expensive and a good learning experience to go it alone. When Leon reported problems, Frank decided to add several senior in-house people to the team to help out and asked that together they should work through the problems. Leon was not sure that it would work but agreed and told the project staff to work harder and start working overtime. He also asked professional friends outside Prego for insights into their problems but received little valuable help since the complexity of the project made it difficult to assist without total immersion.

The project was not rescued – it was several months late, way over budget, was missing several key features and was of limited value to Prego. Since Prego had relied on the new system for its success, the company suffered in the marketplace and needed to cut back its staff across the board. Leon was fired, but Frank – who was mainly to blame – was retained.

Comments: Prego made a typical mistake by initially allocating insufficient resources to the project. That problem was made worse by a management that neglected to support the execution team with sufficient competent resources after the project showed sign of failure.

The knowledge-related aspects in this case included insufficient expertise in the project team for the complexity of the tasks required for successful execution.

Monitoring and Governance Competence and Perspectives

Whereas delegated and distributed situation-handling proves very effective for an enterprise when employees are motivated and competent, there will always be need to ascertain that work is performed according to the enterprise’s intent and not in some other direction. Deviations from the intended direction may be caused by lack of competence, motivation or understanding of what is required. Deviations may also be caused by people with self-serving agendas that are not aligned with the enterprise. In some instances even by destructive or counterproductive actions. Hence, monitoring will always important.

In other cases, such as when an enterprise pursues an exploratory direction with competent and motivated people, monitoring is important to redirect and improvise as new opportunities or constraints are encountered.

Company Works to Meet Societal Responsibilities

Atlee Chemical Corporation had been successful with its specialty chemicals and the future looked promising. Over the years, Pete Reinecker, Atlee’s president, had become convinced that Atlee needed to observe its responsibilities, not only to its owners or its employees, but also to the small town of Crossing in which they were located. Atlee was the town’s largest tax payer and also provided most of its payroll. Without Atlee, Pete was convinced, Crossing would cease to exist and the livelihood of most of its employees would be destroyed. As a result, as business grew, Atlee’s management decided to expand in Crossing instead of seeking more cost effective locations elsewhere.

Not everyone agreed. Outside stockholders argued that the Crossing operations were too expensive and they would like a more efficient plant that possibly could yield greater profits. They also felt that Atlee’s attempts at achieving total recycling with no emissions or effluents also was too expensive although its profits were above average for the industry. A few of Atlee’s employees complained that environmental concerns made it hard to operate the plant. Yet, Pete and his executive committee held on to their philosophy to pursue the company’s broad responsibilities and decided to continue to honor the basic principles.
It was not easy to operate Atlee as a responsible and model corporate citizen. Throughout its operations there were constant needs to balance short-term convenient and low effort and cost actions against longer term and more societal friendly actions. These dilemmas were particularly frequent in Atlee’s physical operations that interacted with air and water quality and other aspects of the environment. Constant monitoring was required both by management to assist rank and file and by operators to ascertain that equipment functioned properly at all times and that proper maintenance was performed whenever needed.

There were reasons why Pete and his team felt the present operating philosophy to be both prudent and in the best interest for all concerned. First, they agreed that whereas stockholders – owners – were an important group of stakeholders and their interests should be observed, they were not important to the exclusion of other stakeholders. Hence other stakeholders included Atlee’s employees who invested their working life in the company and relied on it for their own and their families’ current and future livelihoods. The company also needed to be a responsible social citizen which meant that they could not ignore the effects it had on local economics, social life and the physical environment. It was clear that business analysts and many outside owners disagreed but Pete and his team decided that as long as they were profitable they would stay the course.

Second, a central reason for Atlee’s success was the effectiveness of its stable workforce. Worker morale was high, turnover was low, both leading to unusually high competency among its workers. This was evident in operating statistics which showed unusually low frequency of operational mishaps and accidents, low equipment repair costs since diagnosing and correcting malfunctions was considered everyone’s responsibility. There were other indications as well, product quality was reliably high and everyone took pride in making the operations exemplary.

Comments: Atlee’s approach to lasting and durable success was built around a management philosophy of acting as a model societal citizen and by providing a highly attractive place to work. Their approach to be a had many benefits that management found to exceed the costs of the efforts. The ability to maintain the high performance across several dimensions also required considerable monitoring effort that was judged to worth while.

The knowledge-related aspects in this case included creating a desirable work environment that made it possible to develop and retain employees with high degrees of expertise. Another aspect was the high competence required everywhere in the company to deliver the operating and management performance needed to meet the desired strategy.

**Monitoring in the Enterprise**

In today’s business environment single-factor situation-handling is a rarity except in highly routine cases. Most enterprise situations are fraught with dilemmas caused by conflicting objectives such as between quality and throughput, between satisfying a customer’s special requirements and maintaining streamlined and efficient operations, between special treatment of fast-track employees and the general treatment and motivation of the workforce-at-large, and so on. In addition to being complex, many conflict situations also tend to be unfamiliar and are difficult to handle. Most need to monitored – by superiors as well as by oneself – to ascertain that they are handled to the best of the ability of the people involved.
Our People Do Not Make Balanced Decisions! They Focus on One Factor Only!

Bob Taylor, Bromley Corp’s operations manager was appalled at the quality of decisions made by most people in his area. As he lamented: “Our people not make balanced decisions! When they handle situations, they tend to focus on only one factor that will make it easy for them! And that results in erratic actions that go in whichever direction and do not support our corporate intents!” He pointed to numerous examples where such sub-optimizing was carried to the extreme. Managers focused on controlling inventory turnover at the expense of acquisition costs, parts availability and service levels. Service and sales representatives expedited customers’ special orders in expensive ways without considering other customers, costs or disruptions of operations. Plant operators wanted maintenance assistance right away to maximize their own production without concerns for others. Higher level managers and directors also tended to pursue single objectives: the logistics director on several occasions demanded that production be rescheduled to facilitate bulk shipping to reduce logistics costs without regard for production costs, customer commitments and other factors.

Bob felt that his people were not team players – they did not collaborate, cooperate with each other or even coordinate their activities. They seemed to only be interested in their own responsibility area at the exclusion of all others and seemed to demand that everyone else would accommodate them. Bob was confused because these individuals were reasonable and flexible in other ways and he could not understand their work behavior. When approached, they readily agreed with him the need to deal intelligently with dilemmas and balance requirements of affected departments and operations. But when they needed to decide and act, the broader perspectives seemed to be forgotten and that impacted the effectiveness of the whole operation. Bob could show that the unilateral behaviors cost Bromley money and affected its customer relations.

What then, was wrong? Since Bob was at a loss, he asked June Cousins, a Human Resources Department psychologist, if she could help. June took time to observe several people for hours and talked with them about what she had observed. It became clear that in most cases people engaged in operating decisions and situation-handling that had aspects of uncertainty in addition to multiple competing objectives. Information was often limited or inconsistent and judgment was required to interpret the situation. Typically, situations presented dilemmas by requiring balancing tradeoffs between conflicting objectives. Common tradeoffs were needed for many kinds of situations such as between scheduling competent teams for night or week-end shifts while also accommodating personnel requests, between production expediency and product quality or between minimizing short-term costs and building for the future.

Most found it difficult to make balanced, real-life decisions under such circumstances. Nearly all the decisions June observed also required quick resolutions. Hence, they were personal situation-handling cases that made it difficult to collaborate or use computer-based decision aids. Instead, they relied on the mental models held by experienced personnel. Furthermore, people handled most situations from concrete or, if they could, from routine points of view. That is, the decision makers attempted to frame situations from immediate and operational perspectives without considering decision implications related to other objectives such as those associated with other departments or longer term effects. In effect, the decision makers tended to quickly focus on “first-order objectives” and put “second-order objectives” aside thereby creating single-objective situation-handling cases.
June discussed her findings with Bob who became concerned. If this was how experienced people behaved, how could Bromley expect the balanced situation-handling needed for smooth and competitive performance? June suggested three reasons for people’s tendency to simplify:

1. In general, most people tend to build practical mental reference models – expertise – that reflect immediate and concrete situations in which they are engaged and can observe. Unless otherwise assisted or engaged, they do not observe, nor understand, implications or secondary effects outside their direct operations or those that appear at a later time.

2. Within Bob’s operations, most had limited understanding of Bromley’s intents and strategy. They did not appreciate how their own actions were part of implementing the strategy or how they would benefit personally from achieving the strategy successfully. Hence, they were not motivated to observe or in a position to judge how past or present actions affected broader objectives. Their focus was mostly on the immediate operations.

3. While most people to some extent generalize and identify patterns when engaged operationally in complex situations, they do not appear to build mental models that can be referenced at later times. That is, they tend to not build scripts, schemata and procedural and declarative metaknowledge. Therefore, they become limited in their ability to make balanced judgments and decisions when similar complex situations occur.

June suggested that things did not need to be this way. She referred to other organizations that assisted their employees to build mental approaches to generate and implement balanced actions when handling complicated situations. That could also be done within Bromley. What was needed, was to help employees understand the company’s strategy and intents and how that related to their own work. To make that understandable, it would be needed to engage in extensive discussions and furnish material that included example cases – histories – to facilitate quick mental model development. In this way the employees would be motivated and able to consider higher order implications of actions and other changes.

In addition, people throughout Bromley needed to develop integrative perspectives and be encouraged to break down the existing silo mentality. They should be encouraged to learn more about operations adjacent to their own by networking, and if possible, by temporary personnel rotation. They needed to build understanding and appreciation for the wider workings of the corporate system. Only then would they be in position to judge higher order effects. However, that would not be enough. People also needed assistance to build methodological understanding of how to deal with uncertainties and conflicting objectives. That, would best be done by approaches such as workshops and management simulation games. These did not need to be expensive but could be performed in many ways like teams that competed during lunch hours with computer-based games. Other approaches would require costly off-site sessions.

Comments: By monitoring situation-handling effectiveness, Bob Taylor found that employees needed better approaches. Bromley undertook a thorough analysis to determine the underlying factors behind the lack of balanced decisions and found that corrective actions were needed to help employees use better methods. By observing their decisions, it was found that people needed educational support to develop better strategies to improve multiple objective situation-handling.

The knowledge-related aspects in this case included the need to help employees understand the enterprise strategy and direction. They also needed to build automatized methodological mental models to deal competently with situation-handling dilemmas.
Enterprise Governance Competence and Perspectives

The perspectives and competence of enterprise governance covers a very wide range. It stretches from monitoring of ethical governance of the enterprise’s observation of its societal responsibilities, to monitoring of the way it treats its employees and to the monitoring of the effectiveness of its internal operations. In all cases, the effectiveness of governance is given by management’s philosophy, breadth of insights and ability to determine practical ways of achieving the desired behaviors. One area that often is indicative of management’s posture and perspectives becomes apparent when a situation requires damage control as in the following illustration:

Execute Effective Damage Control after Product Failure in the Marketplace

Luis Galvis, president of Fancy Foods, received a late evening phone call from Stirling Way, his VP of Sales with bad news. Several people in Chicago had acquired food poisoning apparently from eating Fancy Foods gourmet liver pâté. The potential link between the liver pâté and food poisoning had been determined by the Chicago Department of Public Health which continued to pursue the matter. The CDPH had not verified contamination in pâté samples acquired from stores but that did not exclude that other batches could have problems. At the time, it was not clear which batches had been sold in Chicago or the identification of the batches that might have caused the problems. Nor was it clear that Chicago was the only location of food poisoning.

Luis decided to spearhead the situation-handling to determine what Fancy Foods would do. Although it was not clearly established that the pâté was to blame, any doubt about the integrity of the company’s food would affect its image in the marketplace. Hence, Luis wanted to be proactive, pull whatever products were at risk and let the public know what was being done to ascertain that its products offered for sale were safe.

The Georgia plant was the only source of liver pâté and Luis immediately contacted the plant manager, laboratory director and the plant’s logistics manager. Together, they started to identify if any recent pâté batches had shown even marginal signs of contamination. They identified which batches were sent to Chicago and started the process to recall them. Just after midnight, Luis wrote a short press release that described the steps Fancy Foods was undertaking to prevent further illnesses and transmitted these to Chicago newspapers and as a general press release. The press release stated that albeit a firm link had not been established between the pâté and food poisoning, Fancy Food had taken immediate preventive steps. Fancy Foods also asked anyone who had experienced illness after eating its pâté to let them know about it and, if possible, submit the packaging and any remnants for examination.

Over the next days, Luis and his team collaborated with CDPH and reported to the press which steps continued to be taken. As for the source of the food poisoning – it was discovered to indeed have been caused by Fancy Foods liver pâté. But the pâté in question was an old and outdated batch that a small food store had discovered in its warehouse and sold by mistake. No contamination was found in the regular product. Fancy Foods received positive press and market responses for its actions.

Comments: Fancy Foods executives decided to not lose any time whatsoever to respond and to ascertain that its products were safe and that the marketplace was fully informed.

The knowledge-related aspects in this case rests on the president’s and company’s management philosophy and the shared understanding of how to follow up and take steps to implement the philosophy intents in difficult situations.
The Vigilant Knowledge Company Example

Paul Horner, Chairman, President and CEO of Palmera Corporation was delighted with the performance of his company. Palmera was the world leading manufacturer and supplier of high technology consumer goods and had been able to increase its competitive lead through smarts and dedication. The company was known for its innovative research and development that often were made into market-ready products faster than any of its competitors could match. Yet, Palmera employees did not seem to work harder than anyone else. Instead, they seemed to enjoy themselves and achieved a balance between their work lives and private lives that others could only dream about. How did they do it?

Palmera is a company with a Century-long history of adapting to new markets and challenges by proactive thinking and an internal culture that has favored expertise, innovation and daring flexibility, fairness, and a strong sense of family. When Paul became CEO a decade ago, he supported these values implicitly but decided to make them explicit and provide business reasons to back them. On top of his agenda he placed the goal for Palmera to be a combined Global market and product leader, which was ambitious since Palmera was breaking into new products.

Paul, with supported and assisted by his management team and Board of Directors stated Palmera’s intentions by outlining principles for management beliefs and company and personal competence objectives that can be summarized as follows:

Management Belief-Related Principles

- Maintain respect for the individual – whether an employee, business partner or customer – means open communication, fairness, mutual trust and learning from human differences.
- Strive to achieve balance between work content and personal interests and needs, and the impact of that balance on employee well-being in order to maintain work-life balance according to employees’ changing needs and life situations.
- Palmera will pursue approaches to treat people with dignity and opportunities based on the strong evidence that organizations experience a 30 to 40 per cent productivity advantage when they treat their people “right.”
- The four fundamentals of the management philosophy are: Palmera Values, Achievement-Based Recognition, Professional and Personal Growth, and Work-Life Balance.
- Stakeholders are: Palmera as an operational entity, employees and their families, customers, shareholders, suppliers and other contractors, non-governmental organizations, governments and authorities, and citizens where which Palmera operates.
- Palmera’s impact on society comes with responsibilities that go beyond providing useful, safe and quality products. By conducting business in a responsible way, Palmera can make a significant contribution to sustainable development and a strong foundation for economic growth.

Company and Personal Competence-Related Objectives

- Employees are persuaded to develop understanding what is expected from them, how their individual achievements support Palmera overall strategy, and understand how they benefit and are rewarded as a result. Employees are motivated to be responsible for their own development and take advantage of the available development opportunities that Palmera provides.
- Continuous Learning encourages employees to develop themselves and find ways to improve their own and Palmera’s performance. Employees continuously look for ways to develop themselves to stay at the forefront of technological development, share experiences, take risks and learn together.
- Continuous Learning is not just studying and training, it includes that people support each other’s growth, develop and improve their relationships through common exchanges and development of ideas and open discussion and debate. On-the-job learning is also heavily encouraged.
Coaching is regarded as a vital part of continuous learning and provides role models and opportunities to build mental reference models.

Participating in different teams fuel employees’ development provide them opportunities to share ideas and goals with innovators and industry leaders.

Employees are encouraged to improve their competencies through changing their positions. The aim is to give Palmera people the opportunity to manage their own careers.

Foster personal growth in a challenging environment with clear visions, goals and shared management and operational principles.

R&D’s five rules for competitive innovation: Spread people around to maximize interaction opportunities; Keep teams small to allow all voices to be heard – listen! Use flat hierarchies to minimize bureaucracy; Encourage unusual (“crazy”) ideas beyond normal boundaries – celebrate tinkering and side projects; Welcome mistakes – if there are no mistakes we don’t push the envelope hard enough!

The company and personal competence-related objectives in effect rely extensively on active pursuit of new generation knowledge management (NGKM) which is practiced widely, deliberately and systematically throughout Palmera. However, the term “Knowledge Management” is not used, at least not officially. Instead, the active management of knowledge – development of personal and structural knowledge and intellectual capital (IC) and associated innovation and competitive quality of work are considered to be a natural and integrated part of Palmera work-styles and culture.

The Global Leader Example

Solitus Inc. is a medium sized company that develops and produces high technology non-military devices with associated software capabilities for industry and governments. Solitus has technical and manufacturing operations in North and Latin America, Europe, Asia, Africa and Australia. Apart from its focus to remain a successful market leader in its field, Solitus considers it strategically appropriate and beneficial to support and improve the societies and environments in which it operates.

In an annual “town meeting” with the presence of more than 1,000 world-wide employees and with video connections to all major facilities, Hans Schelling, Solitus’s Chairman and CEO described the company’s direction in the following manner:

“During the last year, many of you have joined our ranks and I would like to talk to you about how we operate and perceive ourselves since we find it to be imperative for our success that all of us understand, agree, and believe in what Solitus is all about.

To begin, let me state some basic beliefs on which the Board of Directors, the senior management team, and many throughout the company agree. We believe that corporate excellence and success in the global competitive environment is secured by a knowledgeable, collaborating, motivated, energized, and ethical workforce that is compensated well, has growth opportunities, and is proud of its accomplishments. We believe that a workforce can be effective only when treated equitably and with respect, allowed to exercise its capabilities, and when its members enjoys good personal lives. We believe that for long-term survival, we must not only learn faster than our competitors – we must innovate faster than they do. We believe that misalignment between corporate direction and personal goals leads to ineffectiveness. We believe that greed, politicking, bureaucracy, and dishonesty are counterproductive at any level of the company.

Our intent is to continue to make Solitus a very different company. Therefore, as during prior years, our main objective has four separate thrusts and they are:

To encourage and support world-wide employee mentalities and cultures that make you, the employees proud to work with (not for) Solitus in ways that you find to be challenging, interesting, fulfilling, and promising – and that energizes you to engage to make your work effective in all respects and closely
aligned with Solitus’ purpose. You are our brains and you implement each and every action and we rely upon your expertise, motivation, and conviction that ours is the right approach.

➢ To make our customers select us as their preferred supplier as a result of the quality and cost/performance of our goods and services and the manner in which we treat them. Our customers must trust us and realize that they can work with us to receive the best available.

➢ To build broad capabilities and good quality of life in the communities in which we operate. That means that we will work actively to assist the building of educational capabilities and societal facilities of many kinds. Particularly in developing nations, we will provide better salaries than our competitors to attract the best talents and we believe that World-Wide we need to compensate people equally according to their contributions although adjusted to local conditions.

➢ To sustain our performance so that it is consistently durable – profitable in the short-term and successful in the long-term with secure reserves to buffer unexpected setbacks. We will achieve this by being diligent and effective and being willing to take risks to advance our leadership. We will always be ready to tackle unwelcome surprises. We cannot afford to be vulnerable since we are serious about our responsibilities to you, our employees or our other stakeholders, particularly our customers.

This philosophy brings many conflicts. Because, we also believe in the basic right of each human to live a worthy life. However, there are many ways to achieve these objectives. On the personal level, we need to make it possible for you to achieve an attractive balance between your work life and your professional life. At work, we need for you to understand the goals, intents, and strategy of our company down to the level where you specifically and instinctively know how you can participate in achieving these purposes. And, very importantly, we need for you to agree with these purposes and feel that they are right and that you will be proud to pursue them.

On the company level, we must be honest and operate with highly ethical principles and provide a safe environment where we can deal openly with opinions, criticism, and ideas. We must be equitable in our dealings with you, the employees, with customers, with suppliers, with owners, with all other stakeholders whoever they are. We must participate actively in supporting this society and communities and the environment in which we all live. We must provide products and services of which we can be proud. We must be profitable and provide financial results that satisfy our investors, make it possible to compensate you appropriately, and satisfy all other stakeholders.

There is more. We must make it easy for each other to conduct work. That means that each of us must find ways to build personal knowledge and increase our structural intellectual capital since these are basic pillars that make us able to be effective and excel. We must develop concrete personal knowledge to deal with routine work and highly abstract knowledge to handle novel challenges and difficult assignments. We will help you!

We must transfer all possible personal knowledge to structural knowledge so it can be available for general use to everybody’s advantage. The ever-increasing personal knowledge base must be complemented with intelligent work aids, excellent and relevant information, and availability of advanced and easy to access structural intellectual capital assets. All of this will make it possible for us or to work effectively and to innovate in ways that will make our company the very best. It will also make it possible for all of us to work smart, and not to work unduly hard. By being knowledgeable and by understanding what we need and want to do, by cooperating and collaborating to achieve shared goals, and working with systems and procedures designed to help, as well as providing prudent but not restrictive controls, we will be able to do our work by exerting little effort and feel that much of what we do is both natural and second nature.

We must be critical of inappropriate and unethical behaviors by our coworkers, superiors, and subordinates. We shall have zero tolerance for unacceptable behavior and actions and must observe the laws of the countries in which we operate. There will be no room within Solitus for those who want to pursue different agendas. However, while observing strict principles, we must remember that situations
are not always what they appear to be at first glance. We need to be flexible and allow pursuits of approaches and opinions other than our own.

We must accept risky ventures and actions as long as they hold beneficial promises. At the same time, we must accept that risky ventures can fail without faults of the people involved. In other words: “We must push the envelope and think outside the box!” We must be prepared to enter areas where no one has been – even areas where others have failed.

One more thing. Our company should not be a command-and-control or top-down company. Nor should it be a bureaucratic silo organization where communications are restricted to “channels.” We must be open to suggestions, disagreements, and supportive comments from everyone to anyone. Personally, I will be glad to receive inputs – just make them short and to the point! The management committee and I need swiftly and regularly to learn about what works, what does not work, what could work, and relevant ideas for improvements and new directions. All of us need to work together to innovate faster than our competitors! And, the people who often know best are those who are close to the action.

These are our goals but it will not happen automatically. Nor can we expect all of this to happen flawlessly. But by working together, let us continue on the path that we already have chosen – and let us excel, both as a company and in our professional and personal lives!

Thank you!”

As a result of its management’s efforts to build employee capabilities, understanding, and agreements, the company has a highly capable and motivated workforce. It continues to be the leader within its market niche, constantly providing new or improved products and services. It is profitable in the short-term and has built considerable reserves to ensure long-term survival.

Solitus is a leader in engaging in social and cultural activities in all locations where it operates. The company supports community initiatives and for example has policies to support its employees to participate in activities such as tutoring in public schools on company time. It provides company-based health services and daycare and provides flextime work arrangements. Every year, Solitus employees consistently work fewer overtime hours compared to its competitors and other high technology companies. Solitus is considered to be the preferred employer and has a low personnel turnover with the result that workforce expertise has grown to become high and well distributed.

Hans Schelling and his management team are convinced that the company’s performance and success is a result of its management philosophy, principles and objectives and plan to continue to build Solitus strategy on this foundation.

**Examples of Strategic Benefit Expectations:**

The enterprise will build an increasing competence to provide improved enterprise service paradigms and ability to produce and deliver products and services with higher knowledge content than previously possible. This may be achieved by:

- Having knowledge workers who possess and have access to better applicable knowledge;
- Organizing work to facilitate application of best knowledge.

The organization will develop a broadening capability to create and deliver new products and services and a greater capacity to deliver products and services to new markets and can be expected to enjoy greater market penetration and competitiveness.

**Examples of Tactical Benefit Expectations:**

The enterprise should experience faster organizational and personal learning by better capture, retention, and use of innovations, new knowledge, and knowledge from others and from external sources achieved by:

- More effective knowledge transfer methods between knowledge workers;
- More effective discovery of knowledge through KDD and other systematic methods;
- Easier access to intellectual capital assets;
- More effective approaches to ascend Nonaka’s knowledge spiral by transforming tacit personal knowledge into shared knowledge (Nonaka & Takeuchi 1995).

and can be expected to lead to availability of more highly competitive knowledge.

There should be less loss of knowledge through attrition or personnel reassignments achieved by:

- Effective capture of routine and operational knowledge from departing personnel;
- Assembly of harvested knowledge in corporate memories that are easy to access and navigate; and –can be expected to lead to greater ability to build on prior expertise and deep understanding.

More knowledge workers will have effective possession of, and access to, relevant expertise in the forms of operational knowledge, scripts, and schemata and employees will obtain greater understanding among of how their personal goals coincide with the enterprise’s goals.

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**Knowledge Management Activities**

<table>
<thead>
<tr>
<th>Knowledge Management Activities</th>
<th>KBS-Related KM Effects</th>
<th>Internal Benefits &amp; Effects</th>
<th>Improved Deliverables</th>
<th>External Benefits &amp; Reaction</th>
<th>Bottom-Line Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>- Operations Focus</td>
<td>- Product &amp; Service Focus</td>
<td>- Customer &amp; Market Focus</td>
<td>-</td>
</tr>
</tbody>
</table>

**Example of how results from knowledge management activities propagate through event chains to deliver bottom-line benefits.**


**Examples of Operational Benefit Expectations:**

Employees will have access to, and being able to apply, better knowledge at points-of-action achieved by for example:

- Educating employees in the principles of their work (scripts, schemata, and abstract mental models);
- Providing knowledge workers with aids to complement their own knowledge;
- Training knowledge workers to operationalize abstract knowledge to match requirements of the practical situations they deal with.

These changes can be expected to lead to lower operating costs caused by fewer mistakes, faster work, less need for hand-offs, ability to compensate for unexpected variations in the work-task, improved innovation – just to name a few of the operational benefits that often are reported.

- Operational areas will experience less rework and fewer operational errors.
- The enterprise will achieve greater reuse of knowledge.

As a further illustration of how the enterprise may be affected by KM changes, we may consider the dynamic progression of effects from the initial KM activity until it has been translated into bottom-line benefits. The figure below shows the effects and benefits that can be expected from creating and deploying knowledge based systems (KBSs) to support production workers in a plant that manufactures high technology products.
Realization of most of the examples indicated above will require noticeable changes within the enterprise. These development will influence the culture which may change to promote greater initiatives and greater job satisfaction among employees. With increasing virtual organization operations, it will also tend to change the roles of permanent employees when outside expertise is imported with temporary employees.

**Find and Manage the Most Important Knowledge Areas**

The executive management of a large, high-technology engineering and manufacturing organization realized that the major value-added contributions to their products were derived from on their employees’ knowledge and expertise. The company’s technology could be viewed as manifestations of part of this knowledge and continued to increase in value as more of the employees’ expertise was incorporated. The company’s role was as marketer, designer, specifier of components to be manufactured by others, and as assembler and integrator of final products. Realizing this situation, executive management was interested in gaining an overview of critical knowledge throughout its organization in order to find the major knowledge areas that should receive management attention and should be strengthened to maintain the company’s advanced competitive position.

A small and highly competent multidisciplinary task force was assembled to survey knowledge and its use throughout the organization. The members had advanced degrees in technology, management, psychology, and philosophy and most were long-term employees of the company and well acquainted with all its operations. Information was gathered through several hundred comprehensive interviews with senior and middle managers over a period of one year. The main objective was to find the most important “Critical Knowledge Functions” and best competitive knowledge and relate them to the way business should be conducted in the future. Another objective was to determine potential management actions that would improve these situations. Scenarios were assembled of how the world could be expected to evolve and how business could be conducted in the future.

A large number of highly valuable areas of expertise were identified in individuals and teams and many critical knowledge functions were described. The areas of competitive expertise were analyzed further to ascertain that they would play a role in the corporation’s strategy and that appropriate plans for continued building were in effect.

Six general areas were found to be of enough importance to require top management’s attention. Additionally, many situations requiring middle management attention were also identified and outlined.

The six areas were:

- **Product design knowledge** - particularly, the knowledge associated with practical application of advanced theory to final products so these products would perform exceptionally well in the field in both the short and long terms.

- **Subcontract procurement knowledge** - in the areas of finding and developing competent contractors, and working with them to modify design specifications within allowable limits to obtain products with acceptable quality that could be produced in minimum time and at reasonable costs.

- **Manufacturing coordination knowledge** - to help manufacturing with early discovery and correction of potential production problems and to translate design specifications and requirements into manufacturable designs.

- **General personnel management skills** - in all levels of management to foster better esprit de corps and improved identification of up-and-coming technical and business leaders.

- **Information systems and computer sciences application expertise** - in both management information system (MIS) staff and user organizations to better conceptualize information technology uses to support business and technical operations and to help change the way of doing business.

- **Overall technical knowledge** - in professionals and labor, both on the theoretical and applied levels, with
particular emphasis on understanding technology in addition to obtaining in technology-use skills. Breadth of knowledge was also considered to foster flexibility and understanding of the tasks and problems of “adjacent” functions.

Based on the results of this survey, the company embarked on a focused program to improve knowledge in the six areas through formal education, internal courses, apprenticeships, and other modes of building skills, understanding, and expertise in relevant personnel. Top management created special budgets for this purpose and is now monitoring improvements and conditions on a regular basis.

In addition to identifying the most important critical knowledge areas, the team also explored ways to implement knowledge-based systems throughout the organization. It had collected sufficient information to allow an initial description of the system candidates and their potential benefits. This preparation allowed senior management to rank the candidates and set priorities for implementation of systems and to create a knowledge-based system development program.

The program has now been underway for several years. In addition to top management’s involvement with the six major knowledge areas, a large number of knowledge-based systems have been implemented and are in full operation with considerable economic and non-economic benefits.

**Conduct Strategic Knowledge Audit to Change Corporate Structure and Direction**

The top management of a large process company became aware that they are a “knowledge-based” company and that their major competitive advantage was the knowledge and expertise their people possess. They had never gained a good overview of knowledge assets and shortages within their enterprise and decided to conduct a comprehensive knowledge audit to set the stage for wide-ranging changes. A broad study was undertaken to survey and describe the condition of knowledge and relate it both to business and competitive situations in different areas and to its technology developments and opportunities. Knowledge was characterized in quite general terms, but coverage went into enough detail to describe knowledge use, business functions, and company operations. Several hundred operations and product lines were investigated and additional knowledge-intensive functions were analyzed.

Top management was surprised by the findings. In key areas of work, there were mismatches between those who possessed the knowledge required to get the job done and those whose function it was to do the job. Besides, people’s work contacts and their reporting relations were at odds with the required knowledge flows and with professional groupings that supported the most important areas of knowledge work.

It was also discovered that many pieces of key knowledge that would have significant competitive impact were missing. These gaps had never been brought to management’s attention, and in many cases it was not clear that anyone was aware of the situation; furthermore, no plans existed for developing the missing knowledge. Finally, there was no focus on, no comprehensive plans for, and little or no monitoring of the development, maintenance, and extended use of key expertise within the enterprise.

As a result of these findings, top management decided that several changes were required. Based on comprehensive considerations that resulted in a broad and integrated action plan, reporting relationships and professional groupings were reorganized. It was also found to be possible to simplify the organization and reduce management levels by spreading knowledge and delegating functions. Several R&D programs were revised and new R&D projects were established to develop some of the missing knowledge. Additional key knowledge was obtained through acquisition of a small company. R&D planning for the future was coordinated with marketing and management using a new “partnership model.” Human resource management had previously been responsible for general training and education coordination. This function was redesigned to serve the joint focus of technical-business-management, and tools were provided to maintain overview of the knowledge status, gaps, and progress in personnel and relate it to present and
future business needs. Finally, the overall strategic and annual planning process was augmented to include explicit knowledge perspectives. In this context, management reviews at all levels were revised to include knowledge perspectives. As a result, the company now continues to perform KM audits on a regular basis. The process company, to our knowledge, has not quantified the benefits from its KM program. Their management considers the benefits they have obtained to be strategically very important. There have been indications that the efforts have made the company much stronger both from competitive and financial points of view.

Build a Knowledge-Based System to Exploit the Value of Proprietary Knowledge

The marketing department and executive management of a medium-sized financial institution had explored new product opportunities for their marketplace. They identified that the institution had expertise in financial planning for individuals and that this knowledge potentially could be leveraged further if made available to the public at large. It was decided to harness the knowledge assets by building a large, sophisticated knowledge-based system (KBS) to provide financial planning services for families with average incomes. Where new conditions made prior knowledge invalid, the available expert knowledge was elicited and codified and was augmented with new research. A new subsidiary was created to provide the service to the marketplace and to operate and maintain the KBS.

The direct effect of offering the new service was to build a considerable customer base. Revenues from the services paid only for variable operating costs of the new subsidiary. However, a highly valued side benefit was the new knowledge that was developed and codified to develop the knowledge base for the system. This knowledge was considered priceless for having changed and improved the way financial planning was performed. Although the immediate bottom-line benefits were few, the long term objectives were to improve the institution’s corporate image and to attract new customers for its other services. These benefits seem to be realized and the whole project is considered a success.

Value-Buy

Value-Buy is a large retailer that has numerous department stores each selling thousands of different kinds of items in many lines of merchandise. New products are constantly introduced and consumer preferences are changing as a result of these and other factors.

A new line of merchandise is considered for introduction by Value-Buy. In order to learn more (i.e., build additional knowledge) about its potentials Dana Stint, the marketing manager in charge of the project, decides to undertake a market research study. To obtain knowledge about the potentials of the line, Dana surveys a sample of consumers by using focus groups to create new knowledge about their preferences; she hires a senior professional from a competitor to import knowledge, and she test markets the line in a Midwest store to observe how it performs in the real world.

When Dana has assembled all inputs, she and her team start to analyze what has been learned by extracting and abstracting important and salient aspects of the collected information to identify patterns in preferences and potential relations to consumer behavior. They synthesize the lessons-learned by generalizing observed patterns and relations to hypothesize potential consumer behaviors. They verify the hypotheses and test them to verify that they represent valid concepts. They reconstruct valid hypotheses and relations into a coherent and consistent model. They combine and corroborate the new insights with what is previously known to consolidate the knowledge into a congruent whole.

The knowledge Dana and her team have gathered is organized to serve as support for the merchandising operation with explication of expectations to provide judgments for monitoring performance and managing
local customer response. Finally, the new knowledge is documented and encoded into a set of training materials and reference manuals for use in the field.

**Example of Holding Knowledge**

A metals company specializes in making high-performance alloys for numerous purposes. To become a leader, it has conducted extensive research and developed many proprietary recipes and methods for making the products. It has built an impressive body of knowledge in this area and is considered to be the best in its field.

The company has cumulated its knowledge in this field over a long period and holds it in many forms. Some are quite permanent, some are transitory and even vulnerable to loss. Some of the knowledge is documented and held as research reports and technical papers, some is held as production recipes, operating procedures, and established practices, while some is not documented directly, but alluded to “by reading between the lines” of many of the reports and papers.

Other parts of the knowledge may be embedded into databases. A particular knowledge segment has been elicited from experts and modeled and encoded into the knowledgebase of a system to be available for later consultation and pooling of knowledge. Some, perhaps the major part, of the higher-level and general knowledge and certainly the vast majority of the detailed know-how is held in the minds and memories of experts who know particular aspects of the field and know the practical aspects of making and developing specialty alloys with different properties.

All this knowledge is held by the organization in documented or automated repositories or in people to be available for future uses -- to make alloys for customers, to develop new alloys, or to continue to create new knowledge about alloys through research and development. Ideally, the knowledge should be available for each new application and customer situation.

**Illustration of How Knowledge Can Be Pooled**

Tracy Smith is a young commercial loan officer in a large bank who works with a small service company to determine the magnitude of the credit line they can be given. She finds that the service company has significant market strengths and opportunities, but also shows some severe internal weaknesses. She feels that the situation is beyond her present knowledge and decides to pool her own knowledge with knowledge from the bank’s experts and other sources.

**Illustration of Applying Knowledge**

José Fountain is an expert mechanic who encounters an unusual and critical problem in the form of a broken bolt inside the transmission he is repairing. When he finds the broken bolt, he decides that the scope of his task, and hence his responsibility, covers repairing not only the main fault in the transmission but also any ancillary problems, such as the safe removal and replacement of the bolt while determining why the problem occurred in the first place.

José approaches the problem by gathering information to diagnose the situation as he examines the bolt remnants and uses his knowledge to analyze what he sees. As he analyzes, he also synthesizes options for how to attack the problem with the tools he knows are available and other options that he knows about. After having gone through this process, he decides what his best option is and proceeds to implement it by executing the subtask of fixing the problem with the broken bolt. He removes the bolt remnant in a way that leaves the internal threads undamaged, and he can now proceed to implement the other subtasks.

With less knowledge, the mechanic may well have destroyed the threads and made the situation worse. As
the expert works with these kinds of problems, he often encounters situations that are different from what he has experienced in the past. By transferring his skills to the new situation, he can learn new approaches and obtain new knowledge that he can hold for future reference. He may also decide that there are smarter ways of attacking the situation, in which case he may innovate and create new ways of performing the basic tasks and create new knowledge.

Example of an Aggressive Learning Organization

An aggressive service company in the United States works hard to stay ahead of its competitors. To achieve this objective, its managers deliberately wish everyone to learn as much as they can about its customers, its competitors, the effectiveness and performance of its products and services, what can be expected in the future, and everything else that may be of importance. As a result, the company makes available what has been learned to everybody who can use this knowledge and provides incentives to ascertain that it is put to good use.

Consistent with this approach, the company has adopted formal perspectives of what they need to learn; how they wish to learn it; what they already know, how well suited and organized that knowledge is; who has the knowledge; where the knowledge is needed; and how to get it there. The company has implemented an impressive training program to distribute the knowledge to all who can use it profitably. Every employee spends one half day every week learning -- an impressive 10% of their total work time! -- in formal training or in anyone of many other knowledge building activities. Education and training occurs at several levels. On the most basic level, knowledge about jobs (i.e., task execution, products, services, and so on) is taught to knowledge workers. It is also continually codified and updated into training program formats to provide employees with the latest skills to perform their functions proficiently. On a higher level, employees are provided with education to learn broader aspects and underlying principles of such areas as their industry and how to deal with people and the world in general. On yet a higher level, all must participate in special programs that provide insights into “knowledge about knowledge,” that is, they learn how to view the knowledge they have and how they should use it, how to organize what they learn, how to learn on-the-job, techniques for problem-solving, and so on. They are taught both theoretical concepts and practical methods for these areas.

On a different level, the company works to ascertain that the knowledge is used. It provides incentives to facilitate use of the best and most advanced knowledge available. Further, it embeds what is learned in the design of its products and services and incorporates selected aspects of what has been learned into its systems and procedures in ways that allow relatively quick updating when required. The company strongly promotes the notion that “Excellent knowledge that is not used is worthless knowledge.” The company has achieved a reputation for having the most responsive, cooperative, and knowledgeable service representatives in its business. Besides, it is recognized for being very flexible in its response to customers and for having the most up-to-date and best performing products and services within the industry. The company is very profitable and is also dominant in its market.

Deductive Reasoning

When we reason deductively, we accept one or several premises to be true subsequently and deduce a conclusion that follows logically from the premises. We may use “true-false” logic, which can work in several ways. (We may also use qualitative logic as explained by “fuzzy logic.”) A form of deductive reasoning frequently used in daily life is syllogistic reasoning, where we postulate (or less formally: “have in mind”) two
premises that lead to a deduction. A well known example of deterministic syllogistic reasoning is the following:

Premise 1: “All men are mortals.”
Premise 2: “Socrates is a man.”
Conclusion: “Socrates is mortal.”

Our existing knowledge forms the premises and in those cases where our knowledge is explicit we can often represent these premises in deductive reasoning with “if-then” rules. In terms of the example above, this would lead to if-then rules such as:

Premise 1: If (the object) is a man; then (the object) is mortal.
Premise 2: If (the object) is Socrates; then (the object) is a man.
Conclusion: “Socrates is mortal.”

Simple Data-Driven Reasoning with Declarative Knowledge Items.
The conclusion remains the same. When we reason about a situation, we use deductive reasoning to generate new facts and to deduce conclusions from what we already know and from information (facts and truths) about the situation under analysis.

In many respects, deductive reasoning is safe, well-considered, but dull and not at all innovative. However, it is a very necessary reasoning mode, not least when we are subjecting innovative and creative propositions, hypotheses, and visions to the test of reality. In addition, deductive reasoning is also frequently embedded in the more complex reasoning approaches.

As shown in Figure, a number of declarations can be combined to arrive at a conclusion through deductive reasoning when an investment situation is presented. In this example, the information about the situation is shown as rectangles, prior knowledge as declarations in irregular shapes, local conclusions without frames. The final conclusion is shown in the bottom right corner.

The reasoning shown in this figure is “data-driven,” that is, the data available on the investment opportunity drive it in a “forward chaining” reasoning process to generate the conclusion. As indicated, there are no uncertainties present so the reasoning process is deterministic. The various input data are paired with the appropriate declarations to generate a local conclusion, which then can be used deductively later in the reasoning process. People often reason in this deductive manner. However, we do not always reason as clearly and crisply as this. Most often, we reason with “fuzzy” concepts and under considerable uncertainty. In addition, if the premises and facts are not congruent, we are often willing to make “reasoning leaps” which may lead to rather shaky logical inferences.

The declarations in this simplified example are chosen to reason about conclusions that pertain to the specific goal of identifying if the proposed investment is acceptable (i.e., should it be funded). The underlying goal is dual: “to seek the pleasure associated with making good money while avoiding the pain of investing in a losing situation.” In this case, an expert provided the source knowledge and identified the declarations that should be included in the reasoning situation. The total reasoning situation was much larger including almost one thousand declarations.

**Inductive Reasoning**

In inductive reasoning, we try to see which underlying principle or new conclusion may support our observations. We use inductive reasoning when we generalize and learn about the world. We collect observations to see similarities or create patterns that we then can use as bases for generalizations or hypotheses. This is how we organize and structure our observations about the world and build new concepts, beliefs, and expectations for what the world is like. We use inductive inferencing to create general rules or specific conclusions from examples and patterns. We also use inductive reasoning, as indicated below, when we want to explore new opportunities and create new solutions.

When we reflect over what we know and explore how things are, we generate new knowledge and conditions from existing knowledge and information about the situation that we think about. As discussed in the previous chapter, inductive reasoning plays a central role in learning by humans of all ages. It also is a foundation for construction of scientific theories. A simple example of inductive reasoning is:

“Our customer has given us a large order this week.”

“He also gave us an unusually large order last week.”

“We are his only supplier of these products.”
“I suspect that his business has increased and I therefore expect that we will get a large order next week as well.”

In this case, it is clear that the conclusion of inductive reasoning is not certain and that we are not in a good position to generate a new hypothesis with a high degree of validity if the customer’s demand has really increased, he may be in the process of lining up another supplier, or he may only have experienced a temporary increase in demand. Nevertheless, we may be prepared to act on our hunch. At times inductive reasoning may lead directly to inappropriate conclusions. One such example is:

“I’ve seen that all cats have four legs with claws and a tail.”
“All dogs I’ve seen also have four legs with claws and a tail.”
“I know that dogs and cats are mammals.”
“I therefore, conclude that all mammals have four legs with claws and a tail!”

For those who have seen other mammals, this conclusion can be disputed with some success since we will know right away that horses and cows do not have claws. A similar inductive reasoning script was followed by a major company working overseas:

“I’ve seen that all construction projects in that country have big profit margins thanks to the built-in contingency factors.”
“All the management consulting projects I’ve seen there also have big profits and they did not know their extra costs either.”
“I know that the construction and management consulting projects are so different that together they can represent projects of all kinds.”
“I therefore, conclude that the computer project we are bidding on in the country also will have big profits so let’s reduce the contingency factor and lower the price to make sure we get it!”

Unfortunately, the situation did not turn out that way and led to a large overrun.

Induced conclusions based on observations that are only partially representative of the total domain they aim to represent can lead to hot debates and arguments, but are nevertheless frequently encountered. Even careful professionals and experts fall into the trap of reasoning with insufficient observations and are led to wrong conclusions. We have often found that “expert knowledge” in difficult-to-observe situations, such as chemical process operations or personnel management, contains numerous erroneous conclusions that have resulted from inductive reasoning based on observation samples that are too limited or reasoning leaps that are too broad.

By use of inductive reasoning, we can never prove that a conclusion is correct. We can, however, disprove a hypothesis with it. Yet, inductive reasoning with broad leaps is very innovative and can lead to significantly creative propositions with great merit. We just have to apply prudent reality tests to ascertain that the new propositions “hold water.”

Inductive reasoning is the formal method used by many automated systems that use artificial intelligence techniques to construct crisp if-then rules automatically from examples. To some extent, this type of reasoning is the basis for “machine learning.” Inductive reasoning also forms the basis for learning by induction and for unsupervised learning by observation and discovery as discussed in the previous chapter.
Abductive Reasoning: Creative People Use It to Get Better Insights Fast!

The reasoning examples examined above have limited relation to real-life. Abductive reasoning (Peirce's abduction) is a form of inductive reasoning that is more powerful and realistic and can involve large leaps of faith. Over one hundred years ago Peirce proposed: Buchler “The first stating of a hypothesis and the entertaining of it, whether a simple interrogation or with any degree of confidence, is an inferential step which I propose to call abduction or retroduction.” Abduction is the creative hypothesis-formation process that we use when we follow a hunch or jump to conclusions without sufficient evidence in the form of information or knowledge to make a proper, step-by-step inductive logic chain. Instead, we appear to use abstract mental models, conceptual associations, and relational links to generate intuitive conclusions and explanations for the goals we seek or to generate new designs. We often seem to abduct when we generate new creative notions.

Abductive reasoning is very much the generative aspect of creative “generate-and-test” problem-solving strategies. It appears to be the thinking strategy we use most frequently when we solve problems or engage in general discourse where, for lack of time or information, we cannot cover each logical step. It is also very useful for reasoning with qualitative knowledge, which constitutes the majority of what we know. By using “enlightened abduction” we skip reasoning steps by guessing at what may be a reasonable immediate or end result. When we skip too many reasoning steps, we often end up being wrong. Even when we are right, we have great difficulties stating our position to others with any degree of confidence and clarity, and our argument may be considered invalid. A simple example of abductive reasoning is:

Premise 1. “This order is very large. Do you know who placed it?”
Premise 2. “No. The only customer I know who has a warehouse big enough to store that much is Calamity Industries.”
Conclusion. “I think the order is from Calamity.”

In this example, the conclusion may be far from certain and this type of reasoning may lead to inferences which actually are assumptions that will need to be reality-checked before they can be adopted as truths. We also see that the knowledge used is qualitative rather than “crisp” or defined with precise quantification.

We use abductive reasoning extensively when we “search for solutions” while analyzing or diagnosing difficult and complex situations that we may not fully understand. In these cases, we may generate interesting and potentially valid trial hypotheses that are far from obvious and previously identified facts. We will entertain the hypothesis by searching for evidence that may support it and we may subject it to reality testing by looking for other evidence that would conclusively refute it. Clearly, abductive reasoning is not without “uncertainty.” Instead of statistical uncertainty, however, abductions introduce questions about the plausibility of the proposed conclusions. We also use abductive reasoning in discussions and when we attempt to prove a point that we are not quite certain about or when we want to “stretch the truth.”

Analogical Reasoning

Analogical reasoning is the reasoning process we follow when we formulate hypotheses based on how similar a premise or conclusion is to patterns and situations we know from previous experiences. Also, analogical problem-solving is often used by human experts. It is frequently encountered by knowledge scientists when they analyze how decisions are made and knowledge work is performed, or when they elicit and
model expert knowledge. An example of analogic reasoning is:

“We have a situation here where the Bluegills are exposed to spoils from the channel dredging.”
“The spoils include a large amount of silt and a small amount of heavy metals.”
“The Bluegills are similar to Smallmouth Bass and a thorough study made of Smallmouth Bass indicated that it was badly affected by a situation somewhat like this.”

Conclusion. “I am sure that the Bluegills will be adversely affected by the dredge spoils.”

**Associative Reasoning**

*Bill Jones is setting out to plan the requirements for building a new distribution facility. His task is to create the initial schedule and budget estimates and identify the major functions that must be included. Given the specifications for the facility, he identifies the major project phases from his general schema for other facility projects and includes the players for designing, construction, and equipping. Bill has not planned for a distribution facility before, and while documenting and specifying the major phases, associations surface in his mind to other activities that need to take place according to some experiences he has had and according to what he thinks is required for the situation. With the project start, he associates early permit applications, ordering of long-lead-time items, hiring and training of operating personnel, and many other activities. His reasoning about which items to consider, their importance and impacts, and how they relate to the project are mainly through associations. Bill uses associative reasoning to plan the project.*

Associative reasoning is another powerful thinking and reasoning approach and is related to analogical reasoning. We use associative reasoning when we transfer the reasoning focus from one concept to a different but associated concept and draw conclusions based on associations rather than logical premises. We often do so by building logical bridges and relations between concepts that we associate with each other, particularly when reasoning about situations that we are not intimately familiar with. Since associations are inexact relationships, the conclusions are plausible rather than definite.

When we reason associatively we are often led to new perspectives and new ways to define situations and problems. It is one of the great tools of innovation and creativeness. As a result, many approaches to teach innovation and creativity emphasizes analogical reasoning combined with associative reasoning with considerable success.

*Virgil Joseph is considering how to approach a very difficult customer who potentially could place an unusually large order if handled right. Virgil is apprehensive since this customer has a tendency to give him a real hard and unpleasant time. At the same time, Virgil associates the potential for success with real pleasures -- year-end bonus, excellent annual review, and recognition by fellow salesmen and superiors.*

*Virgil is torn. Should he try to avoid the unpleasantness and pain by forgetting about the customer or should he pursue the opportunity of success? He does not sit down to reason objectively about the situation. Instead, he lets his reasoning be directed by his subjective associations regarding the certain pain versus the less certain long-term pleasures. In the end, he decides that the pain is tolerable, particularly since he also would have some painful explaining to do if he chose to forget about the customer.*

Frequently, as in the situation Virgil faced, the associations that enter into our reasoning are not between concepts, but between the values we place on the potential outcomes from the actions that are considered.
Reasoning with Patterns -- Pattern Recognition

Patterns are reliable and usually observable samples of characteristics of objects, situations, or conditions. Recognizing and matching patterns ("pattern matching") is one of the most important reasoning methods that we have. It allows us to detect similarities and differences between complex situations where they often are quite obscure. We frequently need to determine if a particular pattern is present and compare it with others that we remember to establish if the two are similar.

People are very good at recognizing patterns. We work with visual patterns all the time and can recognize a particular person’s face or see that an object is a chair almost instantly. From this perspective, visual pattern recognition is a simple reasoning method that we all are born with. Similarly, we recognize aural patterns to identify words, and we can easily recognize if a person walks or runs. In reality, general pattern matching is exceedingly complex and involves many mechanisms that we do not understand.

Metaphoric Reasoning

We can also recognize patterns that contain wide varieties of abstract features. Thus, we can recognize if one situation is similar to another, if a behavior pattern falls into a known category, and how it may be characterized in order to be classified with other behaviors. We often employ pattern matching to see analogies and to draw associations.

Earlier, in the story about X’s daughter who looked for sand dollars in shallow water, we illustrated how we match conceptual patterns to identify and compare similarities between complex characteristics that often are highly abstract. That is an example of what has been called “metaphorizing” or “metaphoric reasoning.”

We rely extensively on complex pattern matching in analogic and case-based reasoning. We also use it when we categorize and cluster events, characteristics, concepts, and other mental objects and when we generalize concrete experiences to create scripts and schemas. It has been suggested that a highly developed capability to reason with abstract patterns -- metaphoric reasoning -- is indicative of, and a requirement for, expert and master proficiency. This is particularly relevant for the aspects of mastery associated with the ability to see situations from new perspectives (“reframing”) and identify approaches that may borrow from other areas. We often see metaphoric likeness when we reason abstractly to determine the degree of analogy between generalized cases. For example, we may use metaphoric reasoning simultaneous with analogic reasoning to exploit the content of pattern similarities.

Metaphoric reasoning is not without danger, however. Using metaphoric reasoning to see a situation as an analog of a previously known situation provides a single and limited perspective that often is valid in only a few dimensions. Therefore, we may be unduly influenced by the analogy we perceive and may end up with a conclusion of very limited value.

Spatial Reasoning

We use spatial reasoning almost all the time to identify where we are and where to go next. We do this by building, exploring, and traversing more or less explicit cognitive maps, models, or images of physical situations. Whenever we walk through a door, move from one room to another, or drive around town in our car, we use spatial reasoning to orient ourselves to project what lies ahead and to plan where we need to go to arrive
at our destination. As indicated in Chapter 4, however, the capability for spatial reasoning differs markedly from one person to the next. So do our approaches and representations.

Many people have significant problems building cognitive maps from their experiences and developing the path they need to follow, whereas others do so with great facility. Most people seem to use mental images of a situation or condition when they reason about it. It appears, however, that extensive use of such imagery is not automatically a precursor to good path finding in physical environments. Some individuals report using elaborate imagery and accurately memorized physical entities when reasoning about physical phenomena such as water running in and out of tanks. Yet, the same individuals can be poor path finders who often lose their way and may have problems orienting themselves in a new space even after they have studied maps and other abstract descriptions of the space.

One of the “intelligences” or cognitive styles suggested by Howard Gardner is “spatial intelligence.” There are many indications that a number of people have spatial representations and reasoning as their preferred mental mode. In the same way, others may prefer a verbal mode of thought and others yet an abstract, conceptual mode.

**Reasoning With Uncertainty**

We are faced with uncertainty in almost every situation. For example, the information we have in hand may not be accurate or specific aspects of the situation may not be certain. If we have measures of the uncertainties involved, say in terms of probability functions, we might -- at least theoretically -- use formal mathematically-based methods to incorporate and reason with this information in order to make unbiased conclusions.

Unfortunately, that is not the way in which we normally tackle such problems. Normally, we do not have sufficient information to determine statistical expectations -- even if we would be inclined to do so. Instead, we tend to introduce personal judgments of what the true information is and subjective interpretation of what the potential consequences are.

**Reasoning about Risks**

Several researchers have observed that people are ill equipped to reason under uncertainty. The intuitive reasoning that we engage in when faced with uncertainty is often based on easily used but quite fallible heuristics. When a person reasons about an uncertain situation and arrives at one of several possible conclusions, research indicates that when the person is more familiar with one conclusion than the others, s/he will tend to consider the better known conclusion to be more likely in spite of better information that may indicate the opposite.

Our judgments and interpretations invariably reflect our degree of risk avoidance and we can be very conservative if we try to avoid risks. Our statistical intuition is flawed and we also have difficulties in estimating the likelihood of uncertain events as repeatedly observed by researchers in the field.

This tendency has a profound influence on our perception of risks since we intuitively will assume that the risk is greater for those outcomes that we know more about or have recently been concerned with. We are affected when we think about situations and conditions or hear them mentioned in the news. And we will be more concerned about these situations or conditions regardless of their actual likelihoods even though we may have been explicitly informed about the statistical data.

Such behavior is often detrimental to good management. All of us may know of situations where during the risk/reward assessment of a potential project, one participant is reminded of a serious problem that befell
another project and led to its demise. Whereas that problem is highly unlikely for the present project, the participant proceeds to vividly outline the problem details with the effect that all concerned become convinced that the risk is too great and the project is canceled -- unwarranted.

**Case-Based Reasoning**

*Tracy Jimenez, AltCo’s senior Application Engineer, is approached by Unox Corp with a request to help identify if one of AltCo’s heat shield products can be used to reduce costs while improving quality in one of Unox’s furnace models. Tracy visits Unox and works with their engineers to identify the specifics of the application. As she analyzes the potential application she realizes that in many respects it is very similar to a rocket engine situation she worked with last year. In other respects, it is similar to an automotive engine application she is also familiar with. In both cases, some details are almost identical in addition to having more general characteristics that are similar. The solutions for both previous cases ended up using the same AltCo product, applied somewhat differently with very good operating results. Tracy’s approach to finding a solution was to identify the matching details and general characteristics from both prior cases. Together, they covered almost fully the specifics of Unox’s requirement. She designed an application approach based on the same product with modifications that fell between the two reference cases. Tracy used case-based reasoning to generate her solution -- and the solution worked.*

Case-based reasoning (CBR) is perhaps the approach used most often by people. It is primarily an analogical reasoning strategy that uses prior experiences and reference cases to interpret situations, solve problems, explain events, or generate reality tests and critiques of solutions.

We use reference cases that often are stored in our episodic memory for case-based reasoning. These cases are experiences that we abstract, characterize, and memorize as knowledge objects. The paradigm for the case-based reasoning strategy rests on the view that our minds work as follows:

1. The content of our memory is primarily experience.
2. Our memory is highly abstracted and characterized where concepts, mental models, episodes or reference cases, and other knowledge objects are connected by direct associations, priming associations, chunking and category hierarchies, and in other ways.
3. The structure and organization of our memorized knowledge objects vary over time. *Our memory is dynamic* and is updated and reorganized by new experiences.
4. Our reasoning is guided by our experiences -- our knowledge -- which we use to interpret and understand new situations and decide how to handle them.
5. Learning is motivated and driven by in response to new conditions that we have not previously experienced.

The objective with case-based reasoning is to: (a) analyze and interpret a new situation or condition; (b) compare (by pattern matching) the principles and characteristics of the new case with experiences that are memorized as part of prior reference cases; and (c) identify from experience how the new situation should be handled. By using reference cases instead of going back to first principles, we apply powerful shortcuts to obtain the desired results. We may choose from a wide range of case-based reasoning situations depending on how well the new situation matches previous cases and the degree to which we have abstracted or automated our insights into situations of this nature. For situations that we know so well that we have automated reference cases to routines, and where there is a precise match between the new situation and a reference case, we are in a position to directly apply what we know from the reference case, therefore, it becomes a simple issue of selecting which reference case to apply.
Clearly, case-based reasoning relies on many other reasoning strategies to match situations, interpolate between different cases, extrapolate beyond previously known cases, and extend by analogies and abduction as indicated in the table for the different types of situations. This reasoning strategy is simple only in its most concrete form when there is a precise match between the new situation and a memorized case. In all other instances, CBR is complex. It is particularly complex when it involves pattern matching of complex, abstract characteristics, interpolation, extrapolation, or explication of scripts and schemas to fit a concrete situation. In these cases, additional reasoning is required in the form of associative reasoning and complex approaches such as planning.

Reminding, that is associations triggered by priming memory when the new situation is characterized, plays an important role in case-based reasoning, particularly in nonroutine situations. In these less familiar situations, we are reminded of other cases that share characteristics with the present situation prompting us to start thinking about how we can apply what we learned previously. We also use reference cases to remind us about how to proceed, even in well-known situations.

Other aspects are also important when we perform case-based reasoning. For example, we use complex pattern recognition extensively to identify if the new situation matches one or several reference cases. We use our ability to interpolate between cases or extrapolate from cases to generate a mental case that is similar to the situation at hand. We explicate schemas and scripts to generate concrete and practical mental cases to understand and deal with the situation. And we use simpler reasoning approaches like analogic and abductive reasoning to extend known reference scripts and schemas to cover the situation.

Case-based reasoning is very powerful and allows us to handle exceedingly complex reasoning situations when we are generally familiar with them. This is an aspect of CBR that we need to strengthen in all people who work in our organizations by providing them with a good background of valid reference cases. CBR is not infallible, however. It is reported that some people use reference cases blindly without validating them for the new situations and just relying on previous experience. Thus, they rely on automatic reference cases and often show characteristics of “stagnated professionals.” Even proficient performers may be unreasonably biased by their reference cases and fail to examine the characteristics of the situation appropriately. Beginners have different problems. Because of missing experience, they do not reason well with analogies, nor do they have well-developed judgment to isolate those aspects of the situation they should focus on.

**Good Conclusions Require a Wide Range of Reference Cases!**

Knowledge workers must possess a broad range of reference cases to draw good conclusions in different situations and to be flexible and versatile. These must not all be highly specific and concrete in the form of routines. Most of them, particularly those that pertain to infrequent conditions or conditions with frequent variations, must be more abstract and general to allow the necessary flexibility and ability to adapt to new situations.

To provide knowledge workers with appropriate reference cases, they must be given opportunities to learn. They need to learn specific and routine cases through training and on-the-job operational experience. Equally importantly, they need to learn scripts and schemas for dealing with more general and flexible reasoning situations that they will encounter. The latter is best obtained through broad education focusing on general principles and an understanding of how to translate these principles into detailed analyses and conclusions.

**Case-Based Reasoning Is Valuable When Automated**

Case-based reasoning is not only performed by people. We have been able to create powerful computer-based CBR systems that serve many organizations as corporate-wide memory systems where important
reference cases are stored in knowledge bases to be retrieved when the situation calls for them. One practical advantage of this technical approach is that the description of the reference cases can be in free-form natural language and therefore, can be applied to a variety of different situations.

**Model-Based Reasoning**

*Henry Paulsen, ConloCorp’s CIO, is assembling next year’s information systems budget. He has concluded that he needs to reduce the development budget for the new purchasing support system by some twenty percent. He can take several approaches. He is not willing to cut people arbitrarily across the board since that will just delay the project. Besides, he may lose good people in the process. Instead, he has a model in mind for how to run the project in a totally different way. By introducing a new design philosophy, using fourth-generation languages, or even “object-oriented programming,” Henry thinks that he will be able to reduce the development time by more than twenty percent, keep the same people, and perhaps end up with a superior product.*

*As he thinks about his options, he uses his existing mental models to project how he sees the project develop: the major stages; their resource requirements; and the resulting deliverables. He pencils in times and costs for training, start-up, and all the other activities and finds that he indeed is able to stay within his limits -- if he is willing to take the risk of embarking on a new approach on such a large and critical project! To arrive at this conclusion, Henry has used a complex version of model-based reasoning.*

*We often use static or dynamic mental models, logic models, or even external, possibly automated, models to represent causal chains and other complex relations. When we automate complex reasoning models we may use explicit mathematical or computer simulation models to project what we consider to be likely outcomes to aid our reasoning. In these representations, we use the formalized models to generate results or outputs from a set of input conditions.*

*We use model-based reasoning tools as supports for our analysis by treating them as basic reasoning elements in two ways: (1) to predict resulting outcomes from specified input conditions; or (2) conversely, to impute a set of required inputs that will lead to a specified outcome (resulting state) that is of interest in our analysis. When we use personal computers with spreadsheets, specialized simulation models, and other computer analysis packages, we tend to integrate the results from these models in our thinking process. In effect, we engage in model-based reasoning to extend our reasoning power.*

*Using formalized external models has a number of advantages. These models, and the computers they use, enable us to perform tasks quicker and more precisely and detailed than our minds allow. More importantly, they are explicit and inspectable. They typically include considerable embedded knowledge that is often the best available and may be much better than a single expert can provide.*

**Qualitative or Approximate Reasoning Reasoning**

*Peter Harrow, the new product manager for PRATCO, has made an extensive analysis of which approach he should use to bring a new product to market. There are several options and some flexibility for which features to include, how to price the product, when it should be introduced, and the size of the first production run.*

*The insights that Peter has from his analysis is to a large extent qualitative. He also has a great deal of personal expertise and “feel for the market” that he draws on to make his decisions.*

*He first wishes to decide which features to include and how to price the product. Each additional feature will increase the cost. They will also increase the attractiveness of the product -- some considerably.*
However, if he includes all features, the product will be priced out of the market. There are also trade-offs between increased sales and slightly lower price -- resulting in a lower profit margin.

From past experience, Peter knows that an attractive product in this niche can be priced higher than the average and still sell well. He knows that by including most of the extra features he will be able to offer a very attractive product. Peter, however, does not have crisp logical or mathematical models that describe these relationships. Instead, he has well founded qualitative understanding of what the implications will be of different trade-offs.

According to these considerations, Peter decides to price the product high -- but he will include an extra feature that results in a slightly lower profit margin than PRATCO normally would consider. He reasons that by choosing this strategy, he will be able to offer a very attractive product at a high, but acceptable, price and that it will sell very well.

To be able to take advantage of higher volume sales, Peter also decides to make the first production run much larger than normal and to introduce the product as early as possible before others invade the market.

In the this example, Peter used qualitative reasoning to arrive at his strategy. He reasons according to an approach such as the following by knowing from experience that:

All attractive products while priced slightly high will sell well
The present product is attractive and priced slightly high
The present product will sell well

Based on this premise, and knowing that his product not only will be attractive, but will be very attractive, he reasons qualitatively that:

All attractive products while priced slightly high will sell well
The present product is very attractive and priced slightly high
The present product will sell very well

Typically, real-life reasoning and decision situations are complicated by many factors. Some of these factors involve uncertainties about the accuracy of the information we have or about what is, and what is not, known. Other factors involve the fact that many of our mental models and knowledge objects do not correspond precisely to each other as required by the context we want to reason about. They are not congruent, only peripherally relevant in the same way the knowledge about the smallmouth bass was “reasonably” relevant to the bluegills in the earlier example. Another complicating factor is that we may engage in qualitative instead of “crisp” reasoning in the same way that Peter did in the above example. We are frequently faced with situations that either are outside our direct area of experience when we only have limited knowledge or that are totally new and different and, therefore, require guessing, fact finding, exploration, or pure invention. In these situations, we do not have highly precise models of the situation and conditions available to us and will instead use reasoning approaches that allow us to approximate.

**Qualitative Reasoning**

We often represent our knowledge qualitatively with discrete symbolic categories or brackets. We think about things in terms of whether they are “small,” “big,” or “normalsized” and use similar qualitative labels for the concepts that describe the different conditions that we consider in our minds. We also reason in a qualitative manner rather than with explicit precision, often with “fuzzy” concepts that allow us to deal very effectively with qualitative imprecision and uncertainties. The qualitative nature of our reasoning takes different forms:
• We use qualitative measures for the states of conditions to denote their magnitude, accuracy, or plausibility.
• We use qualitative judgments for the degree of correspondence between two or more mental objects. Hence in order to arrive at a conclusion for expected price elasticity for a new high-tech toaster, we may think that our prior knowledge of price elasticities for a high-tech dishwasher and a low-tech toaster are “sufficiently close” to provide us with the needed insights.
• We have qualitative mental models of the effects that will obtain when a situation is changed.

Human expert reasoning is often qualitative, in addition to being frequently both approximate and judgmental. Further, it is “fuzzy” rather than crisp using a discrete, true-false logic. We use qualitative reasoning to compensate for uncertainties and lack of detailed knowledge; to make it possible to reason with a vast number of factors in a very economic manner by chunking these factors into complex concepts; to work with complex, multidimensional, and often nonlinear relationships; or to be able to deal with large numbers of individual conditions and situations without having to make it explicit a priori how to deal with each. Indeed, we deal more frequently with multidimensional relationships than we may realize. An example of a complex, nonlinear, multidimensional relationship is our knowledge of how to price a product in the marketplace. I may know that the best price to ask for my product depends on the price competitors ask, the quality of my product relative to theirs, the nature of associated services that I also provide, my ability to deliver, my own internal costs, and perhaps the margin that I can provide to the parties who sell my product to the end users.

If, in complex situations, we could choose to reason with classical true-false logic instead of using qualitative reasoning, we would have to provide an enormous number of explicit specifications, beyond what our minds can cope with, and the detailed inferencing required would make it impossible to deal with most situations. Some reasoning situations would be so complicated that we could not even complete them within our lifetime. In addition, most real-life relationships are nonlinear, requiring mental models of how outcomes can change in drastically different ways depending on the situation. An expert who knows such a situation, understands that one particular factor may influence the outcome differently (in a non-linear fashion) depending on the magnitude of other factors, for example. Nonlinear, multidimensional relationships require very complex and extensive specifications when described with binary logic. This may be one reason why our minds represent these relationships qualitatively. To understand how we handle complex relationships, we may use models based on fuzzy sets and qualitative reasoning to describe much simpler representations, yet not as precise, than would be possible with true-false logic.

Fuzzy Reasoning

“Fuzzy” reasoning is a qualitative reasoning paradigm that helps us better understand some of our reasoning behaviors. In contrast to true-false logic which is considered the classical model, the fuzzy reasoning model is more realistic. It attempts to explain how people in real-life reasoning seek “to-what-extent” answers instead of the classical “yes-no” or “precisely-how-much” answers. With the fuzzy reasoning paradigm, we can formally explain how we take into account and manipulate our beliefs that a condition may be plausible or “partially true” (in contrast to its probability of being absolutely true).

When desired, we can introduce fuzzy reasoning paradigm in all reasoning approaches. The paradigm is very powerful in automated reasoning and has a number of important characteristics in this context. For example, it appears that most experts find it much easier to explicate what they know about a particular topic in the form of fuzzy declarations than in the classical true-false form. Thus, we seem to obtain a much more complete knowledge model from these experts using a fuzzy representation and with a much smaller investment
of time and effort. Also, the resulting knowledge base is much smaller, yet includes the same (some suggest -- better) knowledge. Finally, it is much more efficient in its operation.

Even though fuzzy systems and reasoning originated in the U.S. and have been extensively developed here, the concepts have been commercialized much further in both Japan and Europe.

### How Do We Cope with Complex Reasoning Situations?

**Factors That Complicate Reasoning Situations.**

<table>
<thead>
<tr>
<th>Complicating Factors</th>
<th>Characteristics</th>
<th>Potential Simplifying Coping Strategy</th>
<th>Potential Remedial Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lack of Knowledge</strong></td>
<td>Principles governing situation are not known or understood</td>
<td>CBR* MIFR</td>
<td>Outside Help Research</td>
</tr>
<tr>
<td><strong>Lack of Information</strong></td>
<td>Important information about situation is missing</td>
<td>CBR</td>
<td>DHR Gather Information Study Situation</td>
</tr>
<tr>
<td><strong>Uncertainty of Observations</strong></td>
<td>Observations are present but are inaccurate or unreliable</td>
<td>CBR</td>
<td>MIFR Study Situation</td>
</tr>
<tr>
<td><strong>Lack of Time</strong></td>
<td>Insufficient time is available before conclusion must be reached</td>
<td>CBR</td>
<td>MIFR Outside Help</td>
</tr>
<tr>
<td><strong>Too Many Factors</strong></td>
<td>Situation contains many objectives &amp; complex interdependent processes</td>
<td>MIFR (CBR)</td>
<td>Complex Analysis Gather Information</td>
</tr>
<tr>
<td><strong>Too Many Possible Causes</strong></td>
<td>Many reasons may potentially give rise to present situation</td>
<td>DHR</td>
<td>CBR, MIFR Complex Analysis Gather Information</td>
</tr>
<tr>
<td><strong>High Risk</strong></td>
<td>Cost of erroneous conclusions is high</td>
<td>None Known</td>
<td>In-depth Analysis Gather Information</td>
</tr>
</tbody>
</table>

* CBR: case-based reasoning; MIFR: Most-Important Factor Reasoning; DHR: Dominant-Hypothesis Reasoning.

When faced with complex reasoning situations, people tend to adopt simplifying approaches to be able to cope. Many factors that force us to simplify reasoning tasks. Some of the potential coping strategies are listed in the Table and discussed further below. In this table, we have shown the characteristics of the complicating factors and the coping strategies people typically adopt. We have also indicated approaches to how complicated situations can be remedied without resorting to improper simplifications. When people gain expertise in, and understanding of, the area in which the situations are found, they are able to develop judgments and libraries and portfolios of reference cases that allow them to handle the situations very competently and correctly.

**Simplifying May Not Always Be Better!**

Simplifying reasoning is not the only strategy to pursue when faced with a complicated situation. Many consider simplification to be a needless sacrifice that produces inappropriate and wrong results and suggest, therefore, that more powerful reasoning and problem-solving-approaches should be used instead. Some of these are discussed further in this and the next chapter.

Our general ability and approach to handling complex reasoning situations are functions of many factors, including education and social tradition, expectations of peers and superiors, and the quality of available
knowledge and information in the particular situation. Indications suggest that in Europe and Japan, it is socially more acceptable -- even expected -- to solve complex problems comprehensively by taking into account all relevant factors using complex reasoning and analysis approaches. In the U.S., on the other hand, the “Keep It Simple Stupid” syndrome is often praised for its expediency due to its reduced need for mental exertion. It is -- and at times rightfully so -- considered elegant and effective to simplify a complex situation to its most relevant components. “Everything should be made as simple as possible, but not simpler!”

At times, there are good reasons to simplify to avoid being caught up in the complexity of a situation. Researchers have observed that people tend to feel compelled to take into account all the information that is available about a situation, whether directly relevant or not. In such cases, simplification is both necessary and essential to prevent information overload and avoid being blind-sighted by irrelevant and misleading information.

Most analysts are also familiar with the tendency to consider all possible aspects and potential factors of analysis situations that they are unfamiliar with. Such approaches lead to unnecessary complexity and unwieldy, costly, and time-consuming treatment. The only appropriate approach is to obtain improved knowledge about the situation by consulting with others or any other available means.

**Dominant-Hypothesis Reasoning**

Dominant-hypothesis reasoning (DHR), is a particular strategy that applies to complex situations. In these cases, there may be several possible causes for the situation and significant uncertainties may be associated with both observations and understanding of the nature and mechanisms behind it. We find such situations all around us. For example, they are present when we deal with markets and customers, employees, production process, and the general economy. Dominant hypothesis reasoning has received attention within the field of medicine, where it is important to reason with complex situations quickly and with minimal chance of arriving at wrong conclusions -- be it false positive or false negative.

Dominant-hypothesis reasoning postulates the potential causes as hypotheses and then, for each, identifies how much of the situation can be explained by it alone. The hypothesized cause that accounts for most observations is considered dominant and chosen to explain the situation.

A typical medical example is when a physician diagnoses a patient with skin rash, fever, aches, sore throat, and so on, and also knows that measles have been diagnosed in the community. The physician may consciously or tacitly match the patterns of the patient’s symptoms with those for measles and similar illnesses and reach the conclusion that all the symptoms can be accounted for by the measles hypothesis -- which also is supported by the other occurrences of the illness. If the symptoms could also be explained by a combination of acute allergy and a flu, that conclusion would not be considered by the physician since it would be less likely and, therefore, discarded.

People appear to use case-based reasoning to generate the hypotheses they explore. Research indicates that both proficient performers and beginners use experience, in the form of reference cases, to form hypotheses. This is quite powerful since they not only use their own reference cases but also ask their peers and mentors for potentially applicable cases.

Dominant-hypothesis reasoning is far from fool-proof, however. As in medicine, observations may show individual variations, other plausible causes may generate the same observable outcomes (symptoms), and there may be more than one root-cause (independent variable) influencing the situation.
Most-Important Factor Reasoning

Don Halber, Faxco’s Vice President of Marketing, is asked to provide a conclusion to the board explaining why Faxco is lagging its competition in wheelbarrows. He knows that many factors play a role: the price of Faxco’s wheelbarrows is a little higher than average; the quality is good, but not tops; Faxco has at times not been able to ship when promised; the new wheels were late to hit market; and the sales force has not been well motivated and has not promoted wheelbarrows vigorously. There are other factors as well, but Halber thinks that the major factor that really needs to be considered is the sales force motivation. He sets the other factors aside and proceeds to outline why and how motivation affects wheelbarrows and how that should be remedied.

In most-important factor reasoning (MIFR), we consciously analyze the situation and use our best judgment to determine which factor we consider to be most important, the factor that, if changed, will impact the situation the most. By setting all other factors aside, we can reach a quick conclusion with minimal expenditure of time and effort.

Many teachers of business administration have advocated that managers use MIFR to become effective decision makers, that is, cut through irrelevant complexity and quickly arrive at a conclusion. That approach may be appropriate for experienced and knowledgeable managers in situations they are familiar with and where they have developed reliable judgments for relatively simple situations.

However, senior business commentators and analysts now consider this approach to have inherent flaws -- even dangers. To use MIFR properly, the analyst must be able to judge that it is an appropriate approach for the situation at hand. In the hands of relatively inexperienced professionals, MIFR has led to inappropriate and costly conclusions. Many have either not been able to judge which factor was most important, or more often, have simplified important and complex situations to the point that the analysis no longer represents the actual situation. In many instances, multiple factors need to be considered simultaneously to yield appropriate solutions. We see examples of this requirement in customer service expediting, logistics, facilities expansion, pricing, personnel situations, joint venture analysis and recommendations, and in many other important situations.

Complex Reasoning Approaches

Frequently, we need to consider important situations from rather comprehensive and realistic perspectives requiring a broader representation of relations, factors, and objectives. That typically also requires more complex approaches to reason about the situation since idealized and simplifying reasoning strategies are not sufficient. Some of these complex approaches have to be learned since in contrast to the deductive, inductive, abductive, and analogic reasoning approaches, they are not part of our “inherited repertoire.”

Temporal Or Dynamic Reasoning

Mary Paw, product manager for ASCO’s skincare products, is worried that the market penetration of Isolde, the new cleanser, will be too slow. She has prepared a market introduction program with specific dates for ads in journals and on TV, store demonstrations and sales support for the major chains, and new product promotions and give-aways. All is on schedule. Yet, given the present market, she projects that customers will react slower than normal. In particular, Mary is afraid that stores will respond to ASCO’s
promotions by ramping up their efforts over two months instead of three weeks, which used to be the case. In addition, she fears that given the competitive products, customers may react slower to Isolde than ideal -- perhaps over a three-month period instead of the normal two. She also weighs in her mind how many customers will be influenced directly by her ads and how many will be influenced by the stores. She tries to sort out, once again, the complex interaction between general advertising and store displays.

The issue is further complicated by the fact that customers and stores change their response when they see how well the product catches on. Finally, the whole issue is compounded by the evolution of the situation and Mary’s concerns with the speed of product acceptance as much as with the final market penetration.

We use temporal or dynamic reasoning often. We use it in complex situations like Mary Paw’s (illustrated schematically in the Figure), as well as in simple, straightforward situations when we change lanes on the freeway and project if we have enough time before the fast car behind us catches up.

In our professional and daily life, however, we find that many shy away from temporal reasoning. They do not pose the problem as comprehensively as Mary did, nor do they look at the evolution of the condition over time. Instead, they seem better able to cope with situations where quantitative changes are expected in variables such as increases or decreases in demand, population, and so on. In more complex situations, however, most people appear erroneously to prefer to focus on static, snapshot views when the basic nature of the situation is dynamic and is expected to change significantly over time.

Mary Paw’s Temporal Reasoning Paradigm.

We do not know if the propensity to consider the evolution and dynamics of abstract situations is an inherited trait or a learned capability. We do know, however, that we have the capability to reason temporally with physical systems from early childhood, as evidenced by our capability to handle the physical world around us. We manipulate objects, we walk, we run, and we operate cars on the freeway. All of these activities require considerable physical dynamic reasoning.

Abstract dynamic reasoning, though, may be different. Thus, many people have difficulty thinking about dynamically evolving situations, choosing instead to concentrate on what best can be described as static
scenarios. That is, when seeing a particular situation, they do not consider how it may change from one instant to the next.

Frequently, people prefer to only consider stationary scenarios when planning for implementation of a new capability that will lead to changes in behavior or environmental conditions, such as the installation of a new computer networking system. In several cases, we have observed that implementors plan according to a scenario that is fixed in time the instant the new system comes on stream. Therefore, they neglect to take into account how the new environment will affect future use of the system in terms of new practices and, importantly, as a result, they neglect to build capabilities into the initial system that make possible future changes to support desirable evolution.

**Reasoning with Causal Event Chains**

Reasoning about cause-and-effect conditions is closely related to temporal reasoning. We use mental models in both cases to project outcomes, effects, that will result from perturbing the causal system and changing the conditions to cause the system to behave in a particular way. Reasoning with causalities is often very complicated. Our mental models may be highly qualitative and approximate, even when they are correct, but existing cause-and-effect relations are highly precise and often sensitive to minute changes. This is the case with physical systems that we can observe such as when two billiard balls collide. It may be less true for “forgiving” or partially adaptive systems such as the effects of under- or overwatering the lawn.

Many causal systems consist of several links in a chain from input cause to end-effect. Reasoning with multiple-link event chains can be complex and error prone since the outcome of one link becomes the input for the next. This is illustrated in the Figure for a situation where a conclusion must be generated about adding an additional expert buyer in the men’s department in a warehouse.

In business, we often deal will causal systems that are not well understood: our production processes; customer behavior and product acceptance; human behavior in personnel matters; and so on. In these cases, we are asked to reach conclusions that will enable us to act in some way based on our imperfect and qualitative mental models. Unless we have deep insights and well developed judgments, we may make mistakes when we reason about these kinds of situations. If several people are involved, we often find broad differences of opinions and judgments, often deep disagreements, as a result of each individual’s imperfect mental models.

![Simple Example of Use of Event Chains to Portray End-Value Benefits in the Men’s Department.](image)
Nonmonotonic Reasoning

Mary M\textsuperscript{c}Allister is a senior group health underwriter at Enigma Insurance. She is working with OXXO on their policy renewal. She has collected their past claims history, employee demographics, and other relevant information. Based on available information, she has generated hypotheses for expectations for OXXO’s claims over the next policy period and has calculated the corresponding contract terms. In performing this work, she was missing some information on recent claims and on changes in the health care delivery system and practices at OXXO’s plant locations. When that information became available, Mary discovered that significant changes invalidated some of her prior reasoning. She was forced to backtrack in her analysis to generate new hypotheses for expected claims and risks to calculate new proposed policy terms.

Mary’s situation is typical. We frequently start to reason based on what we know, perhaps even with information that we know is incomplete. Later we discover that the situation is different from what we first thought and that we need to revise our understanding and reasoning premises. Our reasoning cannot progress monotonically. We need to regress to a point where our premises are valid and start our reasoning anew from that point in a new direction. In other words, our reasoning is nonmonotonic. Many people have a much easier time with reasoning nonmonotonically than others who sometimes even feel that it is an affront to have to change reasoning direction! These “linear thinkers” might actually refuse to change reasoning direction even in the face of very strong evidence.

Reasoning by Default

Nonmonotonic reasoning frequently occurs as a result of reasoning by default, which is prevalent in commonsense reasoning. In ideal reasoning situations perfect information is available, it is accurate, complete and congruent. That is, the facts and the relations between facts and premises are in perfect correspondence. In such situations, conclusions can be generated using standard logic or other straightforward reasoning strategies.

Real life, however, is usually more complicated. For example, relevant and available information may make it reasonable to presume that some conclusions can be substantiated but cannot be supported directly using logic. The available information may be partial or incomplete, or may pertain only indirectly to the conclusion of interest, relating instead only to a closely analogous condition. In these situations it is not possible to reach conclusions using standard logic. As alternatives, people draw inferences from patterns to permit them to generate conclusions that do not follow strictly from premises given the available information. In other words, they default to the best reasoning approach they feel comfortable with. As indicated, default conditions are found in many case-based reasoning situations when representative reference cases with embedded experience and judgments are used. Reasoning by default may, at times, lead to inappropriate conclusions that need to be revised when more complete information about the situation becomes available as indicated for nonmonotonic reasoning.

Planning

Joe Palmer is planning a project to expand his store into the adjacent suite. He has generated a list of all the major tasks that need to be performed such as constructing a new entrance and passage way, interior decoration, procuring store and point-of-sale (POS) equipment, ordering and receiving more merchandise, and advertising. He does not yet know the best sequence in which to proceed and has not received final
bids from contractors with their schedules. He cannot wait for all information to be in hand before initiating the project since some items to be procured require long lead times.

Joe reasons that he needs to place the long-lead-time items on order right away so they will be available when he needs them. If they arrive earlier than needed, he can easily find temporary storage for them. Since the additional merchandise can be delivered quickly after it has been ordered and since it is quite expensive, he will wait to order until he knows precisely when it is needed. He also may need to hire additional help, but figures that it can wait too until it is absolutely clear that the need is there since there are many well trained people looking for jobs. The advertising project should also be started soon. In the past Joe has waited too long to initiate advertising and has been forced to rush through half-baked ideas that he was not too pleased with. Given this situation, Joe makes a list of those tasks that he needs to do immediately and another list consisting of items that can wait.

We plan many times every day. When we figure out what we will do next, which route to choose to work, what to buy at the store, and how to attack the next work task, we plan. We identify steps to be taken, the sequence of the steps, and what each step will contribute towards reaching our goal.

Planning is a complex set of reasoning tasks that require (a) information on the initial state of a situation, (b) a set of potential actions for changing the situation, and (c) the goals for what we try to achieve. Planning requires reasoning with causal event chains, frequently under uncertainty. Typically it also involves nonmonotonic reasoning when the unexpected happens. This is particularly likely since our planning takes place before the actual event while much of our information consists of imperfect conjectures of what the future will bring. When people plan without using computerized planning models that can handle large amounts of precise information, they use qualitative and fuzzy reasoning. These approaches allow us to handle very complex simultaneous conditions and events in our heads, while also allowing us considerable flexibility for considering alternatives.

Planning consists of more than reasoning, however. It is primarily a problem-solving activity. A considerable, perhaps the most important, aspect of planning deals with synthesizing the nature of potential steps that may be executed to achieve the goal. This aspect of planning is creative and also constitutes an important building block of the more complex approaches to decision-making.

**Directing a Dialog: A Special Kind of Planning Ahead**

We plan ahead whenever we attempt to guide a dialog or a discussion in an exploratory, educational, or influencing situation, or when we attempt to direct any other fast-paced evolving situation. By planning ahead, we identify what our next options and potential steps are likely to be and perform our immediate actions to steer the situation to where we want it to go. Planning ahead in this manner requires a special kind of reasoning and relies on *idealistic* and *systematic* knowledge in addition to being able to “read” the current state of the situation.

It is particularly important to understand this kind of reasoning and its requirements when we provide reasoning support (by for example providing Decision Support System (DSS) applications) to knowledge workers who deal with fast-paced processes. To perform their functions competently, they will need to possess sufficient *idealistic* and *systematic* knowledge (particularly conceptual and expectational knowledge) in their minds to be able to plan ahead and guide the situation. Additional knowledge -- often factual and methodological -- can be supplied by DSS applications. Effective DSS support depends on the degree to which knowledge workers’ can obtain and incorporate the external knowledge competently and timely to match the demands of the fast-paced situation -- often within a fraction of a second.
Reasoning with Multiple Hypotheses -- “Blackboards”

Dick Morse is troubleshooting a situation where a major order was lost, possibly on price, to a competitor known for unreliable quality and mediocre customer service. He works with the sales manager before visiting the customer. The sales manager indicates that preproposal discussions with the customer reflected concerns about price, product quality, and delivery consistency. Dick finds that the proposal was priced to yield average profit, assumed only standard expenses. The price was reasonable but could be underbid by an aggressive competitor. The proposal specified the company’s standard product quality assurance procedures, which did not look very impressive on paper but had worked very well. Statistics of delivered quality over the last year were not included although they were available and of considerable company pride. The only mention of delivery consistency was buried in the middle of a paragraph, even though the company’s record was impeccable. Dick was baffled. He did not know which of the three factors, or which combination of them, had caused them to lose the order. All seemed to be good reasons. As a result, he wrote up a tentative analysis of the three factors, giving the reasons why each could be the root cause leading to the loss of the order. With this analysis in hand he visited the customer to receive better information.

Dick developed and pursued several hypotheses to identify what happened. He documented them on a “blackboard” until he obtained further information that allowed him to strengthen one hypothesis or eliminate another.

We often work with situations that provide conflicting and ambiguous evidence. In these cases, we have to work towards conclusions while maintaining several plausible hypotheses simultaneously as the reasoning situation unfolds. When we reason in this manner, we keep the hypotheses in mind, on paper, or “out on the table” while we search for further evidence. Since the world constantly changes, we must often reason in real time to understand what is happening and be able to arrive at a conclusion before it is too late. This is the case when we drive in the dark, operate a chemical process, or participate in a complex discussion or in a fast-moving competitive sales situation. In all these instances, we maintain a “visible blackboard” with the plausible conclusions in our mind, or on physical devices such as an actual blackboard or a piece of paper.

Multiple-hypotheses reasoning relies extensively, as do all complex reasoning approaches, on simpler reasoning strategies. In addition, multiple-hypothesis reasoning normally involves reasoning under uncertainty and frequently becomes nonmonotonic.

Research indicates that human language comprehension requires support by reasoning with multiple hypotheses and extensive use of complex concepts. When we listen to speech or read and reason to understand what is being communicated, we need to consider several competing hypotheses generated by concept associations and concept hierarchies. We use these hypotheses to identify what is meant while we receive one or more sentences and interpret them in context with the larger message. Use of multiple hypotheses is apparent when we deal with ambiguous sentences, but it is also the case in all but the simplest communications. People also have widely differing capabilities to handle complex verbal communications. It should be noted that a small percentage of high performing knowledge workers -- who may have unusual strengths in other areas -- actually are language-learning disabled with problems performing complex language comprehension tasks on par with the rest of us.
Goal-Directed Reasoning, Proxy Beliefs, and Developing Judgments

Frank Hauser, Oxxo’s fertilizer plant manager, oversees a major plant refurbishing project. It is well-planned and progresses smoothly with the total plant shut down. There is considerable pressure to complete the project early since there is an increasing backlog of orders to be filled. Frank is suddenly informed that when opening the large compressor, it was found that the rotor has a hairline crack in the shaft.

Frank immediately projects in his mind what the implications of the crack could be. His goal is to satisfy the demand for product as quickly as possible. He thinks the compressor could be made to operate at reduced power for “some while” although the rotor ultimately must be replaced. Based on his objective -- to get the plant operational quickly -- he poses premises regarding the different conditions that he knows exist and that may result from the present situation. He uses deductive reasoning to identify what will obtain under these conditions. Using inductive and abductive reasoning he also poses tentative hypotheses for what may happen if he chooses one action or the other. Since his goal is to find the best way to bring the plant into production as quickly as possible without risking premature shut-downs, he directs his reasoning by focusing on generating options that will allow him to reason about, explore, the consequences of these alternatives.

Much of the reasoning we perform is directed by our goals and values. In most circumstances, goal-directed reasoning is part of problem-solving as we discuss in the next chapter. But we all are repeatedly faced with new conditions that may impact our goals. Whenever that happens, we start to reason about what the impacts may be and generate options for how to deal with the new conditions.

Reasoning and Searches

We often reason to search for conditions that are of particular interest. We may for example “search” for the shortest (i.e., optimal) route by car from St. Louis to Omaha by analyzing a number of possibilities. If we look broadly at the map and identify ten roads that may be reasonable first legs, we are performing a “breadth-first” search. That is, we identify ten roads that all seem to point towards Omaha and may seem equally good until further information is obtained. The next step may be to look at several second-leg options for the best first legs. This way we explore the “search space” to identify the best single route. By limiting the number of first legs to the two or three “best” options, we may reduce the search space to a manageable number of options. We “prune” the search tree (narrow down the “solution space”) by eliminating options that appear less desirable by some criterion.

Instead of a breadth-first search, we may conduct a “depth-first” search. In that case we may initially chose a first leg by some measure, perhaps the shortest, or the one pointing in the general direction of Omaha, or completely at random, then the shortest second leg (if that is our criterion), and so on, until we have reached Omaha. We then may explore a second route and continue the process until we either are satisfied that we have explored all good routes or have exhausted all possible routes. In most real problems, the total number of alternatives is prohibitively large, forcing us to reduce the search space. When a person performs a visual search of a simple problem such as the one indicated here, the process can often be shortened since the human pattern-recognition process allows quick screens of the available options. In all these cases, unless we perform
an exhaustive search of a “feasible space,” there is no guarantee that we have found the shortest route.

Human pattern recognition, however, is not infallible and quickly becomes unable to deal with problems when these become complex. As example, the “traveling salesman” problem, which asks for the shortest route for visiting multiple cities, is notoriously difficult for humans (and also for computers) to solve.

We Create “Proxy Beliefs” With Our Mental Models

George Sweany believes that it is vital for our global future to keep the ocean’s food chains healthy and at peak production. George has become concerned about the amount of untreated sewage, pesticides, chemicals, heavy metals, and high nitrogen farm run-offs that we dump into the ocean. He is concerned about the effect that all these substances have on the ocean’s flora and fauna. He bases his concern on the mental models he has built from his understanding of how the chemicals migrate from link to link in the food chain. He has developed mental models for how some of the chemicals affect species adversely and has interpreted reported laboratory experiments and field observations to create other mental cause-and-effect models for the effects of the other pollutants.

George uses his mental models to project the overall physical effects of the annual pollution load on the biota in the ocean and comes up with the conclusion that the biota and, therefore, the food chain will be very badly affected as time goes by. Based on this personal projection, which impinges directly and negatively on his belief for the food chain, he transfers the conclusion to create a new belief -- a “proxy belief” -- directly associated with the rate of pollutants that are discharged into the ocean.

George is emphatic about the seriousness of the pollutant discharge situation and focuses strongly on the actual amounts and concentration of each substance. He does not give a second thought to the fact that his interpretations -- his projections of the effects -- are fully a function of his personal reasoning with his internalized mental models. And these models are qualitative, perhaps questionable in their correctness, and not open to scrutiny. Yet, George has become a strong public advocate to avoid pollution based on his subjective views.

Peter Vaughn also believes that it is vital for our global future to keep the ocean’s food chains healthy and at peak production. Peter has also built a set of mental models of the effects of polluting the ocean based on some of the same information that George has. Peter, however, has a different background. Whereas George was educated as a biologist, Peter is an economist, which gives him a different mental framework. Peter’s mental projections, from the same discharge statistics that George uses, indicate that although there will be adverse effects, these will not be serious and the regenerative capabilities of the ocean make it possible for it to process much greater pollutant load than it now is receiving. Peter also transfers his conclusions to a proxy belief that all is well, as long as we discharge at the present levels. Peter’s mental models are also not accessible and are also largely based on interpretations and sparse knowledge.

Peter and George are in a constant battle over the need to reduce specific pollutants with no end in sight. They argue publicly about the inadequacies of particular regulatory proposals, treatment plant capacities, and similar issues -- all based on very different proxy beliefs about impacts. Even though they share the basic belief about food chain, they do not (yet) attempt to obtain better projections and models of the event chains from pollutants to end-effects, and instead rely only on their preestablished subjective models.

We all have basic personal beliefs and values that govern our lives. Some are associated with self-preservation, others may be egalitarian, others still may be spiritual, and so on. In addition to our basic personal beliefs, we also hold fundamental beliefs associated with our work, such as the belief that the enterprise will go

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4 A “feasible space” is a relative concept; in this case, it is constructed after the length of a known route has been determined. Given that length, it is possible to identify a locus beyond which all routes will be longer and hence infeasible. The feasible space falls within the locus. Each time a shorter route is found, the feasible space is reduced.
under if we cannot make acceptable profits over the long run or that customers will stop buying our products if we consistently overprice them and produce low quality.

We use both basic and fundamental work-related beliefs to generate judgments and “proxy beliefs” that we use in reasoning situations to analyze if a hypothetical condition will be acceptable. We first generate proxy beliefs associated with existing situations or potential scenarios by using our mental models to project what we believe the outcomes will be. Then we compare the believed outcomes with the values that we hold for those kinds of situations and immediately associate the value judgment of the outcomes with the initial hypothetical condition. Finally, we transfer the value belief for the outcome to become a proxy belief for the initial condition. This process is illustrated in the Figure. In this figure, we have indicated how we develop proxy beliefs from basic beliefs and transfer them to be associated with the potential input scenario.

Leisurely or Unfocused Exploration - Give Some Thought to It

On Friday morning Mary Merriweather wonders what she should do during the upcoming weekend. She does not have to make up her mind until later and has many options. There is a movie she might wish to see, she might drive to see some friends in the country, or she might want to sleep in on Saturday, not plan anything but just see what comes up. In many ways she has no strong preferences but would like to have an interesting, yet restful weekend since her week has been very busy. As Friday progresses and she completes her work, she revisits her options and gradually settles on sleeping in and catching up on her reading on Saturday even though it will be a nice and sunny day. Her plan is far from firm and hence when a friend calls at five PM and suggests that they go bicycling on Saturday, Mary gladly accepts.

We engage in “leisurely or unfocused” exploration whenever we mull over a situation, engage in general speculation, or make loose plans for how we might approach a future situation. In these cases, we may not have a clear idea of what we are trying to achieve, nor may we have specific goals or criteria by which to judge the desirability of the outcome that we may achieve using the approach that we generate. We also may disregard many constraints and uncertainties.
Crisis Problem-Solving -- “Avert Disaster!”

Tom Hagan is faced with a problem. His best customer has just called with an emergency order for 30 pallets of the special roofing hardware that Tom’s firm manufactures. Tom finds he has 40 pallets in stock. However, 25 of them have already been sold to another customer and are in the process of being loaded onto the delivery truck. His firm cannot possibly manufacture or buy the additional 15 pallets until two or three days from now. Tom would like to satisfy both customers if at all possible and definitely does not like to create any problems with either. He figures he has several options, but needs to contact both customers immediately to explore if they can be flexible and, particularly, if either can make do with a partial delivery. Based on that information, he determines his best options.

We engage in “crisis problem-solving” when we are faced with a problematic situation that requires that we find a solution -- often to a dilemma, and often quickly. Thus, in such problem situations, we are often under time pressure, have limited resources, or are constrained in other ways. In addition, if we do not solve the problem (i.e., come up with a workable solution) the consequences may be dire. As a result, we may have to make do with whatever resources we have, including our present knowledge. (We normally may not be able to bring in additional knowledge or create new knowledge by research.)

Routine Problem-Solving -- “Perform Competent Knowledge Work!”

Kristi Long manages the short-term cash investments for Sigma. It is about 9 am and she has just contacted two banks and a broker and has offers to place contracts for one million dollars with each at good interest rates for one, two, and four weeks, respectively. She has the new three-month forecasts for cash uses and income in front of her and must identify which of the three offers are most attractive given the daily projections for cash in- and out-flows and expectations for variations from forecasts. The situation is quite familiar. Kristi has performed this task innumerable times before and automatically goes through the reflections that permit her to arrive at an appropriate choice in a very short time.

The majority of the knowledge work we perform as proficient professionals involves routine problem-solving. We are very familiar with the cases we face, hence dealing with them requires mostly automatic knowledge and case-based reasoning involving well-known cases. Even when the cases differ from routine, the experienced knowledge-worker falls back on well-known scripts and general reference cases that guide problem-solving without much speculation but with extensive use of pragmatic knowledge.

In the organization, its structure, procedures, workflows, and each knowledge-worker’s responsibility area are traditionally arranged to facilitate routine problem-solving. In these cases, the functions become highly specialized and it is considered desirable that people become highly skilled (i.e., have internalized the pragmatic and automatic knowledge needed to perform their tasks, even if by rote). Such arrangements lead to great efficiency in situations that are repetitive or relatively uniform.

Systematic Problem-Solving -- “Find Quality Approaches to Special Challenges!”

David James, Paula Hirschbaum, and Harry Peters are appointed to form a taskforce to propose new procedures for order processing at Delta Inc. They analyze the present order processing system and make a
detailed flowchart of how it works and of the tasks and activities that are performed by staff and automation. It is the first time Delta has obtained a comprehensive overview of the procedures involved in this system. The team members identify features that have led to several problems, ranging from introduction of errors to delays in both shipping and billing. They start to specify characteristics that would be desirable in the new system and explore ways in which the desirable attributes could be obtained by redesign. Over several weeks of dedicated work they arrive at a proposed conceptual design for a new system. Since the new system may affect operation in several departments, they review and discuss potential changes with the managers and other representatives from these organizations. When they have arrived at what they think is a very good design, they will submit it and two alternatives to their management for review, modification, and adoption.

Much of the formal outcome-oriented work we perform is systematic problem-solving. At home we may tackle simple daily problems such as determining what we can make for dinner with the raw materials that already are in-house. At work, we may struggle with more complicated problems such as designing new ways of conducting business, exploring which new products to consider, and resolving conflicts between high-priority projects.

**Good Systematic Problem-Solving Expands Scope Before Narrowing It down to One Solution.**

One model of effective systematic problem-solving, presented in the Figure shows that to obtain good solutions, after the initial familiarization, one must broaden the scope to explore and identify new opportunities, perspectives, perhaps learn, and generally bring new knowledge and points of view into consideration.

After the initial familiarization and formulation, depending on available time and resources and progress towards reliable insight and potential solutions, it is time to stop expanding the scope and to start analyzing and considering what we have discovered. This phase should bring new understanding of what is possible and leads to the “alternatives generation” part of systematic problem-solving, where potentially efficient alternatives are progressively refined by “generate and test” approaches until a small set of promising alternatives remain. The last part of the process is the solution selection where the scope is narrowed down to the final version of the present alternative, which often may result in a scope that is different from the original challenge.

The generate and test process consists of repeatedly generating a proposed next step solution which is defined in sufficient detail for it to be tested for expected performance. This process is illustrated in the Figure which indicates a situation that proceeds through four cycles before a final solution is arrived at. The process
concludes (a final solution is accepted) when either (a) significant further improvements cannot be expected, or (b) when allocated time or resources are exhausted.

**Illustration of the Generate-and-Test Process.**

Systematic problem-solving requires the full range of our knowledge. Specifically, we need to bring to bear our idealistic and systematic knowledge to form our visions and guide our goal setting and our methodologies for approaching the problems. We also need to rely on our pragmatic and automatic knowledge to obtain the facts and details for our work. The greater our relevant knowledge and comprehension is, and the deeper it is, the greater our value is as knowledge-workers.

**Decision-Making -- “Generate, Select, and Implement an Approach to Handle the Challenge!”**

Harry Cozak, a Zumak Corporation customer service engineer, is asked by a large customer, Boleen Associates, for Zumak to help redesign a major subassembly that is a big consumer of Zumak parts. The redesign is difficult and could require parts that Zumak cannot provide at a reasonable price. Since Boleen has limited manufacturing expertise, the redesign could also lead to specification of parts that in addition to being difficult to make might not perform well. Boleen has asked Zumak to participate as a strategic partner to ascertain that the redesign will: (a) benefit from Zumak’s expertise in making light, durable, and reasonably priced parts; and (b) create parts that Zumak will be able to manufacture.

Harry has talked to his superiors and has been directed to explore how Zumak can be most responsive without “giving away the store” and to decide what Zumak will do. The situation is not simple. Zumak does not have any design and manufacturing experts who can participate without removing them from other important projects. On the other hand, if Zumak is successful in assisting Boleen, it may lead to significant and highly profitable orders over the next few years. If Zumak declines to assist, Boleen may either go to another supplier or end up with a bad design.

Harry outlines several options for how Zumak can assist Boleen. Some involve Zumak experts full time during the redesign effort. Others require less involvement. For each option, he projects the strengths and
weaknesses of involvement, immediate costs, expected quality of design, potentials for benefits, and uncertainties. He also explores with several department managers the reality of the options and obtains additional ideas.

The next step is for Harry to weigh the options. He finally decides that the best option is to borrow one of Zumak’s best design engineers half time over the next month supported by a manufacturing specialist for one day a week during the same period. He presents his decision and the associated tradeoffs to the management committee before he communicates to Boleen how they will assist.

During his deliberations, Harry has identified the specific decision criteria that he needed to observe.

We talk about “Decision-Making” to denote the complicated process associated with how we face situations that require management or intervention and find acceptable ways to direct or influence it. We discuss Decision-Making in greater detail later.

**Evolutionary and Incremental Problem-Solving -- “Let Me Tackle That Problem When I Get to It!”**

Susan Hammer is traveling from New York to meet her parents in London. She has the name of their hotel but has no idea where in London it is located. That does not worry her, however. She has been overseas many times, is not in a hurry, and has enough money. Her plane will land at Gatwick where she has never been, but she has heard that it has train connection to London, which may be less expensive than a taxi.

When Susan arrives at Gatwick, she finds a bank and chooses to get some more local currency in the event she needs to take a taxi. She then finds an information booth where she learns that she can take a coach that will bring her closer to the hotel. Another and less expensive option, they tell her, is to take the train to downtown London and catch the subway from there.

Since Susan is tired after the overnight flight, she chooses to take advantage of the simplest approach available which is the combination of the coach and taxi, and proceeds accordingly.

Quite frequently, we engage in evolutionary or incremental problem-solving. For example, we postpone -- often very appropriately -- decisions about how to approach the detailed challenges that we know we will encounter until we actually have them before us and can examine them. At times, however, we can prepare ourselves with resources and earlier actions in ways that place us in much better situations to deal with the challenges when they occur.

A drawback of evolutionary problem-solving occurs when the problem solvers take a myopic perspective, solving each new task without considering the goals of the overall challenge. This type of problem-solving is closely related to incremental decision-making as discussed below.

**Exploratory Problem-Solving -- “Find out What Goes on and See If Anything Can -- or Should -- Be Done About It!”**

Peter West is a product manager at Bundin Inc. responsible for fractional horsepower electric motors. His sense is that the market penetration of his products is less than it should be, and this is backed up by independent marketing studies. Bundin’s sales force and distribution system seems to be just as good as its competitors’ and the quality and price of its motors are as good, if not better, than competition’s. Peter decides that he needs to explore if it is possible to improve the market penetration. He does not, however, have good ideas as to what will be most likely to produce the results he is after.

After discussing his notions with his associates, Peter starts two initiatives, both designed to enhance
customers’ willingness to use Bundin’s motors instead of competitors’. One initiative is to redesign the marketing literature to include more applications examples of how to take advantage of special features that Bundin’s motors have. The second is to provide extended application engineering assistance for no fee to customers who want it. Both of these initiatives will require some time to show results but are expected to be worth the effort.

We engage in exploratory problem-solving when we suspect the existence of an opportunity or a problem without knowing what it is or how to approach it. In these situations, we often resort to outright experimentation by changing conditions that we “suspect” will have the desired impact. Clearly, the more we know about the underlying “system” the better we can identify factors that may influence the outcome in the way we wish. In short, when we have insufficient knowledge, we often revert to exploratory -- or evolutionary -- problem-solving.

In exploratory and evolutionary problem-solving it is normally not possible to plan proactively what the next steps should be. As a result, these types of problem-solving may lead to “blind alleys” and require non-monotonic reasoning and other kinds of back-tracking.

**Innovating or Creative Exploration -- “Make What You Are Doing Better!”**

*June Hanson builds small subassemblies that are part of large automatic milling machines. One part that she uses holds several other parts together, fits very snugly into the “cage,” and is very difficult to install. Minute variations in dimensions that do not affect operational performance at times make it impossible to install the part the way prescribed and it has to be scrapped. June thinks that there may be ways around this problem and starts to experiment with different ways of inserting the parts, she even starts to fashion small jigs from metal coat hangers. After a while she discovers that she can use a method to install most of the parts that previously were discarded. In addition, she finds that with her new method she can build the assemblies quicker as well. As part of her work, she also has found out which dimension variation causes most problems and she is able to help define new tolerances for it.*

Knowledge-workers at all levels are likely to innovate at any time. We all try to change the way we work or modify the objects we work with, mostly to make life easier for ourselves. However, we also innovate to improve our performance within the organization we work with, particularly when we understand how that can benefit us.

We are in a better position to innovate in ways that serve the organization well when we are given a broad understanding of our work environment in terms of its nature, how it relates to upstream and downstream activities, as well as the overall goals of the organization. This makes it important for any organization interested in grassroots innovation to ensure that its knowledge-workers are allowed and encouraged to develop broad knowledge and a good understanding of the corporation’s direction.

**Script for Personal On-the-Job Problem-Solving**

*Karen Jones is a relatively new operator of the catalytic cracking unit in a large oil refinery. Over the last four months she has acquired a good deal of knowledge about how the process normally operates at many different throughputs and with different feeds and has become a competent performer. She has learned about many different ways in which the process can malfunction and how to deal with them. In spite of this detailed knowledge, there still are many aspects of the operation that she has limited understanding of, has*
not been exposed to, or does not understand. Hence, whenever the process changes its operating behavior, Karen observes it closely. She uses the process control computer to track changes and potentially abnormal conditions, examines its displays, confers with the outside and upstream operators, and peruses operating history over the last hours. However, she cannot watch all displays and instruments or cope with all the information that is available to her. Instead, she focuses her observations based on her experience, expectations, and perspectives, biased by her knowledge, however valid or invalid. Thus, Karen “filters” the information that she is willing -- or able -- to observe.

In one such situation, the cat cracker’s throughflow pulsates every twenty minutes in a way that Karen has not observed before. She chooses to watch the central heat balance and flows closely but does not quite understand what is happening. She reasons that it must be due to the same condition that caused a similar situation a few months ago and she selects to deal with it in the way that was effective at that time. Thus, she reduces the feed slightly and expects the condition to improve. Instead, it becomes worse over the next hour and she contacts her superintendent. He has seen the situation before and tells her that she must also observe the heat balance of the adjacent coker unit when unstable situations occur and indicates to her what that means. The new insight can also tell her how much to reduce the feed to stabilize the unit. Karen realizes that she has learned a new approach to diagnose the operations.

Problem-solving that reveals previously unknown or misunderstood conditions often leads to valuable ways to build new knowledge as part of gaining on-the-job experience. In this type of knowledge building it is necessary to consider what happens when knowledge-workers perform their functional tasks. A simple script or model to illustrate how this process may be conducted is shown in Figure 8-4 for an oil refinery operator. This script is one of several perspectives of how a person operates when solving problems and learning on-the-job. It includes representations and perspectives on how knowledge-workers may proceed to perform their duties when they encounter unfamiliar situations.

One significant aspect of KM deals with how one may provide support structures for knowledge-workers to aid their work or improve their knowledge and understanding to tackle new situations or different tasks. This is of major importance for the intelligent-acting organization that needs to make knowledge-workers or departments more versatile, empower them to handle nonroutine and unprecedented situations.

Reframe -- Change the Paradigm!

Tammy Cooper is Hydro Corp’s strategy director. She is revising the official planning description of Hydro’s business to prepare for strategy setting and determination of corporate priorities. For many years Hydro has manufactured home water purification systems that it sells through various resellers. Hydro’s management has traditionally considered the company to be a designer and manufacturer of top-of-the-line water systems and have focused on improving designs and reducing manufacturing costs. Lately, however, demand for their systems has declined in spite of significant improvements and lower prices. Consequently, Hydro’s senior managers are convinced they are doing something wrong.

Tammy has been with Hydro for several years and is at ease with the traditional view of its business and strategy. She has recently visited with a number of resellers, customers, and many noncustomers and has started to have second thoughts about Hydro’s perception of its business. As she mulls over what Hydro provides to its customers, she gradually starts realizing that her company really may be in a business that is different from design and manufacturing. As far as its customers are concerned, it appears that Hydro provides a health benefit service -- which is made possible and facilitated by its excellent devices -- and that the value of that service to Hydro’s customers is a function of many factors. As Tammy starts to think about Hydro’s business from that perspective, she also begins to realize that its competitors may not only be the
other water system manufacturers, but also the bottled water suppliers and others that previously had not been considered. She also realizes that Hydro’s marketing literature does not at all address the factors that are important to customers and that its end-user services neglect major aspects of the customers’ needs and interests.

Tammy changes the whole frame of reference of Hydro’s business description to reflect her new view. When she presents her new perspectives to her boss and the other members of the management team, she receives the response: “Of course, how stupid of us not to realize that earlier!”

Whenever we meet a new situation, whether it is one we are very familiar with or a new kind of situation, we may initially represent it from a narrow or inappropriate perspective. In particular, we tend to accept the initial premises and existing understanding as the frame of reference, often without question.

In these cases we need to **reframe**, that is, change the terms of reference and perspective so we can observe the situation from a better or broader point of view or with different objectives. When we frame the situation narrowly we tend to neglect broader issues and interactions with other parts of the world that are of importance. In such instances, reframing, initially, involves incorporating interactions and issues that were previously left out. Later reframing steps will lead to considerations of parallels and analogs, at first with relatively concrete similarities and later with more abstract similarities often based on metaphoric reasoning. In other instances, the situation may initially be framed to focus on a surface issue or symptom instead of the root-cause, on a wrong goal, or only on a small part instead of the complete situation. A more important feature of reframing may be the steps we take to redefine the situation in terms of the basic characteristics that describe its fundamental aspects, much as Tammy did when she reconsidered the basic business of Hydro in the above example. Along these lines, De Bono proposes an interesting and very effective approach to reframing, “lateral thinking,” which we will examine closer below. As its name suggests, that approach, however, does not search for the fundamental characteristics.

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**Automatic or Intuitive Decision-Making -- Decisions by Rote**

*Michael Connor is a commercial loan officer at Broad Street Bank. He has received a request from one of his clients, Zumak Corporation, to increase its credit line from ten to fifteen million dollars.*

Zumak has excellent credit rating and payment history. It justifies its new request with its plans to acquire an integrated machining center in the near future in order to service a long-term order it has received. Mostly, it will finance the machining center with working capital but needs a short-term loan until new revenues can cover the shortfall. Based on his knowledge of Zumak and its people, Mike quickly reviews their credit history on his computer, decides that this decision is a “no-brainer,” and approves the request without additional analysis.

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**Snap, or “Seat-of-the-Pants” Decision-Making**

*Dennis Smart is production supervisor in DCO’s cement plant. Two control operators approach him with what they consider to be a scheduling problem. They are both expert kiln operators and have been scheduled for the same night shift while only two rookies have been scheduled for the preceding evening shift. The two rookies have been known to have problems controlling the kiln and have left it upset for the next shift to cope with. Now the two senior operators want the schedule changed to avoid operating problems carried over to the night shift. Therefore, they propose that one of them change place with one of the rookies.*

*Dennis is used to gripes from the operators. He takes one look the situation, does not ask any questions,*
and decides immediately that the schedule should remain as posted. He tells the operators that it is about
time the two rookies learn to control the kiln by themselves and that if they upset it, it will not be by much.
He concludes by adding that, if the kiln is upset, the two senior operators will be able to “rescue it” on the
night shift.

Dennis does not want to listen to the operators who feel that the rookies would learn faster and much better
if they worked with an experienced person who could guide them and explain how to do things right if they
make errors. He also does not want to take into account the cost of off-spec clinkers produced during a
possible upset. His main reasons for making a quick decision is that it would be too cumbersome to
reschedule (if he makes the change, a rescheduling will be needed, which will require several additional
changes for the following week). His immediate judgment, is that it is more important to make a quick
decision and get on with the other work that is waiting.

**Fixed-Idea Decision-Making**

Tom Powell, PaxCo’s president, is considering building a $5 million bulk terminal outside St. Louis. The
concept has been circulating around PaxCo for more than a year and has been the pet idea of John Kerr,
VP of sales. Over the last few months, the idea has taken on momentum with the whole sales force coming
in behind it. The engineering department has surfaced unsolicited concept memoranda in its support and
the local sales manager has located several suitable sites. Ralph Moen, the conservative VP of finance who
always fights John Kerr, has even analyzed the idea and has concluded that it is feasible and sound. It
seems that everyone in the whole company now supports the idea. Tom also thinks it would be a good
solution.

However, Tom has a small concern that PaxCo has not considered if other alternatives should be explored.
Nor has anyone analyzed if the size of the plant matches present and future demands. But since the idea has
everyone’s approval, Tom decides to ignore his concerns and proceed immediately for three reasons: (1)
building it now with everyone behind it will be easy and efficient; (2) the idea must be good since no one
has any objections; and (3) by agreeing, he cannot be faulted for making a bad decision.

Fixed-idea decision-making takes place when a person or an organization acts on a single idea that has
grown increasingly more dominant and “taken on a life of its own” to the point where no alternatives are being
suggested or even considered worthy of study. We may find this kind of decision-making when an idea or an
alternative is developed by a strong individual who then works the political circuit and obtains a pre-decision
consensus that is so strong that everyone jumps on the bandwagon.

We also find fixed-idea decision-making in crisis situations where many are prone to latch onto the first
feasible alternative that presents itself even though it may be marginal. The objective in these situations seem
to be to find an acceptable approach and to proceed to put the undesirable situation behind.

In general, fixed-idea decision-making is not desirable. It takes strong knowledge about decision methods,
broad knowledge, particularly *idealistic* and *systematic*, about the decision domain, and excellent
communication and social skills to move the organization to consider the challenge in a more comprehensive
manner.

**Arbitrary-Alternatives Decision-Making**

Tom Singley, the Chief Financial Officer of Tangent Corp, a small ten-million-dollar-a-year, successful
software company, needs to acquire and install a management information system. Present systems are
virtually nonexistent and management suffers from lack of accurate and timely financial and operating
information. Tom and his chief accountant have obtained three bids from small financial systems
companies that they have previous experience with. None of these systems addresses operating information to any great extent.

George Hutton, one of Tangent’s senior software designers, has voiced his concern to Tom that the broader information needs of Tangent have not been determined and may not be served well. Nor have any of the software specialists been consulted to ascertain that the new system will be compatible with existing systems and architectures. George also has suggested that other vendors that he knows about be invited to bid since they provide systems with broader scope.

Tom decides that the present alternatives, arbitrary as they may be, are enough and does not want to take more time to consider additional options. Ultimately, Tangent chooses one of them. After it is installed, it is determined that the system is too limited and hampered by its incompatibility with existing architectures and will need to be replaced within the-not-too-distant future.

Unfortunately, arbitrary-alternatives decision-making is quite common for many reasons. Many decision makers will collect the first alternatives that present themselves and soon decide that they have enough alternatives, even though none of them may address the real needs of the situation. For example, we find this behavior when decision makers have little understanding of the situation that they are about to make decisions for. We also find arbitrary-alternatives decision-making when there are no criteria for what a good decision requires, when there is limited time, or when the decision maker wishes to exclude others from participating.

When the decision maker has good idealistic knowledge of what is desired as a result of the decision, arbitrary-alternatives decision-making is typically avoided. At other times, if the decision maker does not have systematic knowledge, may delegate the decision. And when missing detailed knowledge, s/he might delegate to others analysis and considerations requiring such knowledge.

**Dominant-Factor Decision-Making**

Maggie Hogan is a product manager at Appie Corp. She is responsible for product development and marketing for Appie’s kitchen utensil products. The product she is working on is a new, high-technology can opener that she has scheduled for introduction in five months. Unfortunately, she has just become aware that Appie’s major competitor plans to release a similar can opener at about the same time, perhaps even a few weeks earlier. From her information, she gathers that it will be a little less sophisticated than Appie’s but she is afraid that it will steal too large a market share unless she beats it to the market.

Maggie calls a meeting of her development, production, and marketing teams to explore which options they may have. They determine that their present schedule is sound and that they can complete development, tooling, market introduction with advertising, and produce and place enough merchandise in stores by the previously agreed date for a can opener with all the approved features.

The group also agrees that they have an option to introduce the can opener two months earlier if they can delete two of the advanced features, which make it easier to operate the can opener and keep clean. The remaining features will still make it very attractive. These changes will also make the can opener slightly less expensive to make. However, there are two options for producing the desired finish. The more expensive option is quicker to implement while the less expensive, but equally attractive, cannot be completed within two months. Once one finishing method has been implemented, it will be costly to change -- almost as costly as implementing it in the first place.

Given these inputs, Maggie has to make the decision for how to proceed. She decides that timing is the overriding factor. Consequently, she decides that she will accelerate the schedule and introduce the can opener in three, instead of five months. The can opener will have the more expensive finish and be without the two good features. To compensate for the more expensive finish, she decides that the price will be the same as has been planned. Maggie will risk the possibility that the competing can opener might be slightly
better than her new product and, therefore, steal market share once it becomes available. By then, she feels, Appie’s product will already have established itself in the marketplace, preempted a number of sales, and have earned two months of early revenues.

Decision makers use dominant-factor decision-making to simplify complex decision situations. Quite often such simplification leads to sub-optimization and undesirable results. In method and intent, it is similar to dominant-factor reasoning although in many respects it is much more complex as illustrated in Maggie’s case. We encounter dominant-factor decision-making frequently and in all kinds of situations. For example, in a hiring decision, the decision maker only considers the candidates’ expertise, not their asking salaries; or equally likely, the decision maker considers only the asking salary, assuming that all other characteristics meet the criteria.

Dominant-factor decision-making is frequently used as a basis for purchasing and contracting decisions. In these cases, the dominant factor may be considered to be the cost of the transaction which, therefore, becomes the decisive factor after all other characteristics have been checked to ensure that they pass a set of fixed minimum criteria or “hurdle values.” In fact, this approach is deliberately used to simplify decision situations that in reality are complex multi-criteria decision situations (decisions with multiple objective functions). Factors such as quality, delivery time, and so on, are specified in terms of minimum acceptable levels and the transaction is declared acceptable if the factors pass these levels. This eliminates the opportunity to consider tradeoffs between quality and costs, for example, and has led to a myriad of extraordinarily expensive and arbitrary decisions in private industry as well as in the Federal Government. For example, we have all heard the stories about the $2,500 toilet and the $500 “standard” crescent wrench.

The knowledge we use for dominant-factor decision-making is to a large extent domain-related systematic and pragmatic, as indicated in the example where Maggie and her team used systematic knowledge to project outcomes and devise new alternatives. They used pragmatic knowledge to assess the detailed aspects of the alternatives. Since dominant-factor decision-making is relatively ad hoc, we only rarely will use any systematic knowledge about decision methods.

Dominant-Hypothesis Decision-Making

Chuck Potter is one of ApCo’s regional sales managers responsible for bulk chemicals. One of his large distributors has repeatedly reduced its orders over the last several months. Chuck’s sales representative tells that he has tried to come to grips with the problem but has come up empty-handed. Chuck has himself talked to the distributor and has been told that the reduced orders are the result of less demand from the small businesses that use the chemicals for metals cleaning and finishing. However, Chuck has learned that those businesses as a group are enjoying increased sales. He is not aware of any new cleaning or finishing methods or substitute chemicals that can explain what is happening. He hypothesizes that there can be several reasons for the reduced demand. All will require quick action:

• There is indeed an alternate method for cleaning and finishing metal that is more attractive and does not require ApCo’s chemicals. (He does not believe this).

• There is a competing distributor that sells the chemicals to the end-users at more favorable rates and provides better service. (He has no indication that this is the case.)

• His distributor favors another chemical company and this change in allegiance may have been caused by:

  -- Lower prices. (If that was the case, his sales rep would have heard about it and reported it)

  -- Better service -- perhaps in the form of just-in-time service

  -- Different terms -- perhaps as better credit terms or even consignments instead of outright sales. (His
sales rep would have told him.)
-- Ordering or billing problems. (He would have heard about customer complaints.)
-- His sales rep is not performing his job

Chuck looks at the options and decides that the real problem most likely is that the distributor favors another supplier and has started to receive significant shipments from it. He suspects that the reason is that his sales representative is not sufficiently attentive and vigilant. Chuck, therefore, plans to call on the distributor and will be ready to make significant changes to get the business back.

The general strategy of dominant-hypothesis decision-making is to: (a) consider several hypotheses for the situation and choose the hypothesis that explains most of the observed conditions; (b) assume that only one basic thing is the matter with the situation; and (c) select the alternative for how to handle the situation that best addresses the dominant hypothesis. For example, physicians are often taught this strategy to decide how to treat patients. They should assume that there is only one thing wrong with the patient and that they need to correct that.

When using dominant-hypothesis reasoning, one should choose the hypothesis that leads to the best remedial strategy. If there is a toss-up between root-cause hypotheses A and B, but the presence of A would require prompt handling -- and that action would not jeopardize the handling of B -- then, A should be chosen until more information can be obtained.

The knowledge we use for dominant-hypothesis decision-making is basically systematic for the primary work-related domain. We also use systematic and pragmatic methodological knowledge to diagnose the situation and to develop appropriate approaches.

To avoid engaging in dominant-hypothesis decision-making, when a more appropriate approach is needed, we need to possess greater idealistic and systematic knowledge. We also need knowledge of adjacent work-related domains and in many instances world knowledge.

**Incremental “Muddling-Through” Decision-Making**

*Denise Quigley is Director of Technology in the Information Systems Division at Bolac Industries. She faces a situation where Bolac needs to implement local area networks (LANs) in seven locations which now have none or inadequate installations. In addition, Bolac has LANs of different ages, makes, and often incompatible architectures, in thirteen other major locations around the world.*

As Denise investigates how to approach the situation, she determines that Bolac has several alternatives. Most of the new locations pose rather special requirements. One has high speed real-time operations with high data transmission needs. Another has a small LAN in place for its engineering work stations but needs a facility-wide network that is compatible. A third is converting from a mainframe with a few terminals to “PCs on every desk.”

Denise thinks that Bolac ideally should “bite the bullet” and use the opportunity to start converting to an advanced LAN solution for gradual implementation throughout Bolac as a company standard to serve all LAN needs for the next decade. The other options are to continue the present piecemeal strategy of implementing lowest-cost specialized solutions everywhere although it will continue to lead to considerable incompatibilities, technical bridging problems, and reduced capacity and capability. Short-term, the present strategy is less costly and disruptive. Long-term it is much more costly and impedes the operational capabilities of the organization in many ways, including reduced capability to upgrade to more modern workstations, database architectures, and other office and plant automation approaches when these become desirable.

There are three alternatives for a standard LAN solution. Each will serve Bolac well for more than a
decade. All of them, however, require considerable additional expenditures in the first year over and above the specialized low-cost solutions.

The decision on which alternative to pursue lies with Don Tucker, Bolac’s Chief Information Officer and Denise’s manager. Denise presents the alternatives and their implications to Don, who weighs the pros and cons of each and also considers such issues as established budgets, political consequences, and available in-house expertise. Based on these considerations, Don decides to continue the present strategy to implement the specialized low-cost solutions for each location and postpone any decision to create a standard for Bolac’s LAN technology. He justifies the decision by its low cost; lack of need to rejustify and renegotiate budgets; continued reliance on present -- albeit somewhat outdated -- in-house LAN expertise; and lack of disruption to several of the departments. Since it alleviates the immediate needs for the seven locations, Don decides to ignore that his decision will lead to low capability. He also disregards that the specialized local solutions will also be temporary and will need to be scrapped whenever Bolac adopts a uniform standardized LAN architecture and will therefore, be more expensive in the long run.

Depending upon the circumstances, incremental decision-making may be the worst possible or the very best way of handling a situation. This approach is based on making narrow decisions and suboptimizing them to be as small as possible and with a scope that covers the narrowest part possible of the challenge. It frequently considers the last analysis and decision made in the area involved and builds upon these by making minor adjustments or expansions if that is defendable in the current situation.

Incremental decision-making is geared to: (a) continue the status quo or (b) “put out fires,” that is, continued implementation of good policies or small adjustments to fix shortcomings in present situations. It is attractive, in a detrimental sense, because it permits avoidance of difficult or elaborate cognitive tasks that may require extensive knowledge and effort. Over time, however, incremental decision-making accumulates to large decisions that may prove to be arbitrary and often lead to undesirable and unanticipated results unless used deliberately to implement a good strategy step-by-step.

Incremental decision-making is often wrongfully applied when the decision maker has limited knowledge of the overall goals of the general situation of which the immediate challenge is a part. In such instances, the decision maker can see no reason to expand the scope of the decision-making process.

In spite of its potential problems, incremental decision-making is useful and can be highly appropriate in situations where such decisions are part of a continued series of implementing decisions of a policy that still is valid and good. In many similar situations where a good goal is known, there is nothing to be gained from going back to first principles to reevaluate the underlying reasons.

Proper application of incremental decision-making requires excellent knowledge of how the present challenge relates to the direction of the general situation of which it is a part. It also requires good understanding of the continued validity of the underlying premises. In all instances, application of the approach depends on assessing how the available alternatives will affect the overall goals as well as understanding how it will affect the immediate situation.

Mixed-Scanning Decision-Making

Hollis Crocker is Vice President of Project Staffing at Dapper Engineering. Dapper’s business had expanded and Hollis needed to reassess the approach used for on- and off-site project staff selection and assignment. According to the present approach, which was difficult to administer, the Management Committee appointed the project manager while Hollis as the VP-PS and his staff of two selected and assigned the project personnel pending approval by the project manager. With the increase in Dapper’s business, over one 150 new engineers had been added to the different specialty department staffs. The
hiring workload became too great, the selection was not always the best, and a better approach had to be
developed and adopted.

Hollis assembled a taskforce with representatives from Human Resources, Business Development, and the
major departments involved to develop a staff selection approach that would work better under the new
circumstances. The taskforce quickly developed several alternatives, ranging from minor modifications of
the present approach to selection procedures that would rely on a large central project staffing group with
full overview of every engineer’s experience, skills and personal characteristics, schedules, and
commitments, and to project managers staffing their own projects. Over a dozen different approaches were
identified and sketched out. After a preliminary evaluation it was found that only three alternatives were
suitable for further exploration. The other alternatives were rejected for different reasons. For example, a
large central staffing group would be a Utopian dream since it would require unrealistically good insights
into each engineer’s capabilities and commitments. A computer-based “skill inventory system” was judged
to be too time-consuming to implement. Having the project manager select his own staff would be too
parochial, lead to too many conflicts and arguments, and create unbalanced teams where the project
manager’s weaknesses would be amplified.

By outlining the remaining alternatives in greater detail and using the broad perspectives of the taskforce to
generate creative suggestions to be criticized, a final solution emerged. The solution involved creating a
small group of senior and long-term Dapper employees from different parts of the company to become
Project Staffing Directors (PSDs) under Hollis’ direction. The PSDs would receive initial education to
develop deep understanding of Dapper’s corporate goals and good staffing strategies for different types of
projects. They would also be given access to all relevant personnel and scheduling information with
support from readily available computer-based tools.

Each project manager would be assigned a PSD part time. The two would collaborate as equals and
negotiate with department heads and individual engineers who under this system would be given the
opportunity to have greater inputs to their assignments. Department heads would continue to be
responsible for the quality of work and professional development of staff assigned to the projects, and for
their general schedules and availability.

To ascertain that the approach would be feasible and acceptable, Hollis and the taskforce developed a
detailed implementation program to appoint the PSDs, provide them with additional education, create the
necessary organizational structure, and develop the computer-based support systems. They also discussed
the approach in detail with nearly all department heads and a number of project managers and made minor
revisions to alleviate some problems that were uncovered during this process.

Mixed-scanning has possibly always been the most common approach to in-depth and thorough decision-
making. We use this method when we approach a challenge that requires that we go into a fair amount of depth
to develop several “good” alternatives and test them for validity and expected performance before we can select
the best. Mixed-scanning may even be considered to be a “quasi-vigilant” decision-making approach. The
approach was first described by Etzioni, who outlined a script for mixed scanning decisions consisting of the
following five steps:5

1. List all relevant alternatives
2. Examine all alternatives and reject those with “crippling objections”
3. Repeat Step 2 in increasingly greater detail until only one alternative is left
4. Before implementing:
   -- fragment the implementation into several steps
   -- divide the commitments to implement and the assets into serial steps and maintain a strategic reserve

-- arrange implementation to let costly and less reversible decisions appear later in the implementation process
-- design a schedule for additional information collection

5. Review while implementing and replan as required

From our perspective (we have benefited from much additional thinking by other decision theoreticians like Simon, Janis, Kahneman, Tversky, Raiffa, Keeney, and others), Etzioni’s script captures and highlights the particular nature of the process but disregards the creative aspects of the analysis and synthesis phases for generating alternatives.

The mixed-scanning approach can be tailored to utilize available time and resources to the fullest and thereby provide very valuable alternatives that are not artificially constrained by the simplifying coping approaches introduced above. At the same time, however, although developing some “good” alternatives, the approach is still limiting since it draws from an arbitrarily limited sample space, potentially with limited dimensionality, where each alternative can be considered a sample. (Due to time and resource constraints the sample may be only partially developed, i.e., be less than optimal for its particular solution direction.)

The reduced dimensionality that may result from mixed-scanning decision-making is in many ways identical to a situation where a bridge design team designs a suspension bridge based on only the perspectives of static loads while ignoring the effects of dynamic loads from strong winds and heavy, fast traffic. They spend the time and effort required to arrive at what they judge to be a sound and appropriate design. As has happened with many such bridges in the U.S., Europe, and Australia, the static safety was not a sufficient criterion and many fell down during heavy winds. The inadequacies were evident! In organizations and business bad decisions are not always as easily detected and verified. Yet, we strongly suspect that a large proportion of such decisions are flawed, similar to the bridge design decisions.

**Satisficing Decision-Making**

*Phil Post, Hull Corp’s plant engineer, is facing the dilemma of how to approach rebuilding the motor control center that was destroyed in yesterday’s fire. Time is of the essence and he has a limited budget.*

Phil and the electrical engineer, Tom, sit down to explore their options. They have good and recent drawings (which they tell each other is unusual), and would be able to reconstruct the control center using the same type of equipment that was destroyed. That equipment was due to be modernized, but new engineering plans had not been made and there is no time to redesign the whole center. There is another option that they are familiar with. One manufacturer offers “PowerSwitch,” a line of relatively modern equipment that replaces what was destroyed on an almost one-to-one basis and therefore, can be installed without significant redesign. That equipment is good, but does not offer all the features that Phil and Tom had planned on. It will, however, upgrade the center to a fair degree. There may be other manufacturers and other solutions that will serve the purpose even better, but they do not know about any for certain.

**Phil and Tom decide that since PowerSwitch will be able to do the job and avert future fires, it will be “good enough” even though it is limited compared to their goal for the plant. They decide to not look any further and order PowerSwitch for immediate installation.**

When a decision maker looks for an option that is just “good enough” s/he satisfices. Herbert Simon introduced the concept of satisficing to characterize the expedient behavior of decision makers who stop short of finding the best solution that fulfills all criteria to the best degree.

Businessmen may decide to invest in a new enterprise if they expect it to return a “satisfactory profit”

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6 Simon (1976), *Administrative Behavior*. 78
without bothering to compare it with the other available investment alternatives. Typically, a number of alternatives are examined sequentially until one, found to be “good enough,” is chosen without further analysis.

It has been found that satisficing decision-making -- and problem-solving -- is the most common approach used even when people are quite serious about finding and pursuing the best alternative. In reality, there are always limits to available time, resources, and patience and these limits tend to stop the process and force closure before an optimal result has been identified.

From a decision maker’s perspective, it is important to have sufficient knowledge about the situation to understand when it may be prudent to stop the process -- and when it is premature. To have this insight, specific knowledge is required about the expected performance of the identified alternatives, the requirements of the situation, and expectations for what can be achieved by continuing the process. It is also required that the decision maker understands the general decision and problem-solving process that is pursued.

Much too often, decision makers have a lack of understanding of these areas and will cut the process short prematurely and with undesirable results for the corporation. The decision maker satisfies -- but without well-founded judgments of the implications of the decision.

**Vigilant Decisions**

_Hattie Fuller is Marketing VP for ProCold, a medium-sized manufacturer of industrial freezers. In conjunction with the Management Committee headed by the CEO, she has determined that ProCold needs to make a deliberate change to become dominant in their market niche. ProCold is now number four, but has arguably the best products and is in a very good financial position, which allows them to make a big move, should they decide to do so. Their top competitor has management and product problems but has the major market share since historically it was the only sizable supplier. The other two competitors also have problems.

As they see it, ProCold’s only option is to make a significant change. If they continue with business-as-usual, they expect to lose market share and possibly become an unprofitable “also-ran.”_  

_The Management Committee has appointed Hattie to lead the effort to identify what ProCold should do. She works closely with the committee and has a small taskforce of three of the brightest professionals from Engineering, Marketing, and Finance to help her._

_ProCold’s major problems are that they have limited geographic penetration and limited name recognition. They have always sold direct to ensure excellent sales relations but have had problems delivering good after-sales service (they contract service to a national service chain). In addition, their manufacturing facilities will have limited capacity if sales would increase. On the positive side, they have an excellent reputation for application engineering, technical sales support, and initial installation and start-up. Their products have the best on-site performance and highest manufactured quality compared with competitors’ products. Their prices are also comparable with the competitors’ due to ProCold’s low internal costs._

_Hattie has worked on this challenge for two months and has developed several options. Most of them are still being explored to determine precisely how they can be implemented and what their implications will be. The options that seem most interesting cover a wide range and while some are stand-alone, others could potentially be combined. In no particular order the options are:_

* **Merge with one of the three larger competitors.** Sell out to provide buyer with superior product design and manufacturing facility
* **Buy competitor Atlan (No. 3),** who has a complementary geographic market, a reseller network, and outdated products
* **Increase the size of sales staff to cover the whole country**
Switch from direct sales to a national agent network

Embark on aggressive advertising and PR campaign

Expand the Initial Installation Department to include an in-house after-sale service organization with locations throughout the U.S. Cancel the present service contract

Increase manufacturing capacity in present location

Increase manufacturing capacity. Build new plant in different location

The taskforce meets with the Management Committee in formal weekly sessions and informally with the CEO and other members on a daily basis.

During this period, Hattie and her taskforce, with the help of everybody else, have shaped and reshaped the options so that they have become quite attractive and feasible. At the risk of letting their competitors know too much, the CEO has even explored potentials for mergers with competitors through an intermediary. The criteria for what the best course of action will be have also been developed and have been a major driver for shaping the options.

Initially, everyone thought that ProCold was in the business of manufacturing and selling industrial freezers. Therefore, the corresponding criteria dealt with how well they could design, manufacture, and install the products leading to the desired financial performance. As they worked with the challenge, it became clear that ProCold needed to look more broadly at the business it is in. In the long run, ProCold is in the business of providing their customers with cost-effective capabilities to preserve food around the clock. That realization was a whole new paradigm for ProCold’s management. It resulted in new criteria and shaped the development of options in totally new directions.

Given its strengths and its new perspectives, ProCold decided to invest heavily, expand its sales staff, expand its installation department to include service, and expand its present plant as volume rose. It also built a new customer service function, embarked on a PR campaign, and offered new guarantees for system availability and service. As part of its overall program, to minimize down-time and demand service calls, it retrofitted its larger models with monitoring computers that regularly would dial into ProCold’s maintenance computer to report on the condition of the systems.

It Takes Conviction to Make Decisions!

Committing to making a decision takes conviction. In addition, it also takes vision and ideas to make it clear that the available options are “good enough” and that it is unlikely that other options will yield a much better result. Often considerable understanding -- knowledge -- is required to bring about the necessary conviction, visions, and ideas.

Core Corporation’s management committee was faced with making a major decision regarding reengineering its marketing, sales, and manufacturing operations. The project would be performed by the in-house reengineering staff assisted by a few outside specialists and would result in redistributing knowledge-intensive activities, change work and management practices, many decision rights, and organizational responsibilities, and introduce a new information support system to make it all possible. The problem was made more complex since considerable policy and cultural changes were also required for the project to be successful.

Pete Core, the Chairman and CEO was not convinced that this was the right thing to do and members of the management committee were concerned that GC’s expertise was lacking. They voiced their concerns to the reengineering staff and together they decided that the management team needed to develop a much better understanding of the whole situation. In particular, the reengineering team and others needed to help them firm up their ideas and visions for what could and should be done considering the company’s needs and the market situation, and to gain conviction that it could be done with the resources at hand and would be worth it.
Example of Understanding in the Form of Transferred Knowledge Needed to Develop Visions and Convictions Required to Make a Decision to Act.

With the help from marketing, manufacturing, human resources, and organization development, the reengineering staff focused on developing the management team’s knowledge and understanding in nine different areas. After considerable exploration and discussion, the management committee felt that they would be willing to act. They made the decision to go ahead, commissioned the project, developed the action plans, and the project was undertaken and completed with realization of most of the expected results to everyone’s satisfaction.

Core Corporation’s decision situation and understanding process that in the end led to undertaking the reengineering project is illustrated in the Figure. The reengineering staff aided by partners throughout the organization, provided management with complementary understanding -- knowledge -- in all the nine areas. This scenario is typical in that the decision makers must frequently be helped to understand the broad position of what is proposed, the proposal itself, and the implications and capabilities to make it happen. The decision makers need to be given confidence in the visions and ideas that they themselves have as well as those provided to them. Likewise, they need to be reinforced to develop conviction “that it can be done and that it is worth it.” Only then can they be expected to be willing to change and resolve to act.

It Takes Networking to Handle Customer Requests

Chet Hawkins, PotCo’s customer service specialist, receives a request from John Alexander, PamliCo’s chief engineer, for assistance with an application problem that PamliCo experiences when using one of PotCo’s products. The application problem is complicated and unusual and is beyond Chet’s experience. Chet realizes that solving the problem is important. Finding a working solution is worth a lot to PamliCo, who is a large customer for PotCo’s products.

Chet decides that he will need considerable help to assist John Alexander. Most likely, he thinks, he and someone else will need to go to the customer site for several days to diagnose and solve the problem. From
previous experiences, he judges that solving the problem will require either a new way of applying the product or, if that does not work, a slightly different product will have to be formulated.

Chet calls Pete Holden, his manager, to alert him to the situation and to obtain his authorization to provide the assistance he thinks is needed. He also gets hold of Jennie Hall, the technology expert, and Ollie Thorpe, the product developer, to ask their opinion on what might be the matter and how they ought to proceed. In spite of being very experienced, Jennie and Ollie have not heard of this kind of problem before, but they check with Pete. He thinks he has seen something similar at another customer who has similar applications with which he is familiar.

Pete and Chet decide that they will go to the customer site and take Jennie with them even though she does not know applications as well as Ollie and is not an expert in new product development. She does, however, have a better understanding than Ollie of the product’s scientific basis and might, therefore, be of greater assistance in this situation.

Many everyday situations are similar to this example. Nonroutine problems often exceed the expertise and experience of the persons who “own” them. To explore how these problems should be handled, the problem owners network with others who they think have complementary expertise or who have the decision rights to authorize extended efforts that may be required to handle the challenges correctly.

A schematic illustration of the networking that took place at PotCo is provided in the Figure, which also shows the roles of each network participant. The initial networking was between the owner of the problem (Chet) and his informal expert network. Only when Chet determined that he needed additional help did he seek out the manager.

An Example of Networking to Handle a Customer Request.
Collaboration by Equals

Paul Jones and Mary Stewart work together to operate the alkylation unit at Star’s oil refinery. They are equal partners but have different backgrounds. Mary is a chemical engineer three years out of school and Paul has been an operator since he graduated from high school 20 years ago.

It is noon on Friday and the plant has been operating relatively well all morning. At about 12:30 the process starts to show signs of becoming slightly perturbed but it is not clear what might cause the problems. Paul thinks it may be due to contamination in one of the feeds although the symptoms are somewhat different from what he has seen many times before. Mary listens to Paul’s explanations but is slightly cautious since they do not make sense based on what she knows about reaction kinetics. She does not know the typical operation of the plant as well as Paul, however, and does not press her views.

The plant reacts slowly and Paul and Mary have a few hours to figure out what the problem is and how to deal with it before the situation becomes urgent. They listen to each other and try to incorporate the other’s observations into their own thinking to explore how they may proceed. They send a sample of the suspect feed for analysis but will not get the results for three hours. After a short while, they agree to increase the catalyst recycle rate as a prudent approach to dealing with the problem. That might help the contamination issue, if that is the cause. It might also alleviate some problems that Mary suspects and will prevent flooding in some vessels that now have rather high liquid levels. Finally, it will give them additional time to try to find the root cause of the upset.

Paul and Mary work closely together. They look at instruments, decide which computer settings to implement, and continue to try to generate the best ideas they can come up with.

When two people collaborate on operating a complex chemical process, they engage in a sophisticated interpersonal process. They may independently inspect the behavior and performance of the different parts of the plant as time goes by. They will discuss what appears to happen, which behavior may be expected next, what causes the present operation (particularly if it is unusual), what the advantages or disadvantages may be to make certain changes in operation, and so on. They bring their respective experiences and perspectives naturally into their discussions and actions without reflecting much about their own thinking processes or the strategies they use to solve problems. They will try to make the best use of their knowledge. When one of them presents an idea, the other will use the best understanding of the other’s suggestion while also using her/his own knowledge to build upon -- or refute -- it. The resulting operating performance of the plant will manifest the ideas and perspectives of the two operators and will most likely be much better than if either person had operated the plant alone.

What Is the Meaning behind the Information?

A much more important aspect of the use of information is associated with the question, “what does the information mean?” What does it tell us about the situation that it pertains to -- given everything else.

Alice Carpenter is the customer service director at Apex Corp. Paul Gantt, the chief engineer of ProPak, one of Apex’s medium-sized customers, calls Alice to request assistance in redesigning a part Apex makes for ProPak. Paul is asking for almost immediate action and is also requesting that the design service to be free contrary to Apex’s normal practices.

Alice cannot remember precisely what ProPak’s records are, and she is hesitant to promise too much for fear ProPak is only on a “fishing expedition” to explore options and may in the end go to a competitor. She queries Paul and discusses the situation with him, accesses the customer service and history files through her workstation. While talking to Paul, she also lets the computer search the marketing and competitive
information databases to identify what else may be going on that relates to ProPak and other potential suppliers. Since ProPak is a public company, Alice also has the computer look up and evaluate their recent financial and market situation.

During her discussions with Paul, Alice performs many knowledge-intensive tasks on several conceptual levels. On the lowest conceptual level, she engages in fact finding. On an intermediate level, she processes the information by analyzing what she obtains from her computer and what is communicated by Paul. She evaluates the information for reasonableness and plans the next steps required to obtain additional data. Alice’s purpose in performing these tasks is first to identify what Paul’s and ProPak’s situation is -- how big and capable are they, is this a reasonable evolution of the relationship, are they in a bind, etc. In other words, she is forming a mental model of ProPak’s general situation. Next, she attempts to determine what ProPak’s intent is -- what Paul’s inquiry means given the general situation.

What Alice is particularly interested in, is to determine what Paul’s inquiry will mean to Apex and to explore in her mind what the potential alternatives are. She holds Paul off while discussing options with Apex’s engineers. She calls Paul back to discuss the best alternatives with him and negotiates a mutually satisfying approach that they also agree on how to implement.

Throughout, Alice has continually turned over in her mind how the whole situation with ProPak might be approached from different perspectives to provide a setting with alternatives that are more suitable for both Apex and ProPak and that may provide better overall results as well.

In this example, the knowledge-intensive activities Alice has engaged in are similar to those shown in Figure 3-2. Alice uses her basic skills to obtain the facts she needs to create a mutually satisfactory situation for the two companies. She then uses knowledge of a different kind -- professional knowledge -- to evaluate what the information tells her and to form opinions of the customer situation, the customer’s intent, and what to do about it.

We find that proficient workers use professional knowledge in all situations to interpret the available information in an effort to determine what it means -- to determine what the situation is, what is wanted, and how to deal with it. The quality of this determination and the quality of the subsequent work performed, is in almost all cases in direct proportion to the worker’s expertise and knowledge.

**Budget Cutting May Lead to Detrimental Knowledge Gaps**

In the 1970s, a Silicone Valley semiconductor company had perfected its production of 4k dynamic random access memory (DRAM) chips to the point that yields were good and production costs were low. The plant ran with few operating problems: Operators and technicians were able to run production and maintenance with little or no help from engineers and product designers. The company made good money and looked forward to a long and profitable product life span. However, price competition was strong and management decided to improve profits by cutting back costly R&D and engineering staffs. As a result, most engineers and scientists were laid off or resigned leaving only a skeleton professional staff.

A year later, the new generation of 16k DRAM chips were introduced and the demand for 4k chips started to fall. Due to its R&D cutbacks, the company did not have a competitive 16k design of its own, and it was too late to create one. Management also discovered that without a strong engineering staff, it did not possess the knowledge to adapt its production line to the more demanding technology required to produce 16k chips, should it decide to buy someone else’s design. To make matters worse, competitors had invested in R&D to improve their 4k chips to be faster, more reliable, and have lower power consumption to serve the shrinking market better. The company gradually lost sales and within another nine months, it ran into red and was liquidated by the bankruptcy court shortly thereafter. The only assets left were real estate, machinery, and some raw materials. It had no intellectual property, knowledge assets, or market recognition and was essentially an empty, worthless shell.
Don’t Transfer Work to the Field without Accompanying Knowledge!

A large chemical firm decided that its salespeople needed greater autonomy in matters relating to negotiating terms of new contracts. The firm had lost considerable business which it judged as stemming from its rigorous and bureaucratic internal procedures for preparing and reviewing quotations and contracts.

It was assumed that the salespeople had sufficient understanding of the deliberations that needed to be taken into account to close a contract. A brief document was created and distributed to outline the new policies that increased decision rights and specified basic terms and the room for negotiation. Based on the feedback of a few sales managers, it was judged that the new procedures were simple enough to be competently handled by all.

A few weeks after the new program was initiated several dozen new short- and long-term contracts had been negotiated and forwarded to the VP of Sales for review. It was found that most of them violated the terms of the new policy, giving customers prices and delivery conditions beyond what had been intended as the outer limits, although those were not clearly delineated since they depended upon several conditions. After interviewing the “offending” salespeople it was found that they had never understood how to take into account the need to balance regional product slates, calculate overhead allowances, the internal system’s needs for advance notice, and so on.

It had been thought that the sales force was better educated. The VP of Sales had indicated: “Everybody knows these things and I learned the first month on the job!” The present situation was intolerable and the VP of Sales decided that instead of centralizing decisions, it would be better to support the new policies by a quick and intensive educational program supported by videos and interactive CBT programs. A knowledge-analysis was performed to delineate the knowledge gap and the programs were implemented with the desired results.7

Automating without Adding Knowledge Can Be Costly

Many American companies have embarked on massive automation projects but have not received the intended benefits. An example:

A large producer of consumer goods had high production costs which it determined were due, to a large extent, to inefficient use of its workforce. The number of work hours per product unit was one of the highest in the U.S. and significantly higher than its more efficient international competitors. Many overseas competitors had automated their plants extensively, and this was generally accepted a major factor in their success. As a result, the company decided to embark on an aggressive automation program.

The company created specialized engineering teams that studied automation opportunities throughout its operations. Massive changes were made in layouts of the production processes, the production line was streamlined significantly and new plants were built to facilitate automated production. After several years of planning and engineering, the new automated processes started to operate. The usual start-up problems occurred, but they were expected to be easy to iron out.

Unfortunately, many operating problems that appeared at start-up persisted. For example, the automated lines had frequent production stops and long downtimes. When the lines did work, the quality of

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7 When the VP of Sales started as a junior salesman 15 years earlier, the field had great autonomy. However, as the firm grew, many unprofitable decisions were made and pricing and contract decisions were later centralized. The reasons for this move had been erased from the corporate memory; hence, the errors repeated themselves.
the products were less than satisfactory, and the scrap rate was unacceptably high. It had also been expected that transition of products from one line to another would be “seamless.” Instead, significant manual adjustments were often required for intermediate products to be acceptable downstream. As a result there was considerable rework, in-process inventory was much higher than expected, and schedules were constantly delayed.

What was wrong? In retrospect nearly two years later, the company discovered that they had made two major management errors, both of them knowledge-related:

1. The workers had not been educated. Those who operated the new automated systems had only received instructions and training in how to run the equipment under normal circumstances. If something went wrong with the automated equipment they were to report it to specially trained mechanics who would make repairs. Quite often this would lead to shutting down the line while mechanics were summoned to fix the problem. Also, all too frequently, the workers did not spot problems early enough, thereby aggravating the equipment failures resulting in costlier and longer repairs.

   The workers had not been given knowledge to diagnose their equipment and perform simple maintenance and adjustments on-the-fly as these were needed. In contrast, overseas workers in the same industries with equal levels of automation were considered knowledge workers, having received considerable education in the theory and technology of the automated equipment. They had also received general education in basic physics and electronics and in the more conceptual areas of diagnostics and trouble shooting.

   Overseas workers in similar situations were expected to be sufficiently knowledgeable to understand how their equipment functioned and to participate in the process of improving the operations. The American workers were not expected to understand, nor were they expected or encouraged to participate in making improvements in the line operation.

2. It was assumed that the new production lines initially would continue to make the old products. The product design engineers had not been educated in the operations and capabilities (and lack of capabilities) of the new automated production equipment. As a result, they did not have sufficient knowledge of its strengths and weaknesses and, therefore, did not know how to design products that could be manufactured optimally on the new production lines.

   As a result, many of the parts had to be completely redesigned to make it possible to manufacture them. It took almost a year to realize that and longer to accept it. In the meantime, older part designs were manufactured with difficulty, and the shapes and tolerances of many parts and assemblies had features that created aligning and machining problems in the automated line.

   Only after the design engineers had been thoroughly educated in automation design capabilities and principles were they able to generate workable designs.

**Dangers of Technology Transfer without Underlying Knowledge**

A large technology company manufactured high-quality industrial equipment with great success. A competitor had developed a complementary line of equipment but wanted to concentrate on other areas and, therefore, was willing to sell rights to its new products. The company bought all rights, drawings, product and material specifications, and manufacturing and tooling directions. However, it did not acquire any of the marketing, engineering, and R&D knowledge that was the basis for the new product line.

With all the technical information it had obtained, the company was able to produce and market the new equipment in record time and make high-quality products at a very competitive price. After they had produced the products for about a year, they needed to improve the equipment models to enhance their capacity and efficiency. Initially, they were able to make small improvements very smoothly and foresaw no
problems.

However, after a short time attempts to implement further improvements became problematic. Materials started to break, overheating occurred in unexpected places, and other physical limitations that had not been predicted started to appear. The engineering and research staffs worked on crash projects to reverse-engineer the products at great expense. Improvements became less than promised and some were delayed nine months before they could be shipped.

In the end, the company’s management evaluated the situation and found that it would have been cheaper and faster to develop the new product lines in-house instead of buying them. They also determined that if they had acquired only part of the underlying product knowledge -- in the form of transferring or borrowing personnel -- they could largely have avoided the costs, time delays and market embarrassment.

Knowledge Management Is Approached from Many Perspectives

Managers are motivated to become actively concerned about knowledge and how it is managed for several reasons. These reasons may originate from opportunities or problems or from management initiatives that initially had a different focus. Typically, as pursuit of management initiatives such as business process redesign (reengineering) or organizational flattening becomes more in-depth, the need for a more comprehensive approach becomes evident. This often leads to analysis of underlying factors, in particular knowledge, and how it is managed on a broader scale. Examples of initial foci and the changes in perspectives in such situations include:

1. **Knowledge Transfer Mode Perspective.** The initial focus of this large personal service company was on transferring knowledge to critical points-of-action when it was discovered that knowledge workers in the field needed additional expertise to deliver work of the desired quality. As the transfer program progressed, it became evident that attention also needed to be directed to the knowledge sources -- experts, outside resources, R&D programs, etc. -- to improve the quality of the knowledge involved. Further, attention needed to be given to approaches to capturing and organizing knowledge -- the acquisition process -- into knowledge repositories (the formal “corporate memory”) from which it could be transferred to points-of-action. Later, a broader approach was developed to manage the whole process including all knowledge resources and assets.

2. **Knowledge Asset Building Perspective.** The early concerns in this medium-sized manufacturing firm were associated with creating and collecting competitively and operationally valuable knowledge. It soon became clear that an additional and major issue was the need to categorize and represent the assembled knowledge so it could be accessed, validated, maintained, and made available to those who needed it. The training department found that its functions needed to be changed to assist with the transfer of the new knowledge resources to points-of-action using new technology that piggy-backed on an expanded information system infrastructure.

3. **Knowledge Asset Management Perspective.** In a large engineering firm the beginning emphasis was on making managers responsible for building, maintaining, and exploiting the knowledge assets under their control. This quickly led to realizations that other areas also needed attention to make it possible to transfer the responsibility to individual managers. Better knowledge-analysis methods were implemented to identify which knowledge was already present and where additional knowledge was needed. Knowledge sharing between experts and users and departments was found to have hindered effective corporate use and, therefore, was revised. Personal incentives to educate and help others were instituted, and after some time a comprehensive KM approach was implemented under top-executive management control.

4. **Intelligent-Acting Operation Perspective.** The management’s initial objective in a small process company
was for its employees to act more intelligently to make operations effective and serve the customers better. After the new initiative was communicated, it was discovered that most employees lacked critical knowledge of the process, customer needs, and the company’s real goals and objectives. Therefore, they could not immediately follow the intended directions. Consequently, a comprehensive educational program was started which in turn, led to a comprehensive, yet low-effort, program for acquisition and collection of expertise. Later, a broader KM program was created to support the initial intelligent-acting initiative.

5. **Reengineering Perspective.** A medium-sized transportation firm decided that its operations had become too unwieldy and did not reflect actual needs. Operating costs were higher than industry averages; besides, delays and other unwarranted problems caused management to start a reengineering effort. From process, information flow, and job-function analyses it was found that workers had not been properly prepared -- they lacked crucial knowledge. In addition to defining many reengineering opportunities, the task force identified an important need to strengthen the expertise of the workforce. A subsequent knowledge transfer program required a new emphasis on capturing lessons learned, organizing knowledge, and methods for deploying it to those who needed it. In addition, managers were for the first time made responsible for managing the knowledge assets under their purviews through personnel reviews.

6. **Learning Organization Perspective.** The management’s focus in a large marketing company was at first that it needed to become a learning organization in order to succeed. That meant that everyone had to learn from customers and monitor competitors. After an ad-hoc version of the initiative had been implemented for some time, it became clear that the collected intelligence needed to be structured and assembled into well-organized knowledge bases. It also became clear that effective mechanisms were needed to make the new knowledge available to all who needed it. Further experience indicated that additional capabilities were necessary. As a result, incentive programs to promote learning, use of superior knowledge, and an information technology infrastructure were implemented.

7. **Total Quality Perspective.** A medium-sized school system decided that its immediate approach to improving education was to adopt TQM methods. After much deliberation, they defined what constituted quality work and then discovered that the teachers often did not have the requisite knowledge to deliver the appropriate services to students. To alleviate the knowledge gaps in the short-term, the district adopted team teaching and other professional teaming approaches while waiting for the staff to upgrade its content knowledge.

8. **Core Competence Perspective.** An advertising firm identified the key knowledge that distinguished it from its competitors. At the same time, it discovered that this knowledge was held by only a few individuals. One of them felt unappreciated, was generally unhappy and, therefore, was a potential liability if she would leave for a competitor. Management changed the incentive system to reward key individuals, broadened the transfer of core knowledge to be possessed by all who needed it, and started to upgrade the knowledge of all its employees.

9. **Knowledge Culture Perspective.** The CEO of a medium-sized process firm believed that the best way to excel would be for all its employees to be knowledgeable as possible. From the start, it was decided that all employees should be salaried, that all should receive in-depth education in the fundamental sciences of the processes used, as well as in finance and operational micro economics. In addition, all should be allowed to search for operational changes and would receive feedback on the efficacy of their suggestions once they were explored. After a few very successful years, additional steps were taken to redesign the plant and to embed considerable knowledge into automation and systems and procedures. The company is now a world leader.

As these examples illustrate, KM can be initiated from many different starting points. After the focus shifts to consider knowledge explicitly from a given perspective, it soon becomes evident that a number of activities and functions are intimately related and that most, if not all, of them need to be considered in order to make knowledge play its important function in the organization. The KM approach that are pursued will often be different and will emphasize areas and activities specific to the organization, its business, its priorities, and its capabilities.
Knowledge Management Focus Is Driven by Needs

Most companies pursue KM to satisfy very real needs. Initially, they may have been led to consider broad KM approaches in order to solve practical and pressing problems. Later they often find that the associated perspectives and methods have wider merit and applicability. A few companies have initiated KM after concluding from visionary and idealistic considerations that it is a useful and powerful competitive weapon. However, in a number of instances management teams with broad and long-range perspectives identified knowledge and expertise as fundamental strengths of their organizations, and consequently decided that KM approaches were appropriate to deal with their operational problems.

Examples of problems that led to adoption of KM approaches on a broader scale include the following:

• **A service company** discovered that: “we are letting millions of dollars of expertise walk out the door after each retirement party. We had no way to replace this knowledge in the short-term and had to start learning many things all over again!” as one senior manager phrased it. They decided to look at the knowledge that remaining senior employees possessed as a crucial resource and corporate asset.

  As a consequence, they set up a program to motivate employees with critical knowledge to postpone retirement, and to capture the expertise of those who were leaving. Expertise was captured by several methods, ranging from letting relatively senior people become apprentices to the experts, to eliciting and codifying the expert knowledge to document and preserve it in knowledge repositories of different kinds. In a few instances, knowledge-based systems were built. It is expected that this solution will become more frequent in the future as the company expands its capabilities in this area. The company has now instituted a broad program to organize and operate its “knowledge-bank” as an active and ongoing activity.

• **A high-technology company** discovered that a key individual provided an important interface between their sales and manufacturing departments. He translated equipment orders as expressed by the sales department into manufacturing documents which then became the basis for producing the equipment. Only one individual had this expertise and the work load was becoming so large that a knowledge bottleneck (critical knowledge function or CKF) emerged.

  Management immediately started to remedy the situation. In addition, having been sensitized by this type of problem, they also started a program to locate other CKFs that needed management attention. A regular activity is now in place whereby managers at all levels help find, investigate, and manage CKFs.

• **A heavy equipment manufacturer** discovered during its long-range planning process that the number of new product candidates in its development pipeline was insufficient to meet competitive challenges. Further, additional investigations revealed that the company did not have sufficient in-house expertise to develop all the products they needed. They also discovered that they were missing experts in areas judged to be crucial for future products.

  The company immediately embarked on an impressive and costly “knowledge acquisition” program. They hired a number of experts and started several new development and research projects to create the missing expertise and the desired products. They now have in place a considerable R&D program and are regularly assessing its direction from perspectives on technology and with particular emphasis on the knowledge that underlies the technology. The knowledge perspective has spread throughout the company to include considerations of knowledge required for many engineering functions, make/buy decisions, personnel reviews and staffing of operations and sales.

• **A financial company** had implemented and put into production a number of knowledge-based systems over a period of four years. Senior management decided to evaluate the efficacy of this activity with the objective that if the systems were as good as projected, more should be built and used. The evaluation indicated that about half of the systems were useful. However, to their surprise they found that many of the implemented systems had been selected without much forethought and that the work functions they
supported had not been modernized or redesigned to the degree desirable if a broader view of the operations had been taken.

As a result, senior management instituted a permanent program to coordinate planning for knowledge-based systems with a broader activity to rethink the way business was being performed and to include considerations of knowledge flows and intellectual tasks to ascertain that the new capabilities would serve the organization in the best possible way. Different priorities for the knowledge-based systems development program also resulted from the new program.

In all of these examples, the company management initiatives led to broader -- yet relatively narrow -- KM approaches. It is interesting to note that all these organizations now pursue still broader KM programs that enable them to gain overall perspectives and strategies that lead to better results.

The Learning Organization

Companies, as other organizations, are operated to ensure that they are successful by attaining their operating objectives to the largest extent possible. Frequently, that means they are expected to be better than their competitors and must maintain or better their financial and market positions as the world around them changes. To fulfill these expectations, companies constantly need to change and improve. They constantly need to learn -- from their own experiences, from research, from observations of what others do, and from any possible source that is available. To change, organizations must put to use what they learn and not forget the valuable lessons. Only when they are successful in these activities, can they be successful. As a matter of fact “for any organization to survive and have a chance of growing, its rate of learning has to be equal to, or greater than, the rate of change in its external environment.” Some organizations are very organized in their approach to learning as exemplified in an aggressive service company in the United States.

A service company works hard to stay ahead of its competitors. To achieve this objective, its managers deliberately wish everyone to learn as much as they can about its customers, its competitors, the effectiveness and performance of its products and services, what can be expected in the future, and anything else that may be of importance. The company makes available what has been learned to all who can use this knowledge to its best advantage.

This approach has led the company to adopt formal perspectives of what it needs to learn; how it wishes to learn it; what it already knows and how well suited and organized that knowledge is; who has it; where the knowledge is needed; and how to get it there. The company has implemented an impressive training program to transfer the knowledge to all who can use it. Thus, every employee spends one half day every week on learning -- in formal training or in other knowledge-building activities.

In this company, knowledge transfer occurs at several levels. On the most basic level, knowledge about jobs (i.e., task execution, products, services, etc.), are continually codified and updated into training program formats to provide employees with the skills necessary to perform their functions proficiently. On a higher level, employees receive education to learn broader aspects and underlying principles of such areas as their industry and dealing with people and the world in general. On yet a higher level, special programs provide insights into “knowledge about knowledge” -- how to view the knowledge they have and how it should be used, how to organize what is learned, how to learn on-the-job, techniques for problem-solving, and so on. Both theoretical concepts and practical methods for these areas are taught.

On a different level, the company embeds what they learn in the design of its products and services. It also incorporates selected aspects of what has been learned into its systems and procedures in flexible ways that allow relatively quick updating when required. The company has achieved a reputation for having the most responsive, cooperative, and knowledgeable service representatives in its industry and is recognized
for being highly flexible in its response to customers and for having the most up-to-date and best-performing products and services within the industry. In addition, the company has become very profitable and dominant in its market.

**Transfer Knowledge from Expert Areas to Points-of-Action**

**A Challenging Scenario**

Alta Co is a large service firm with a central pool of experts who work with difficult customer-related issues. In addition, they develop new perspectives, judgments, and approaches to deal with problems and work with outside experts to continually improve available knowledge. They are responsible for supporting customer representatives in over a hundred field locations whenever difficult situations occur.

Over time, as the organization grew, these activities led to thousands of daily telephone calls and e-mail messages, most of which would not be required if the field reps could be provided with appropriate knowledge. Unfortunately, the experts’ ability to help was often hampered by not having as complete information on a given situation as the fields reps had. Overall, the need for field reps to refer to the central experts caused delays, was disruptive to customers, and very costly to Alta -- a highly undesirable situation.

To improve customer service and reduce costs, the firm decided to transfer as much knowledge as practical from the central experts to the field reps. The reps are well trained in the basics of their work so the major questions became one of determining how the additional knowledge they needed could best be made available to them.

Alta undertook in-depth analyses of the knowledge-intensive scripts and activities for the most important (most frequent and highest value-added) tasks, thereby identifying the knowledge required by reps to perform competently. The results also determined which knowledge the reps needed to possess in their minds and which knowledge could be provided by computer-based or other support systems.

The resulting knowledge transfer program includes several modes: education of complex and general concepts (rather than training of factual knowledge to develop skills), knowledge-based and conventional decision support systems, and several reference documents -- some paper-based and others available in electronic form. Some of the less frequent and more difficult situations still need referral to the central expert pool which has been reduced as many of the experts are transferred to demanding positions elsewhere. The pool now also assumes greater responsibility for benchmarking and building new knowledge where that is required.

**Organizations Forget – and Miss Learning Opportunities**

Organizations lose good and valuable knowledge in many different ways. A typical example is found in the following experience:

A medium-sized engineering company experienced reduced demand for their services. Its business was cyclical, and its management was convinced that the setback was temporary. Nevertheless, it was decided to downsize by laying off one-third of the engineers -- about 300.

The company did not have a good overview of which departments and employees possessed critical knowledge. As a result, the top managers decided that all departments were to cut their staff by 30% to achieve the desired overall reduction.

Nine months later, the company received several large orders that required more engineers with critical design expertise than were available. It was realized that over 20 such experts had been laid off from the design department -- the largest with most experienced engineers. Attempts to hire back these experts resulted in three returning, the rest were unavailable.
As a result of the shortage of experts, the company needed to team with one of its competitors with a significant loss of revenues. The management team realized that it had made a grave error by downsizing across the board and initiated a program to develop a “skill inventory” to obtain an overview of where its critical knowledge was located.

The company in this example realized that it needed to change its practices to manage the knowledge-related situations deliberately for future situations. Nevertheless, it had lost valuable expertise by not focusing on knowledge and paid a stiff price for that. This experience is shared by many companies that downsize without ascertaining that they retain critical expertise.

New Product Strategy and Introduction by Argyll

Strategy to Introduce New Products by Argyll Chemicals

Argyll had recently invented a new line of adhesives with many promising uses for applications areas not possible to serve with existing products. However, there were problems that required a new approach successfully to market and service the new product line. The new adhesives would require extensive customer education about their application and uses. That would require that customer service representatives (CSRs) needed to learn more than usual about customer requirements and about how to create new product variants. They would also require to participate in difficult pricing decisions that involved deep analysis of customer situations such as customer product value and life cycle costs. This would require investigating and understanding customer’s customer situations and contexts.

Argyll decided on a new product introduction strategy. Previously Argyll’s strategy had been to support its customers with Applications assistance and troubleshooting with relatively little customer involvement in creation of new products and new applications. To implement its new strategy, the customer service representatives needed to engage in a different and more creative role. In particular and they would need to understand the product opportunities and how to collaborate with the R&D department. In addition they needed to take on an investigative role that would involve considerable dilemma as and trade-off analyses per.

Argyll’s management position for the new strategy was that intellectual capital (IC) of their managers, R&D researchers, CSRs and marketing people would be the major enabler of the performance of the new strategy. As a result, they decided to pursue effective and systematic Knowledge Management to achieve the strategic goals and support it with incentives and other support to facilitate positive personal attitudes. In particular, they decided to pursue knowledge management (KM) systematically and deliberately.

Senior management agreed that: “Our KM practices and efforts must have clear business objectives and we must educate CSRs based to achieve the business value of strategy implementation. We must combine responsibilities throughout Argyll for both business performance and creation and leveraging of the relevant IC assets.”

Argyll’s management realized that personal knowledge and structural application knowledge within their own people were of great importance and that it could be perceived as illustrated in Figure 1. However, in addition, they also realized that unless they could provide all relevant personal and structural IC to their customers, the customers would not be able to take advantage of the new adhesives or be able to redesign their products appropriately. Hence they needed for their CSRs with assistance of D&D staff and others to be able to diagnose customer situations, to identify opportunities for new products, and to assist in educating customer personnel at all levels. Their KM initiatives were undertaken with high priority and can be summarized as:

1. Start by creating a systematic plan for how, why, and when to undertake each KM effort and ascertain that pertinent resources are allocated to secure successful completion
2. Work to support a knowledge-vigilant culture and an “intellectual asset management mentality” (IAMM).

3. Educate CSRs and support them with Expert Networks, Management Coordination, and interactive tools. Define expectations for behavior by creating a “Customer Service Paradigm” (See Appendix).

4. Establish and teach knowledge-related business diagnostics to everybody within Argyll while initially focusing on teaching CSRs for adhesive-related analysis of customer opportunities.

5. Provide insights to CSRs on how to develop knowledge and understanding issues associated with products in customers’ worlds.

6. Make everyone – at all levels of Argyll – understand our business strategy and enterprise direction and help them develop knowledge of how they can assist in strategy implementation and what that will mean for them personally.

7. Create incentives and discontinue disincentives to pursue the new directions.

8. Provide information and communication technology (ICT) capabilities to support internal and external knowledge flows as indicated in Figure 2.

In summary, the critical factors that has made Argyll’s KM efforts successful include:

- Having senior management adopt, live and act as role models.
- Supporting the six success factors:
  1. Knowledge-supportive management philosophy and practice
  2. Deliberate and systematic knowledge management
  3. Knowledge and other resources
  4. Motivation and personal energy.
5. Opportunities
6. Permission
- Removing disincentives
- Adopting new incentives, build new culture, support and recognize IAMM
- Providing slack time for development
- Placing people a points-of-action and rotate them to give them broader understanding
- Delegating authority and as people to accept responsibility and accountability
- Monitoring gently

Argyll Figure 2. The Knowledge Flows to Be Facilitated by ICT.

Appendix – Argyll’s Customer Service Paradigm:

1. Produce and Deliver Products and Services Reliably and Competently
   - Provide high quality and on-time deliverables
   - Always use best available knowledge
   - Work closely with customers with effective “one-stop service” philosophy
   - Apply critical thinking
   - Take responsibility for “completed staff work”

2. Secure and Improve Customer Relationships and Internal Contexts
   - Implement Argyll Strategy – Understand and satisfy customer needs while meeting enterprise business intents
   - Maintain and improve customer – enterprise contexts
   - Collaborate, help coworkers, and build internal relationships
   - Identify, curb, and control improper behaviors

3. Conserve and Preserve Enterprise Resources
   - Work effectively – on target, efficiently, and be engaged
4. Renew Argyll Capabilities

- Use down-time creatively
- Make prudent tradeoffs considering business consequences

**Forrex Uses KM in Customer Service**

Forrex Corporation provides high-technology products to commercial customers who are supported by technical and application services. Forrex’s management had become aware that its 200+ customer service representatives (CSRs) provided services with considerable greater variability and less effectiveness than was desirable.

**The Problem**

CSRs would generally work alone either in their offices or on customers’ premises. All held engineering degrees and received considerable in-house product and application education and should be able to provide competent assistance. Nevertheless, too frequently errors were made, misleading advice was provided and follow-up was erratic. These situations led to unhappy customer relations and outright economic losses for customers that Forrex at times would cover.

Some CSRs were outstanding and consistently provided excellent customer service. The service problems of others were not attributable to a select group of CSRs. Instead, they were widely distributed among most of the CSRs and many problems were repeated – there seemed to be insufficient learning taking place. The educational program had been revised and expanded over the last years to increase CSR competence, but that had not resulted in sufficient improvements. These characteristics indicated that the underlying problem might lie with the ‘system’ instead of with the individuals. It might also lie with a lack of understanding by many of the CSRs of what was expected of them to support the direction of the Firm.

**What Was Learned**

Forrex’s sought outside assistance to look into the problem from knowledge perspectives since its management suspected that to be the underlying cause. The outside expert collaborated closely with a team of in-house professionals who already were specialists in total quality management, learning organization, and educational and change initiatives. The team visited with a number of CSRs to interview and observe them at work. These sessions were audio and video recorded and transcribed for detailed analysis. There were follow-up visits to pursue important topics. Among the characteristics that were identified were:

- The exceptional performers worked with mindsets and objectives that were quite different from other CSRs. In particular, they took longitudinal responsibility for episode management for each situation they encountered. Exceptional CSRs had well-established mental models of: (a) How the customer would best be served by their actions; (b) How Forrex would benefit from what they did; (c) How they themselves would benefit from their actions (in terms of future compensation, job security, and recognition from peers and superiors); (d) How they best could navigate Forrex to obtain all help and resources required to satisfy the customer situation; and (e) The extent to which they could improvise and improvise around Forrex policies to achieve the best combined results for both the customer and Forrex. In addition, most of them
appeared to maintain well-structured metaknowledge about what they knew and how to use their understanding.

➢ The customer service paradigm that Forrex senior management intended to be delivered to customers was not well understood by CSRs, managers, and educators. It had never been made explicit and it was not clear which knowledge needed to be made available to CSRs to make it possible for them to deliver quality services, or how much responsibility they were expected to assume. The CSRs themselves did not understand how they were expected to behave. The exceptional performers had formed personal opinion about the desired service paradigm and that generally seemed to match the tacit visions of management.

➢ Whereas the CSRs were well educated and had a high degree of familiarity with the practical and theoretical aspects of products and services, no one knew everything needed to deal with the variety of situations they faced in practice. The body of knowledge was simply too large.

➢ There were no incentives for CSRs to seek assistance from others when facing difficult issues. Additionally, knowledgeable individuals elsewhere within the organization were given no incentives to ‘drop what they were doing’ to assist CSRs who might approach them with problems. Consequently, CSRs would ‘do the best they could’ on their own to provide what in their judgment were sufficient results. These issues seemed to be a common contributor to the problems.

➢ The corporate reward system (personnel reviews, compensation, promotions, etc.) supported individuals for their personal contributions – for what they achieved, knew, and how they conducted themselves as individuals. The reward system did not recognize collaboration and activities that strengthened the organization as a whole. The culture did not support sharing.

➢ There were no mechanisms to capture and make available ‘lessons learned.’ Hence, organizational learning was often ineffective. (This was an interesting finding since a Learning Organization emphasis had existed in the past.)

What Was Changed

In order to improve the situation, several changes were made and some new capabilities were implemented. Some of the more important changes and capabilities were:

➢ The **Customer Service Paradigm** was made explicit (see below). It was supported by several examples to clarify what was expected and to delineate how far customer service should go to ascertain that ‘error-free’ service was rendered.

➢ The mental models of the ‘exceptional performers’ were investigated and made explicit in the form of **concept hierarchies** (similar to chunking hierarchies), **scripts**, and **schemata** and other teachable characterizations.

➢ The knowledge needed to deliver quality services according to the customer service paradigm was mapped out in **K-Maps** to determine which knowledge CSRs needed to possess ‘on the top of their minds,’ which they needed to have ‘at their finger-tips,’ and which they could obtain through consultation with others or through automated performance systems.

➢ An **expert network** was established to make consultation services available to the CSRs. To facilitate this without delay, policies were quickly set in place to define how experts would help CSRs. To support the expert network, a **knowledge inventory** was created – initially as a crude computer data base that could be searched through key-word-in-context, later as a more sophisticated system – ‘yellow page system’ – supported by **case-based reasoning (CBR)** technology.

➢ **Guidelines and incentive programs** were made available to provide recognitions for helping and sharing knowledge. These changes also rewarded people for using best knowledge and asking for assistance when required. Other incentives were made available to motivate people to capture and document new lessons learned – positive, negative, and innovative.
Over a one-year period a comprehensive ‘Case-Based Reasoning’ system with over two thousand reference cases was created to support CSRs with ‘finger-tip’ knowledge. This system also became a repository for lessons learned.

The educational programs were changed to reflect the new knowledge requirements and to provide a better coverage of ‘systematic’ and ‘idealistic’ knowledge that CSRs and others needed to possess. The new programs placed less emphasis on training of routine tasks and greater emphasis on deeper understanding that was provided through education, workshops, and discussion sessions with expert CSRs.

Knowledge Cafés were conducted with all CSRs to promote understanding of what the enterprise business direction was and what the service paradigm meant for them individually and to provide them with opportunities to build insights into how they might adopt the expert CSRs’ approaches. In addition, guidelines were presented and discussed for how CSRs might improvise to serve customers within what became new and more flexible policies.

The changes and new capabilities required considerable time to complete. There were short-term benefits – within a few months – from expert networks and new incentive programs to promote knowledge sharing and assistance seeking. A particularly quick benefit was obtained by creating the service paradigm and providing the CSRs with the Knowledge Café discussion opportunities. Whereas the short-term changes constituted a small step towards the full program, the changes brought noticeable reduction in customer service problems.

The more permanent, longer-term changes have led to considerable and consistent reduction in customer service problems. That again has led to improved customer relations, market image, and reduced cost of delivering customer service, primarily from reduction of work to correct errors, but also, records indicate, from quicker response and less time required to complete service calls.

Forrex Corporation’s Customer Service Paradigm

Proactive enterprise managements look beyond the specter of daily work. They pursue sustained performance over the long term by maintaining broad awareness. They emphasize that they, and their employees not only must deliver work products that are directly associated with their functions but that they also act responsibly and productively in other respects. In particular, they expect that all employees, departments, and organizational functions, as part of their daily activities, will support a wider scope of work. They emphasize four areas of expectations:

Forrex created a broad service paradigm to describe the nature of services to be provided to its customers within the next two years. It was expressed as:

1. **Generate Job-Related Deliverables Reliably and Competently**: Deliver the basic work products of the unit.

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8 We categorize knowledge according to its conceptual level as: 1. **Vision and Paradigm Knowledge**. Part of this knowledge is well known to us and explicit – we work consciously with it. Most of it, however, is not well known, it is tacit – and only accessible nonconsciously; 2. **System, Schema, and Methodology Knowledge**. Our knowledge of underlying systems, general principles, and problem solving strategies to approach situations is to a large extent explicit and well known to us; 3. **Decision Making and Factual Knowledge**. Decision making knowledge is practical and mostly explicit; 4. **Tacit Automated Routine Working Knowledge**. We know this knowledge so well that we have automated it – most has become tacit – and we use it to perform tasks automatically – without conscious reasoning; 5. **Tacit Subliminal Knowledge**. When we first are introduced to new concepts or we first observe new events and relationships, we build initial mental models and tie their meaning to other knowledge by forming associations which initially may be quite weak.

9 Knowledge Cafés is a term used for group sessions where a number of people (from a small number to several hundred) are assembled to discuss implications of some topic that affects them and their organization. Typically, the knowledge café is conducted by presenting the topic and its background to the group. This presentation is followed by brief (10-15 minutes) discussions small groups (five or fewer persons) of the implications and what they may mean for the participants. The groups are then scrambled and discussions are repeated – often for four or five cycles before summaries are collected. Continued informal discussions may be encouraged for days or weeks.
- Conduct and deliver work competently and according to high professional and craft standards and the enterprise’s overall interest.
- Ascertain that deliverables consistently are of high quality.
- Ascertain that deliverables consistently are on time.
- Take responsibility for competent handling of complex and unexpected work tasks.
- Take responsibility for ‘completed staff work.’
- Ascertain that best available knowledge is matched to the situation and that it is applied.
- Apply critical thinking.

2. **Secure and Improve Customer Relationships and Internal Contexts:** Maintain or improve contexts and relationships within the work environment, between different departments and enterprise entities, between the enterprise and its customers and other stakeholders.
- Understand and satisfy customer needs and requirements while meeting enterprise strategic intents.
- Maintain and improve customer – enterprise contexts.
- Collaborate, help coworkers, build positive relationships, and network.
- Help curb and control improper behaviors.

3. **Conserve Enterprise Resources:** Deal efficiently with enterprise resources, including time.
- Work effectively – on target, efficiently, and be personally engaged in work.
- Use opportunities such as slack time to improve work environment, capture knowledge, establish valuable internal and external contacts, and so on.
- Use every opportunity to learn, share, and embed knowledge – build intellectual capital.

4. **Renew Enterprise Capabilities:** Aid in the renewal of the enterprise.
- Innovate to improve capabilities of work processes, work environment, and other areas.
- Envision opportunities for, and pursue improvements of new products and services.

Service paradigms define what often has been implied but has not been made explicit. They outline the broad nature of the entity’s services defined from the perspectives of service recipients and the parent enterprise. They describe how products and services should be delivered and how employees are expected to act and perform. Service paradigms serve several purposes. (a) They delineate what each operating unit is expected to deliver from strategic and tactical perspectives. (b) They define expectations against which general unit performance may be judged qualitatively. (c) Indirectly, they indicate expectations and outline requirements for knowledge and other resources and conditions needed. Service paradigms tend to outline the expected performance according to the four emphasize areas outlined above.

Within the enterprise, each operating entity – unit, department, team, and individual employees – is expected to deliver ‘business services’ in the form of work products that support the enterprise’s operations and purpose. The desired business services can be defined explicitly in considerable detail such as in procedures manual for a function or job description for a position, or they can be general and broad. For particular positions and functions, job descriptions often specify the expected work deliverables and the professional or crafts knowledge and tools preferably might be used.

Models for which level of performance is required and expected within an enterprise vary widely. Management philosophies can differ greatly, and consequently, the authority given an operating function or individual may range from being quite broad to very narrow.