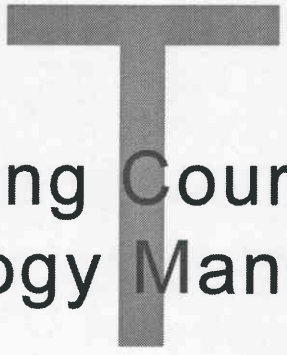
United Nations Industrial Development Organization
Vienna, Austria

International Centre for Science and High Technology
Trieste, Italy

# Module 4

# IMPLEMENTING TECHNOLOGY



## Training Course on Technology Management

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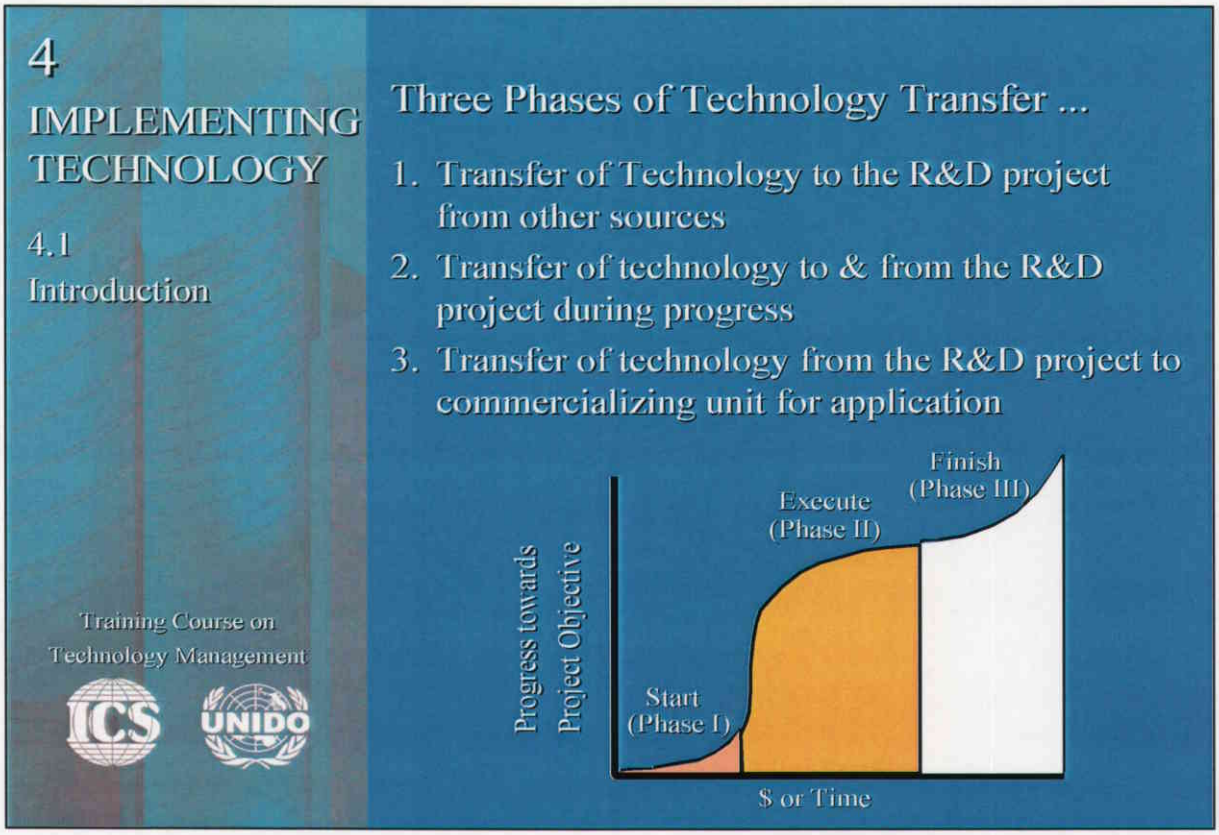
Technology acquisition is the process of taking ownership of technology. Once a company has ownership of a technology, it must implement it, or insert it into an application within the company in order for the company to benefit from the technology. Module 4 discusses technology implementation. It explores

- the design of technology implementation projects
- implementation problems
- designing and using project teams
- parallel implementation
- change management
- project launch

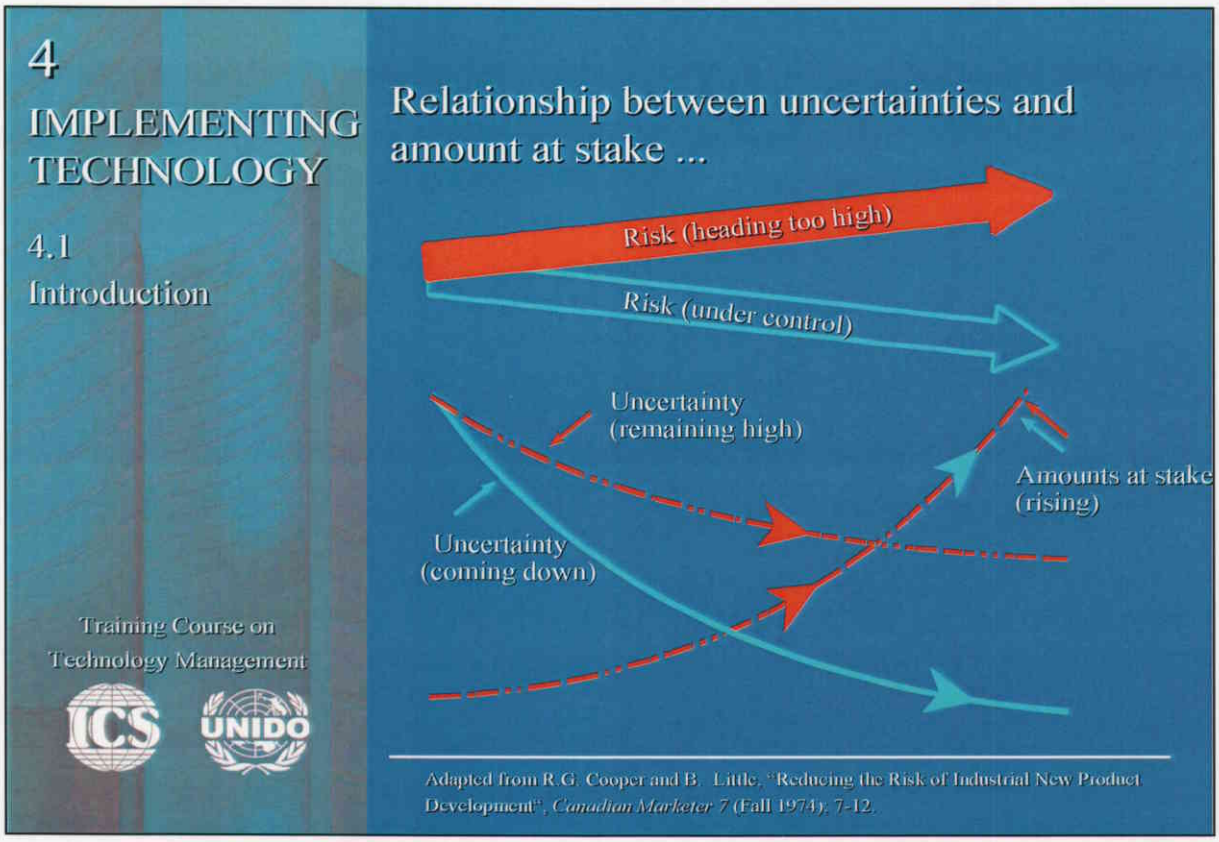
This module prepares the reader for moving from the more cerebral activities of planning and negotiating to the more active process of launching the newly-acquired technology into the company. Up to this point, the UNIDO technology management program has repeatedly made the point that without proper planning and analysis of the information available to the company, the technology acquisition and implementation process is likely doomed to failure. From this point forward, the emphasis will shift from planning to action. Just as projects without planning are likely to fail, technology that is not successfully implemented is guaranteed to fail.

Module 4 will provide information on project design for both technology development and technology implementation projects. The absolute importance of effective teams, project communication, and effective decision making will be stressed.

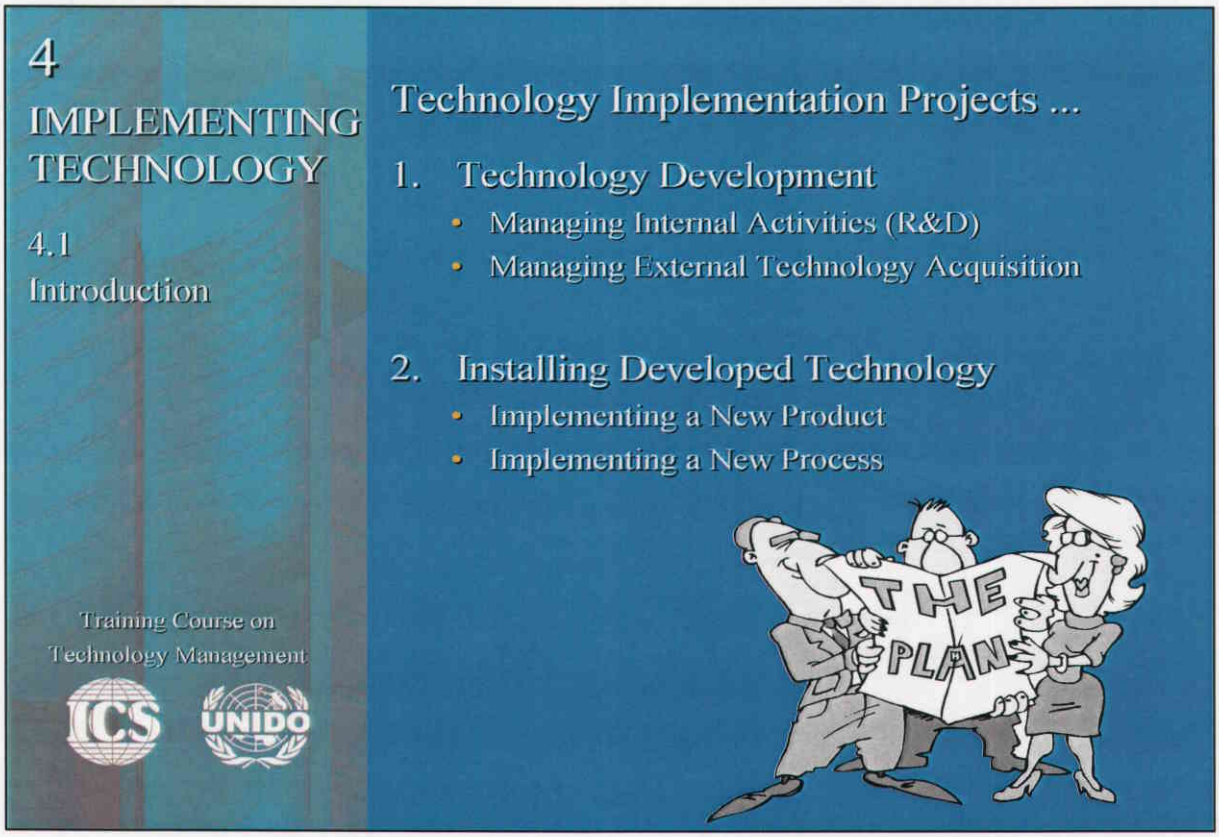
In addition, the module will elaborate on some tools and techniques that will facilitate the technology implementation process.This discussion would be enhanced if the trainer can provide examples of technology strategy successes and failures from his/her experience, especially if the examples are from companies in the participant's region.




Implementing technology is fundamentally a technology transfer process. It starts with the transfer of technology from external and internal sources to those responsible for the research and development project. This is true even if the technology is developed entirely outside the company. Next there should be interaction between the R&D people and those that will ultimately use the technology once it is ready. This technology transfer is two-way. The researchers communicate what they are learning as they proceed with the development activities to the users and the users inform the developers about the application and how the development will or won't be useful to the users. The better this two-way communication is the more likely the resulting technology will meet the needs of the application. Finally, the completed technology is transferred in a physical sense to the application. It is implemented or installed into the application. However, technology transfer at this stage is more than physical. The installers and the users must be taught about the technology, how to use and maintain it properly. Technology implementation is about technology transfer.

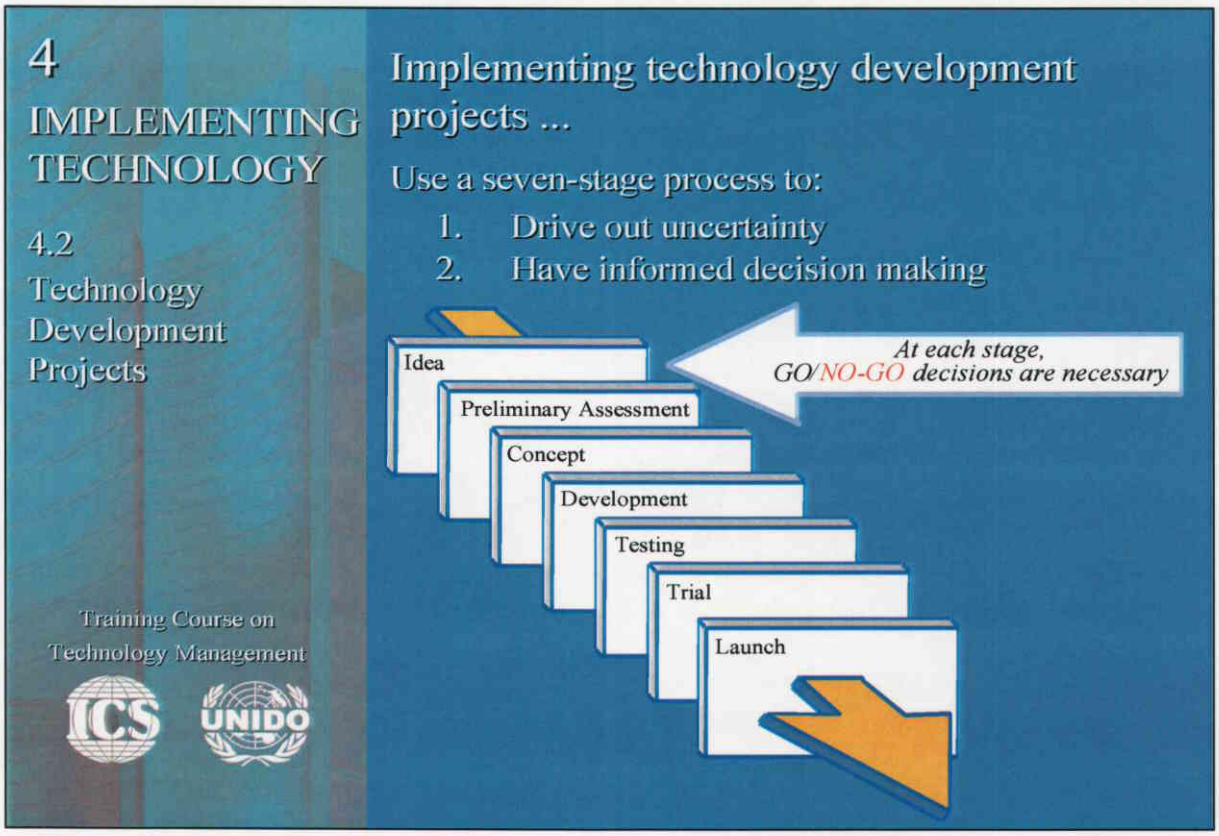



Implementing technology in developed and developing technology projects have some things in common, in spite of their fundamental differences. Implementing technology involves financial commitment. The amount invested usually increases as time goes by. Implementation activities need to be structured in a way that, as the amount at stake increases, the uncertainty involved in the technology decreases. Reductions in uncertainty reduce the risk of failure. Structuring implementation activities according to the following concepts will help reduce risk.




Methods of technology acquisition, as pointed out in Module 3, fall into three categories: internal, external and some combination of internal and external. Even a cursory look at these will reveal that internal acquisition methods and those with a significant component of internal acquisition were generally technology development projects. At the same time it will be seen that external acquisition methods and those combinations that were primarily external acquisition tend to be dealing with already-existing technology or developed technology. Technology implementation projects, therefore tend to fall into two categories: implementing technology development projects and implementing developed technology. These categories have some fundamental differences. Sections 4.2 and 4.3 of Module 4 will address how to conduct projects resulting in these two types of technology implementation.

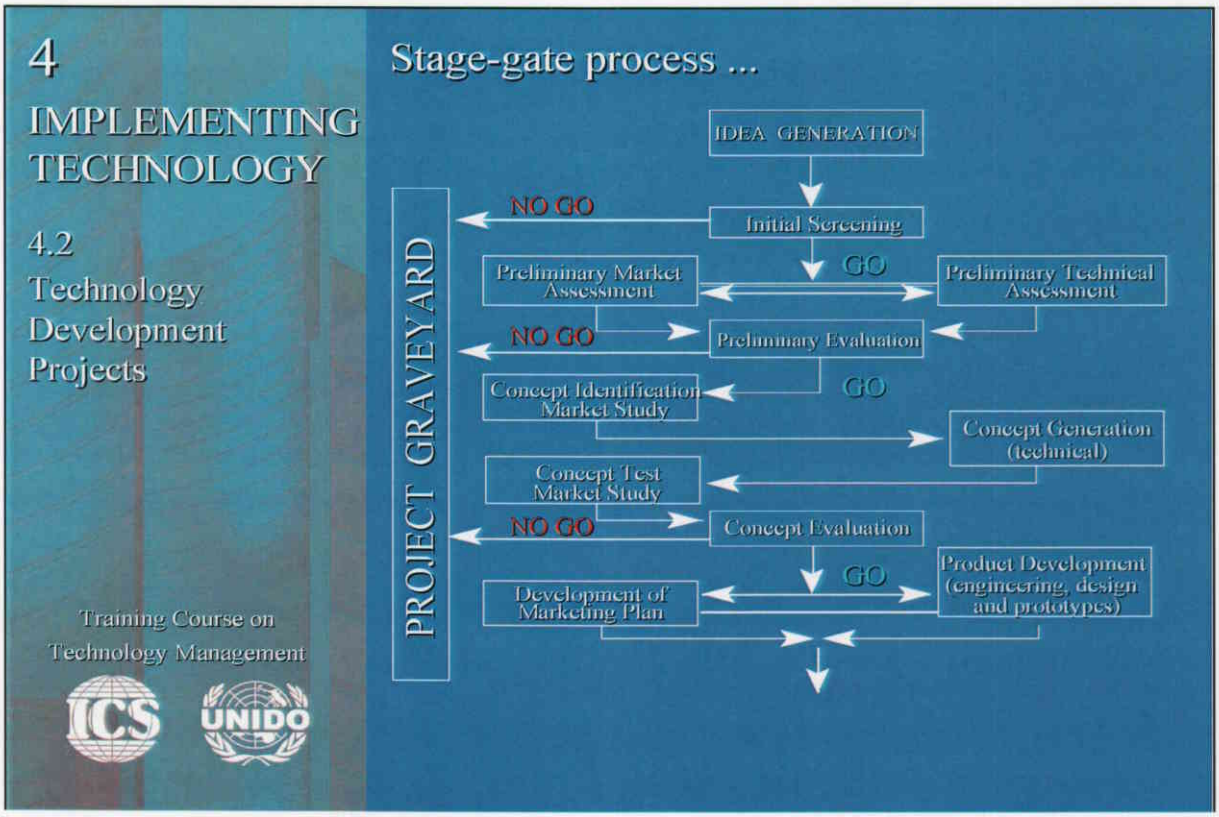
The fundamental difference between developing and developed technology projects is that they are two different steps on the road to the use of technology. Both are necessary, but in the case of developed technology implementation, someone else has completed the creation process. It needs only to undergo an implementation process to make it useful to the company. Developing technology projects must complete both the technology creation process and the step of being inserted into the company in a fashion which makes the technology useful. This fundamental difference results in other characteristic differences. Developing technology projects are done by research and development people, while developed technology projects are implemented by operational people. These people tend to be different in nature, education, and priorities suggesting a need for some differences in approach. Finally, developing technology projects, regardless of how well they are planned, have a degree of uncertainty about them, while developed technology projects are more straightforward. This difference must also be addressed.




Technology development projects are characterized by uncertainty. The developers begin with a collection of known information and a goal or conceptual description of the final output. The gap between what is known and the final output is unknown. Although the primary purpose of a technology development project is to create the output, the project itself consists of a set of activities that are designed to convert the unknowns into knowns. The project must be structured in a way that uncertainty is driven out and those responsible for the project can make informed decisions. An effective structure is the Stage-Gate Process. The project is divided into the following seven stages with GO/NO-GO decision gates between each stage:

- idea
- preliminary assessment
- concept
- development
- testing
- trial
- launch

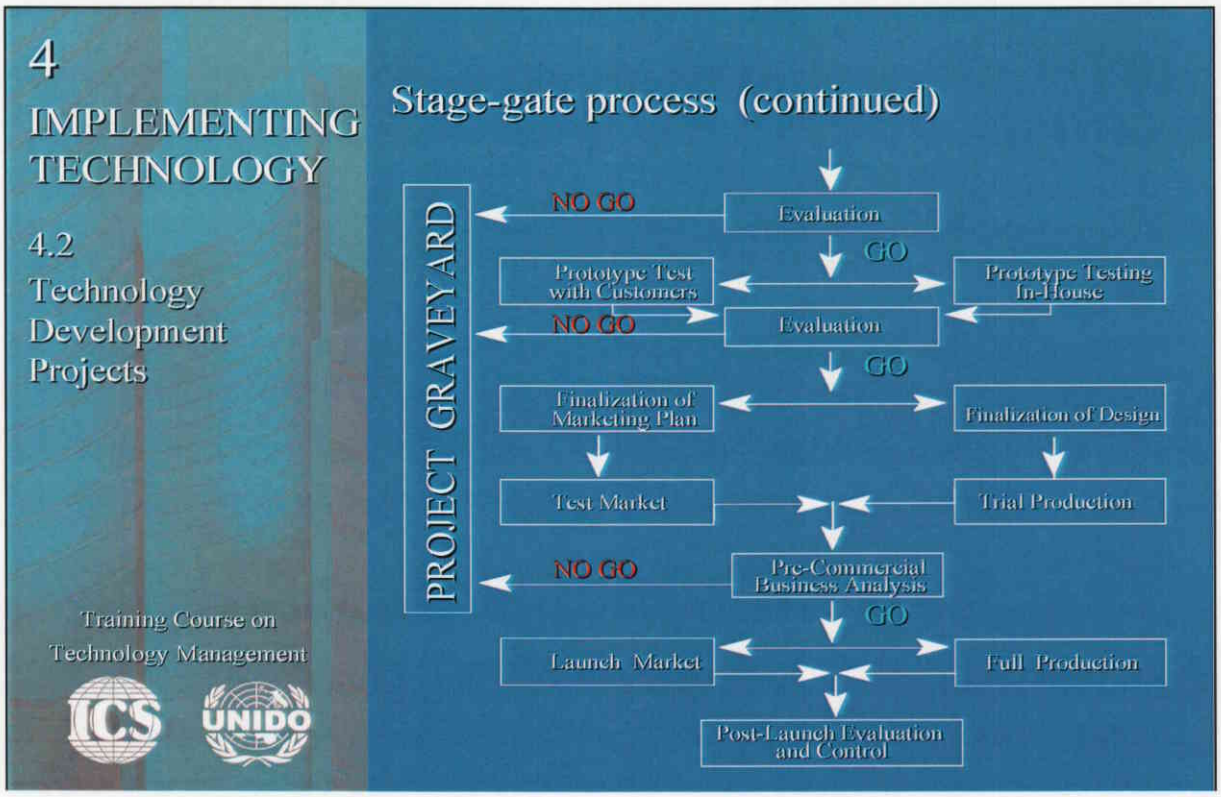
Each stage is designed to reduce uncertainty to a new level and to provide the company's decision makers with the information they need to decide if the project should continue to the next stage or be scrapped. Robert Cooper of Canada's McMaster University, developed a process that is now used by many companies all over the world.




Dr. Cooper's stage-gate process forces the company to continually consider and evaluate the technology being developed from technical and market perspectives. The flow chart on this and the next page illustrates this. The center column of boxes contain the project's stages. To the right of the column of stages are the technical activities that need to be done. To the left of the column of stages are the market-related activities that need to be completed. The project cannot proceed to the next stage unless the technical and market activities have been done and the results are encouraging enough that the company management can justify the further investment that the next stage will require. If proceeding to the next step is not justifiable, then the project is killed and sent to the graveyard. This forces the company's limited resources to be spent on projects in which the unknowns are converted into knowns, and the new-found knowns provide evidence that the project will be successful.

The first stage consists of idea generation. The idea can come from an identified market need that requires a technological solution or from a technological breakthrough that needs development to result in a product or process that will benefit the company. An initial screening of the idea by company management, against company goals, will lead to discarding of ideas that do not fit the company's plans. Those that appear to have a fit are permitted to proceed to the next stage. The preliminary assessment is done from both technical and market perspectives. The preliminary assessments, which are "quick and dirty", look at the market and the technical hurdles to be encountered in the technology being considered. A description of the products and rough estimate of the sales that could result from the technology to be developed is made. In addition, a description of the technical unknowns that stand between the present state of the technology and the conceived products, a rough estimate of the money and time needed to achieve the technological goals, and an assessment of the likelihood of success is made. This information is submitted to management for a decision. Management looks at the issues involved, compares the benefits and costs, considers the risks in light of the company's financial and technological position. It then decides if the project is to proceed to the next stage or if it is to go to the graveyard.

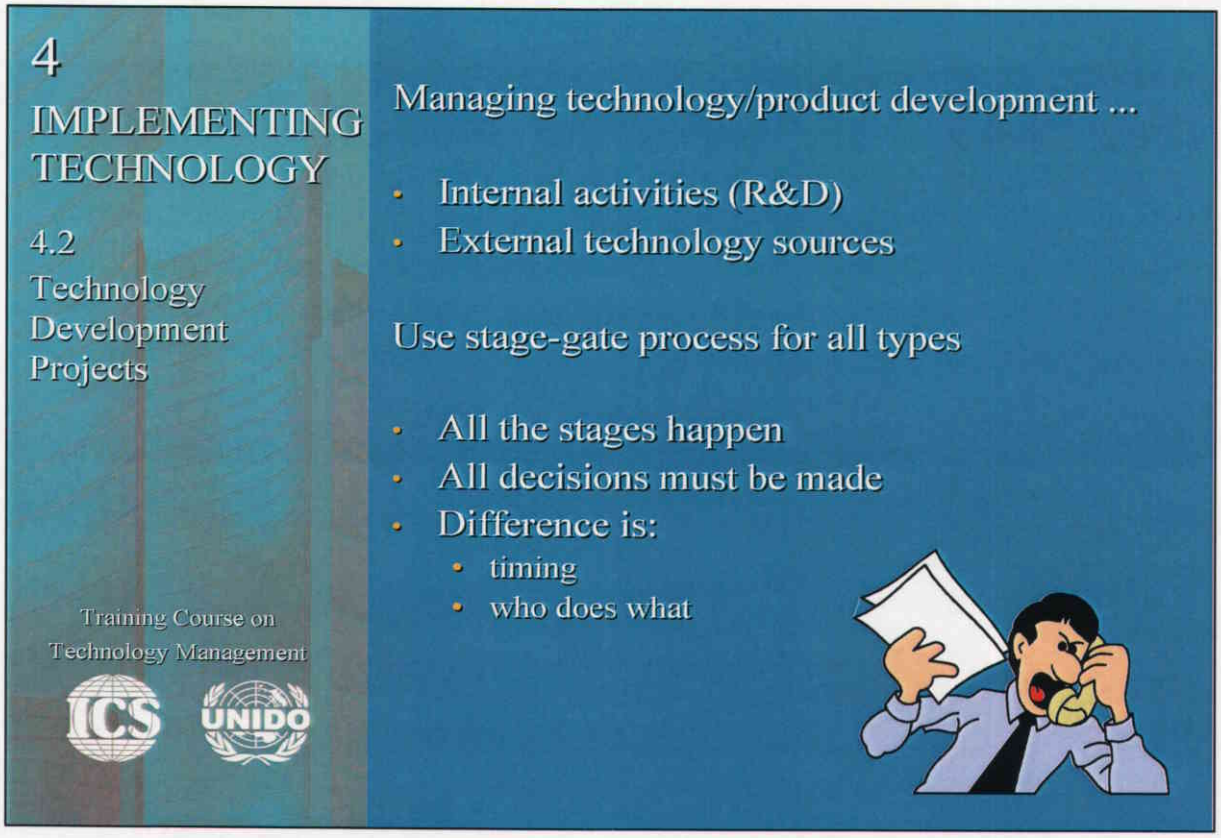
Technical or market activities that produce a negative answer to an unknown are blessings in disguise. Although no one wants to learn that the technology development that was planned will not work, the sooner this is found out, and investment in a "dead horse" is stopped, the better. The stage-gate process is designed to find out the most obvious project stoppers early in the process before investment is too great. The stage-gate process is iterative. The technical and market assessments are repeated in several stages, each time in greater detail.



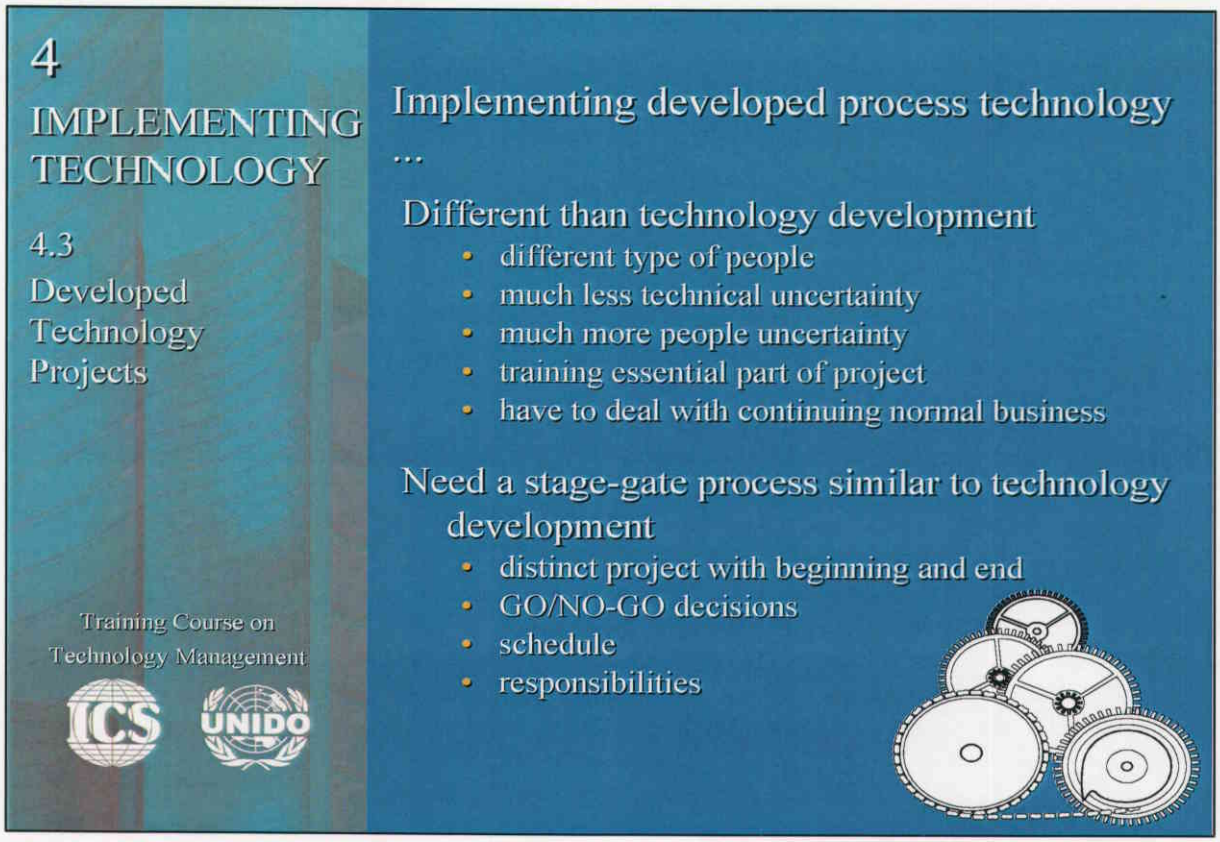

Easy-to-identify reasons (i.e. low monetary and time investment) to kill the project are found as early as possible to minimize investment in a project that cannot succeed. More elaborate assessments are made in the concept, development, testing, and trial stages, each time trying to establish whether the project will succeed or should be killed.

In the concept stage, conceptual descriptions of the ultimate product(s) are developed from a market and technical perspective. This further defines market and technical issues that must be solved. Some hypotheses are developed and experiments designed and conducted to prove or disprove the theories behind the technology being developed. The technical work can be described as applied research and experimental development. Initial market studies are conducted to see if the products conceived have market potential. The concepts and the results of the technical and market tests conducted are submitted to management for a third GO/NO-GO decision. If the project survives this stage it moves to the development stage. Here full-fledged product (or process) development activities are conducted. On the technical side, remaining experimental development work is completed, engineering design is done and prototypes are put together. On the market side the marketing plan is developed. Management reviews the resulting prototype and the marketing plan against its goals for the project and again makes a GO/GO-NO decision.

The product(s) that can result from the new technology have now reached a stage where they can be thoroughly tested for technical performance and market acceptance. These tests can uncover issues that will kill the project, even at this late date, or will require further development to address. Management considers the results of the technical and market tests and decides to kill, go on to the trial stage or return the project to the development stage for further work. The trial phase produces small amounts of product that are sold to customers. The market acceptance of the product, along with the problems encountered in the trial production, form the inputs to the last evaluation point. The management looks very hard at the results from a business perspective. The project should have uncovered and dealt with any negative issues by this point. However, it is possible that market or production issues not known until the project reaches this stage can still kill it because the risk of the impact of failure on the rest of the company may be too great. It is also possible that some solvable market or technical issues have been identified. Management, after being supplied with an estimate of the cost and time to address these issues, can decide to return the project to an earlier stage for further development. If, however, all the signals are "GO", the development project is complete and the product is launched.




The stage-gate process as described above is focused towards technology development projects that result in a product that the company makes and sells. In those cases where the technology development project results in a process improvement that makes it possible for the company to make its current product better, the stage-gate process is very similar. One difference is that the "market" includes those responsible for the products made with the present technology. They must be able to see that new technology will have the improvements expected without introducing unexpected problems. Another difference is that once the project reaches the launch stage, it is placed into a new project, a developed technology implementation project. This topic will be covered next.




Implementing developed technology has a lot in common with implementing developing technology projects. The most important similarity is the fact that each implementation is a distinct project with a beginning and an end. The project needs a plan with a schedule and clear GO/NO-GO decision points, a project team, and well laid out responsibilities. The stage-gate process with some modifications is well suited to implementing developed technology projects.

The areas of difference have more to do with people and circumstances than with the process itself. Developed technology implementation projects have less technical uncertainty but more people uncertainty. People uncertainty is partly due to the fact that the project is to be done by operational people rather than development people. Operational people have less experience and feel less comfortable with uncertainty. They are more likely to feel threatened by the new technology. Much more emphasis must be placed on training and communication of the benefits of the technological improvement. In addition to this is another major difference. The people implementing developed technology also have to cope with the day-to-day business as usual while they prepare for the transition to the new technology. They, in effect, have to do two jobs. The person working on a technology development project does not have this added burden.


The first key to successful implementation of developed technology projects is to realize and remember that the implementation is a project with a beginning and an end. With this understanding, a team of affected persons can develop a project plan by using the checklist in the slide above.

Documenting the project plan by developing and writing down the details associated with each of the items in the checklist addresses the first major cause of implementation failure - poor communication. Documenting the plans gives everyone involved something to refer to. Everyone is then at least trying to "sing from the same song sheet."

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IMPLEMENTING TECHNOLOGY

4.3

Developed Technology Projects

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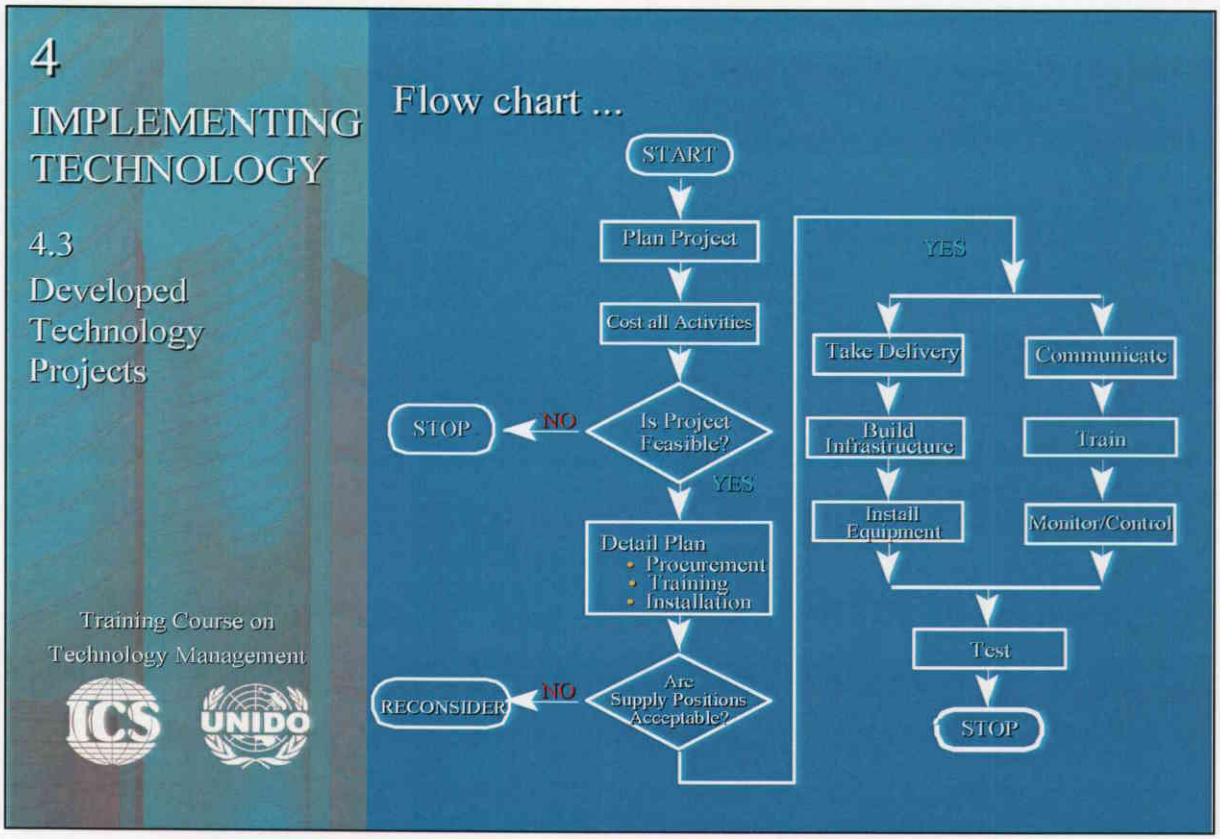
## Tools for developed technology implementation ...

- Flow Chart
- Project Milestone Status Report
- Gantt Chart
- Complex Network Diagram
- S-Curve (Schedule and Costs)
- Work-Breakdown Structure
- Project Team Meetings
- Communication to Rest of Organisation

A number of tools exist to help project planners design and successfully conduct implementation projects. A few relevant ones are indicated above. These will be explained on the following pages.




A flow chart illustrates the flow of work from the beginning of the project until its completion. It consists of boxes containing words describing each step or set of activities connected by arrows that demonstrate the order of the work. It illustrates decision points by showing steps that if certain conditions are not met the project either stops or returns to an earlier step. It shows when some activities can be done in parallel and when they have to be done chronologically.

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IMPLEMENTING TECHNOLOGY

4.3

Developed Technology Projects

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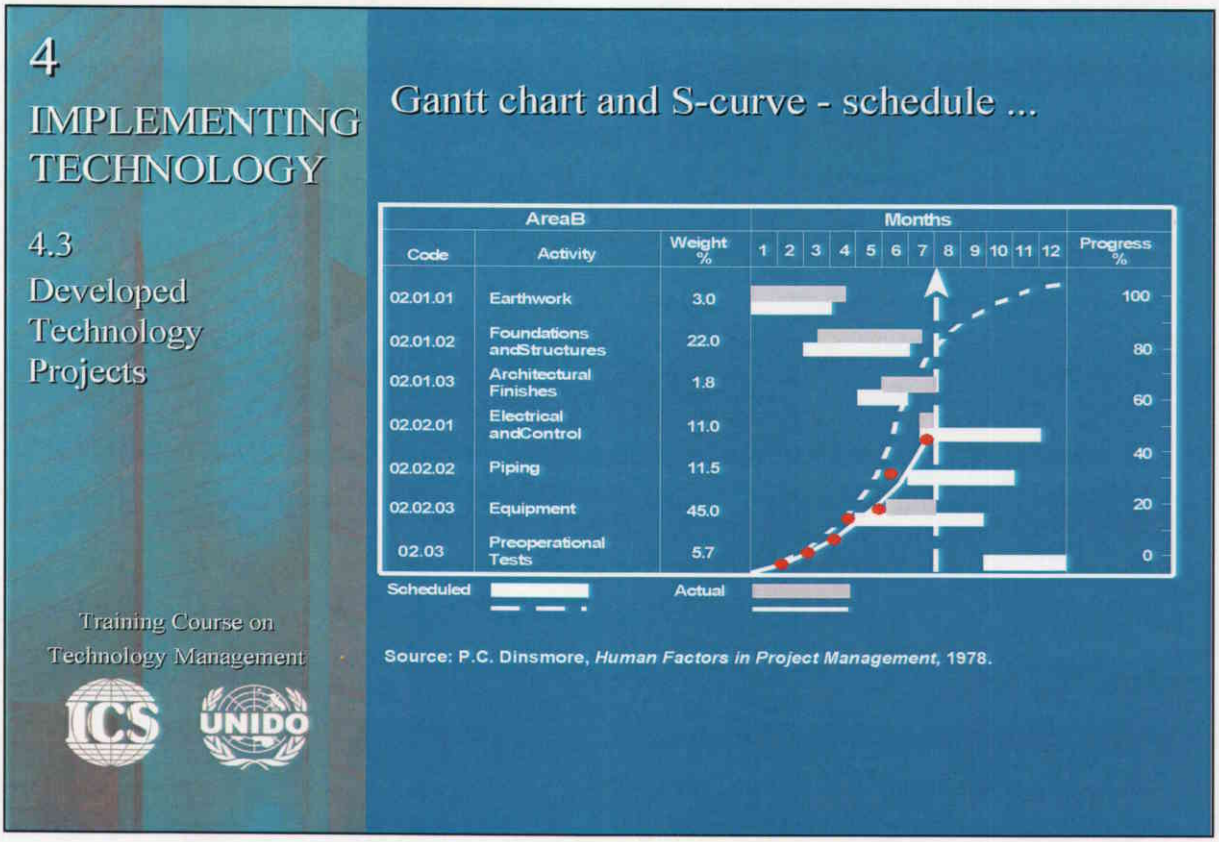
## Project milestone status report ...

### A Sample Milestone Chart

| Area B: Project Milestone Status | | Date: August 10 | |
|---|---|---|---|
| **Description of Event** | **Scheduled Deadline** | **Actual Date Completed** | **Delay (Days)** |
| Complete Earthwork B | March 30 | April 15 | 15 |
| Complete Main Foundation Concrete | April 15 | April 30 | 15 |
| Equipment B Received on Site | April 15 | May 15 | 30 |
| Complete Equipment B Foundations | May 30 | May 30 | 0 |
| Piping B Installation, 20% Complete | July 31 | -- | 30 |
| Install Main Transformers | August 15 | -- | -- |
| Start Area B Preoperational Tests | October 01 | -- | -- |
| Complete Electromechanical B | December 01 | -- | -- |
| Complete Tests--Begin Operation | December 30 | -- | -- |

Source: P.C. Dinsmore, *Human Factors in Project Management*, 1978.

The project milestone status report puts a start and end date on each step (the set of activities in a box on the flow chart). The milestone status report also records actual completion dates which provides feedback to the project planners and the performers as well as management as to how well the project is meeting the schedule.

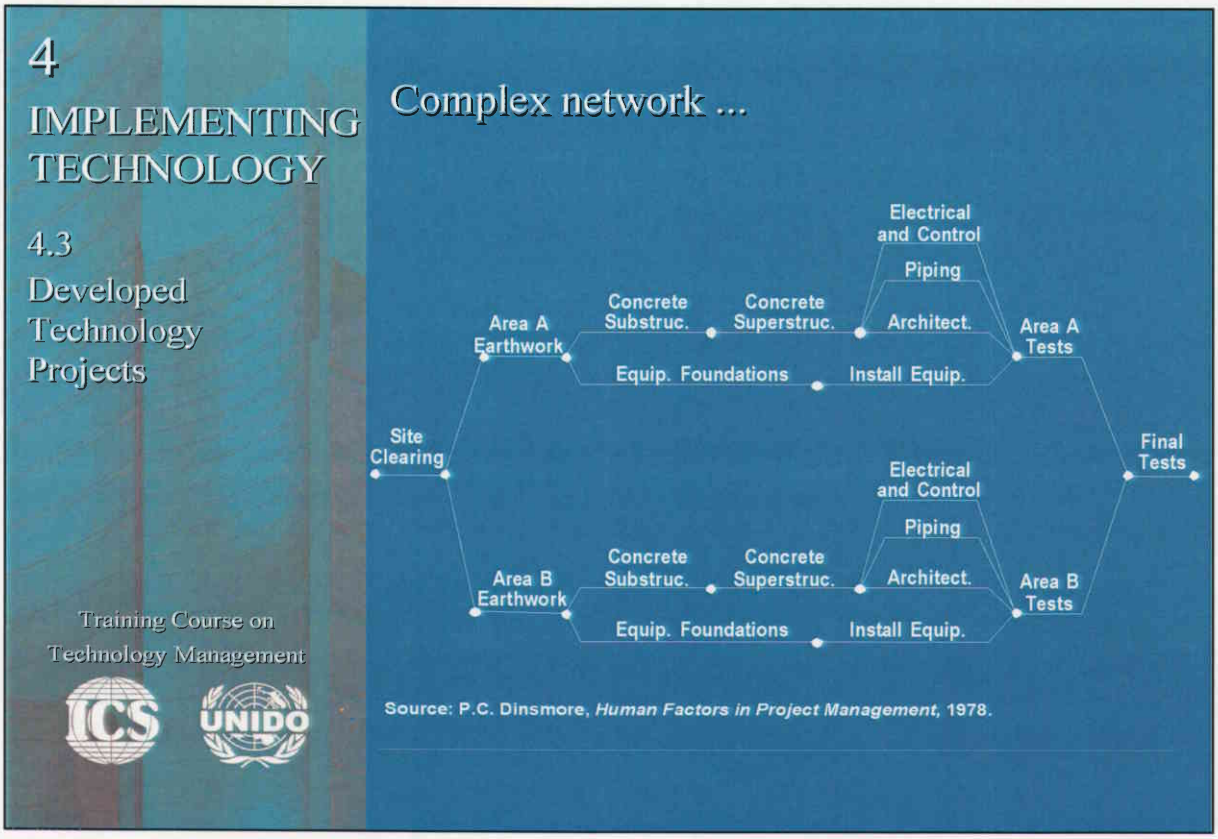



A Gantt chart graphically illustrates the information in the milestone status report. It consists of the list of project steps on the vertical axis and time on the horizontal axis. It shows the beginning and end point planned and actually experienced for each step. Some Gantt charts also contain a column that indicates how each step compares to the others in terms of the amount of effort required. This is often called weight and is expressed in percent of the total budget or person-hours required.

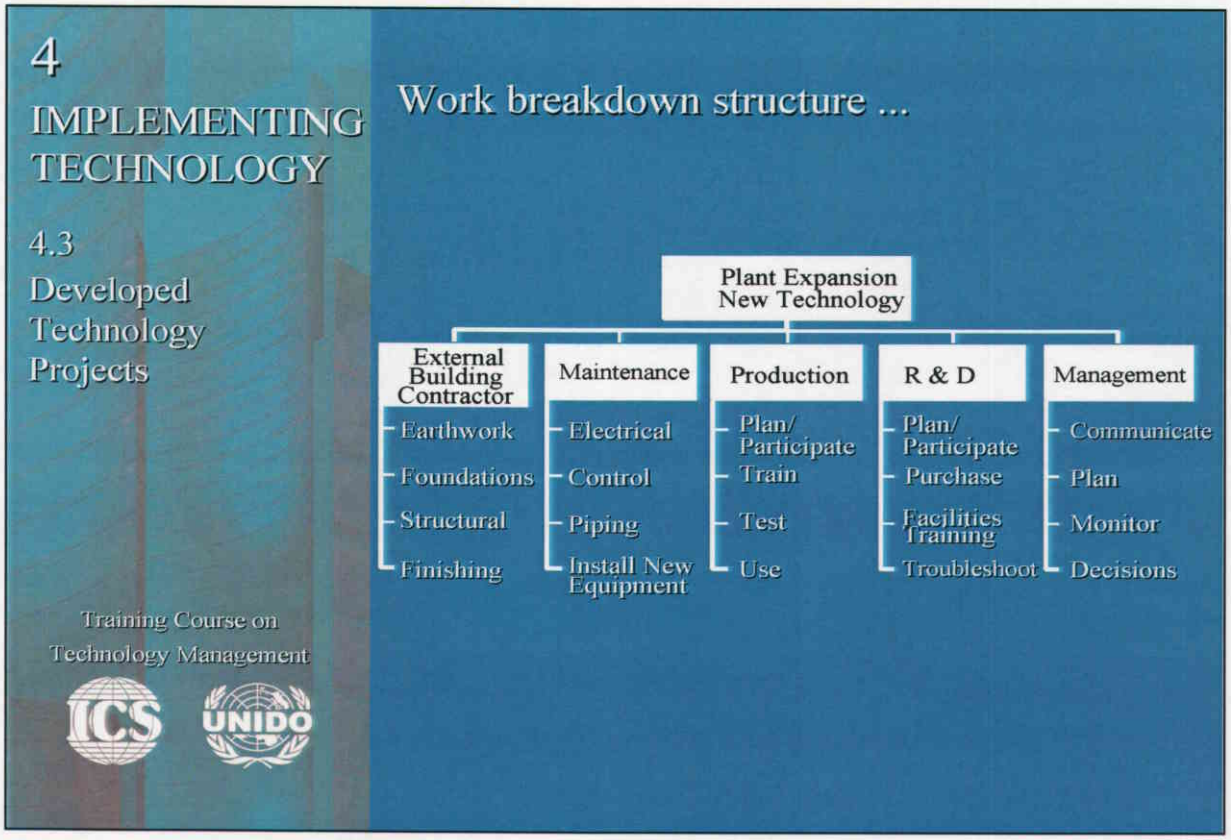
The Gantt chart above has two bars for each step. The white bar is the plan for each step and the cross-hatched bar shows what has actually happened. The Gantt chart is both a planning and a project management tool.

A Gantt chart can be enhanced by adding an S-curve. The S-curve illustrates the planned expenses throughout the project in percentage terms from the beginning (0%) to the end (100%). Plotting actual start and end dates and actual expenses (S-curve) on the Gantt chart provides management and the project team with a very quick understanding of how the project is doing relative to the plan in terms of completion of steps and expenditures.

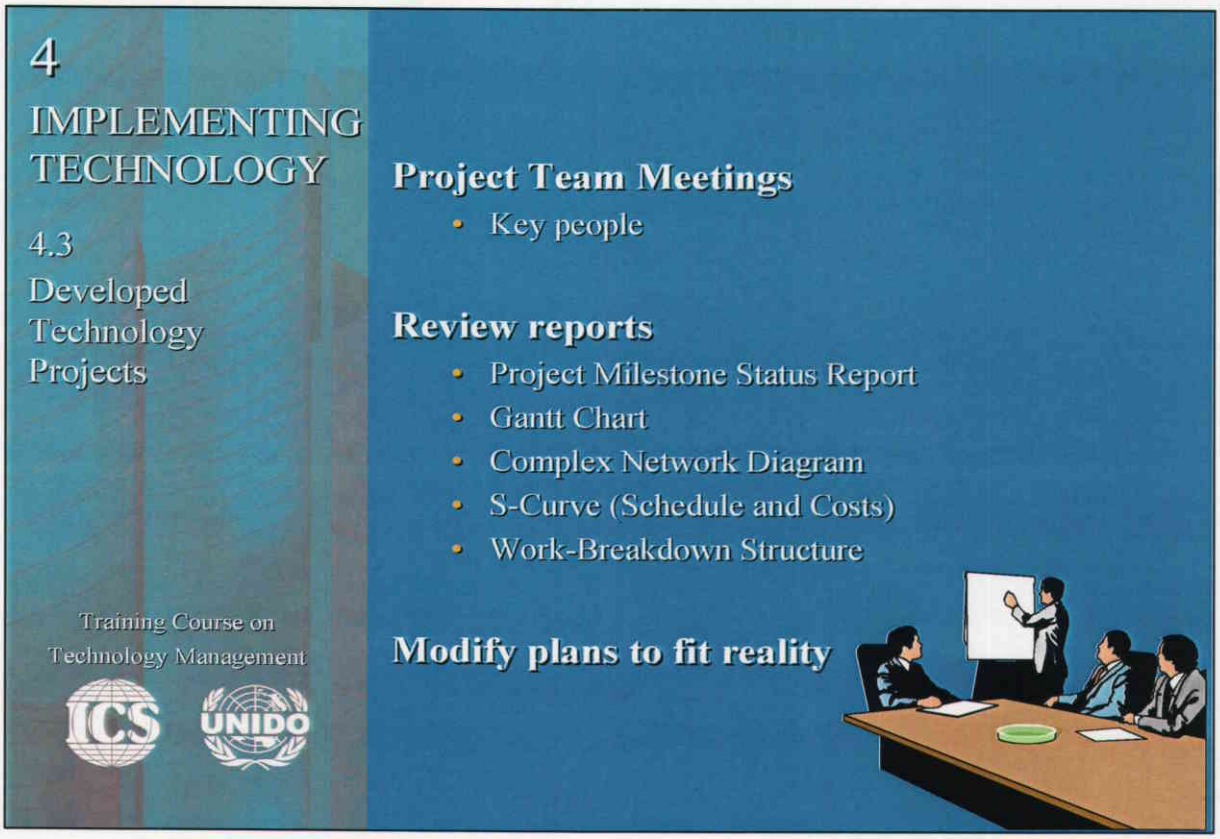
In the S-curve example shown on the slide, the actual expenditure rate is slightly behind that planned. This could be because the project is behind schedule or because activities are being completed below budget. The Gantt chart shows that some activities were behind which is what has caused expenditures to lag the expenditure plan as represented by the dashed S-curve.




Gantt charts clearly illustrate the project's steps and their timing. However, they do not show the interconnectedness between steps. In order to show that an activity in Step 2 must be completed before another activity in Step 3 can begin, the flow chart or a version of the flow chart used for more complex projects called a network diagram is used. The flow chart/network diagram sacrifices the clear relationship with time that the Gantt chart has in return for illustrating interconnectivity between steps.

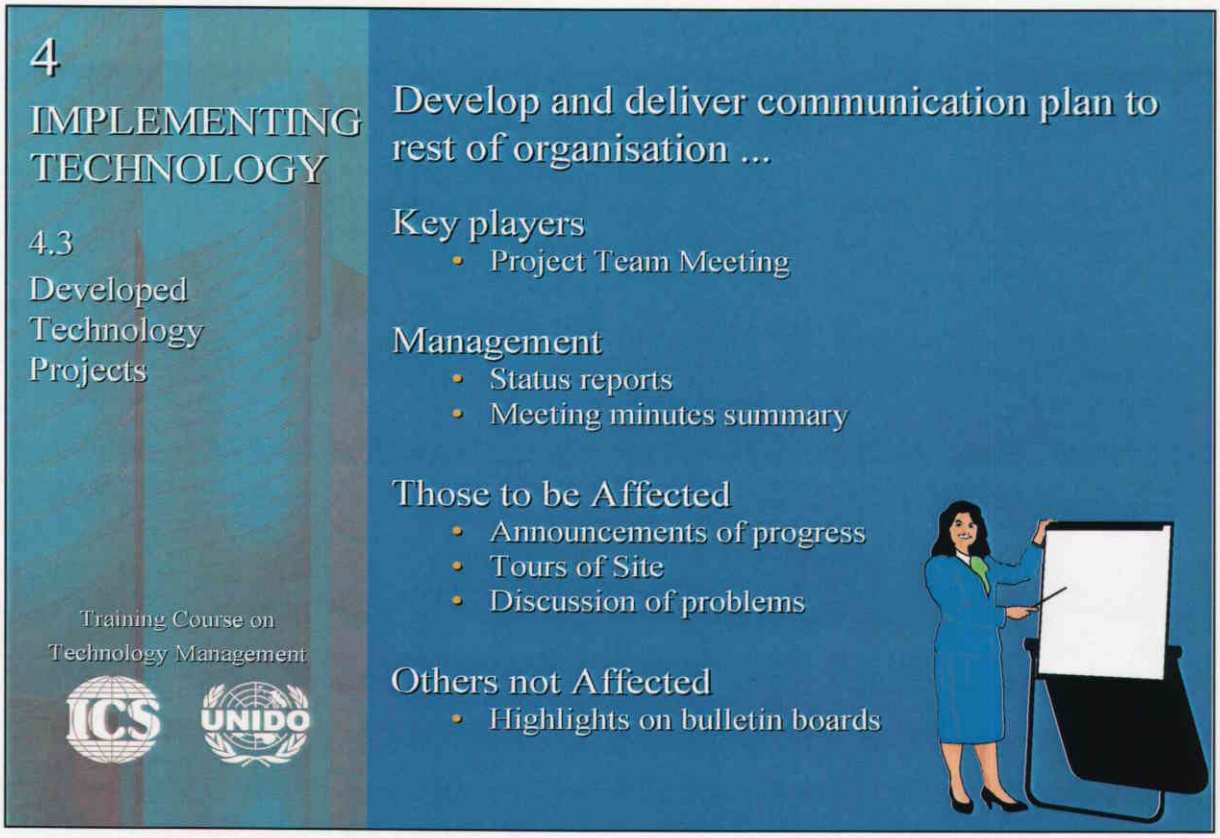



Another useful tool is the work-breakdown structure. This shows the roles of each participating department in each step. The flow chart and Gantt chart show when each step is to be done. This shows what each group's role in the project is. This adds the "by who" aspect to the project planning activity in more detail then there is room to put on the flow chart or Gantt chart.



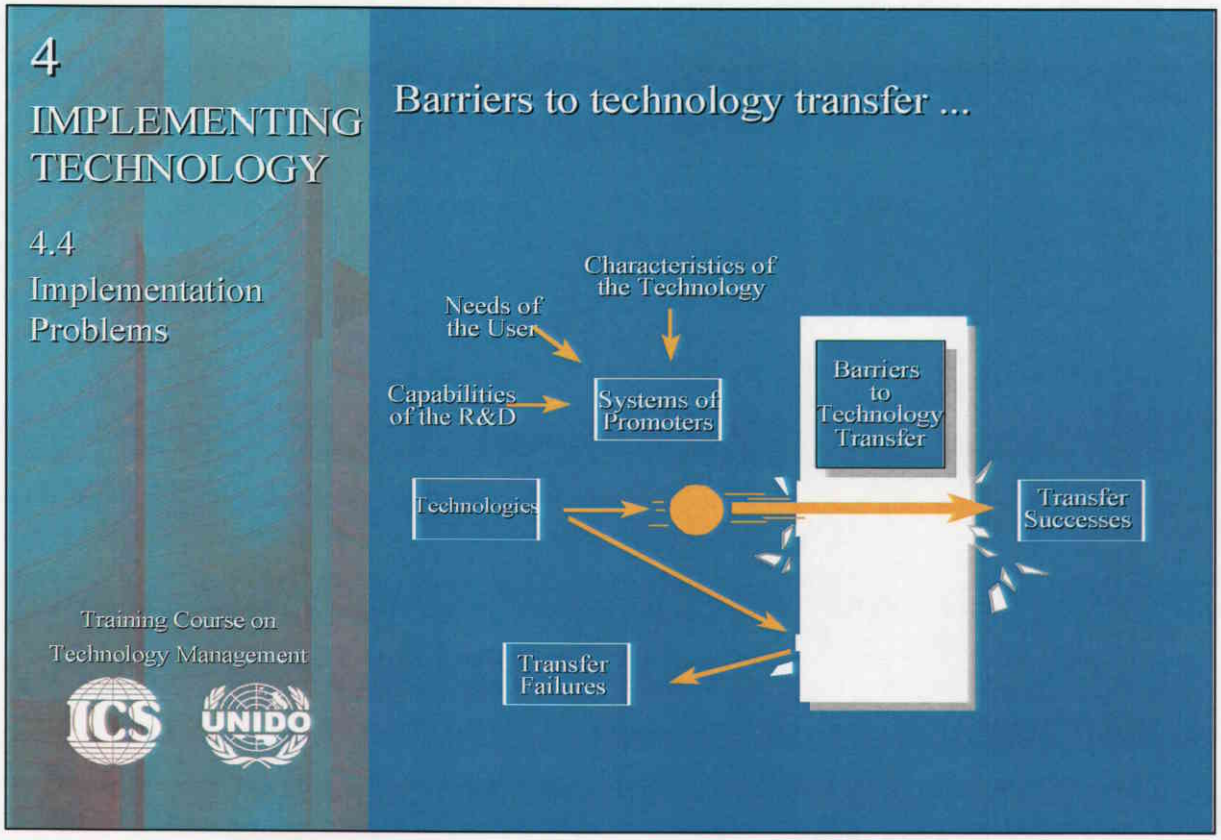

An essential tool for a successfully developed technology implementation project is project team meetings. The project team should be a multidisciplinary group that together has the set of skills and knowledge needed to properly introduce the new technology. It should include those involved in the technology's creation (from in-house R&D or from the technology supplier), those responsible for the physical construction activities (internal maintenance personnel and external contractors), those that will be responsible for using the technology after it is installed (production workers and management), and a representative from the company's management. The primary purpose of the meeting is to ensure that all are kept abreast of happenings on the project. Project management tools like the milestone status report, Gantt chart, S-curve, complex network diagram and work-breakdown structure are updated and presented at the meeting. Problems encountered are discussed and decisions made.

Those knowledgeable about the technology are necessary because implementation plans may include decisions that will negatively affect the performance of the technology. For example temperature control may be critical for successful operation. Without technology experts on the team, this fact could be overlooked and no provision made for controlling temperature to the accuracy required. The production workers that will use the equipment will have suggestions about physical layout, location of the control panels, and interaction with other processes that, if heeded, will lead to long-term efficiencies. The construction and installation people will be able to adjust their plans to deal with suggestions and requirements from production and the technology experts. Finally the management representative will bring the decision making authority to enable decisions to be made in the meeting. This is especially important if issues come up that require additional expenditures. The management representative can either make a decision on the spot or, after hearing the arguments for the additional expenditure, be in a position to make the request to the rest of the management team in a timely fashion.



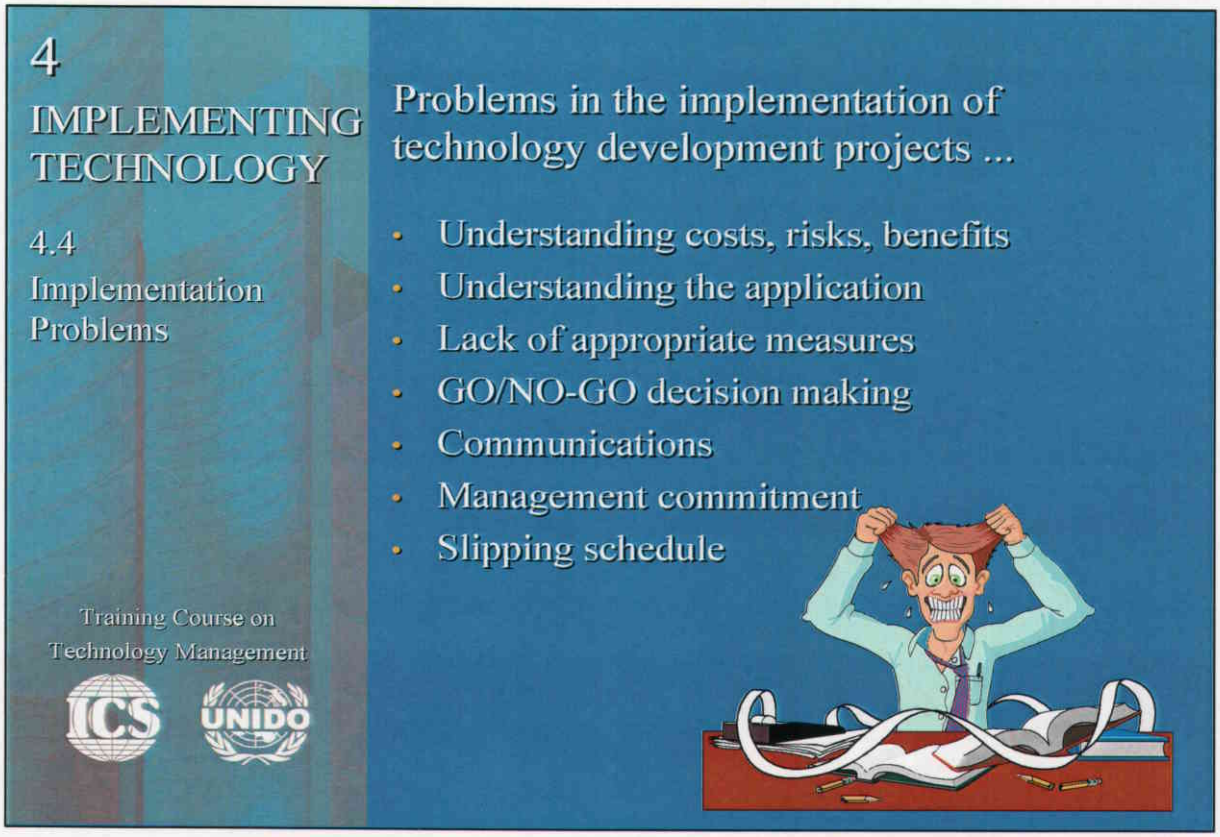

Communication to the rest of the organization is also critical. A major hurdle to be overcome in any new technology introduction is the need for acceptance of and overall enthusiasm for the new technology. This has to start long before physical work begins. The new technology should not be a surprise to anyone in the company. People must see how the new technology will help the company survive and thrive thereby protecting their jobs rather than being a threat to them. Even if the new technology will result in some staff reductions, the point has to be made that if this company does not do this and the competitor does all the jobs are in jeopardy.

The level of detail required depends on the role of the people receiving the communication. The most complete and frequent communications will be within the project team. The company's management needs status reports highlighting any issues or variances from the plan. Those affected, the production workers that will use the technology and those interacting with the technology such as being responsible for providing material to be processed by the new equipment need be informed about things that affect them. This includes announcements of progress, explanation of reasons for delays, and tours of the site so they can begin visualizing the new environment. They also need a forum to discuss concerns and to point out any short comings they see in the plan. The greater the level of involvement in the planning and construction phase that these people have, the less resistance to the new process will be experienced. The last group that needs to be communicated with are those in the company that are not really affected. These people still need to be informed of plans and progress so that they feel involved. Highlights of progress posted on bulletin boards should be sufficient.




Technology implementation is fraught with problems. On one hand there are a number of factors encouraging technological change. The potential benefits of the technology itself and the evangelistic endeavors of the technology experts push for change. The needs and frustrations of the user can provide a "market pull". However, these factors must have enough energy to break through the barriers to technology transfer that form a wall of resistance to change. The more that can be done to reduce or eliminate the barriers to technology transfer, the greater chance that the energy provided by the factors encouraging change can break through the wall. Barriers to technology transfer can be understood by looking at the problems in technology implementation and their solutions. This section looks at problems and solutions in implementing technology projects.

Technology implementation project problems vary depending on whether the project is to implement developing or developed technology. Common problems include the lack of appropriate measures, poor communications, and slipping schedule. Technology development projects also suffer from a poor understanding of risks and costs, poor understanding of the ultimate application of the technology, lack of decision points, and inconsistent management commitment. Implementing developed technology projects suffer from resistance to change, poor managing of the project's logistics, and the fact that those involved are often preoccupied with the present operations that must continue simultaneously with the implementation project. Section 4.4, Implementation Problems, will discuss problems and solutions in these two types of projects.




Technology development projects often suffer from a lack of understanding of the costs, risks and benefits. This is normal because the very nature of technology development is that the result is unknown. Therefore the time and costs to accomplish the development can only be estimated. The actual impact of the developed technology is also unknown. There are risks in being able to accomplish the development as planned and concerns that the development may not have the impact hoped for. Even the degree of risk can only be estimated. The ideal solution to this problem would be a method that defined costs, risks, and benefits. However, this is not possible. What is possible is to undertake a concerted effort to establish costs and benefits and to update them as findings in the project change the information available.

Imposing a project management system like the stage-gate process already described is the beginning of dealing with the cost side of the equation. Those in charge of the project must take more care in estimating costs in order to make a plan which success will be measured against. The key to doing this is to first establish what is known and predictable. Then, for the more difficult aspects of the development, establish best-and worst-case scenarios, and make some assumptions that will enable the conversion of this range into a discrete estimate. Communicate and document the assumptions, as well as the best-and worst-case scenarios. As the project proceeds new information will be developed that will convert some of the unknowns into knowns and will change some of the assumptions. Use this information to update the plan so that management is always dealing with the best information. Be sure to include manufacturing costs in the discussions. In order for management to fully understand the costs they need to see the costs from the beginning through to installation of the resulting technology.

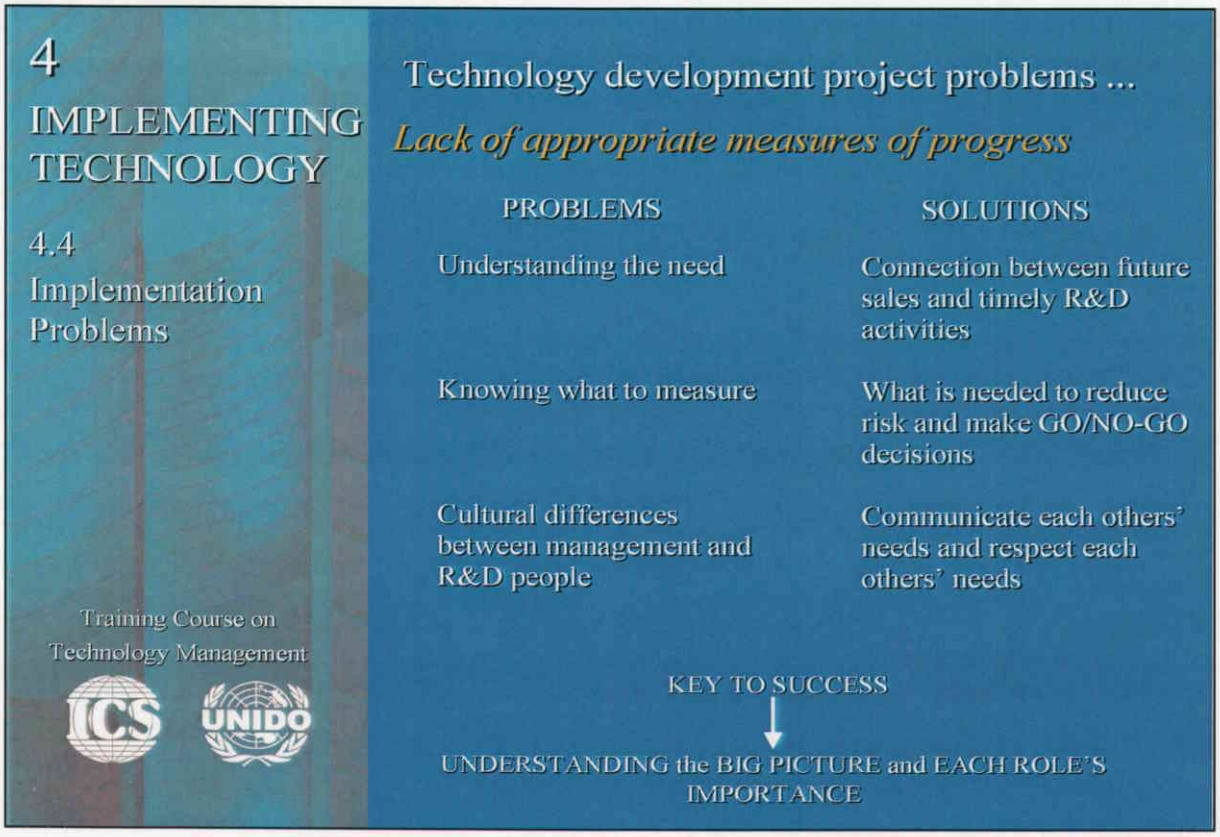
To properly estimate the benefits, the revenue impact on the company resulting from the technology development must be made. This entails conceiving the product(s) that will be possible with the technology, estimating their market and the impact on the company. The company's marketing personnel must be key players in this process. The same process of establishing what is known, defining the best-and worst-case scenarios for the unknowns, documenting, and constantly updating as more information is developed, should be used for benefits as was proposed for costs. Management needs to understand the costs of the technology development in light of the benefits to fully assess the value of the project.


A related issue to consider is the fact that researchers do not tend to think about costs or benefits. They are more motivated by the new discoveries that could result from their work than from the business aspects of revenues and expenses. Managers, on the other hand, do not understand the risks and problems involved in technology development. They expect to be able to treat predicting costs and outcomes with the same level of confidence as other aspects of the business. The first step to dealing with these problems is recognizing that they exist. When researchers realize that managers need to see technology development in business terms they can communicate in the managers' language. Using a stage-gate process and reporting results against a plan and schedule will go a long way toward helping the manager understand the technology development process. When managers see the controls in place that they can understand, their minds become more free to appreciate the difficulties that researchers face. They will then build contingencies into future plans to enable the organization to deal with the uncertainties of R&D.


There is plenty of evidence to support the theory that if the technology development team does not understand the application for the technology they are developing, the result of their efforts will not meet the company's definition of success. The company wants developments that have a positive impact on its bottom line. It is unlikely that developing technology that does not directly fulfill the needs of an application will have a positive financial impact. The solution to minimizing the risk of not meeting the application's needs is for the technology development team to understand the application in complete detail. There are several problems working against this. First, researchers prefer to spend their time in their labs and offices. They do not like it out there in the plant. Second, no matter how much effort researchers put into understanding the application, it is not the main focus of their life. They will never know as much about the application as the those that work with it daily.

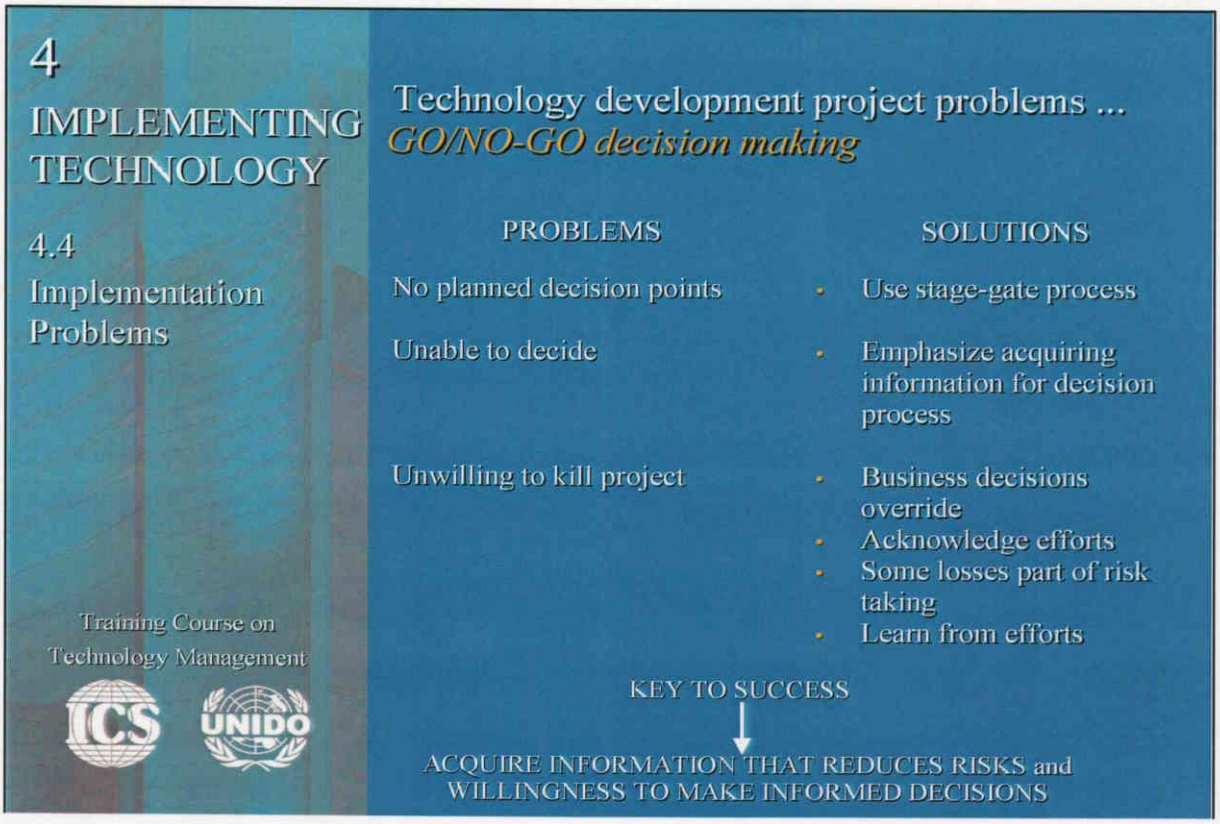
The solution to the first problem is to take the researcher into the plant. Ideally he/she should be assigned to work along side the production worker for a few days. Give him/her ample opportunity to see what the process is intended to accomplish, to experience the limitations and frustrations of the present technology, and to understand other constraints imposed by other processes and the environment. This may not be practical for all of the project team, but there must be at least one of the researchers that can see the problem from the application's perspective. Since the researchers can never fully understand the application, an application person should be on the technology development team.

There is a third problem in the understanding of the application area. This is the fact that application personnel can be a hindrance in the technology development process because they do not understand technology well enough to see the potential. This can be dealt with by constant communication. Placing an application person on the team will create the forum for this. In addition, conducting experiments that further demonstrate the capabilities of the technology relative to the application will show that there is more to the theories than words. People involved in applications tend to be motivated by practical and visual experience, while those in the more academic activities like R&D tend to relate better to concepts and theories. This communication style gap must be bridged.




Lack of appropriate measures of progress result in projects that run on and on, constantly draining funds and never accomplishing their goals. Part of the problems is a lack of understanding of the project's goals, how the project goals fit into the company's plans, and knowing what to measure. The root of the problem is in the cultural difference between R&D personnel and management. R&D people are primarily interested in science and development, while the company's management is interested in financial viability. It is not necessary to change these cultural differences, it is just necessary that they are understood. When management realizes that R&D is not motivated to study the company's financial situation, they can provide information to help R&D see their role in the company's big picture. When R&D sees how the company's financial success relates to what they do and how financial success makes it possible for them to continue to do what they do, they become more willing to provide the measures management needs.

The next issue is knowing what to measure. This can be established by understanding what information is needed to reduce risks quickly. Instituting the stage-gate process with clear milestones and decision points is key. At each decision point certain information is needed for management to make decisions, and agreement must be reached between the research team and management as to what information is needed to make those decisions. This will dictate what has to be measured.



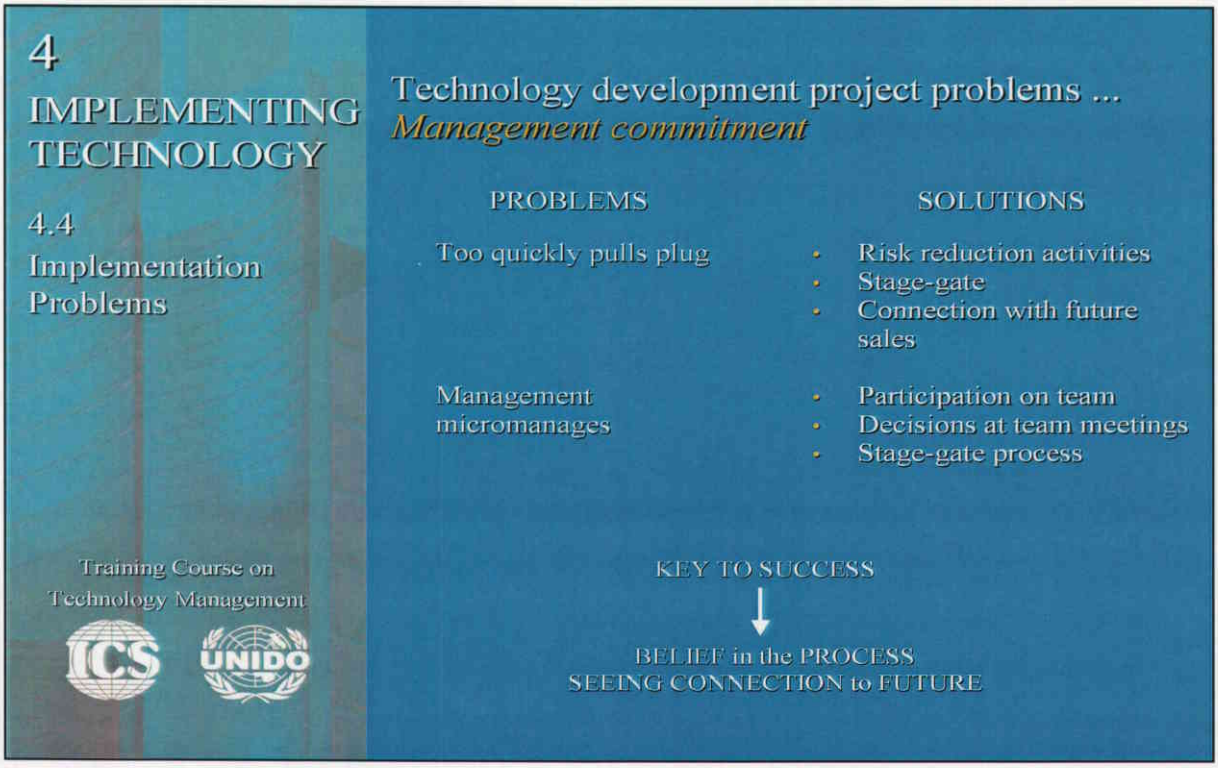

The never-ending project is often the product of the inability to decide. Inability to decide costs the company in several ways. At times, spending on the project continues even though results do not suggest that the investment is warranted. This is purely a waste of resources. On other occasions, the project continues in R&D even though the technology has been developed far enough to be implemented and earn some revenue. This is also a waste of resources, although it does not appear as bad because the project has had technical success. However, until the technology is implemented into a revenue-earning application, the result is the same.

The problem has two sides. The first is a lack of decision points. Without deliveries and schedules, there is never any time or reason to evaluate the project. The lack of milestones just allow it to continue indefinitely. A properly-managed stage-gate process solves this. The decision points are specified and the decision makers are presented with the information they need to make their decision. The second side is that the responsibility for the decision has not been assigned to the right person. Often the head of the R&D group is expected to make decisions on technology development projects. Although he/she needs to be accountable for the activities within the group, this is usually not the right person. The R&D manager tends to put his/her love of science and development ahead of the company's best interests. A person with the needs of the business as his/her first priority must be the decision maker.


Poor communications tend to be at the root of many problem areas in organizations, and technology development projects are no exception. The problem can lie with the developers not communicating poor progress and/or potentially project-killing problems. It can also lie with a disinterested management team. Either can have serious impact on the success of a technology development project. When both problems are present the project is doomed to failure.

To have effective communications, an environment of trust must be created. R&D must know that their job is not on the line if they reveal project-killing information. In fact they should be rewarded for saving the company from wasting resources. They must understand the connection between overall company success and the continuation of their R&D activity. The communication process can be further enhanced by using project status forms. If providing good information is easy to do, it is more likely that it will happen.

The best way to interest management in the results of technology development projects is to present information in their language. This means discussing technology development in light of the company's strategic plans. It means talking in costs and benefit terms, and making recommendations based on cost and benefit logic. They must demonstrate that those involved in the technology development projects understand the company's overall goals and know what part their activities contribute to those goals. The best way to encourage R&D personnel to reveal the truth about their projects is to build an attitude of trust. R&D personnel have to feel safe in the presence of senior management.

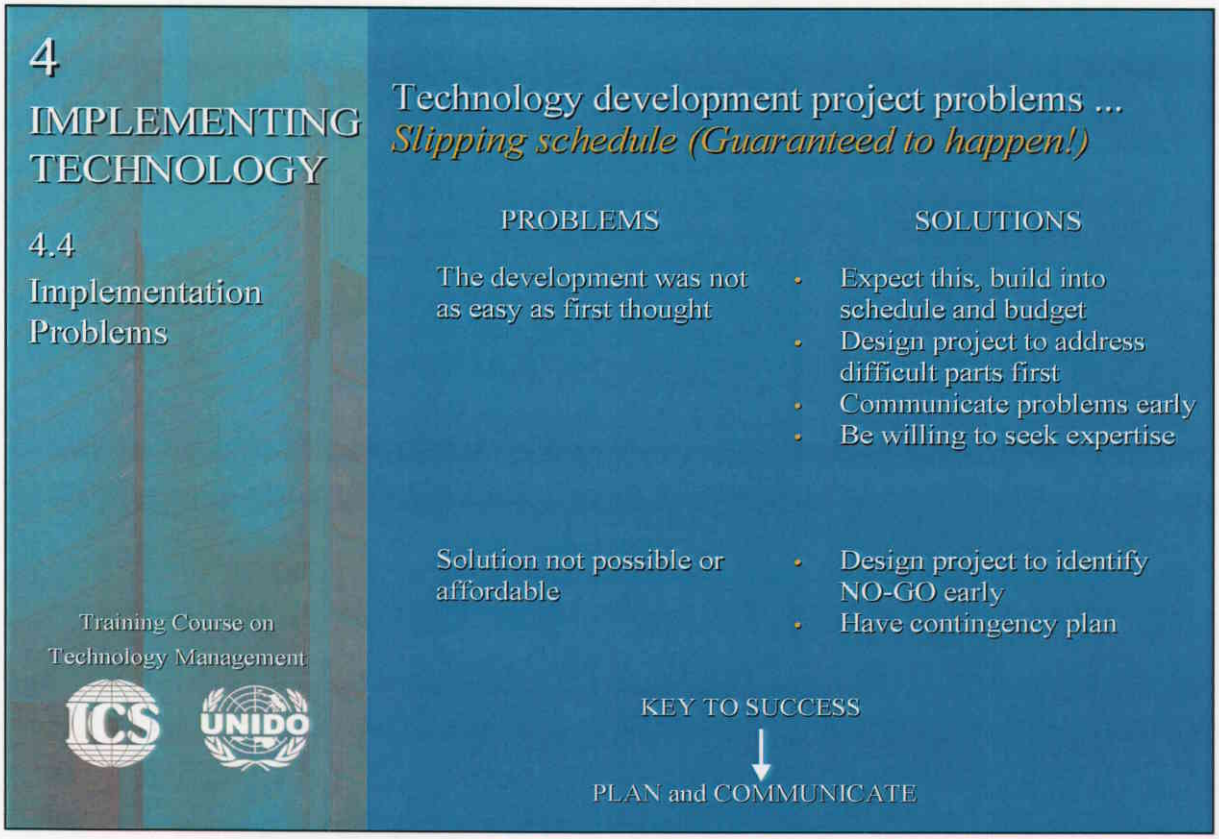



Technology development projects are often initiated in companies with the initial approval of management, but where management has no real commitment to the project. This is especially common in small companies which are generally cash poor. It is hard for the manager (usually the owner) to spend money in technology development that is not going to have immediate returns when it is needed in other areas like sales or production that will have quicker results. Often the manager does not understand the project or believe in the benefits. Related to this is that he/she expects the solution to happen quickly and has no feel for how much money the endeavor will require.

The solution to this is two fold. First, the communication and control methods already discussed will help the manager understand the problems and benefits and will at least provide logical times for stopping the project (i.e. at a gate). Second, deal with the financial part of the problem. With the thorough cost estimating analysis already discussed, the manager can be informed of the best-and worst-case cost scenarios. Similarly, the potential benefits can be quantified. With this information, assuming the project is viable, the manager becomes knowledgeable enough to decide if the project is worthy of the investment required, not just a drain on the company's resources. He/she will then be willing to put the financing in place to manage the cash flow during the development period. The project should not be started unless the financial plans have been put in place. With finances under control, the manager is free to make GO/NO-GO decisions based on technical and market information generated by the project rather than outside pressures.

Another problem that is common in small companies is the company owner wants to micromanage the project. This is especially true in companies that grew out of an invention that the owner made. Technology and product development is this person's first love. However, the owner does not have time to devote to technology development while also running the business. Project managers are frustrated because the boss flies in with ideas (that the staff presume to be orders) and flies out again. The manager's authority is undermined and he is left to clean up the mess caused by poorly thought out ideas. Worse, the owner gets upset with staff for not keeping on schedule, not realizing that the main cause of delays is his demands.

The project team with the stage-gate process offers a solution. The owner should be on the team. Take advantage of his/her love and talents in the development area. Since he/she has to make the milestone decisions anyway, the knowledge developed from being on the team will be an asset at decision time. The owner's role would be limited to team meetings. The rest of the time can be spent running the business. He/she has to agree to bring ideas to the team to be discussed and a team decision made about what to do with them. In this way the good ideas will be tested and used and the poor ones will be assessed and discarded without diverting the staff onto different paths. The project manager is no longer placed in the position of having to either undo the effect of the owner's "suggestion" or having to be viewed as in opposition to the owner. Now he/she is responsible for implementing team decisions, knowing full well that he/she has the support of the owner.




Technology development projects usually get behind schedule. The development is never as straightforward as it seems. The owner/manager has to accept this reality and budget for it. However, the project team should be given the original budget and schedule and expected to deliver within their constraints. If the original budget is expanded to include the contingency, then the team will expand the work to fill the new budget and still be short. It is human nature, at least the nature of the humans who go into technology development. The technology or product is never good enough for them. This is why it is essential to have business-oriented people making the decisions. The design of the project is critical. The team has to identify which aspects are most likely to make the project impossible or at least unaffordable. These need to be done first so that if NO-GO decisions result, they can be made early in the process. The team has to be willing to be open about its difficulties so that financial or other adjustments such as contracting specialized expertise can be made.

4

IMPLEMENTING TECHNOLOGY

4.4

Implementation Problems

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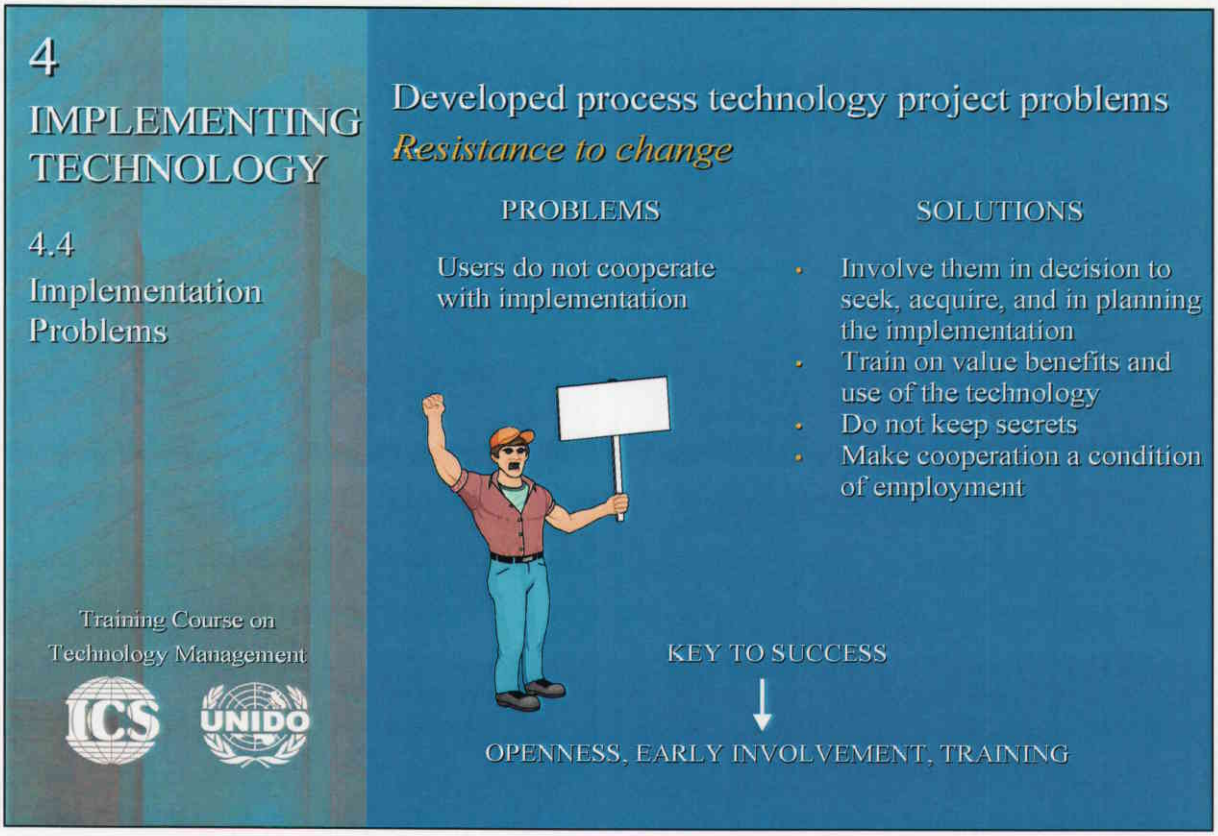
## Problems in implementation of developed process technology ...

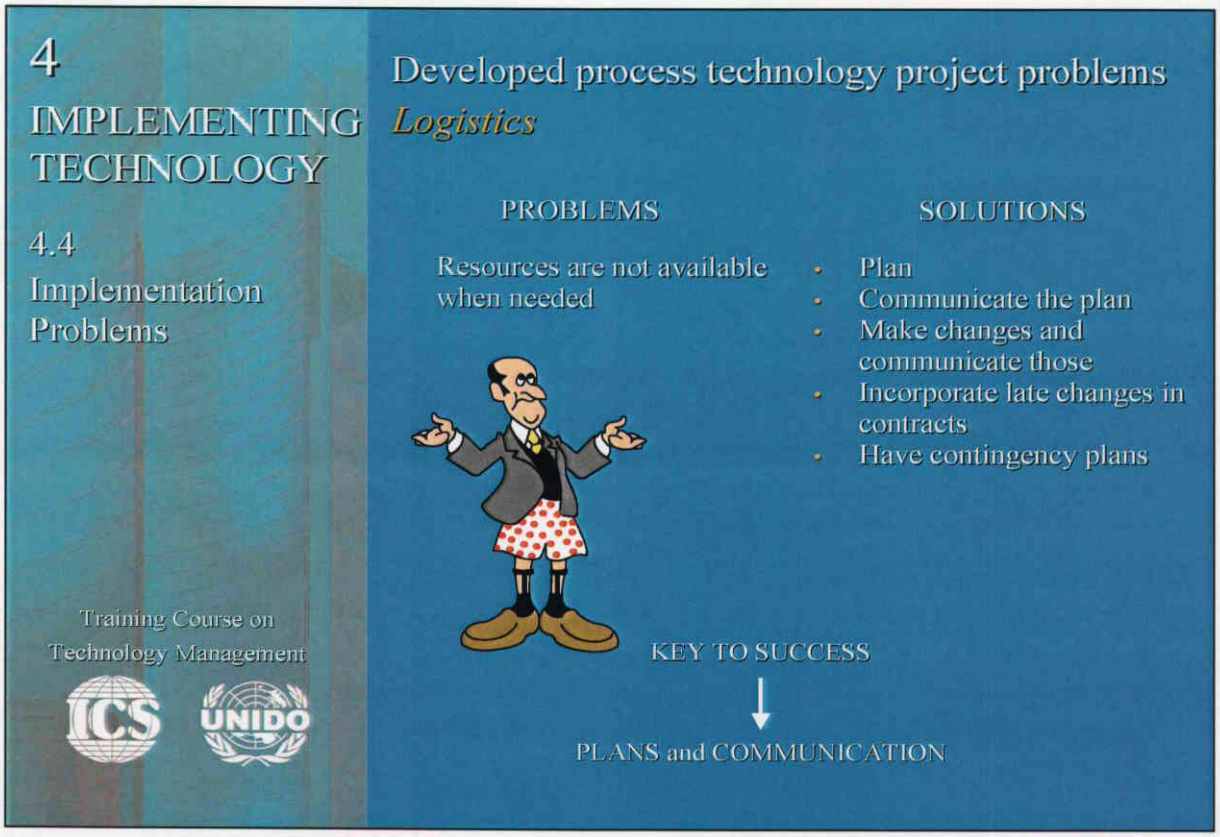
- Resistance to Change
- Logistics
- Inadequate resources
- Lack of appropriate measures
- Communications
- Preoccupied with existing operations
- Slipping schedule

Implementation of developed process technology has some of the same problems as implementing technology development projects. These include lack of appropriate measures, poor communications, and slipping schedules. Implementing developed process technology projects are more prone to failure due to resistance to change, poor management of the project's logistics, and the fact that those involved are often pre-occupied with present operations that must continue simultaneously with the implementation project.



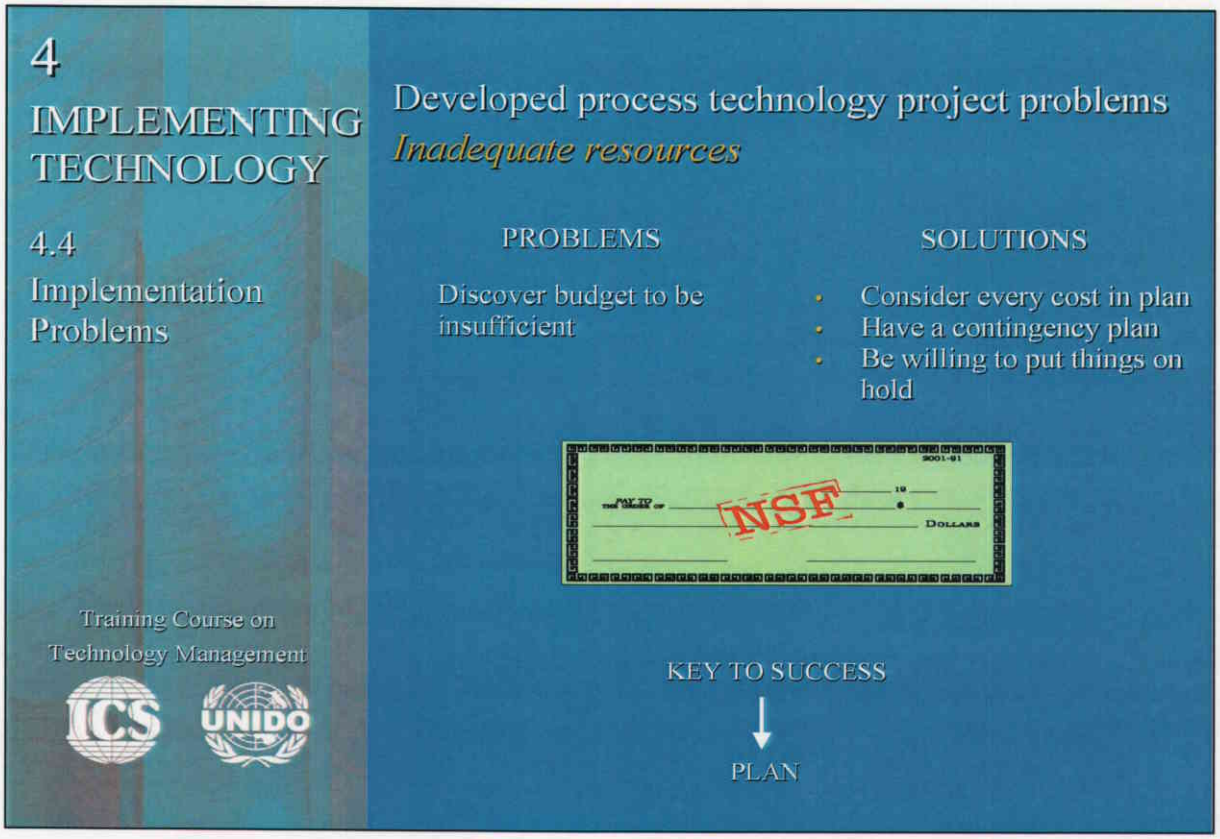

Resistance to change is probably the biggest problem facing the implementation of developed technology projects. If it is not the biggest, it is at least the most frustrating. Management, having invested in the acquisition of a technology that can benefit the company, cannot afford to have the investment wasted because the users of the technology sabotage the project by resisting its implementation. This problem must be solved before it happens. The solution is realizing the fears of the people affected. They are operating from a much smaller knowledge base than those involved in the decision to acquire the technology. Because they do not know the positive impacts of the new technology, they will assume the worst — that it will replace their job. Resisting the use of the equipment that will replace them seems like a logical thing to do by someone who believes that they will be removed once the new process is up and running. This reaction is especially likely when the people affected are "surprised" one day when they come to work and the new technology is sitting in a crate on the shop floor.

The people affected must be involved early. They should be well aware of the benefits of implementing the new technology and the dangers of not implementing it long before it arrives. Ideally, some of them should be involved in the technology acquisition decision. Even if the new technology results in some job loss, this fact has to be communicated long before the equipment arrives. Decisions about who will stay have to be made so that those who will work with the new equipment have the security that they will still be there after the implementation is complete. Openness and honesty with everyone involved is the best strategy. In return for early and open communication, the company has the right to expect commitment from its employees. After all, it is the company that issues the paycheque. They can expect cooperation in return. However, it is in the company's interest to give its employees the information they need when they need it so that they willingly cooperate.

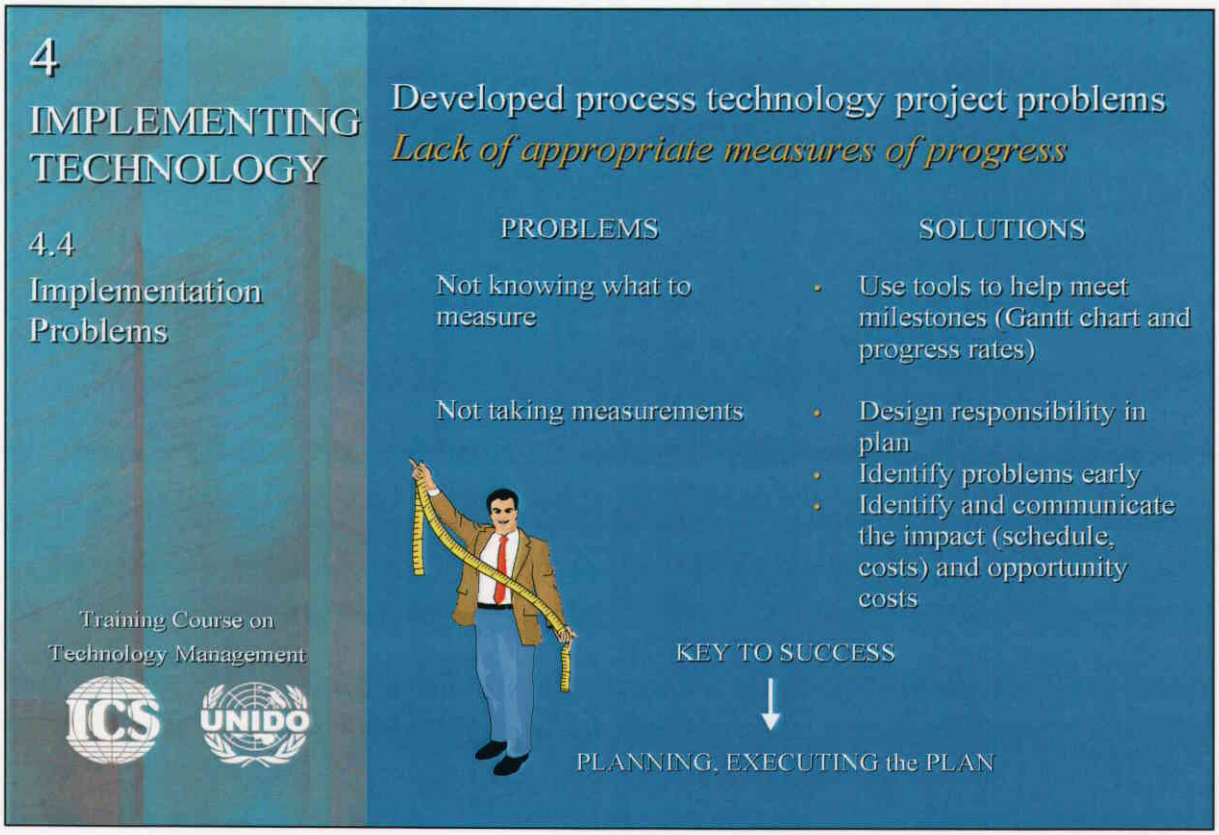



Logistical problems, resources not being available when they are needed, are generally the result of poor planning. Implementation of developed technology does not have the unknowns that technology development projects have. The company should know (or be able to find out) everything that is needed to complete the implementation. It should identify suppliers and find out delivery times for the various components. This information is used in the creation of the project schedule. The schedule needs to be communicated to all involved so that everyone knows when his/her piece of the project must be delivered to mesh with the other activities. In short, the solution to most logistical problems are making plans and being good at communications.

There are some logistical problems that are beyond the company's control. A common example is when a local supplier promised delivery on a certain date, but could not deliver because an international supplier did not deliver to them. Building late charges into the contract will help reduce these occurrences. Sometimes they are unavoidable. Identify for which pieces of equipment this is likely to happen and develop a contingency plan for each one. This consists of alterative activities for the project implementation crew if the equipment has not arrived on time.




Developed technology implementation projects that run out of money are the result of poor planning. Developed technology projects consist of known entities. It has been done before. It is the responsibility of the implementation team to have a full list of the things to be done and the associated costs. Quotations should be acquired for equipment and services provided by outside suppliers, leaving only the internal activities with a variable cost. The development of the implementation plan requires considerable effort. Nothing should be missed. But, since we are human and fallible, management needs to set aside some budget for contingencies. The project should not be started unless there is money to complete it. However, if the company's financial situation changes after the project has begun and expected resources are not available, the company needs to identify this as early as possible and postpone the project until finances can be arranged to complete it. Losing the company to acquire new technology, no matter how wonderful it is, makes no sense. If the implementation project is draining all the cash to the point that it cannot continue operating, the project must be stopped.




The problem of lack of appropriate measures of progress has two components: knowing what to measure and not taking the measurements. Not knowing what to measure is related to the planning process. Those who have done a good job of planning along with Gantt charts with S-curves will know what to measure. They know that the expenditures have been planned over time, and plotting the actual expenditures on the same sheet as the plan will show how closely the actual implementation is keeping to the plan. They will also have established milestones that are to be accomplished according to a schedule. Plotting the actual start and end points for completed actions will show how well the project is keeping to its time schedule. For tasks underway, the project manager can estimate what percentage of the work is complete to predict how close the current task will be to its predicted end date. It almost goes without saying that those who do not know what to measure have not done a good job of planning.

Having measures planned but not taking them is a symptom of other problems. Perhaps the plan did not identify who was responsible for a task and therefore no one is doing it. This is easy to rectify as soon as it is identified. Perhaps everything is in place and it is still not happening. This is likely a symptom of lack of commitment to the project. The person does not realize the financial implications of the project being off schedule. Or the person does not realize that early detection of a slipping schedule offers opportunity to accelerate other activities or even do some things in parallel that were planned to be consecutive. These problems can be fixed with some education. If the explanations have been made and the person persists in not providing the needed information, he/she will have to be replace by someone who will do it. Not only has the project team been forced to make decisions without important information, the person's attitude will have a negative impact on others involved. The technology implementation project is too important to risk people who are not committed to the process.

4

IMPLEMENTING TECHNOLOGY

4.4

Implementation Problems

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## Developed process technology project problems ...

*Communications*

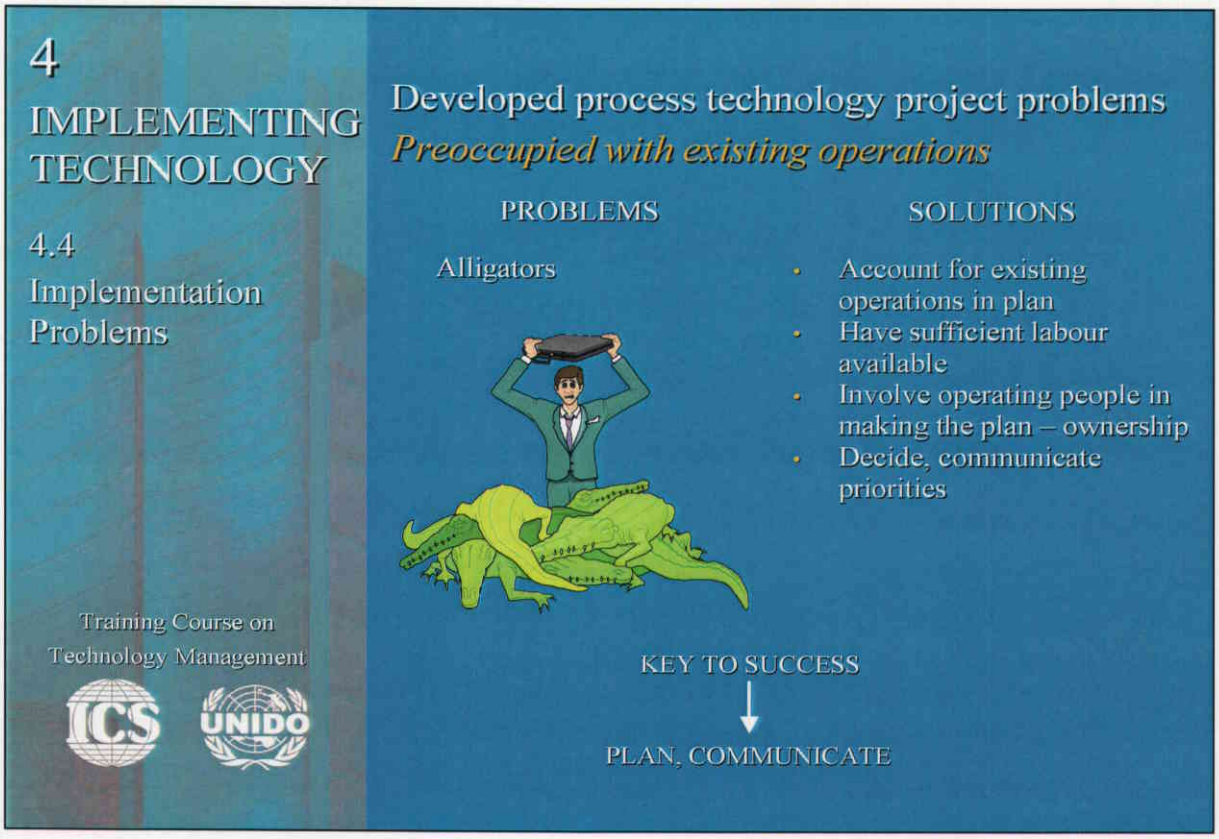
| PROBLEMS | SOLUTIONS |
| --- | --- |
| • Resistance to change<br>• Doing the wrong thing<br>• Not doing things | • Be open, have meetings, have a communication plan, use the communication plan |

KEY TO SUCCESS

↓

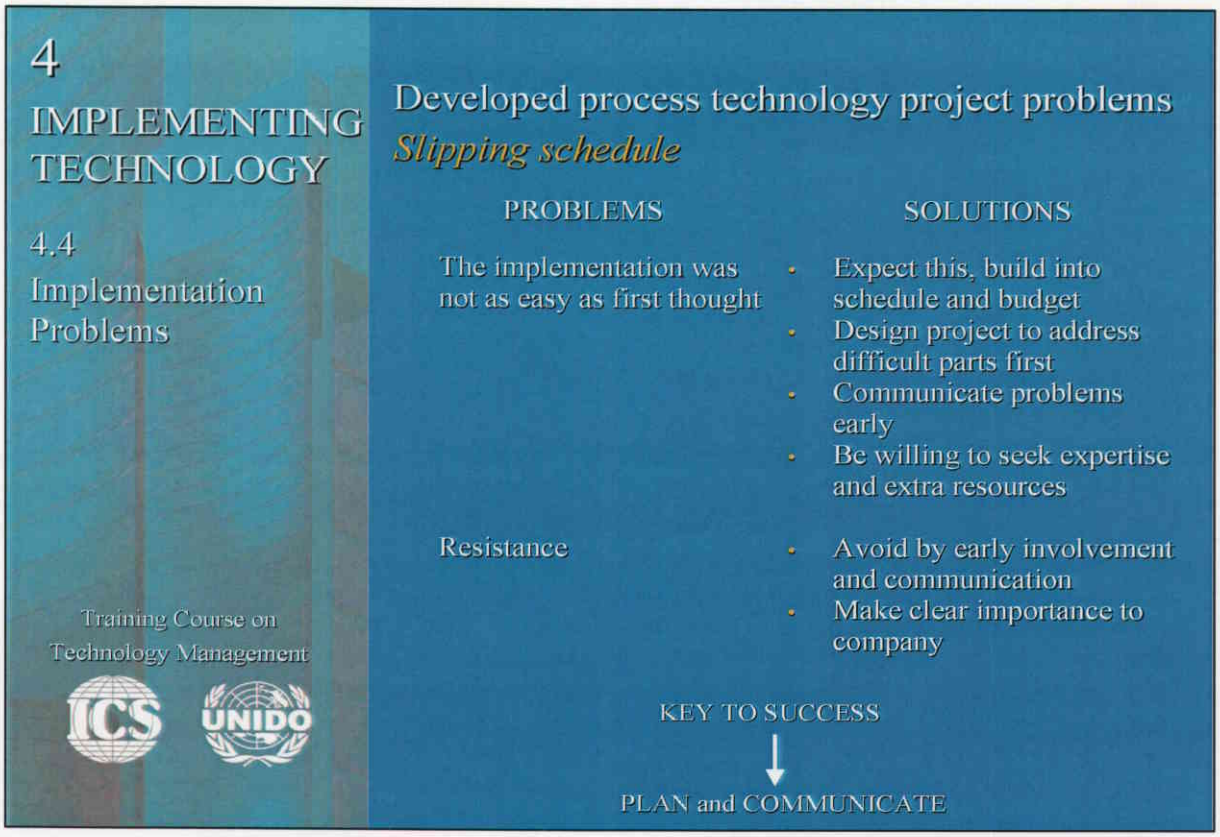
OVERCOME ALL BARRIERS to COMMUNICATION

As with technology development projects, good communications are essential. All barriers to communication must be overcome. The project plan must include a communication plan. This outlines what will be told to whom, when, and by whom. Poor communications are the main cause of resistance to change, and, as has already been pointed out, the best solution to resistance to change is communications. Poor communications can cause team members to do the wrong thing or to leave out necessary activities which could have a serious impact on the schedule.

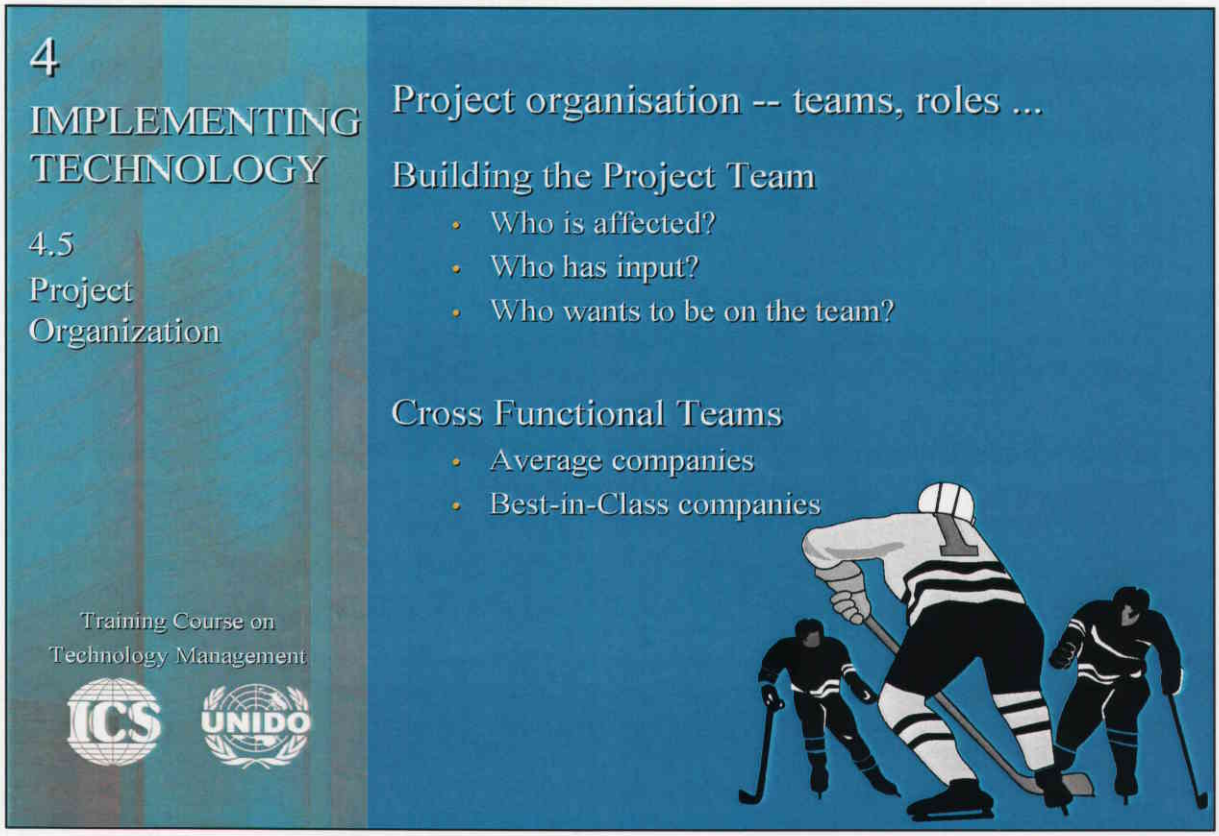



Preoccupation with present operations ranks near to resistance to change as a chief cause of technology implementation project failure. New technology implementation projects are often conducted at the same time as production continues with existing technology by the same people. As the saying goes "When you are up to your ass in alligators, it is hard to remember that your objective was to drain the swamp". Even though draining the swamp would get rid of the alligators, you still have to deal with them as long as they are there. Likewise in the production environment, the day-to-day problems of running the old technology will continue, even though the new technology promises to get rid of those problems. If the frustrations of dealing with the old and the new simultaneously are coupled with some resistance to change the result can be deadly.

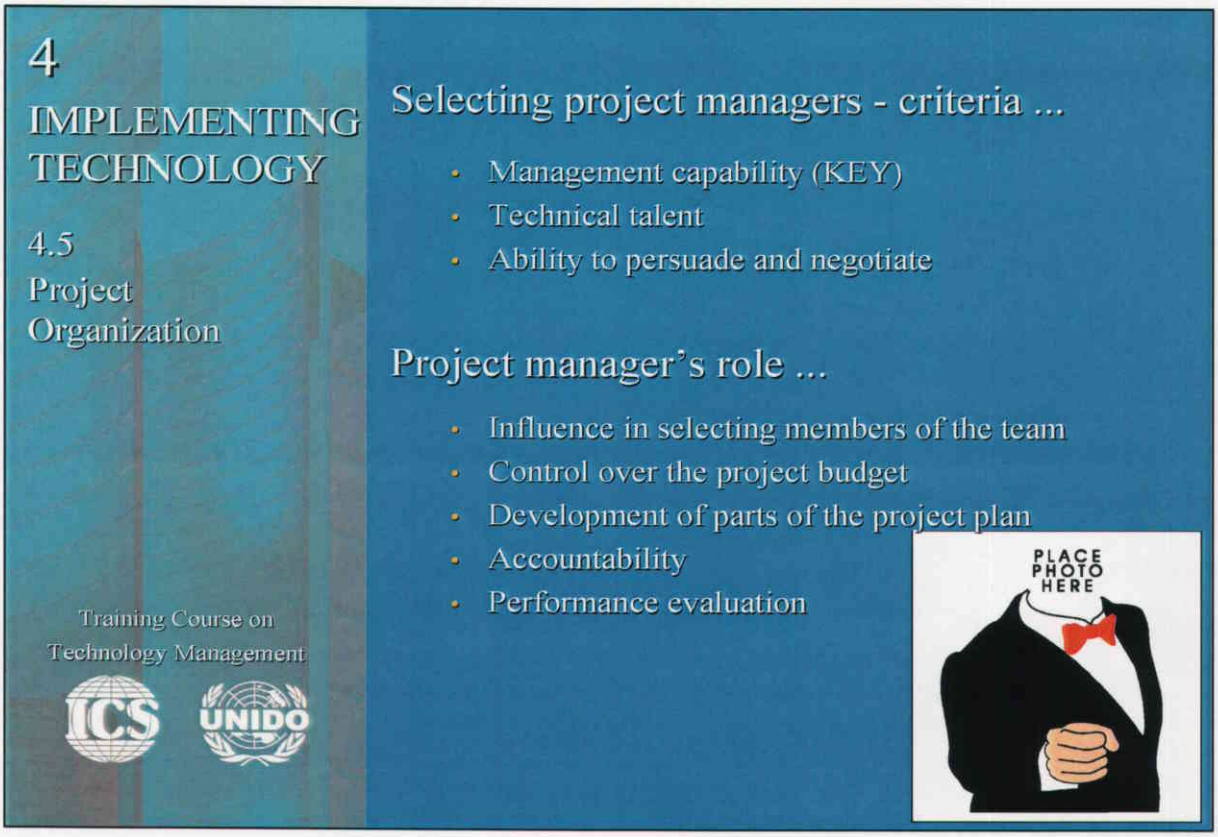
Management must account for the additional work involved with introducing new technology while continuing existing operations in the plant. Some additional staff will be needed, although the complete crew does not need to be replaced. One or two persons have to be dedicated to the new project while one or two different persons have the responsibility to keep the old process running. The other people can be shuffled back and forth as needed. Everyone will have to contribute more during the changeover period. If the communication effort has been handled well, the staff will be enthusiastic about the change and willing to give the extra effort. If the staff are not enthusiastic about the new technology, be prepared to spend a lot of time and energy fighting alligators.




The schedule will slip with developed technology implementation projects, although the slippage should not be as serious as with technology development projects. The slippage is usually due to some aspect of the implementation that took more time than was planned. It could also be due to late delivery on key components. Management has to expect some of this to happen and build some slack into the schedule and the budgets. Address difficult parts first if possible so that if delays happen, there is more opportunity to make up the time or at least adjust post implementation plans. Also be willing bring in outside expertise to help with problems rather than struggling with them alone. Generally the opportunity cost of the postponed production far outweighs the cost of hiring an expert to deal with a specialized problem that is holding the project back. Schedule slippage can also be caused by resistance to change. As has already been discussed, resistance is best dealt with by early and frequent communication.

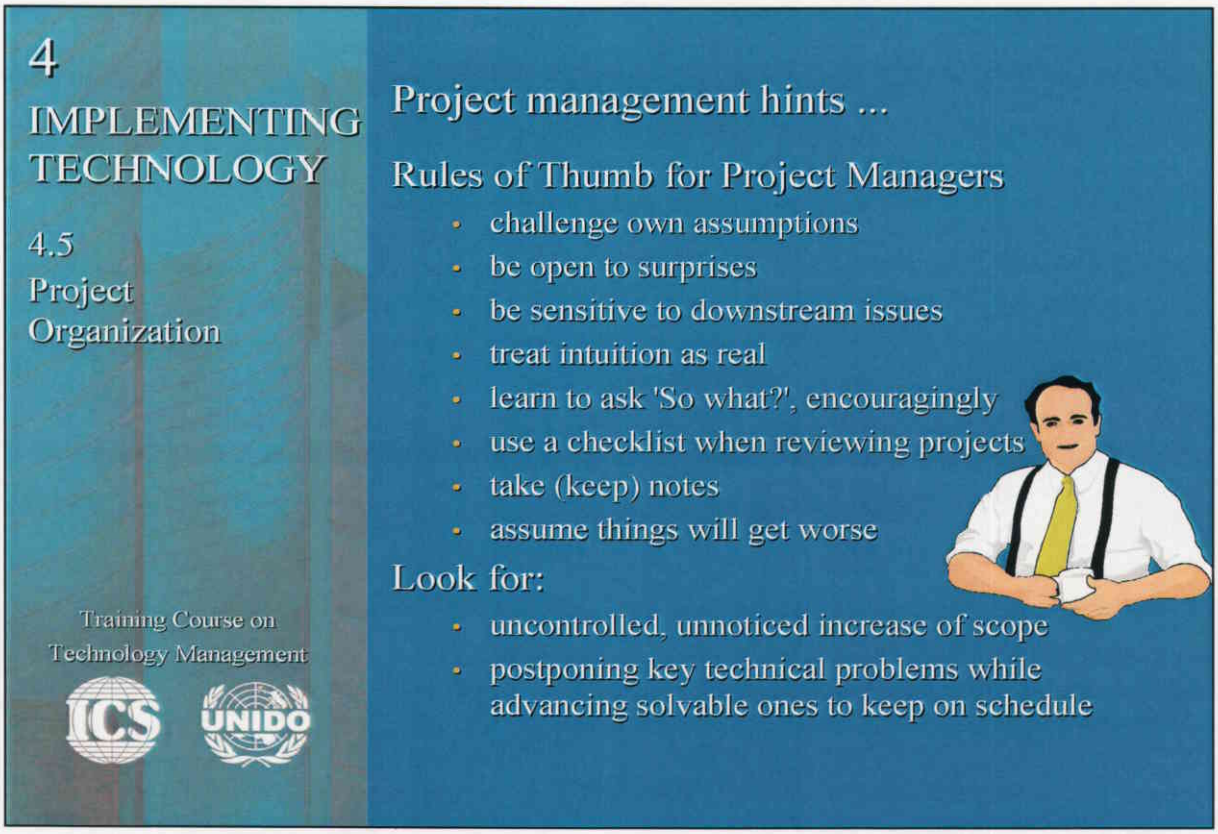



Technology implementation projects are conducted by people. These people can be assembled in ad-hoc style or they can be grouped together into a project team. Creating a formal project team has been found to be by far the most effective. The fact that it is a formal assignment gives the project the importance it requires to succeed. It provides the authority channel for making decisions and a place for project execution responsibility. Finally using a project team approach provides opportunity to assemble the right set of expertise to accomplish the project. Companies have found the best success is with cross-functional teams composed of people affected by the new technology (the users and those that interact with them), those knowledgeable about the technology itself, those expert in implementation (construction, installation, set-up), and someone from management with a overall business outlook and decision making authority. It is also very good to have people on the team who want to be there. It is much easier to continue and spread enthusiasm for the new technology if the team members are naturally excited about it.




The role of Project Manager is an absolutely critical component for success of any technology implementation project. The best companies select project managers that have strong skills in three areas. They must be good managers. They must be able to handle the multiple demands and pressures that come with a project with complicated logistics and a variety of risks. They must have a good understanding of the technology involved. Technical weakness will result in difficulty in dealing with technical experts on the team, contractors, and suppliers leading to some poor or untimely decisions. Finally, a good project manager must be good with people. People skills are necessary to keep the team focused and excited about the project. They are also essential for developing buy-in with affected employees. As has already been said, if the resistance to change issues are not addressed, the project will fail. The project manager has a central role in leading the charge to break down the barriers to technology transfer.

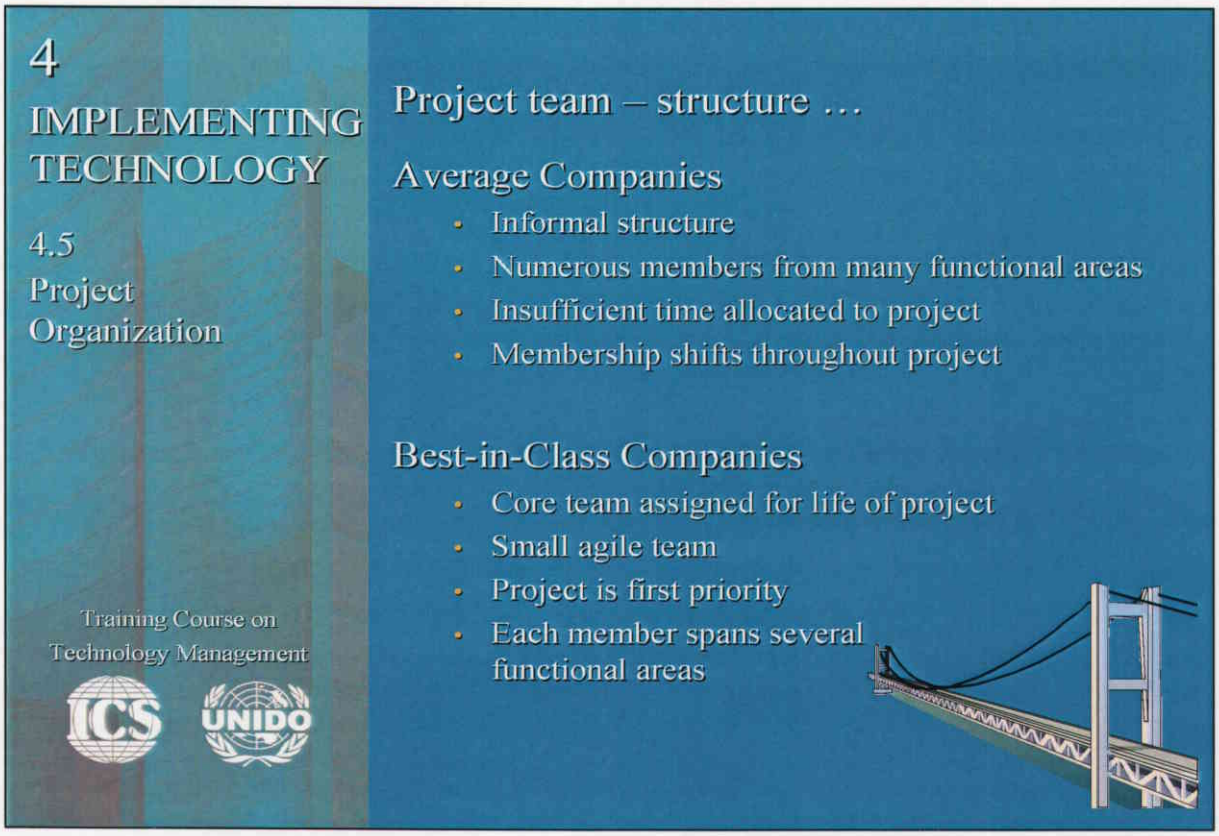
The project manager's role should begin before the project starts. He/she needs to be given authority and responsibility for the project. Freedom to make operational decisions that affect the outcome of the project must be given along with giving responsibility for the project. Therefore, the project manager should select or at least heavily influence those that have responsibility for selecting the project team's members. He/she should participate in the development of the project plan and its budget. Once the plan and budgets are approved, he/she must have freedom to operate within those constraints without outside interference between milestones. The project manager can be held accountable for the success of the project once he/she has been given this level of control. Without it, is difficult for the project manager to deliver and unreasonable for the company to expect success. It is too easy to blame others for failings when relevant activities are under the control of someone else.




Project management is not rocket science. It is common sense attention to detail, in personal and technical areas. Plans are based on assumptions, which if incorrect cause poor plans. Project managers must be able to challenge the assumptions upon which the plan was based. When assumptions are shown to be wrong, they must be able to make the appropriate corrections. They have to be constantly thinking and asking themselves questions about the future. What happens when the current tasks are finished? How are our present results affecting the future plans? If the project manager is not ready to move to the next step when it is time, you can be sure the team will not be ready. One assumption that need not be challenged is that Murphy's law will apply. This says that whatever can go wrong, will go wrong. Do not be surprised, be prepared.

Project managers should never disregard intuition. It is the experience factor. It can be a guiding light when the facts fail or even when the facts appear to be pointing in a direction that does not make sense. When facts are presented that do not match intuition, project managers need to be able to ask why. They need to be able to ask in a way that does not put down the persons with the unexpected findings. The question needs to be posed in a way that encourages them to either develop a logic that deal with the red light that intuition has switched on or leads them to re-investigate their findings.

The project manager has overall responsibility for the success of the project. This can be a daunting task. A checklist of each of the small accomplishments within a task can help. Keeping notes of issues, problems, decisions, and observations that could affect outcomes will assist the memory that can get clogged with details. It is especially useful when the project manager remembers it one way and the person responsible for an activity remembers it another. A note made at the time goes a long way toward settling arguments. Project managers need to keep the "big picture" in their mind. Expect to find areas of ever-expanding increases in scope, especially in technology development projects. These have to be identified and brought under control. Also expect to find people solving easy problems to keep the overall project on schedule while leaving the difficult things to last. While working on easily-solvable problems can have an encouraging factor (winning encourages winning), it does not meet with the overall goal of constantly reducing risk. So long as the difficult problems remain untackled, the risk remains high while expenditures continue. Project managers need to use every project management aid they can access to cope with their responsibilities. In addition to the points raised in this section, project managers have access to phase reviews, project management tools, and communications. These will be discussed in detail in subsequent sections.




Project team structure has a significant impact on the project's success. Informal teams do not work well. They represent a lack of commitment to the project. Team members are assigned more on the basis of availability than on their ability to contribute. The members' priorities are with their regular job and work on the project is an added activity that becomes a burden rather that an exciting opportunity. Informal teams tend to get too large, making decision making difficult and action planning even harder. Much better success has be found with those companies that assign team members for the life of the project. The project becomes their first priority. They use small core teams that can more quickly make decisions and react to changing situations. To address the fact that many functional areas (affected departments of the company) need to be represented, members are chosen that have experience in several areas. If required expertise is not represented, the team identifies the need and seconds a qualified person to interact with them on the portion of the project that requires that expertise.

4

IMPLEMENTING TECHNOLOGY

4.5
Project
Organization

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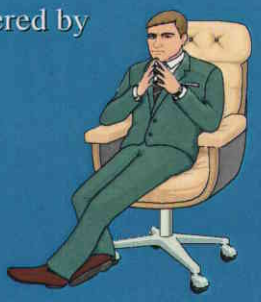
## Project teams -- responsibility/accountability

### Average Companies

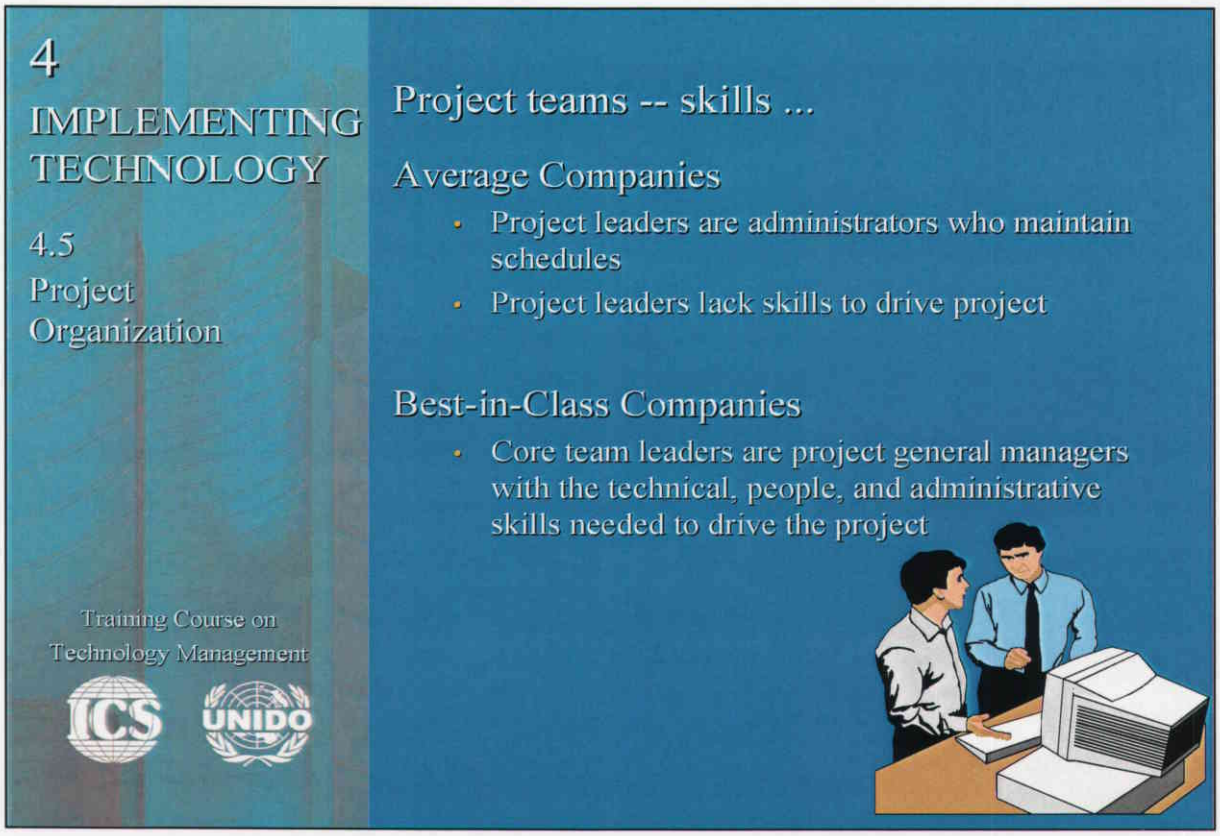
- Team members take direction from their various managers
- Responsibility dispersed throughout organisation
- Project is generally not first priority of each manager

### Best-in-Class Companies

- Core team members are empowered by senior management
- Core team accountable to senior management
- Primary responsibility is delivery on the project

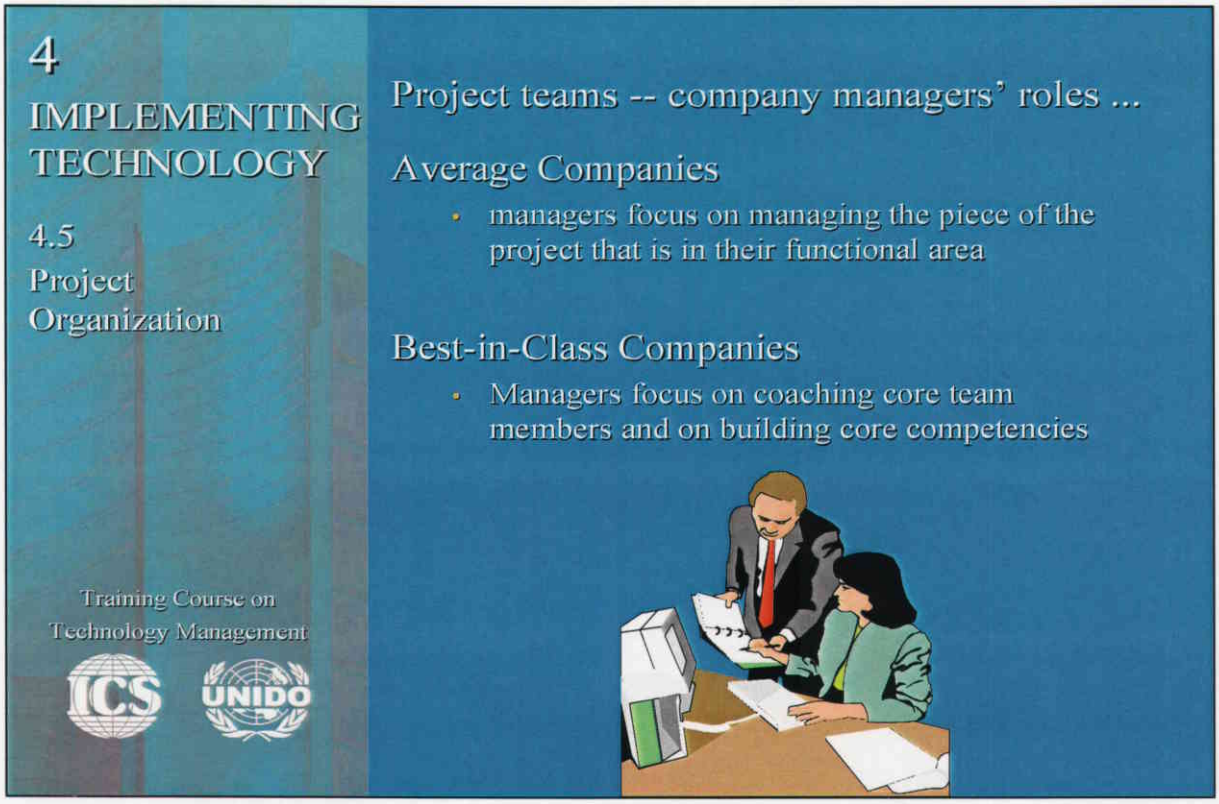


Giving the project team clear responsibility and one path for accountability is another factor in successful projects. When team members report to their functional managers (the departments they normally work in) their role on the project will not be their first priority because it is not the first priority of their managers. Each team member will experience a different set of direction due to the personality differences of the various managers. In the informal structure model there tends to be no one ultimately responsible for the project. Even if there is, that person does not have authority over the project team, so he/she has a very difficult time meeting project goals. Companies that execute projects well have a dedicated core team that is empowered by the company's senior management. Its primary responsibility is to conduct the project. The Project Team is responsible to senior management, making it very clear who is directing that the project must get done and get done well. The fact that senior management have ultimate authority on the project helps give it more profile within the company which helps result in success.

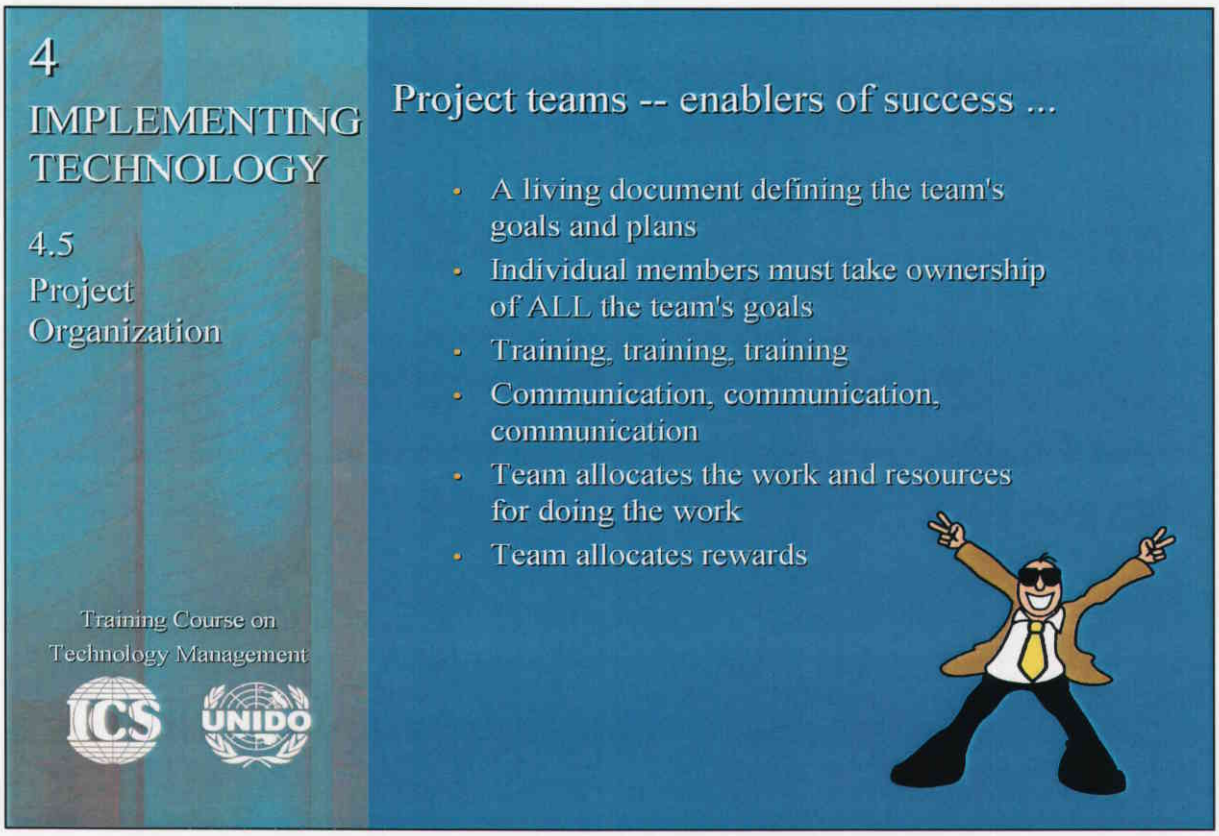



Average companies have been found to typically use administrators to be project leaders. These people are generally good at using project management tools and can handle things like logistics and budgets. However, they lack the technical skills needed to deal promptly and effectively with the technical issues that will arise. Implementing technology is, after all, primarily about technology. The best companies have recognized and addressed this. In addition, the best companies have recognized that project managers must have strong people skills. They must be able to persuade and negotiate. They must be able to excite and enthuse. They are the generals in the battle against resistance to change. Project managers in the best companies are strong administratively, good with people, and understand the technology involved very well.


In addition to the team responsibility and authority issues, it is also important to define each team member's responsibility and authority. When member roles are not well defined, confusion and conflict result. When it is not clear who is to accomplish a task and by when, chances are quite good that the task will not get accomplished. When it becomes obvious that the task was not accomplished, conflict results as team members point fingers at their colleagues. This is especially true when the team members role on the project is secondary to their regular function. Whenever the person is pressured with more to do than there is time for, the project will always suffer. Clearly defining roles and responsibilities for each team member results in a smooth running project and happier employees.

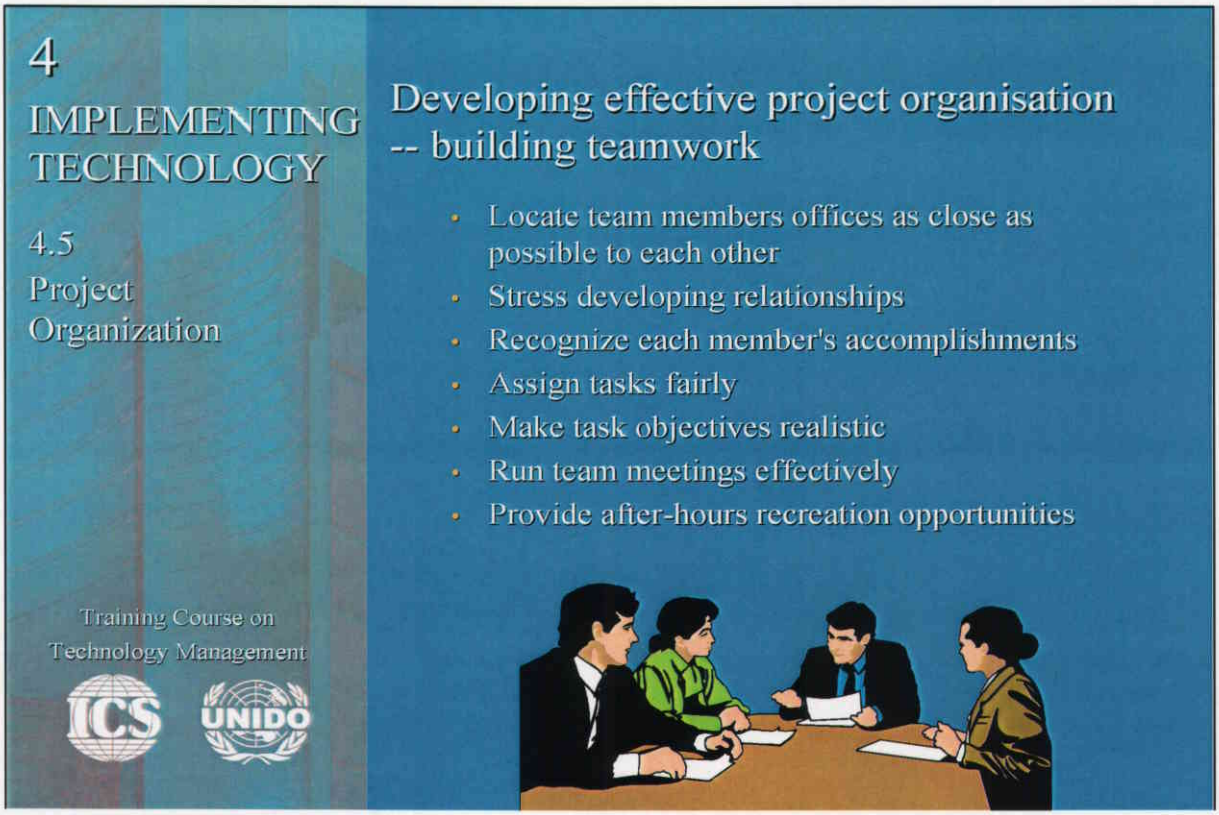



Managers not on the team can affect the team negatively or positively. Those who are only concerned about how their functional area is represented on the project are myopic, not thinking about the overall good of the company. These managers, even if they are not on the team, will still attempt to manage that portion of the project that relates to their functional area. A functional manager pulling the project in a different direction than the one the team has decided it should go can be very counterproductive. Functional managers' energies can be much better spent coaching the team member that is representing their area on the skills and knowledge needed to make sure all the issues that affect that area are addressed properly.




Teams can be very successful if a few key issues are addressed. The first is a living document that defines the team's goals and plans. This should include the stage-gate and other process design and monitoring tools already discussed. It should also include a description of each person's role and how they are to contribute to overall project goals. The word "living" in the earlier sentence is key. The document should be developed at the beginning of the project, but not put on the shelf. It must be reviewed and updated on a regular basis. The team members have to realize that the project's goals are everyone's goals. Even though each person has specific goals, they are all responsible for all the overall project goals. They are a team. The team wins (or loses) together.

The team needs authority over the project to be successful. It must be able to assign tasks and have the freedom to acquire the budgeted supplies and equipment. Between the milestones determined at the project's outset, the team needs freedom to act without interference. This includes the allocation of rewards for exceptional performance of those contributing to the project. Management is still able to exercise control by allocating budgets by phases and by making the GO/NO-GO decisions at the milestone points. Teams are not automatically able to function in this fashion. They need specialized training in project management and communication. Once operational, they have to communicate — to each other, to management, to affected parties, and to the entire company.

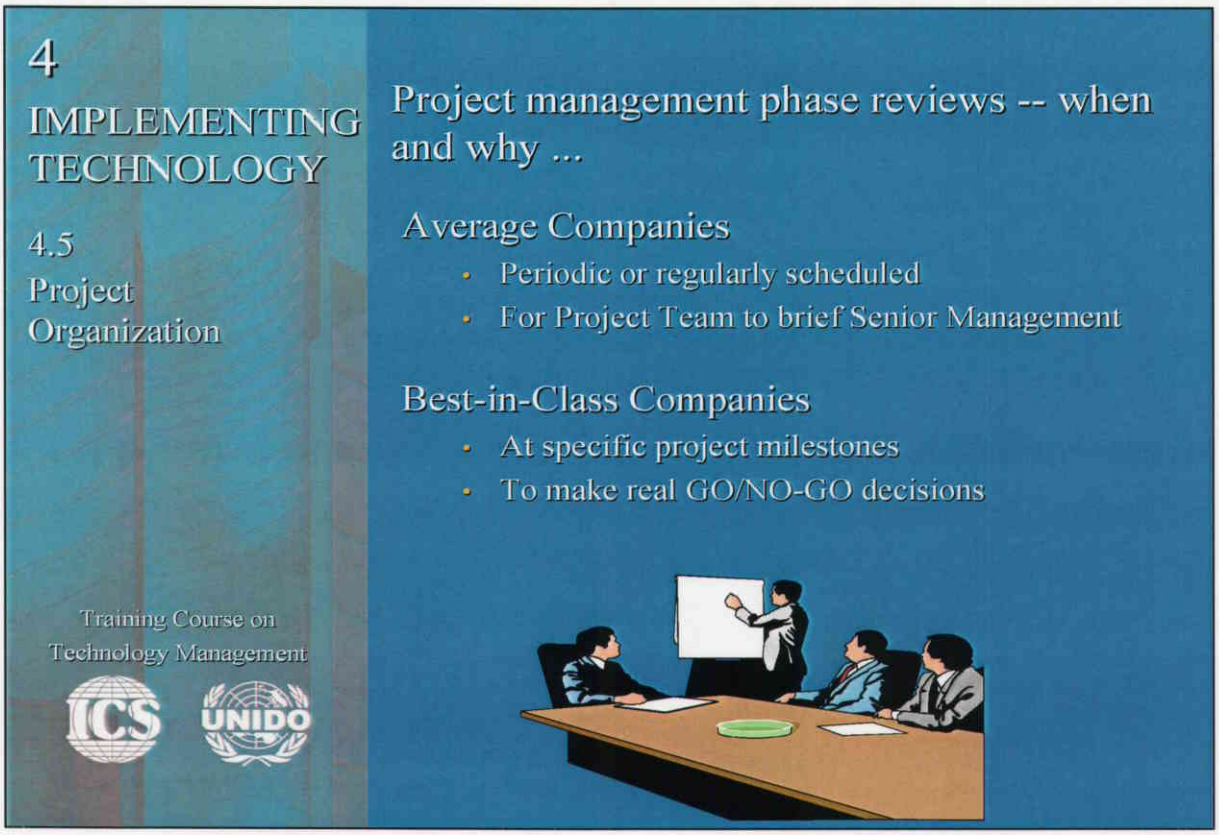



The best project managers work very hard to build an attitude of teamwork among those participating in the project. There are a number of things, that by themselves are small, but together go a long way to facilitate this goal. Locating team members in the same physical location really helps. They see each other every day. They meet in the hall and the coffee room. Many issues get addressed in these informal meetings. Small issues (that could become major issues) are generally not addressed when a team member is not located nearby. When contact is easy and frequent, these issues come up and are dealt with. Project managers need to stress developing relationships. Team members that trust each other on a personal level are much more willing to expose technical difficulties that they may be having. The more that know about a problem, the greater chance there is that someone will conceive an idea that will lead to a solution. Organizing after-hours recreation opportunities like a sports team or a social get together create good opportunities for developing relationships.

Project managers must be fair and seen to be fair if they are to expect high performance from their team. The logic behind tasks assignment should be communicated. The work load should be as equal as possible within the constraints of skill and knowledge. Tasks should be in manageable, measurable and doable chunks. Breaking things into pieces that are too large can be demoralizing because the goal may seem (and may actually be) unattainable. Making tasks too small results in the project manager micro-managing everything. This is demoralizing to the team members because it communicates that the manager does not trust that the team member can accomplish the task. It is also an inefficient use of time and talent.

Project managers need to be well skilled in running meetings. They must come prepared with an agenda of issues to be discussed and decisions that need to be made. The facts behind the issue must be quickly and clearly communicated. Team members must be given opportunity to freely voice their opinions and relevant experiences. The project manager must work to keep the discussion on the subject and recognize when a solution has emerged. He/she must allow a balance between letting free discussion happen to bring out as many ideas as possible and limiting discussion when team members repeat a point that has already been made. As soon as it appears that consensus is near, he/she must make a statement like "it appears to me that our discussion has lead to the following conclusion.....", followed by a statement of the conclusion. The project manager should then ascertain if everyone agrees with the statement, and if they do, it should be recorded and the discussion should move to the next item. Long discussions that never reach conclusions can be very demotivating to team members and are certainly not conducive to good project management. The primary responsibility to manage this area of project implementation falls to the project manager.

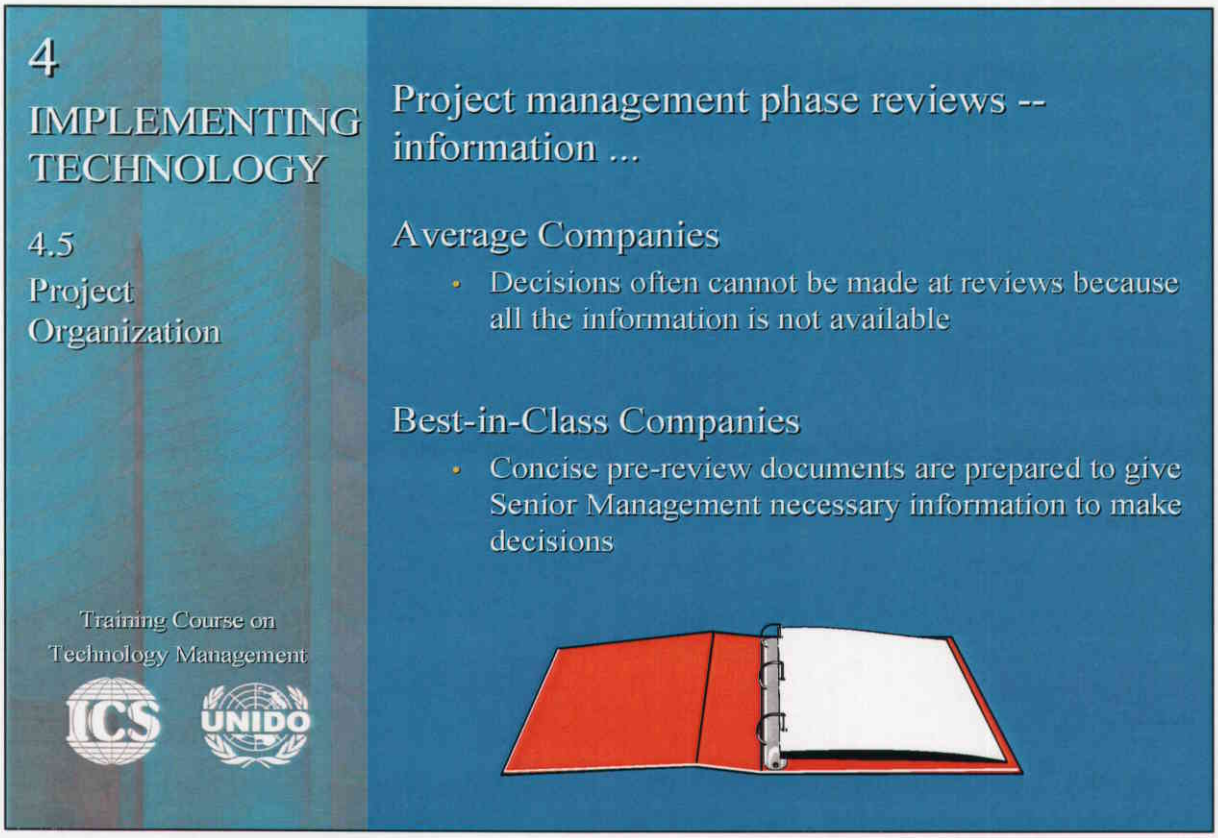

Good project management consists of good planning and control of actual activities relative to the plan. Planning is analogous to the theory and has a lot to do with what the planners think will happen. Control has more to do with dealing with what actually happens. It is largely reactive, although with good measurement systems issues or problems can be recognized soon enough that some proactive steps can be taken. The literature is full of material on planning. The number of tools available to assist in planning are too numerous to count (although most are a variation on the same thing). The literature contains far less on the control aspect of project management. However, since plans are worthless without action, the control side of project management must be addressed. The key to control is measurement. The key to measurement is knowing what to measure, how to measure it, and what to do with the information gathered from the measurement process.



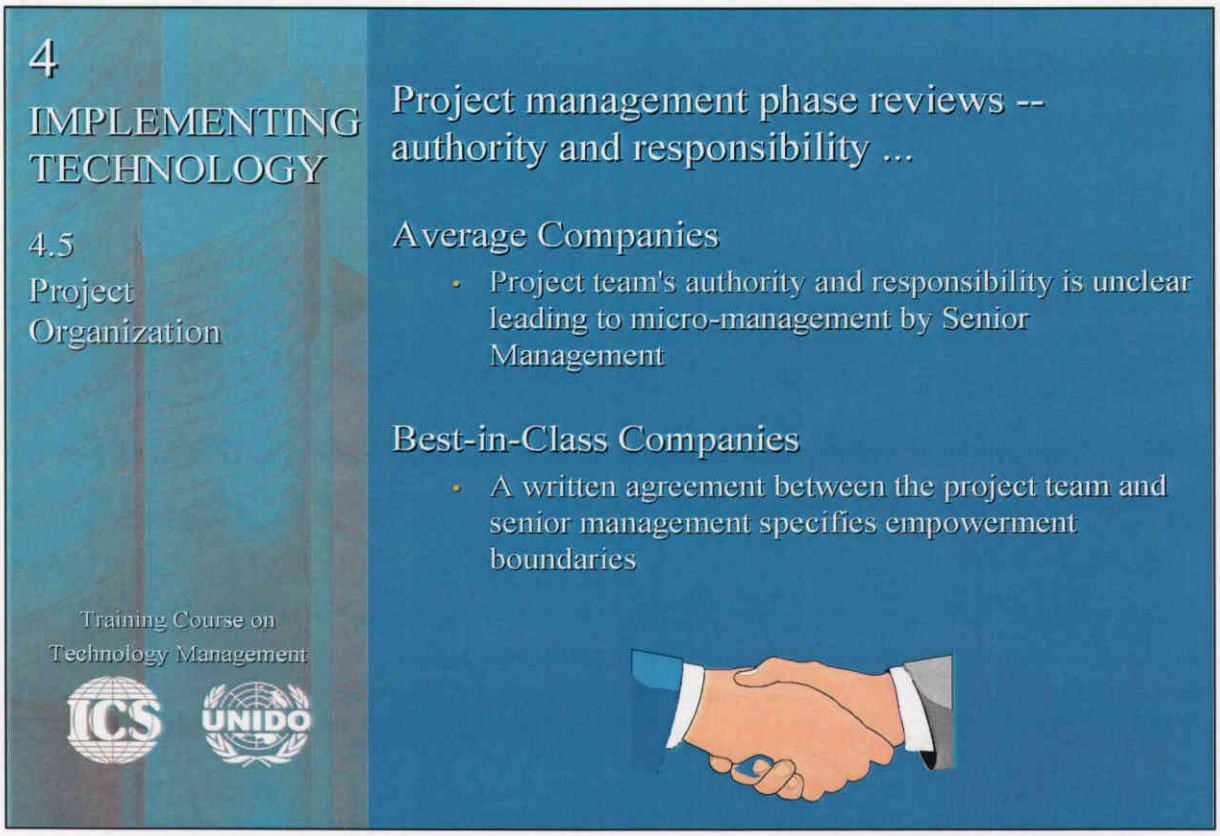

Phase reviews are the best method of communication between the project and company management. They provide a vehicle for communicating progress and for project decision making. The best companies design projects with milestones with specified deliverables expected at each milestone. Each milestone is a decision point where the company's management reviews the findings to that point and decides what to do based on the findings. Phase review meetings are held at the end of each phase (i.e. the milestone point). The project team presents reports on the technical and financial aspects of their work, along with recommendations for the future. The company management receives, reviews, discusses the findings with the team, and then makes decisions about the future of the project. Those companies that hold periodic or regularly scheduled project review meetings for the purpose of the project team briefing management on the project results are less successful at technology implementation. This is because the meetings do not result in decisions. Not tieing the timing of the meetings with project delivery points (milestones) results in insufficient information being available for making decisions. Projects either continue indefinitely or are prematurely ended without clear understanding of why. The organization as a whole does not learn from the project.


Part of the reason why less successful companies have difficulty with technology implementation projects is the fact that the seat of power for decision making relative to the technology implementation projects is not clear. Even though it is known that the owner or company president has ultimate authority it is often not clear how the decision making authority relative to projects is delegated. In some cases the head of research and development has the power to decide on a project's fate. This does not work well because these people tend to be biased toward continued technology development rather than using what is best for the company as the primary decision criteria. Worse than this is the situation where the R&D manager theoretically has the decision making authority, but is constantly overruled by the company owner or president. A third dysfunctional way that less successful companies handle projects is to have each functional manager responsible for the activities that are conducted by those people reporting to him/her. This results in a varying degree of commitment to project components and no overall commitment to the entire project. Finally, the most dysfunctional practice of all is to not delegate responsibility and authority to anyone. This is surprisingly common. The company management decides to embark on a project and assumes it will take care of itself.

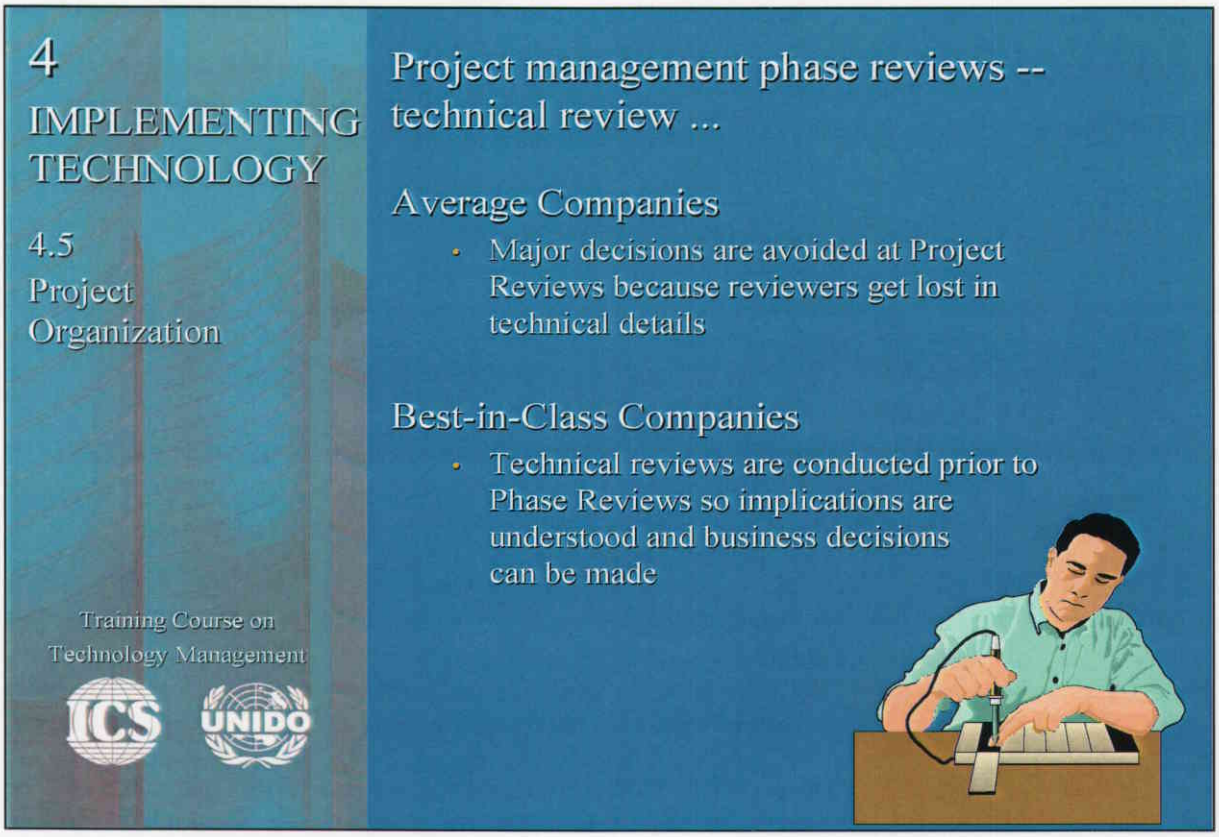
Successful companies make it very clear who has decision making authority over projects. The most successful ones have senior management be the decision makers at phase reviews. These people are the best able to see the big picture and make decisions that are best for the company. The presentations at phase reviews keep them exposed to the technical side of the company which helps them stay in touch with the company's core technology. This impacts on the company's success in ways other than good decisions being made. The more exposure senior management gets to technology and its benefits, the more likely the company will be technologically current.



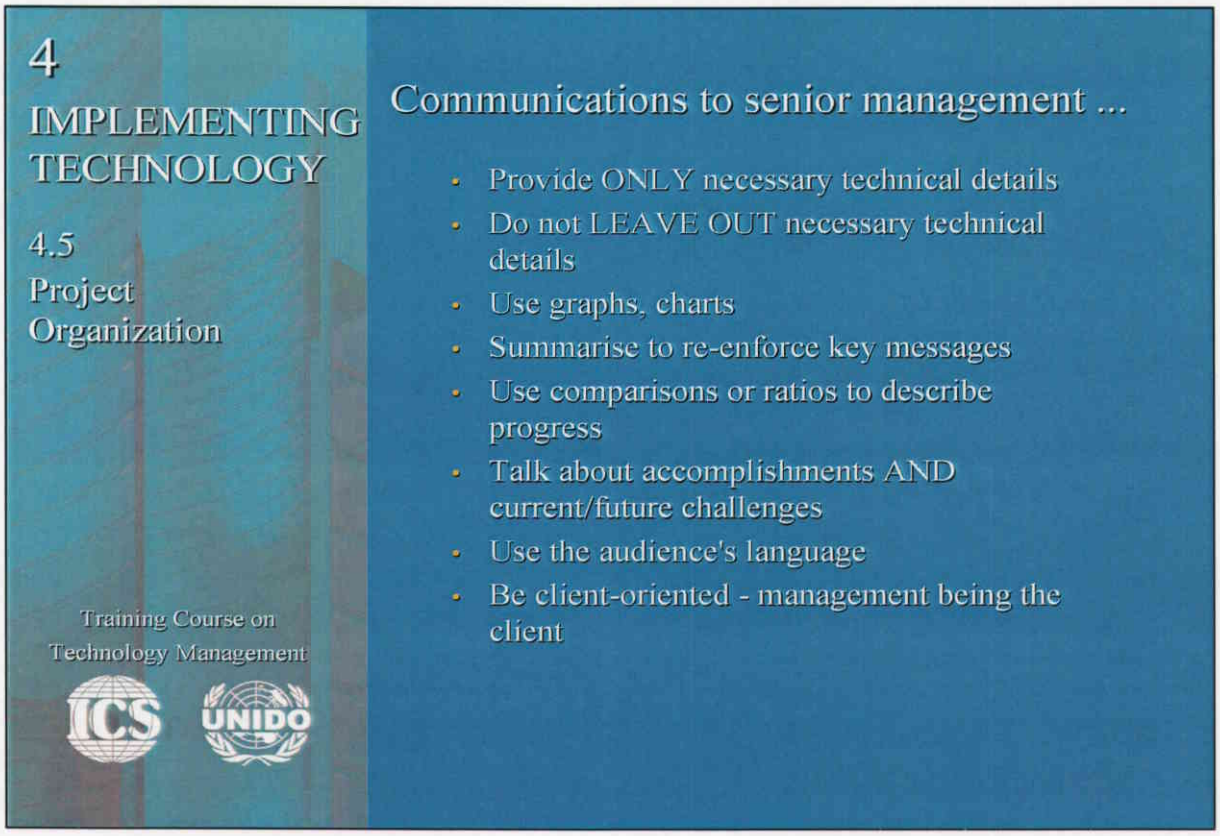

Phase review meetings are primarily for decision making. The heart of making good decisions is good information. The presentation of critical information in a concise manner is critical to making good decisions. Project teams in the best companies put a lot of effort into developing clear concise information presented in the language and manner (pictures and charts) that is easily and quickly understood by management. The written information is supplied to the decision makers prior to the meeting giving them a chance to digest it. Less successful companies do not prepare all the information the decision makers need and do not present it in a way that is quickly and easily understood. The result is either poor decisions or no decisions being made because the key information was not available or understood. Poor decisions and no decisions are quite different results, but neither result in an excellent company.



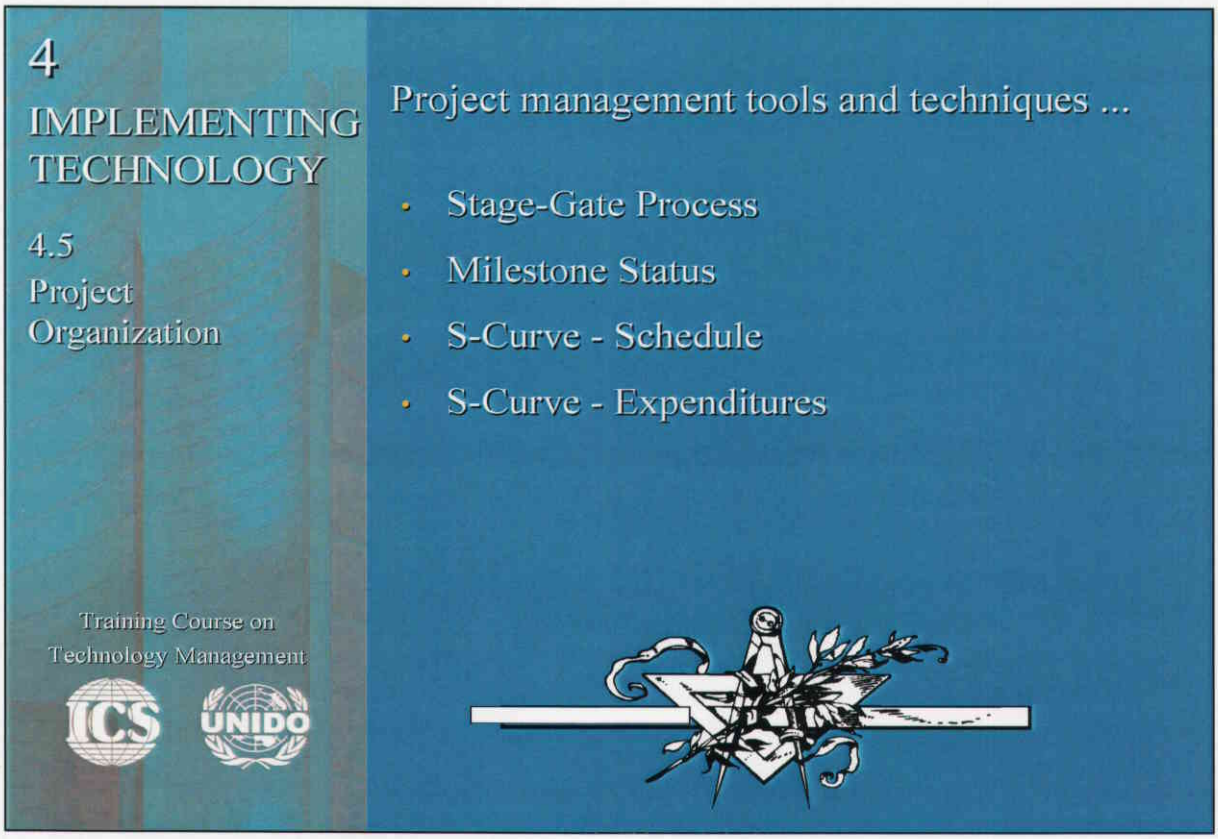

The best companies not only clearly define who is responsible for project phase review decisions, they put it in writing. They prepare a written document between the project team and the company management. The document defines the boundaries of the project team's authority. This frees the project team to operate without interference from management inside the identified boundaries. Management in turn knows the limits of its exposure and is less tempted to micro-manage. The project team also clearly knows what issues are beyond its authority and must be submitted to management. In companies where this is not the practice, considerable management time is wasted dealing with issues that could be handled at the project level, while issues that have significant impact on the company are handled by those that do not know all the implications of their decisions. Unclear (not recorded) authority/responsibility structure leads to poor project performance.




A common problem at poorly-run phase reviews is that the reviewers get lost in the technical details so that they cannot make decisions about the project's future. The best companies solve this problem by conducting and summarizing the technical review prior to the meeting. Management is told about the successes and failings of the technical aspects of the project and the resulting impact of these facts on the project's future. Management, after acquiring a good understanding of the implications of the findings, becomes free to make decisions based on business priorities rather than technical issues. This puts more responsibility on the technical people to honestly report the implications accurately. The process of forcing the technical people to think and report findings in terms of implications enhances their appreciation of the need for full and honest disclosure. Recommending that a project be continued when the evidence states that stopping is in the best interest of the company, may meet the short-term technical interest of the project people. However, the long-term negative impact on the company may hurt these same people far more than not being able to see the project through to its conclusion. Even scientific personnel can think in practical terms when forced to look at the implications of their decisions.

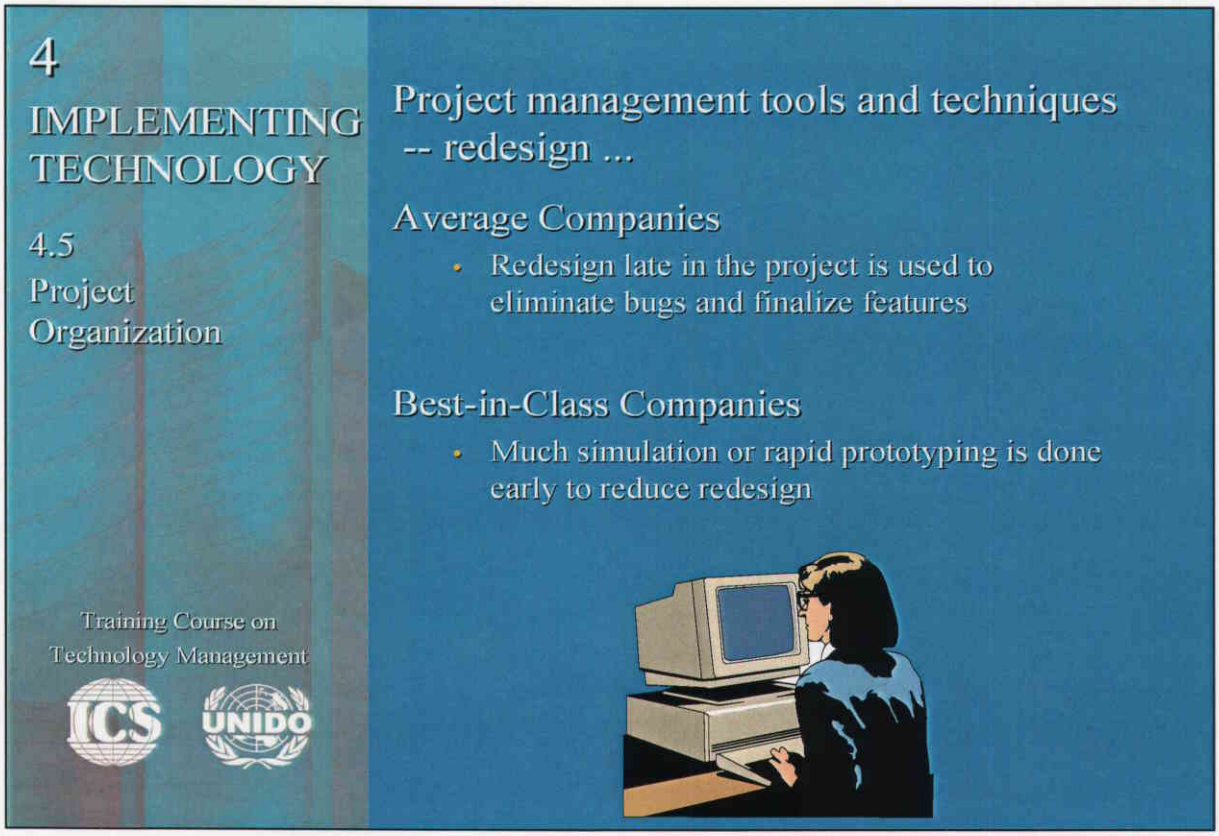



Communicating project progress to senior management in a way that they can quickly understand the project's status is critical in a technology implementation project. Those making the presentations need to be client orientated. They need to put themselves in the shoes of the company management and think about the information they would need if they were the managers or owners. They need to develop a vocabulary that describes project issues in a language that is understandable by the company's decision makers. This is especially difficult for the scientific person that uses scientific terms and acronyms with the same ease as the terms used to describe what he/she wants for breakfast. Realizing that the audience does not have the same familiarity should lead to the use of either more understandable terms or regular reminders to the audience of the meaning of some key words. Pictures and charts help immensely. Too much detail will lose the audience. Leaving out key technical details does not give them all the facts. Managers need to know what has been accomplished, what still needs to be done, what are the risks and what are the rewards. Management and project people will find their relationship strengthened if presentations focus on addressing these four areas in terms the audience can understand.



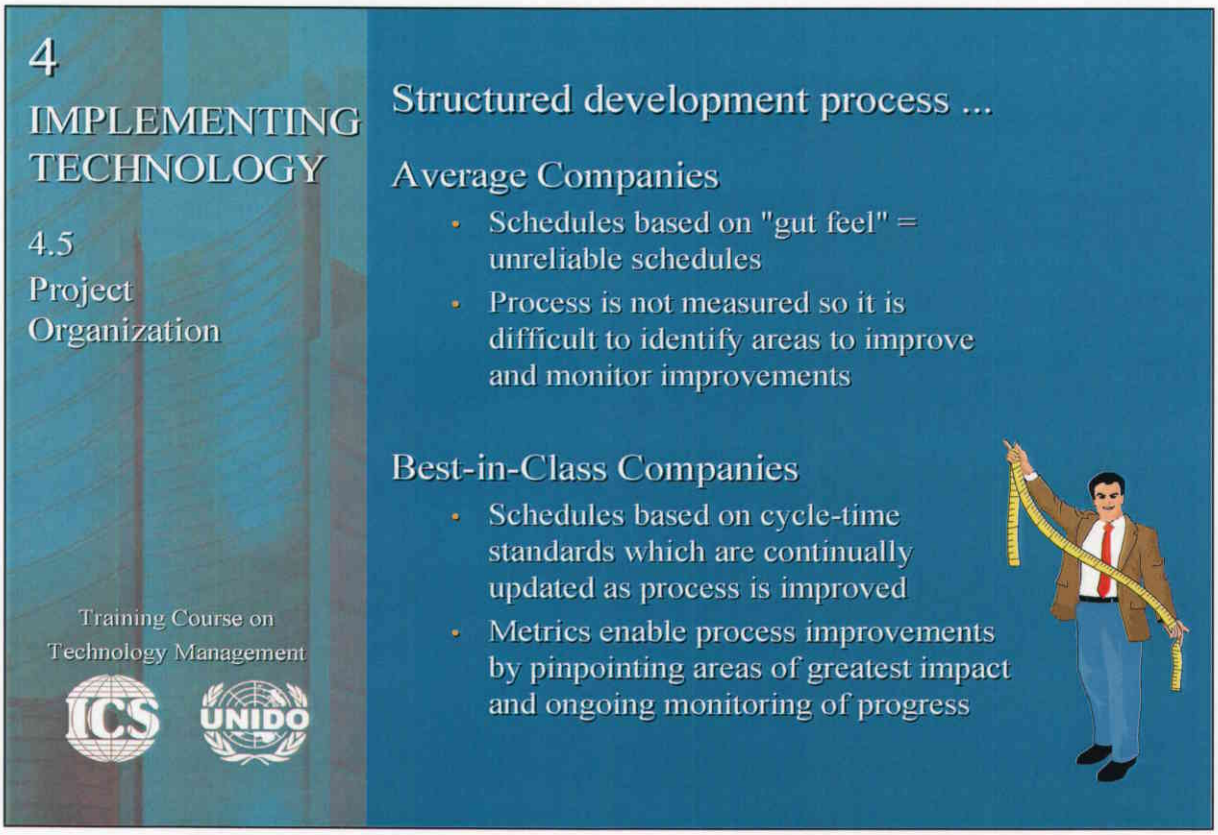

Project management can be greatly aided through the use of several tools and techniques. The stage-gate process delineates clear decision points — milestones when decisions to either continue or stop the project must be made. The process outlines what information must be developed in order for good decisions to be made at each gate. When the stage deliverables are clearly written down and communicated to the project team, management is much more likely to receive the information it needs for good decision making at the decision point. The milestone status report conveys how well the project is adhering to the planned schedule to all those involved in the project. It reports the variance between the planned and actual start and completion dates for each step conveying how much the schedule has slipped and if the rate of slippage is increasing. Schedule S-curves convey the same information graphically. Some people comprehend visual representations better than verbal, while others understand text more quickly. The expenditure S-curve illustrates the financial aspect of project progress. It shows cash flow versus time and compares it to the plan. A project that is still on its calendar schedule, may be in serious financial trouble. Company managers, the project manager, and the project team can be easily and quickly informed of the project status and make necessary adjustments with the proper use of relatively simple tools.

New project management tools are being developed every day. These are advertised in the business media and promoted through books aimed at progressive business managers. Some companies get caught up in the hype of the latest and greatest tool and put more emphasis on the tool than on what it is supposed to accomplish. The fact that they are using the latest tool is part of their attempt to portray the image of being a strong company. They add bureaucracy to meet the needs of the tool without understanding the tool and how to apply it for the company's benefit. They take on the cost of acquiring and implementing the tool without accessing the benefit. Best companies analyse the available tools with their business needs in mind. Those that fit the company and its projects and add value compared to the present practice are integrated into their project management system. Those that do not are not acquired. As a result new project management tools have a substantial positive impact on the company.



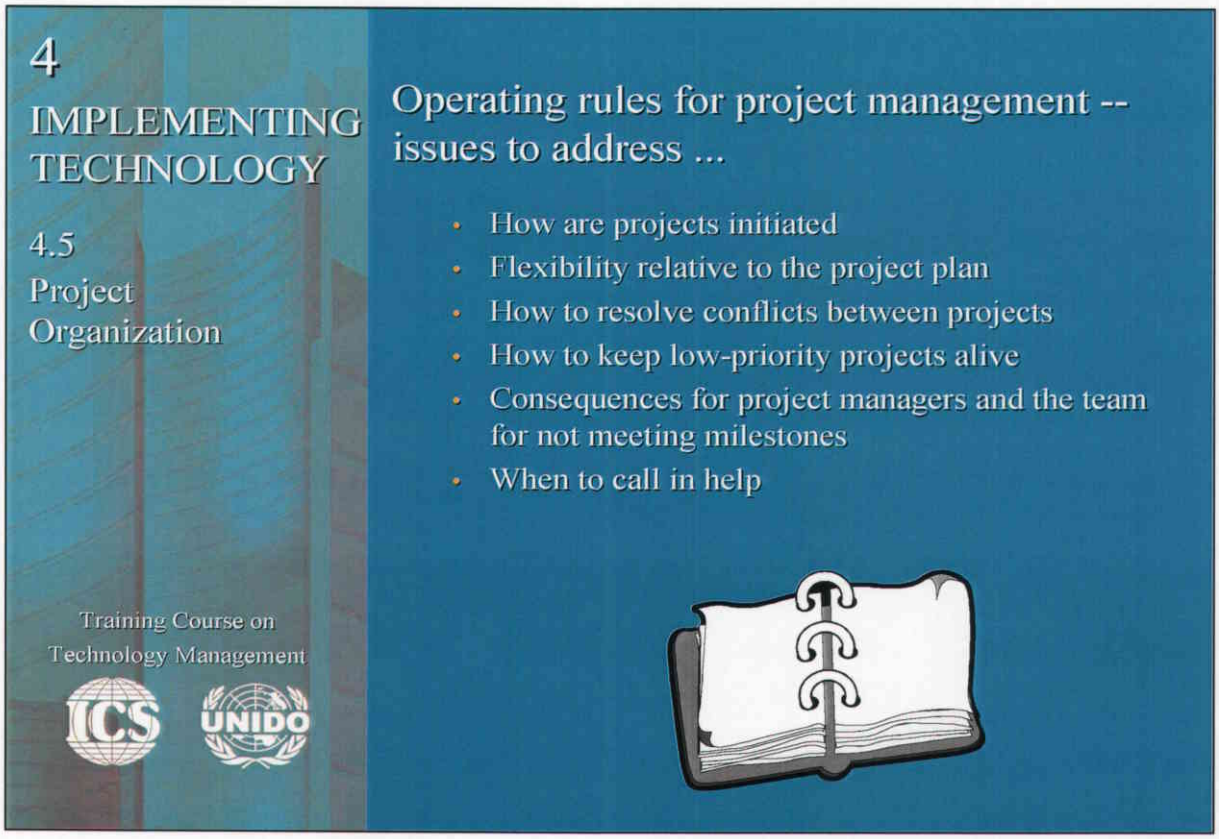

Project management can be affected by other tools that are not in themselves project management tools. For example many companies use the build-first-and-fix-later approach to technology development. This approach results in considerable design changes late in the development process which still have to be proven. This is not consistent with the principles behind the stage-gate process which is designed to reduce risks as early as possible. This approach allows unknowns to still be unaddressed even though a product is developed to the stage it is being offered to the customer. If the unknowns prove to be fatal, the cost of bringing the product to the market launch stage would be lost. The best companies use simulation tools to deal with as many of the design unknowns as possible long before the product reaches the launch stage. If these problems prove to be too difficult to solve, the project is stopped long before significant investment is made. Simulation tools include computer modeling, rapid prototyping, and good old-fashioned engineering. Many small companies incur considerable financial costs by introducing products with flaws and weaknesses that a good engineer could have eliminated through engineering design.

Once a tool has been identified as having the potential to have a positive impact on a company, the best companies implement it into all areas of the company. Less successful companies are less holistic. They allow each area to develop or acquire their own tools. Even if each area has done a good job of identifying the best tool to support its activities, the interface problems that result when information from several areas needs to be combines generally cost more to sort out than the benefits the tools deliver to each area. Finding the best overall tool that allows for integration of the company's data and easier communication among project participants is the best practice.

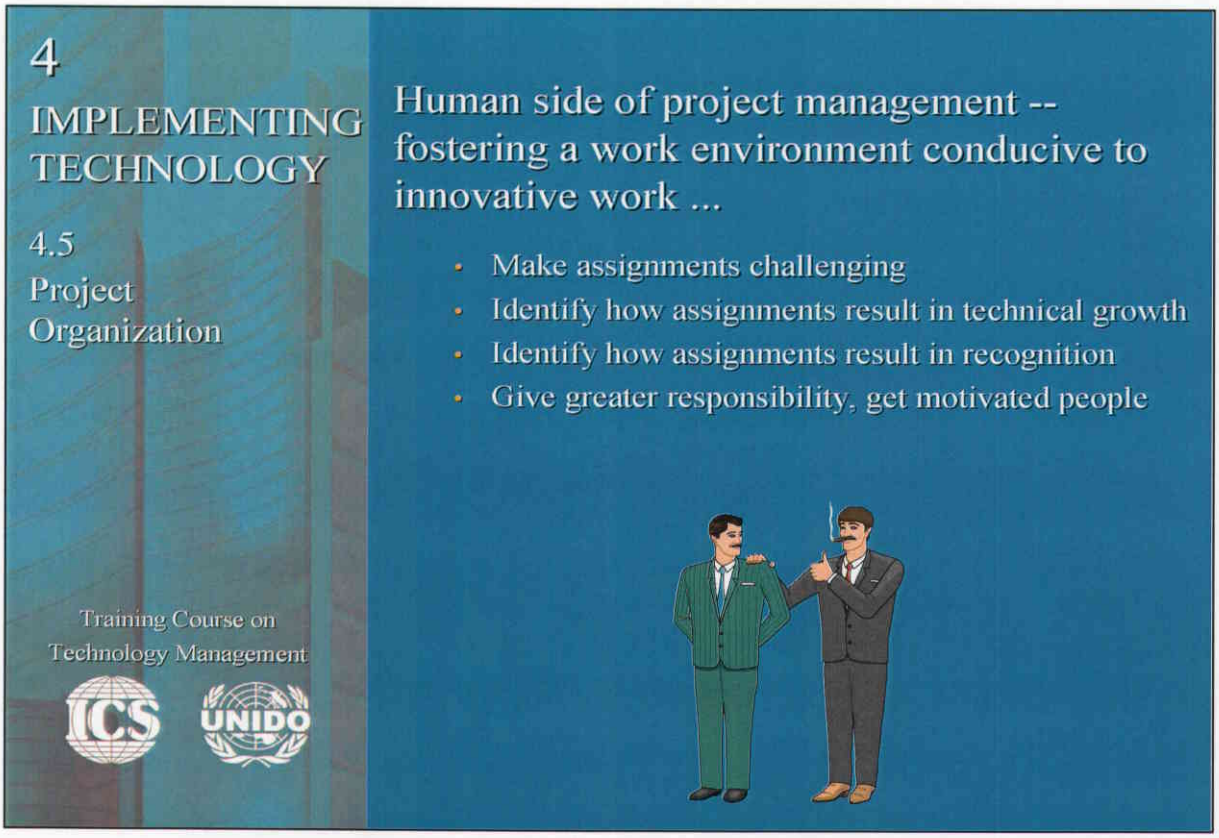



Successful companies have found that a structured process is needed to manage projects. The process is documented. It defines what information is needed for good decisions to be made. The process addresses the part each player (company management, project team, project manager, other affected people) has in the project. Since the process addresses the role of each player, it is integrated. It uses information reporting mechanisms that are easy to use (simple forms, asks for data that is within the capability of those asked to deliver, etc.). A good project management process is considered an important aid by those involved in conducting technology implementation projects, from the company president to the most junior technician. Everyone knows what is expected of him/her and by when. Companies without a structured process suffer from project time and cost overruns. It is impossible to keep a project on track when the track is not defined.

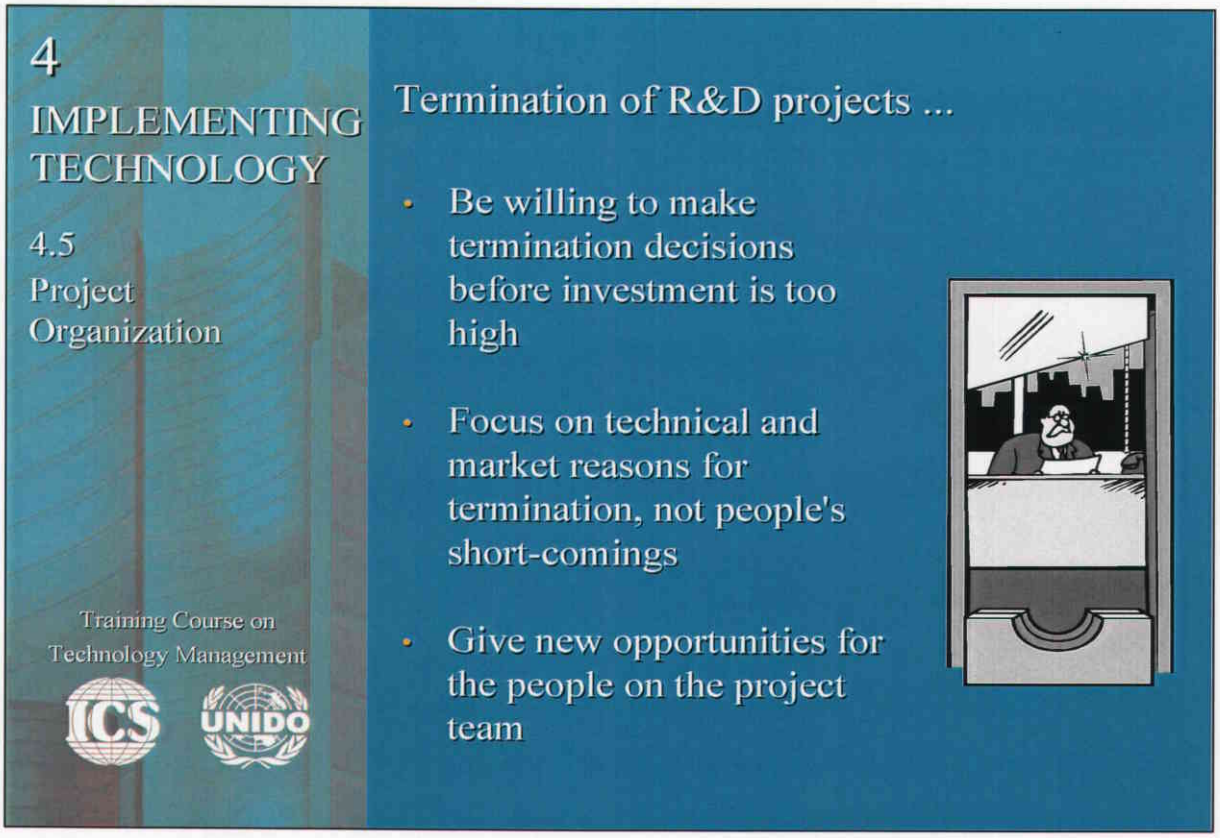
Measurements are the key to the control side of successful project management. The best companies benchmark times and costs and learn from each project. They identify areas where they can improve, introduce improvements, and measure to see if the improvements expected were realized. Changes are made in companies where measurements are not taken, and no one knows if the changes helped things or made the situation worse. When it is time to plan a second project those companies that do not measure start at square one again. Those that do measure are able to transfer knowledge gained in the first technology implementation project to the second, resulting in a better plan. The plan identifies what to measure by setting a target. The measurements report how well the project was able to achieve the target.



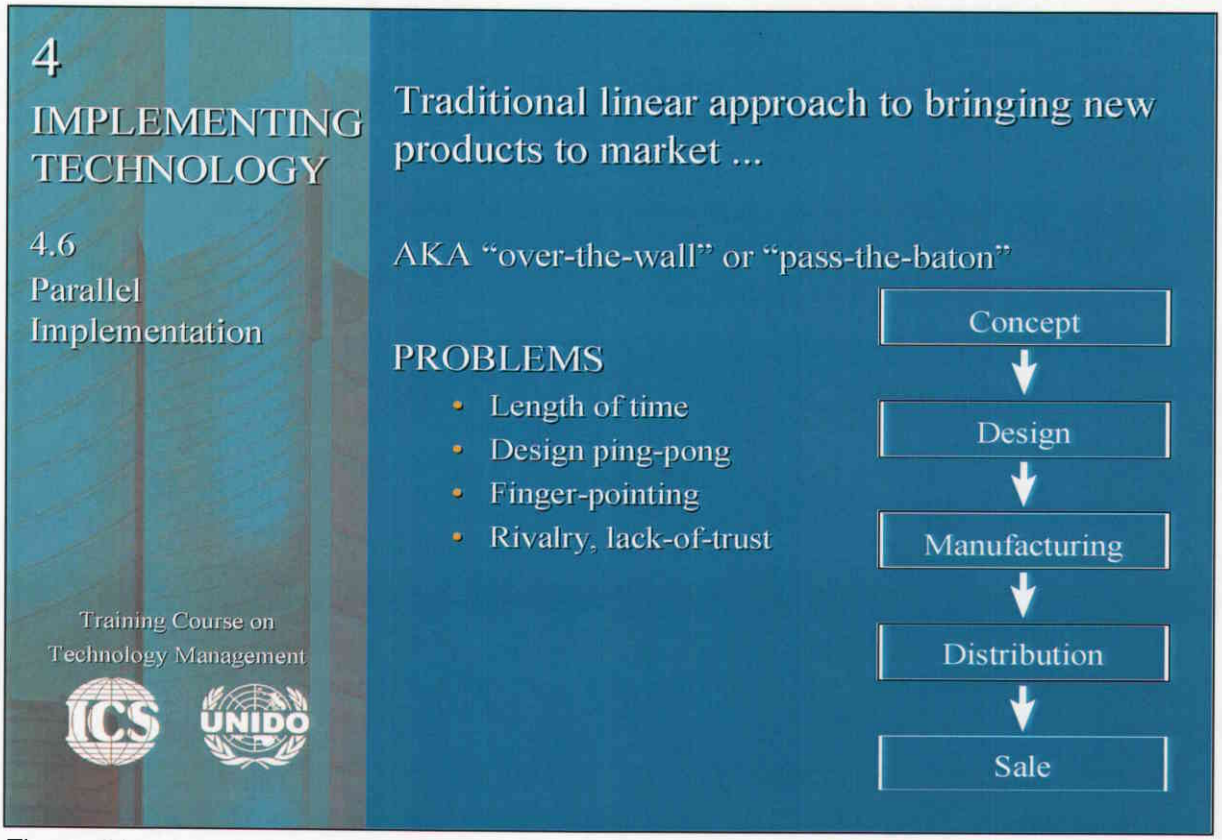

Some operating rules will help project management. The rules will keep the team from re-inventing the wheel each time an issue arises. The process for initiating a project needs to be outlined. This can be anything from a suggestion box to a project application system that accepts fully-developed proposals. The details of the system are not as important as the fact that there needs to be a system and it needs to be understood by all. Those involved in projects need to clearly understand how much flexibility they have within their projects. Even if the projects have well-developed plans, things will be discovered during the course of the project that suggest a change is necessary. The team needs to know at what point do they have to go to a higher authority to have changes approved. They also need to know that regardless of the degree of deviation from the plan, the change has to be documented so that they and others can learn from the change. The team members have to clearly understand the consequences for missing milestones or exceeding budgets. There must be consequences for failing to meet commitments. However, there should not be consequences for not being able to attain the project's technical goals. Applying consequences for not attaining technical goals will reduce the team's willingness to admit failure. Finally, the team needs rules to address when to call in help. There will be situations (technical and administrative) in which a little help at the right time would be very cost effective. A team member can flounder for days on an issue that is outside his/her expertise, which can be addressed in minutes by someone else in the organization.




Upon receiving the authority and responsibility to manage the project, the project manager must share this with the project team. Assignments must be given in a way that is challenging and rewarding for team members. They also must have the freedom to manage within the constraints of the project plan, budgets and schedules for the aspects of the project they have to manage. Knowing that they will be held accountable for assignments given them encourages stronger performance from each team member. Knowing how participation in the project will result technical growth and will provide opportunity for recognition and advancement will motivate team members even further. The project manager has primary responsibility for motivating team members by communicating this knowledge to them. He/she also needs to have primary responsibility for measuring the performance of team members and dealing with any performance problems. Those organizations that do not give project managers control over the performance management of team members, significantly restrict their ability to manage the people that together with the manager are responsible for delivering the project.



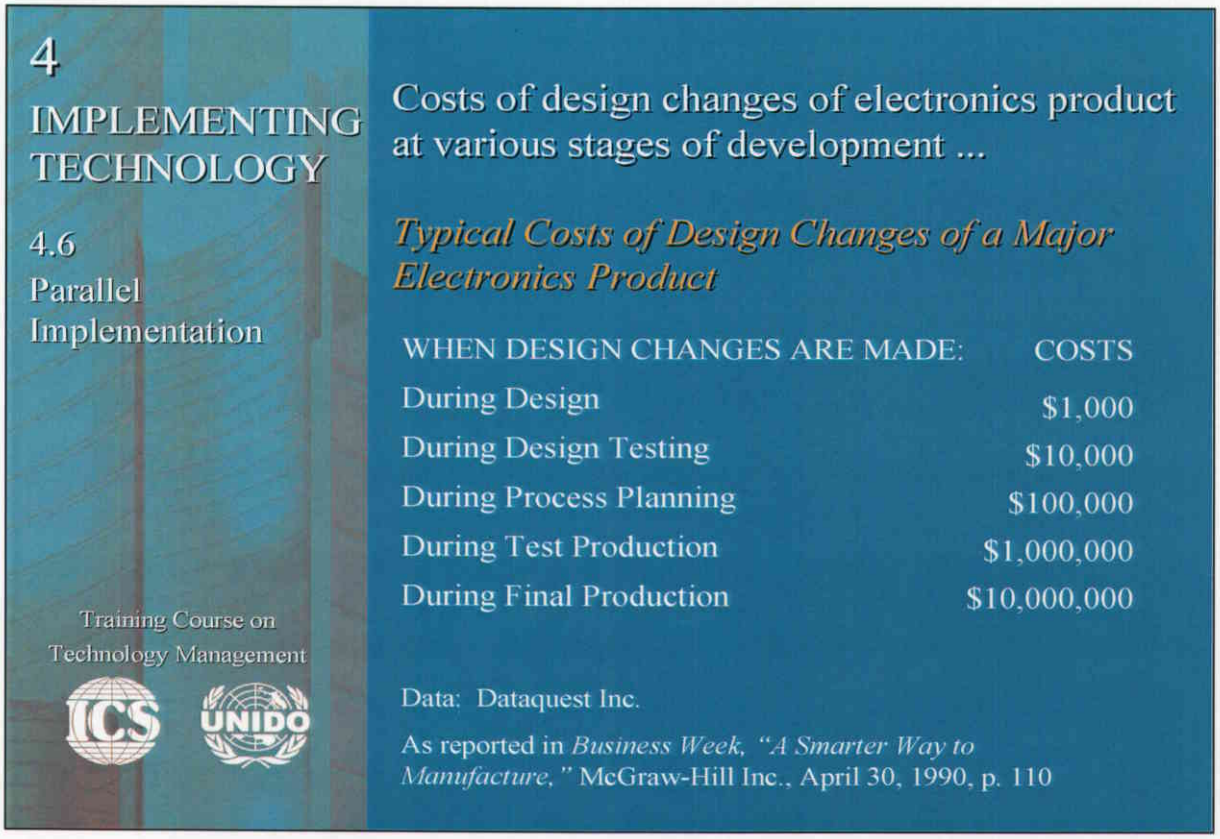

Companies must be willing to terminate failing projects. The sooner that the project team can conclude that termination in required the better off the company will be. However, project termination must be handled very carefully. The reasons for termination should never be based on personalities. They must be business decisions such as: the technology was not as well developed as expected or the market is not willing to pay the price the company would have to charge for the froduct. Care must be taken to communicate that the failure of the project was not a failure of the people. People naturally equate their personal success with what they accomplish. It is very easy for people to conclude that the project failed because they failed. Management needs to reward project teams that recommend project termination as well as they reward those with a project success. The company also needs to provide new opportunities for the people involved in a terminated project. Any positive impact from rewarding project termination would quickly be undone if those in the terminated project lost their jobs.




The traditional approach to technology development is linear. The idea is conceived by marketing or as a result of technological breakthrough. Then it is passed on to a product development group that develop it to the point that it can be made. Then the manufacturing department takes over, creating tooling and adjusting the product design so that it is easier to manufacture. Then the product is passed on to distribution that develops a distribution methodology appropriate for the product. Finally sales gets responsibility for the product, developing and implementing a sales strategy. This process is sometimes called pass-the-baton because the responsibility moves from group to group the same way the baton is passed from runner to runner in a relay race.

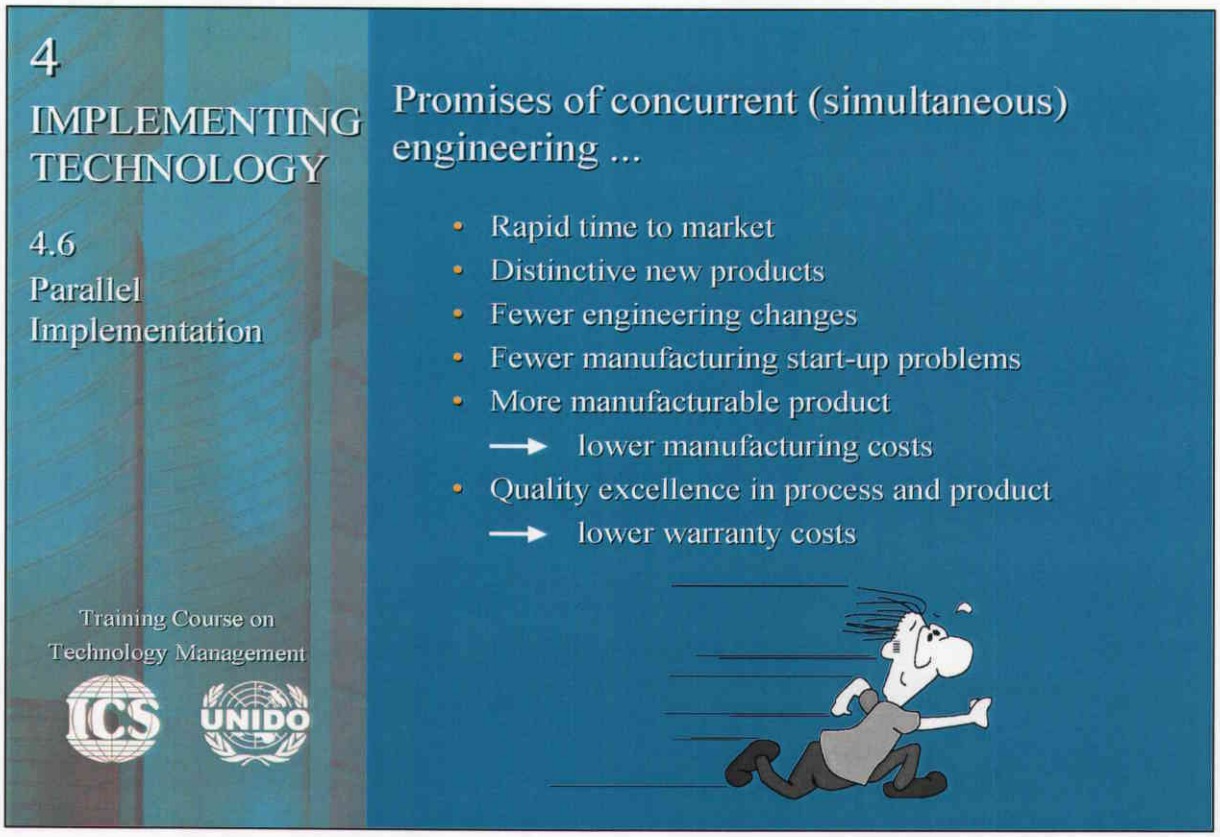
The traditional approach is also known as (AKA) over-the-wall because of one of its problems. The analogy of throwing the product over the wall from one department to the next illustrates one of its basic flaws. The wall prevents communication between the groups. Once the idea is conceived it is thrown over the wall from marketing to development. Once development is finished with it throws it over the wall to manufacturing. And so on. Each group that receives it complains about what the previous group or groups have done. Development says the idea could never work as it was originally conceived. They "improved" it by developing something that could work, but gave up some features that marketing had consider most important. Manufacturing, after receiving the product over the wall from development says the product as designed could never be built. They "improve" it again to make it easier to manufacture while giving up a few more features and introducing an engineering weakness. Distribution, not knowing how marketing intended to sell the product, creates a system that has worked for other products but is not appropriate for this one. Finally sales, puts a sales system in place that is not effective for the type of product.

The result is a less-desirable product that does not reach the customer in the best way and that takes a long time to develop. In addition, relations among the various groups involved in the process are strained to the breaking point as they each blame the others for problems that arise.

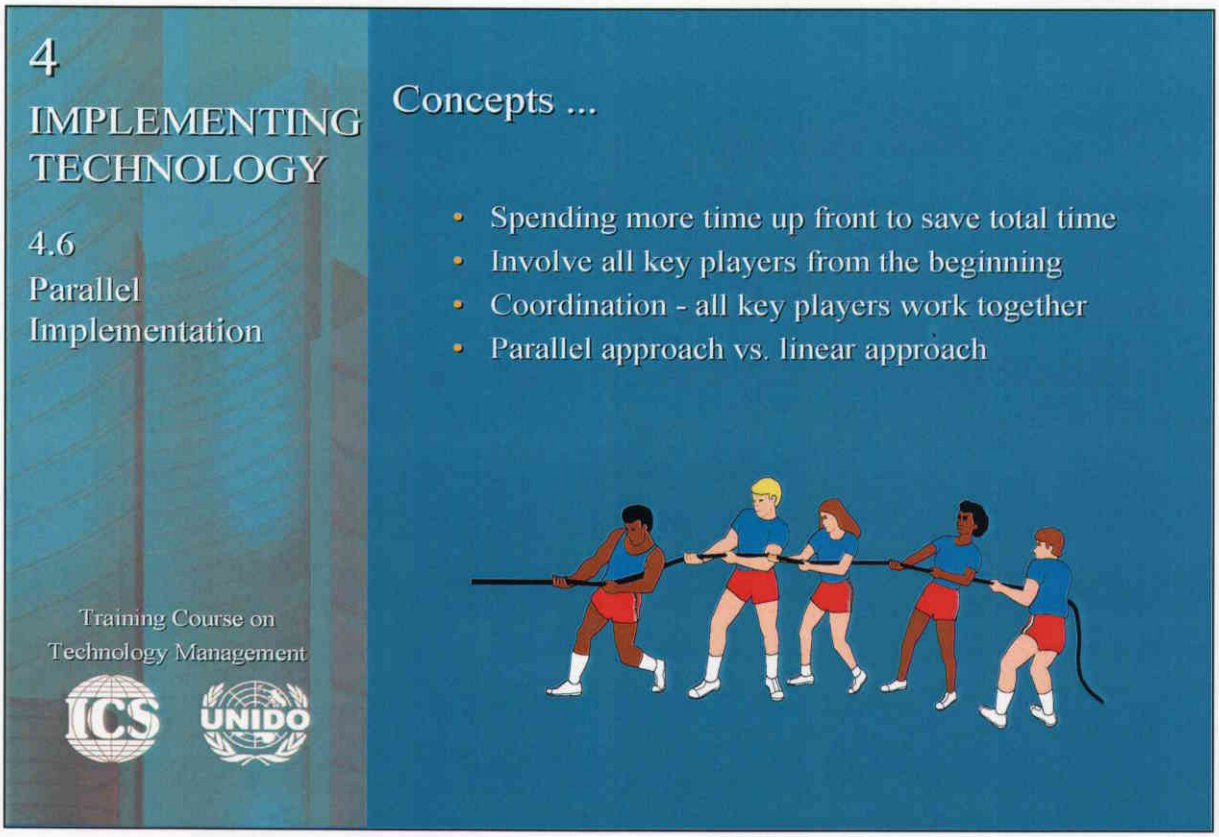



Removing the walls between departments would greatly improve the result. If each group in this chain communicated their ideas and reasons for design choices that were made, the final product would probably not lose as many features or appear on the market with engineering weakness or using the wrong distribution channels. However removing the walls only fixes part of the weakness of the linear approach. A big weakness is the length of time it takes for the entire process to be completed. Even if each group does its part of the job perfectly well, the time from idea to product on the market is measured in years. Unfortunately, it never goes that smoothly. Manufacturing will discover a engineering weakness that results in rejects coming off the assembly line so it throws the product back over the wall to development for redesign. This not only significantly increases the time to market, it also causes hard feelings between groups as they blame each other for the problem.

Another problem with the linear approach is the cost. First there is the cost of design changes. If problems are discovered while the product is still in development, a design change leads to some costs, but since most of the systems needed to bring the product to market have not been developed the cost is relatively small. If it is discovered after production drawings have been made and tooling has been built the costs are considerably more because the drawings have to be changed and the tooling redesigned and rebuilt. If the change has to be made after the product is on the market, changes not only include drawings and tooling, they include changes to repair manuals, promotion information and the cost of either replacing or retrofitting the product that has been made with the design flaw. The cost of design changes in the electronics industry increases by a factor of 10 for each stage in the development. A change discovered at the testing stage costs 10 times more than discovering it while the product was still being designed. Changes made as a result of discovering the need when the product was in final production costs 10,000 more than finding it during the design stage. A change that costs $1,000 to make at the design stage will cost $10 million if made when the product is in final production. This is because major costs of bringing a product to market have not yet been incurred.



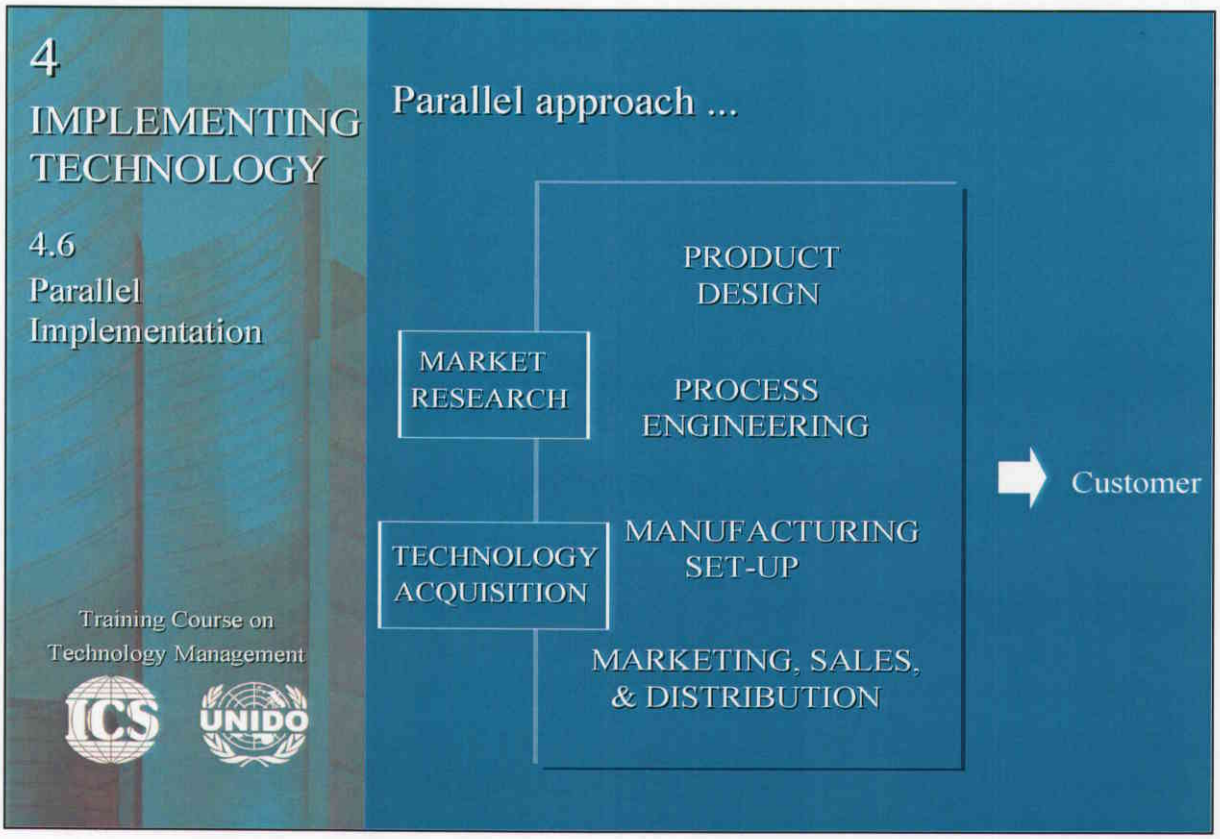

Parallel implementation (concurrent engineering in the case of new product development) addresses the shortcoming of the "over-the-wall" approach to technology implementation. The benefits are staggering. From reduced time to market to higher quality. From unique products to increased sales. From improved white-collar productivity to increased return on investment in assets. Parallel implementation positively impacts every area of the business. The results are so impressive, the question "Why doesn't every one do it?" needs to be asked. While the answer is partly ignorance (company managers do not realize the potential), it is mainly resistance to change. Companies need to take a serious look at how their present processes are structured and assess if they are the most appropriate for their company to be able to compete in this age.




At first glance this appears rather unbelievable. How can you design the manufacturing process for a product that has not yet been developed? The answer lies in the underlying concepts of concurrent engineering. First, more effort is invested before the product development process is begun. This means that several iterations of the market assessment and the initial technology investigation activities are done rapidly and thoroughly. This process clarifies and solidifies the product concept and establishes market size and production rates. It also identifies technological problems that will either kill the project or have to be solved quickly and well if the product is to even advance to the development stage.

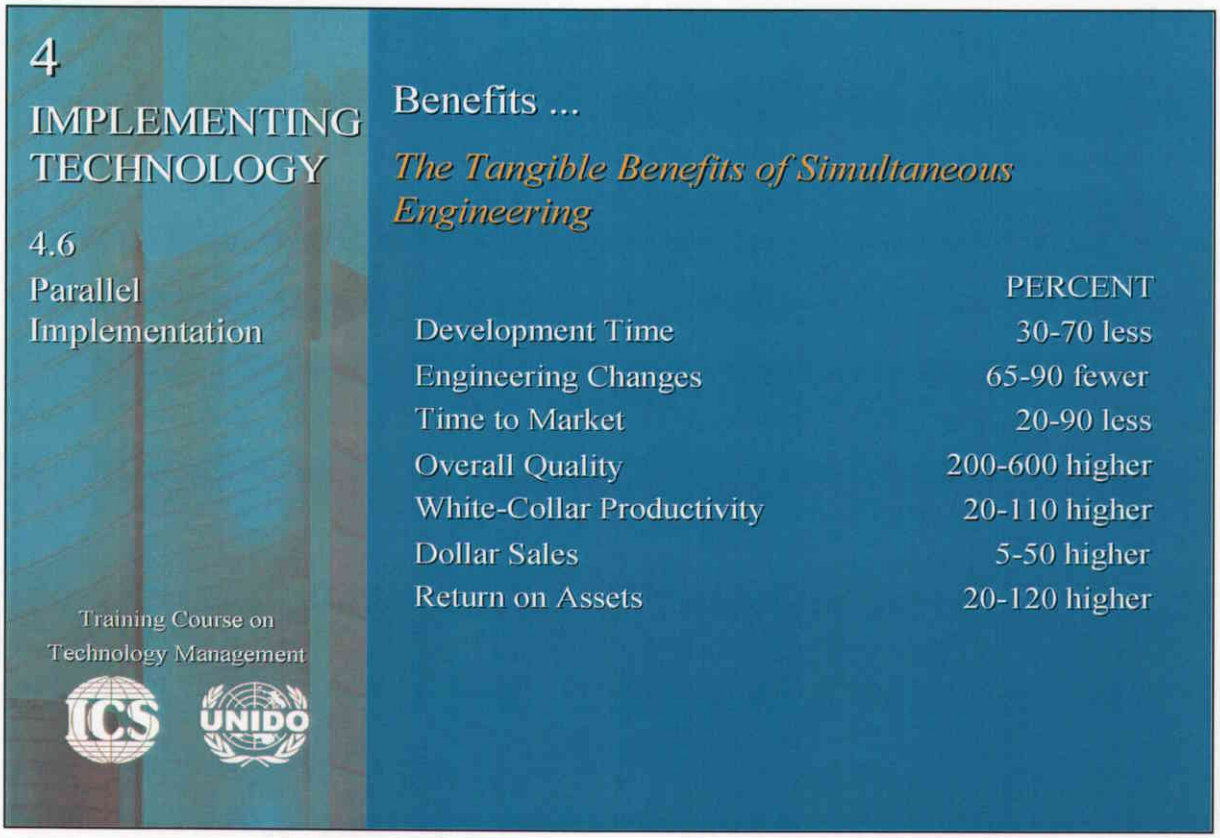
The second concept is that all key players work together from the beginning. This almost unheard of aspect of the traditional approach happens almost automatically. When confronted with having to design a manufacturing process for a product that is only a concept, those responsible talk to the product designers to at least understand what they are thinking. The process people react to the designers' ideas by identifying those things that are being considered but would be difficult to build before they are even on paper. The designers respond to the process person's observation with an alternative that still meets the product concept design goals and addresses the manufacturing issue raised by the process design person. This interaction also happens with the key people involved in manufacturing, marketing, sales and distribution. Ideas are shared, critiqued, modified and refined until a product design emerges that is the best compromise among the often-conflicting demands of the various aspects of bringing a new product to market.

The third concept is that of coordination. Although involvement of all the players happens at the beginning out of necessity, it can stop once the groups begin to be comfortable with their understanding of the product concept. Actively coordinating the activities of the groups keeps the interaction continuing throughout the project. It also makes it possible to adjust resources so the output from each group is timed to be completed simultaneously.



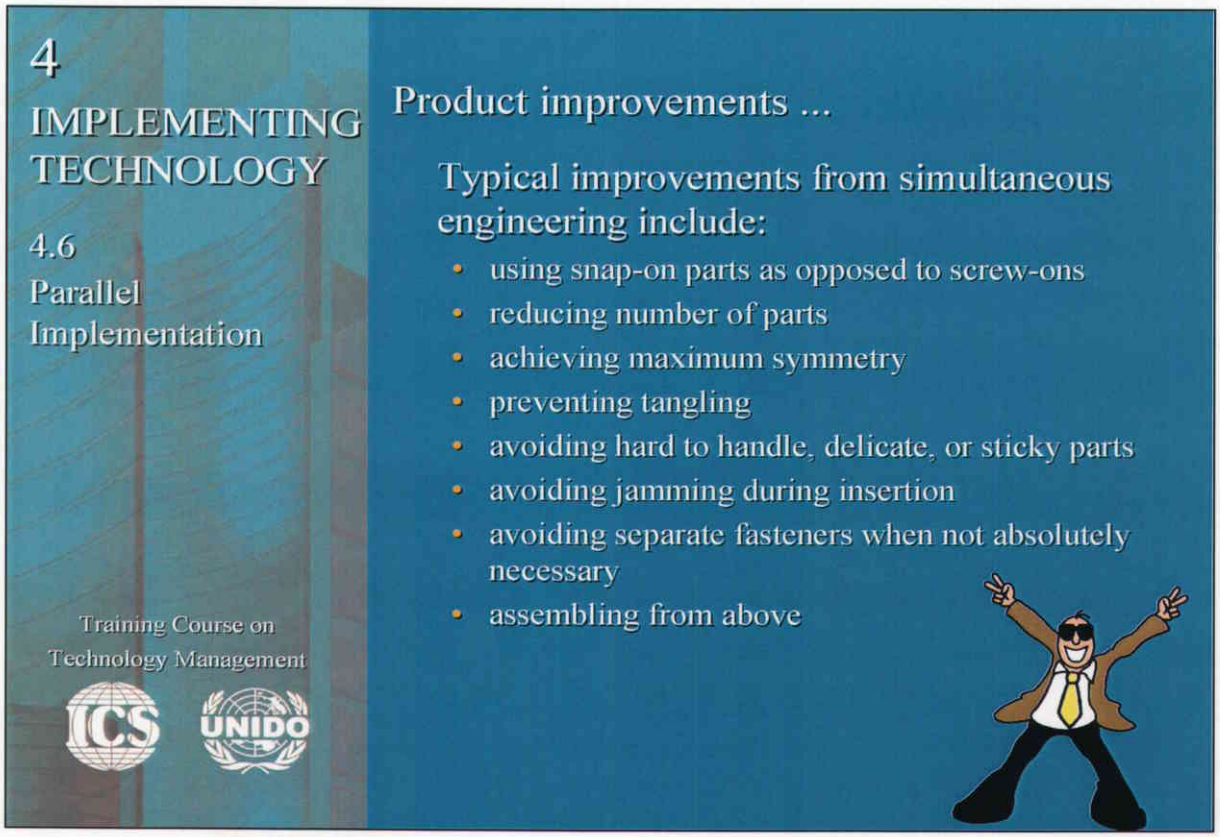

Parallel implementation (also known as concurrent engineering and simultaneous engineering) promises to address the problems of the traditional approach. The basic principle is that a number of the development stages are done in parallel (concurrently or simultaneously). Once the market investigation and/or technology acquisition is completed far enough that the product concept can be conceived, the development aspects of the product development process are begun in parallel. The engineers begin designing the product, the process development people begin the design of the manufacturing process. Manufacturing begins preparing the facilities where the product will be manufactured. Marketing, sales and distribution begin to design the sales and distribution systems.

The final concurrent engineering concept is the actual parallel implementation of development in each area. The product design, process design, manufacturing facility development and sales/distribution system development all happen in parallel. Each development activity relies on the other ones to provide constraints and inputs to their own part. Parallel implementation saves time because so many activities that used to be consecutive have become simultaneous. However, the aspect of the process that leads to the involvement in each other's development process results in many more benefits far exceeding that of the time saving alone.




Parallel implementation promises many benefits. Reducing the time to market is the first and most obvious reason why companies consider concurrent engineering. Companies using CE have measured development times 30% to 70% less than the traditional approach. These companies also reported 65% to 90% fewer engineering changes representing an overall time to market of 20% to 90% less. The reduction in time to market was due to doing the development simultaneously rather than consecutively. The reduction in engineering changes was due to interaction that resulted in design changes at the idea stage, long before the product reached the stage of development that formal engineering changes were required to redo the design.

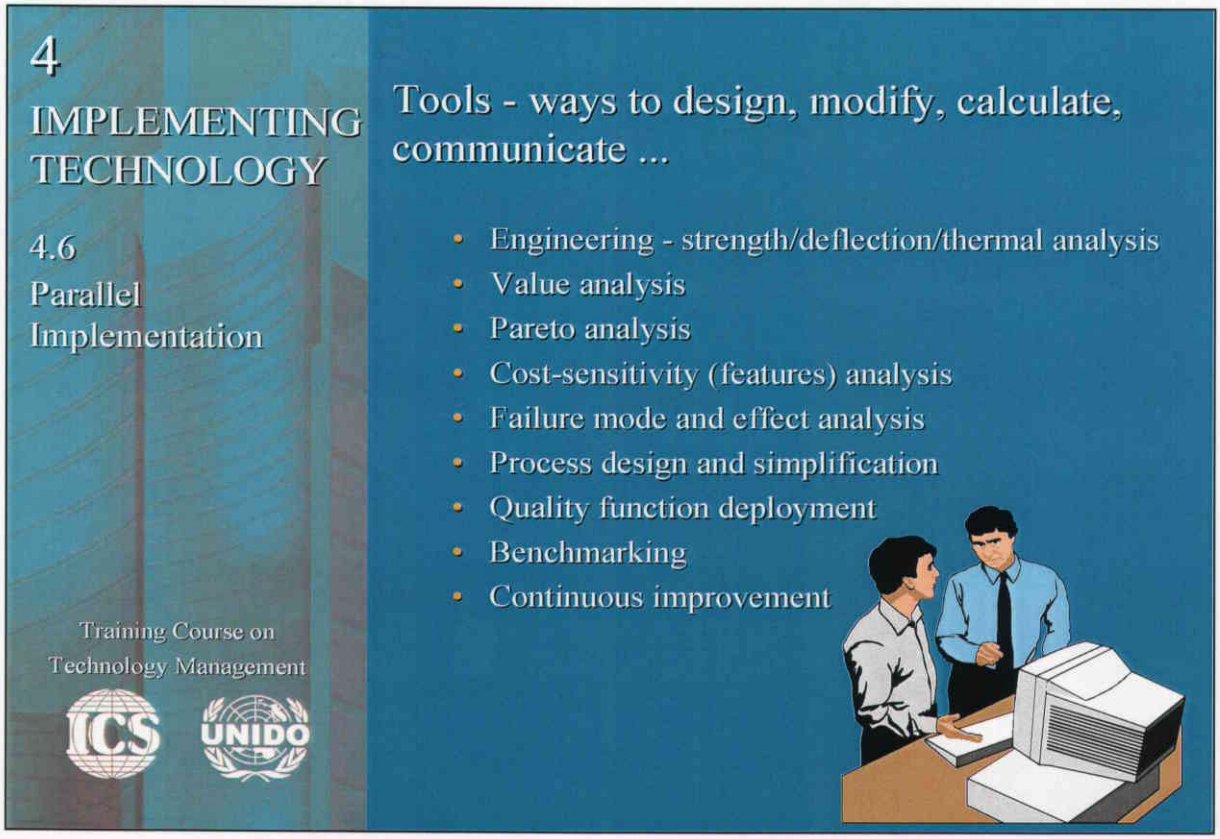
The products resulting from the process were distinctive, unique and more appealing to the customer. This is the result of the involvement of marketing in the entire process. All the features originally identified by marketing as necessary were not designed out because they were difficult to design or manufacture. Features that were demonstrated to be important to the customer were maintained unless it was physically impossible to do so. When a planned feature had to be discarded because it proved to be too difficult, the concept was retested without the feature to be sure the product still had sufficient market in the modified form. Fewer manufacturing problems were encountered because the design was developed from the start in a way that accounted for manufacturing's capabilities. The more manufacturable product reduced production costs due to faster throughput and less problems. The interaction between marketing, design, and manufacturing resulted in a higher quality product that had lower warranty costs. Overall quality was reported to be from 200% to 600% better. Sales increased between 5% and 50% and return on assets were increased between 20% to 120%.



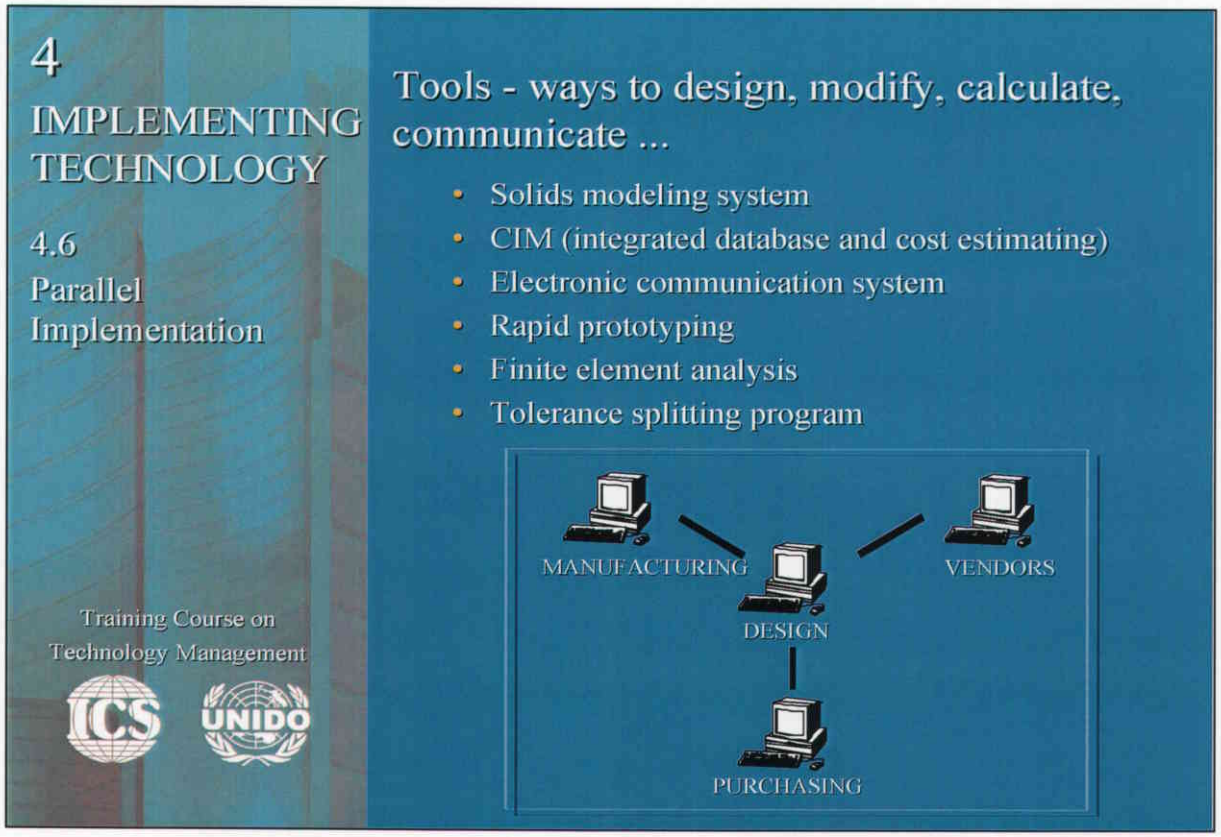

Concurrent engineering has led to many product improvements that have either benefited the customer by giving better performance or helped the manufacturer through reducing the manufacturing cost. CE has lead to snap-on parts that reduce assembly costs compared to screw-on. It has reduced the total number of parts in the product. This has major ramifications from less parts to make and assemble, to less inventory and parts to maintain in the future. CE has increased symmetry which reduces mold costs because the same mold can make parts for each side and, for the same reason, reduces the number of replacement parts that need to be kept. Product design improvements have greatly reduced process problems. Tangling has been prevented, hard to handle parts avoided, and those that jam during insertion eliminated. Fasteners not needed have been eliminated and new, more effective ways of assembling have been introduced. This is all the result of interaction between the product design team and those that have to live with the results of the design process in the future. Knowing what the product needs to succeed in the market and then designing it with the understanding of what makes it difficult or easy to produce has a tremendous impact on the result.


There are a number of tools that are available that make parallel implementation possible. Most of these were developed independent of CE, but when considered in the context of CE, and used together with CE, enable the kinds of gains that CE has delivered. These tools will be discussed in three sets. The first group is a collection of industrial engineering approaches often used by process development. Each has merit on its own, but when used in parallel by an interacting team, they have a massive synergistic effect. The second group is similar, with the only difference being that these are tools are more often used by design and development personnel. These have also been used for years independently, with the CE approach bringing their value to the forefront. The third group have come onto the design and development scene more recently, being the product of the explosion of computer technology.

For years industrial engineers have advocated that a collection of "design fors" be used to make life easier in the manufacturing plant. Design fors include design for manufacturability, assembly, testability, reliability, and maintainability. These are a list of very logical things to do to result in a better, easier to make product. They also just happen to represent the core of the benefits of parallel implementation. If the product designer considers the needs of the people and processes involved in manufacturing, assembly, testing, and the user (reliability and maintainability), the product will be much better than the over-the-wall approach. If the experts from these various areas of the company are forced to interact with the designer as the design unfolds because they are trying to develop their processes at the same time, the resulting product will be better yet. A matrix diagram of the product's parts and features will help the multifunctional group keep track of aspects that have been addressed (correlated), those that have yet to be addressed, and those parts or aspects that were eliminated through the CE process. Finally, process development must develop a master schedule for manufacturing the product. Critical path scheduling identifies the optimum order in which the parts have to be made. The parts on the critical path must be made on machines that will reliably deliver them when they are needed. Those not on the critical path have more flexibility.

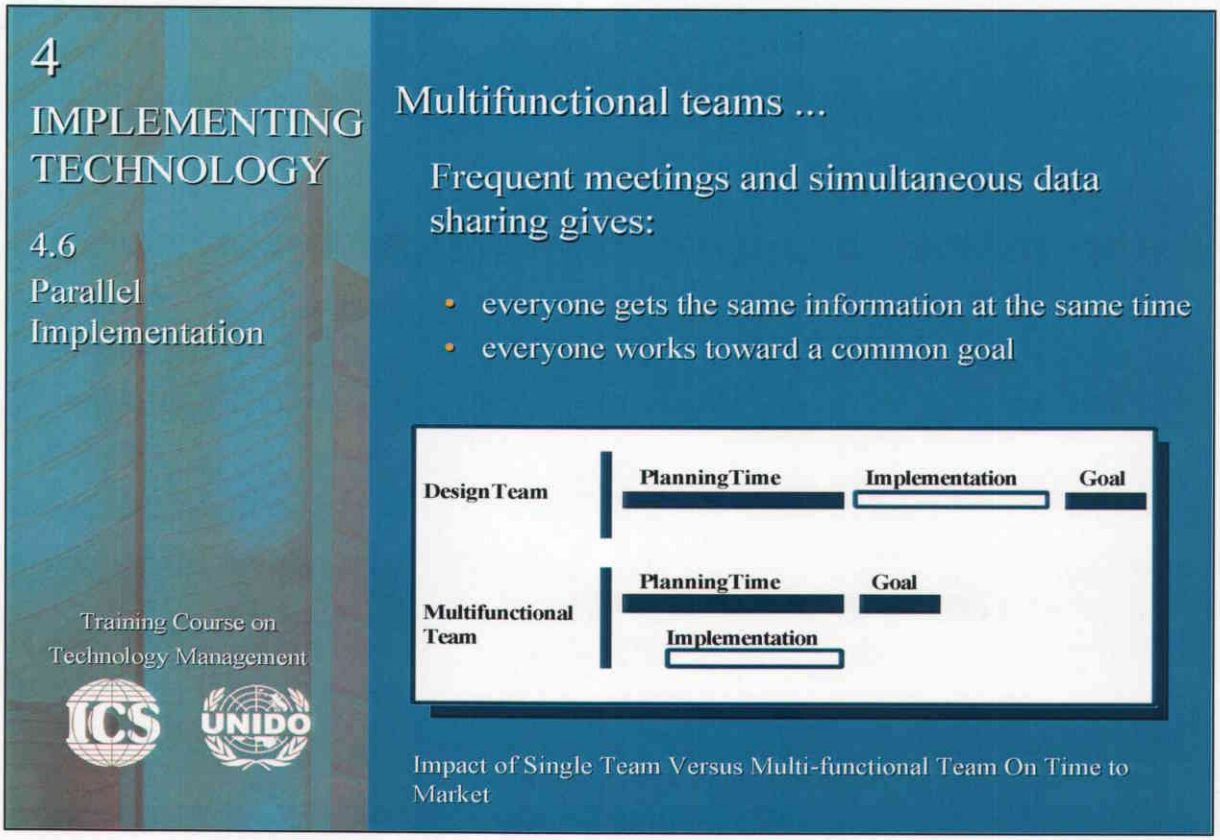



The next set of basic engineering tools has also existed for years. Product developers that use basic engineering calculations such as strength (load capacity), deflection, impact of thermal changes, fatigue, etc. can significantly reduce the number of prototype iterations required to bring the product to the final stage. Engineering enables prediction of product performance under a variety of conditions. It is amazing how many small companies do not take advantage of this very old profession. Many do not have engineers because they have never worked with one, or have had a bad experience with a poor one, and therefore do not know what engineers can do for them. Engineers are considered glorified draftsmen. There are a collection of analysis tools that engineers have used for years that can aid CE. They are: value analysis (putting a value on each part of the product and attempting to eliminate those parts that contribute little value to the customer), Pareto analysis (80% of the problems come from 20% of the parts, 80% of the value comes from 20% of the cost), cost-sensitivity analysis (which features affect the cost most significantly versus how necessary they are), and failure mode analysis (engineering calculations that demonstrate which conditions will cause failure and what that failure consists of). Other tools that overlap into the process development include: process design and simplification, quality function deployment, benchmarking, and continuous improvement. The use of these tools in a multifunctional context improves their individual impact and makes it possible to develop the product and the processes necessary for its manufacture and sale simultaneously.

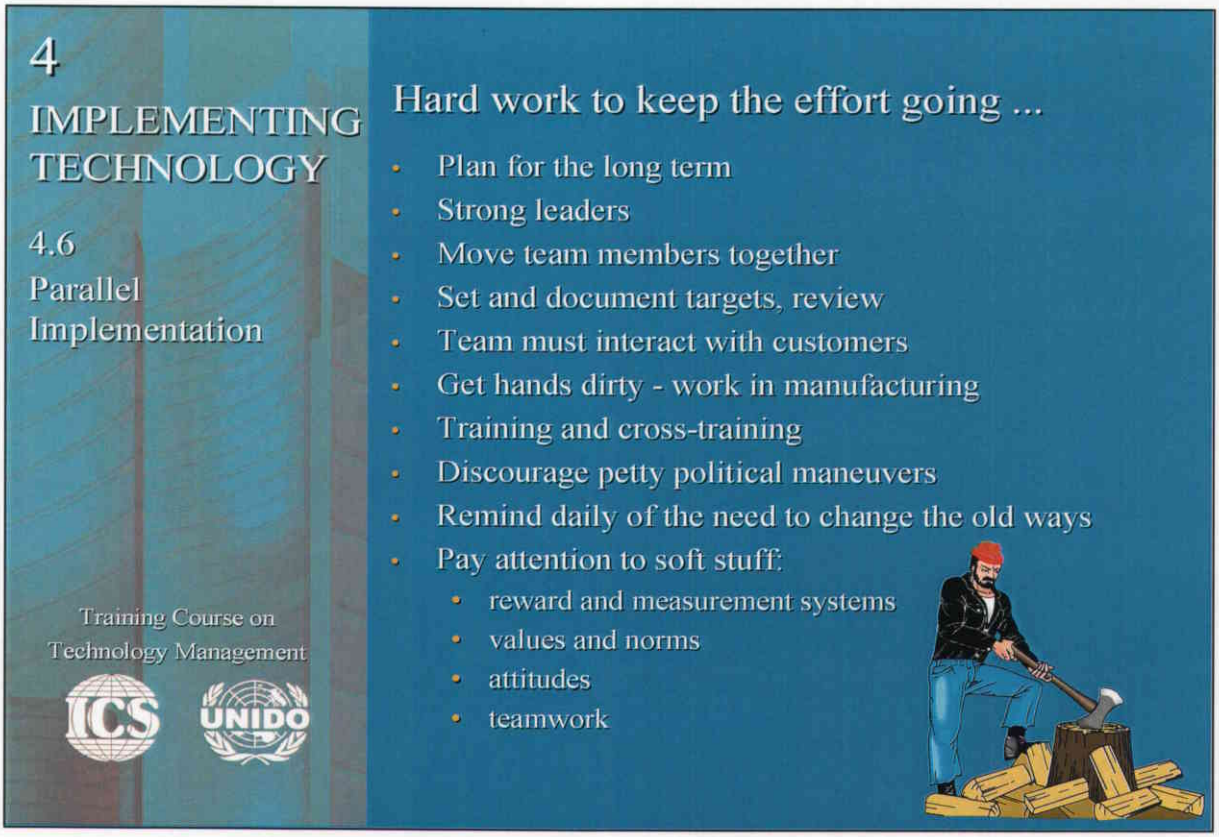



The final set of tools to be discussed in this section are computer based. The phenomenal growth in computer capability and associated cost reductions in recent years has made it possible for small companies to access these tools. Solids modelling enables accurate visualization of the product for market development purposes as well as identifying interference problems and conducting engineering calculations such as center of gravity on irregularly shaped parts. Finite element analysis conducts further engineering calculations (strength, deflection, thermal effects) much faster and to a higher degree of accuracy than can be done by hand. Rapid prototyping produces a plastic version of the product quickly to further help with visualization. CIM (computer integrated manufacturing) and electronic communication systems enable all to be working from the same information. Computer databases enable storing of existing part information which reduces the time involved in estimating costs. Tolerance splitting programs calculate stock allowances and their tolerances.

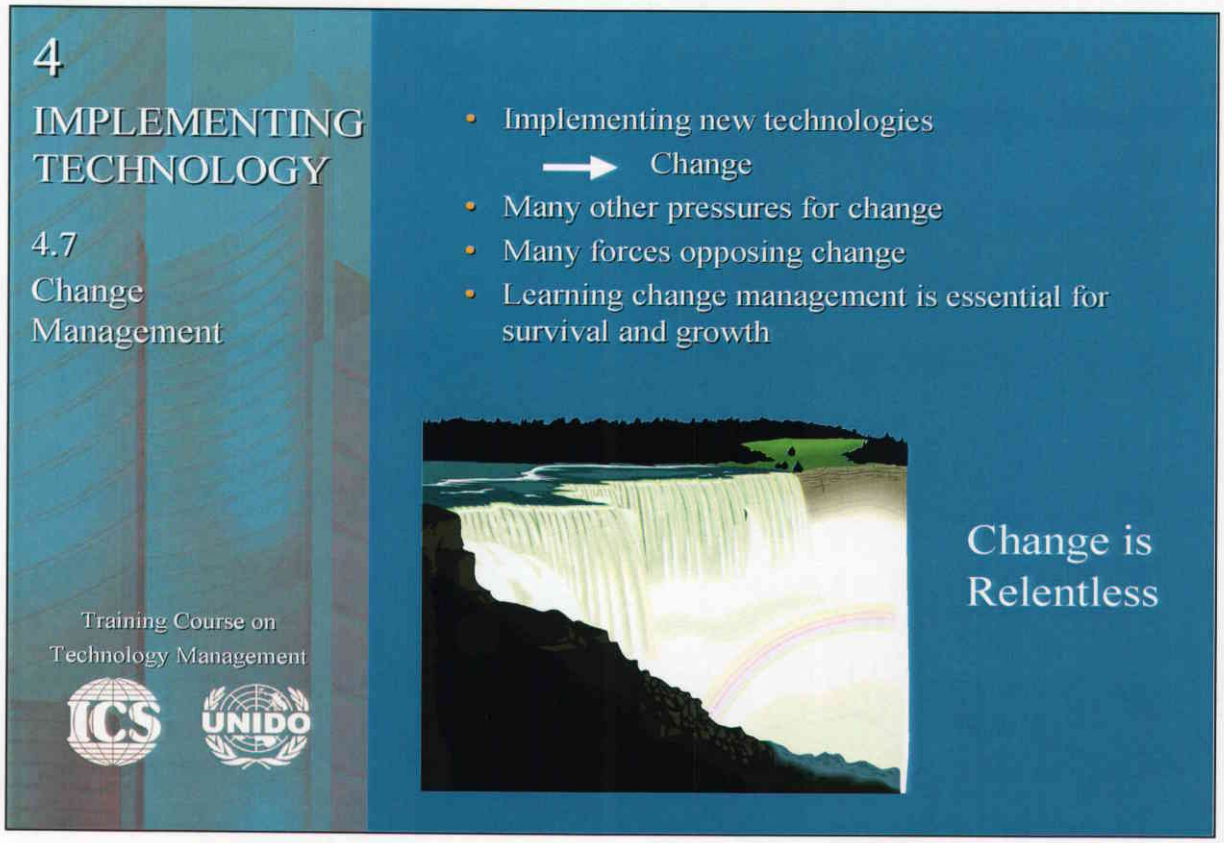

The term multifunctional has been in common use for a number of years. It has been recognized that bringing a variety of expertise together onto a product design team produces better results. Having the electronics, plastics, and mechanical people designing together produces a product that is better integrated. Parallel implementation has carried this concept further. The team includes experts from all areas of the company (design, testing, manufacturing, purchasing, marketing, sales, etc.) as well as some outsiders such as vendors and customers. Each contributes to the design or technology implementation, working toward a common goal. Each learns from the others. They each return from team meetings to their own area to work on their aspect of the parallel implementation with a full knowledge of the project's status and what everyone in the project requires for their component to work well.



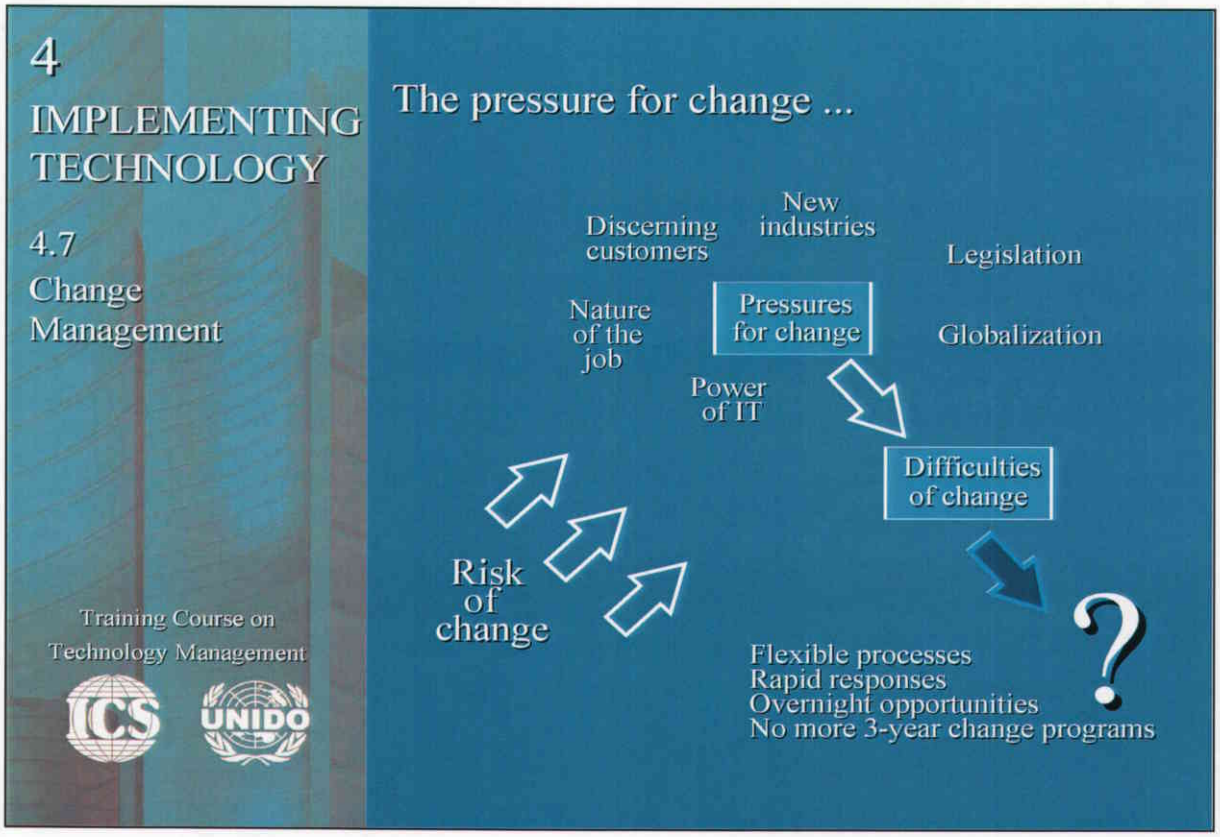

The key to parallel implementation success is frequent meetings and simultaneous data sharing. Everyone is updated regularly and frequently. Everyone gets the same information at the same time. Everyone works toward a common goal. One result is that the time to market is reduced because the planning and implementation happen in parallel rather than concurrently. Another is that everyone's constraints are considered by everyone. The product hits the production line with far fewer start-up problems and it meets the needs of the market niche that it was intended to serve. The same is true for implementation of developed technology projects. Because everyone's constraint has been considered, the technology successfully delivers as expected from the moment the switch is turned on.




Parallel implementation is not easy to keep going. It requires strong leaders committed to the concept. Turf battles and petty interdepartmental issues must cease. Change is the norm and leaders have to work daily to keep the enthusiasm for change and the new way alive. Some helpful hints include moving teams close together to encourage informal interaction, creating situations where team members interact with customers, and having design personnel spend time in manufacturing. Interacting with customers helps the designers see things from the customer's perspective. Getting his hands dirty in the shop helps him be more cognizant of the concerns of the shop floor personnel. Parallel implementation needs constant attention to the soft stuff. Reward and measurement systems must reward and measure the right things. Company values and the norms expected of company employees have to be communicated and recommunicated. The company and its employees have to realize that peoples' attitudes are as important as their technical skills. In fact there are those who believe that it is easier to teach new technical skills to someone with the right attitude than it is to successfully use someone with strong technical skills and some attitude problems. Teamwork is central to parallel implementation and if a person is not a team player he/she hurts the entire team.

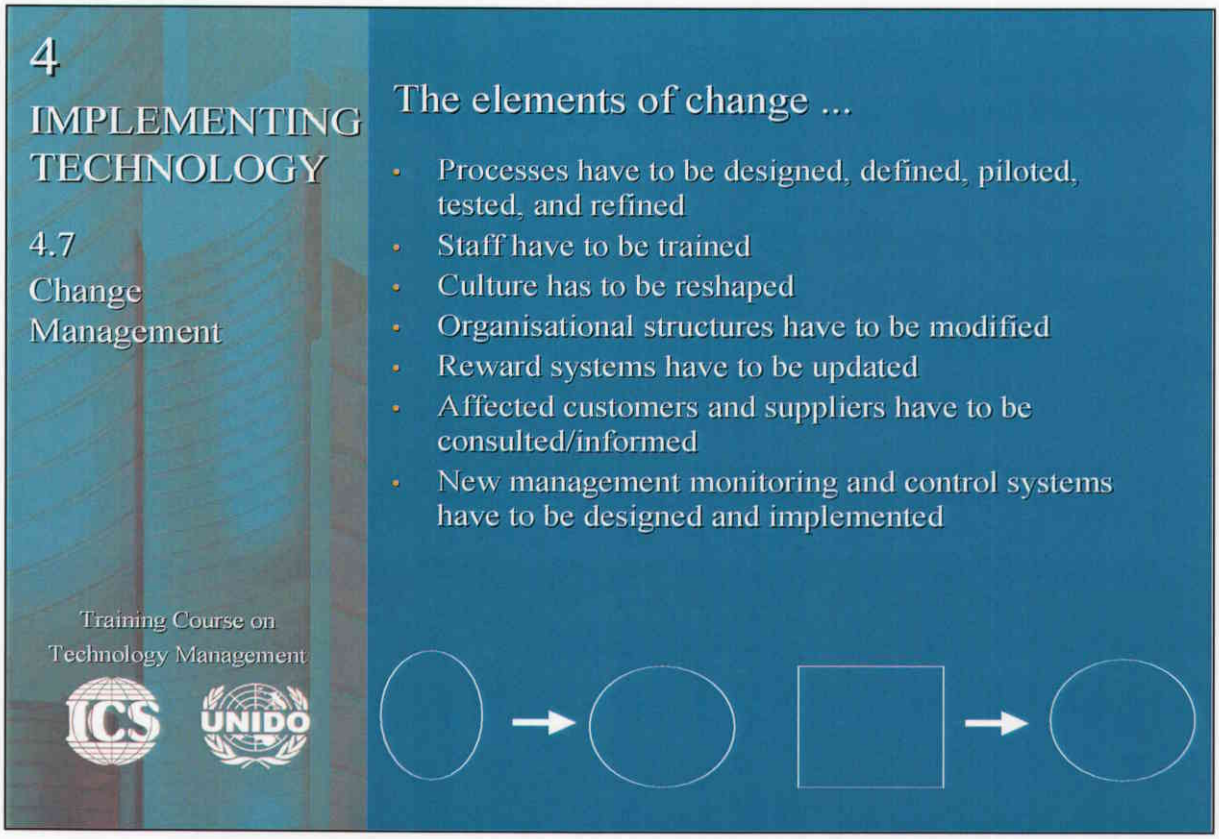



Change is a very real component of technology management. New technologies are needed because of the relentless pressure for change being imposed on the company by external forces that the company cannot control. The process of implementing new technology is, in itself, the introduction of significant change into the company. This exposes the many resistances to change that reside within the company. As has been said many times in recent years, change has become the only thing that does not change. Constant change is with us. Companies must learn how to manage change and manage themselves in the midst of change if they want to survive and grow.



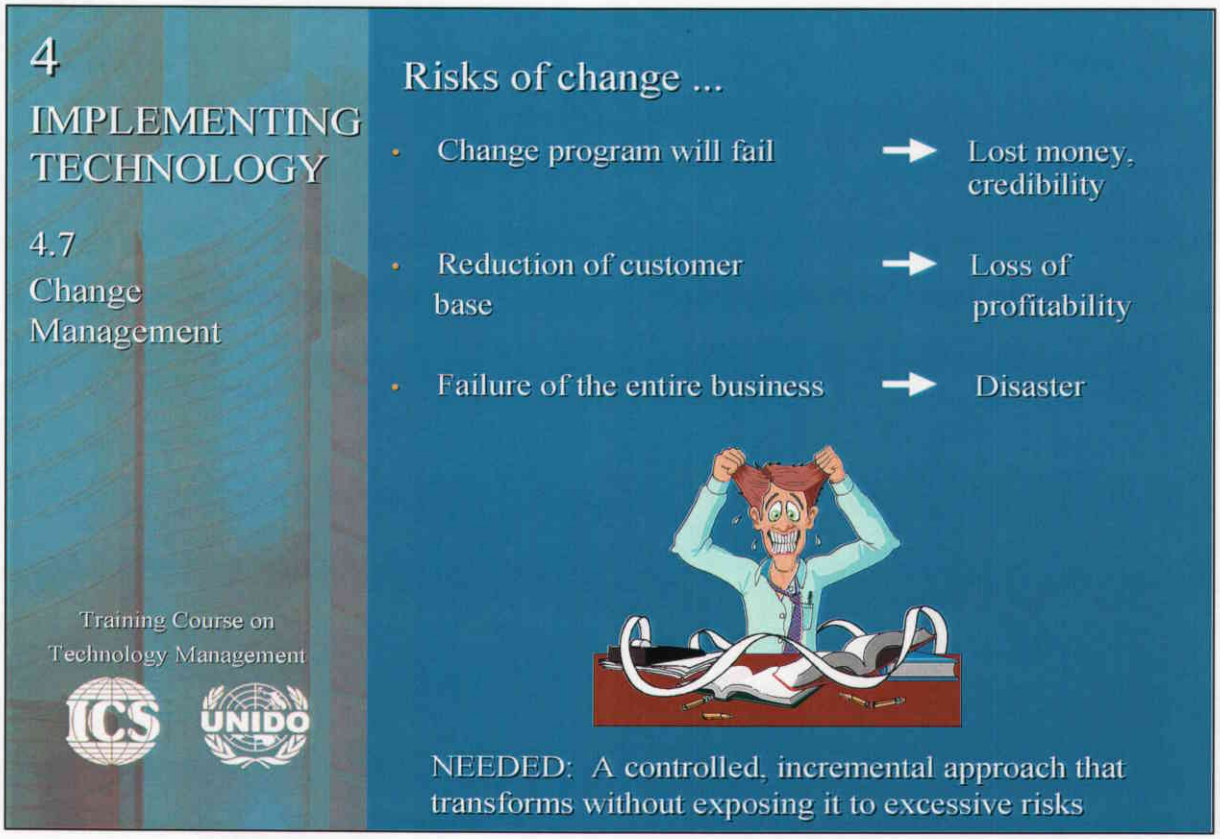

Companies experience many pressures for change. Customers have a never-ending list of new needs and desires for improvement of the existing products. They are more educated and experienced causing them to be more discerning and more demanding. New industries appear from nowhere that compete with existing industries. Look what computers did to typewriters and what plastics did to steel. Legislation, especially environmental legislation, is imposing significant controls on manufacturers, forcing them to change the way they make their products or even forcing them to cease production altogether. Globalization is opening the door of every market to everyone. Not many years ago companies, especially the smaller ones, considered the local area to be their market and the competition to be the company across the street or in the next town. Now companies have access to international markets and international companies are competing in small local markets. Customers love it because they have the pick of the best products in the world. This change is enormous and life threatening to companies that do not react in the right way. Jobs are changing. It is almost impossible to acquire an education or training that will prepare a person for his/her career. The university degree or technical school diploma are only good for a start. A person must continue to learn or fall by the wayside. And finally, one technology, information technology (IT), is driving change more than all others. The information available is growing at exponential rates. Accessing and managing it a massive growth industry. IT plays a huge role in technology acquisition, implementation, and management. In many ways it is both part of the cause of change and a component of the solution for dealing with change.

Change, in spite of the enormous pressure causing it, is not easy. The risks are huge. The difficulties are daunting. Companies must develop the capability to manage the risks and deal with the difficulties. The first step in this process is education, learning about the elements and risks of change, and exploring concepts and methods for addressing change.



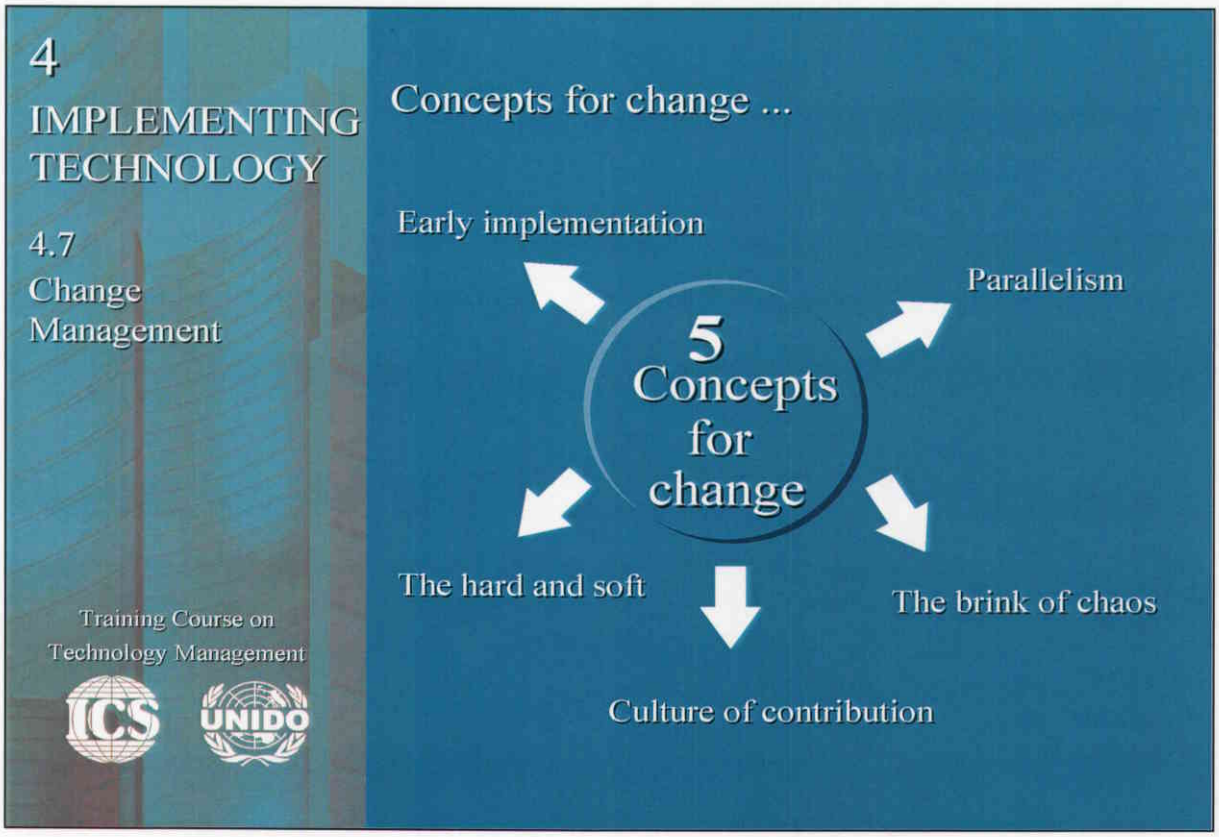

The elements of change, in the context of technology implementation, include process design, staff training, culture reshaping, organization restructuring, and reward and measurement systems development. The degree of change being introduced affects the amount that each of these have to be changed. A simple analogy would be that the amount of change required to change from an oval to a circle is nothing like changing from a rectangle to a circle. The result is the same, the effort required is significantly different.


The reality of change is the fact that it is human nature to resist change. We all like it the way it is. We resent being forced, by something beyond our control, to do something we were not planning to do. Inertia is on the side of the existing situation. No matter how good the new technology sounds the work involved in the implementation of the new technology (design, test, train, restructure, modify) and dismantling the old methods is enough to discourage most. Added to this are peoples' natural resistance to change, the day-to-day operational pressures, finance problems, complexity, fear of failure, real failure, and general fatigue. It is clear to see that introducing change is fighting an uphill battle on a steep hill.

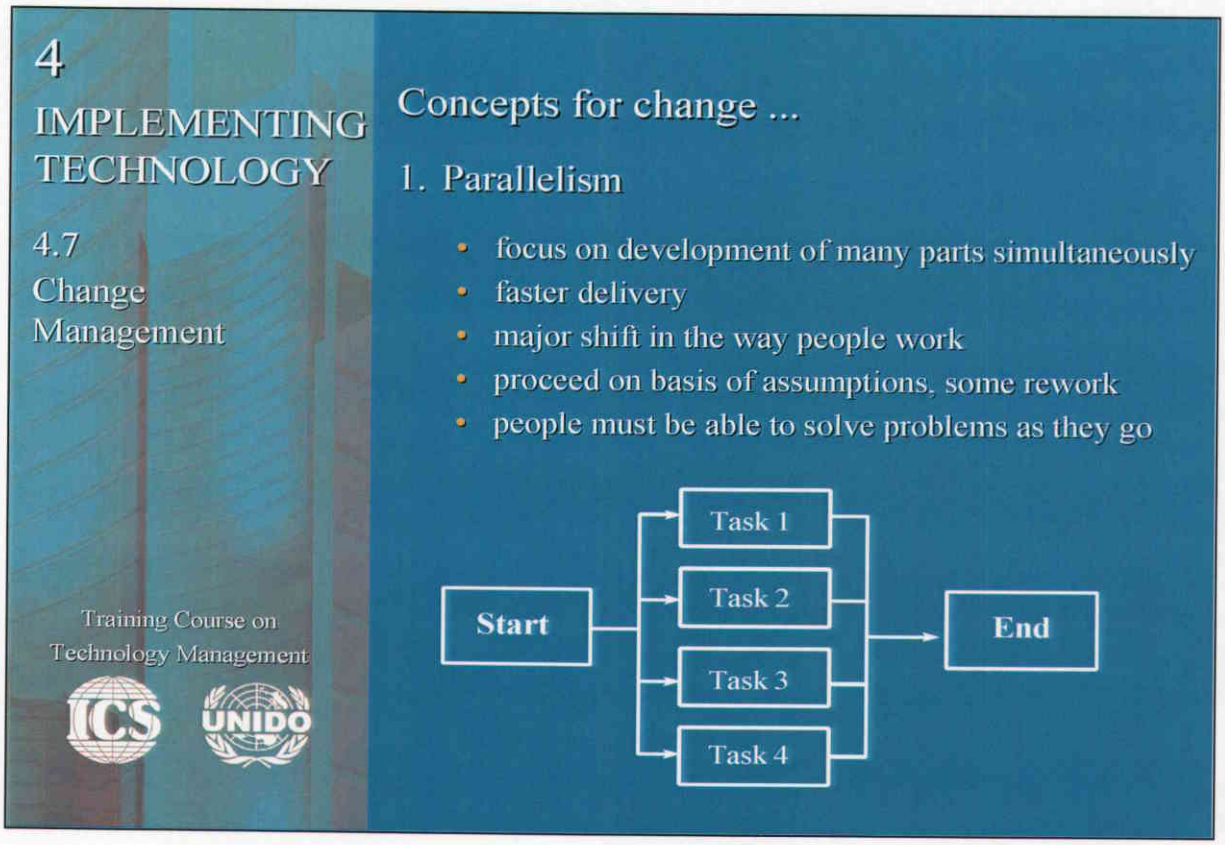



The obstacles to change are further enhanced by the risks of failure. If the change program itself fails the money invested in it is lost as well as management's credibility. If the new product or service that results from the new technology is not accepted by the customer, it will affect other aspects of the business. Some customers will lose confidence in the company and take their business elsewhere causing a reduction in customer base and loss of profitability. The biggest fear of all is that the introduction of the new technology will cause such havoc that the entire business will fail. The temptation to fall back on the old saying "if it ain't broke, don't fix it" is enormous.

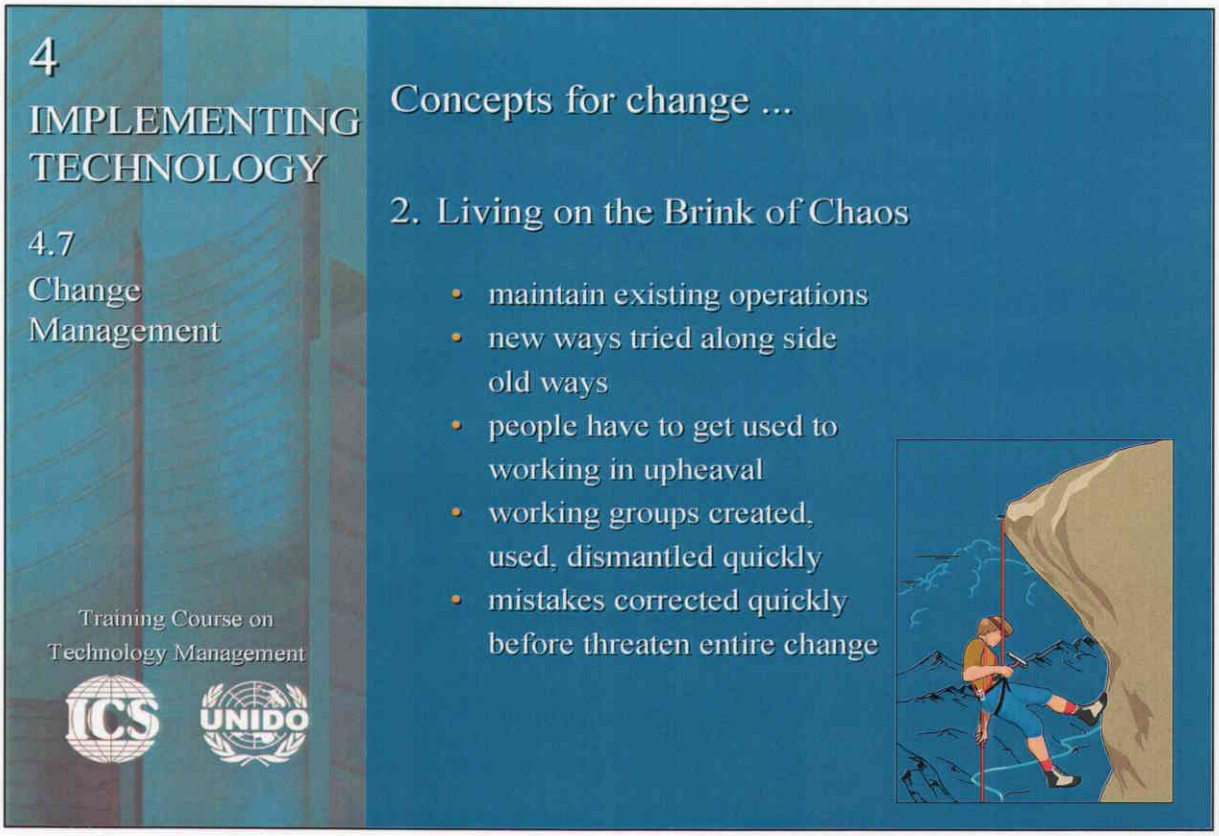
However, change is unavoidable. If the company does not react to the forces of change, it will fail anyway. It is stuck between a rock and a hard place. It must react, or even better yet, take its future into its own hands and be proactive. It needs a controlled, incremental approach that continually transforms it without exposing it to excessive risks.



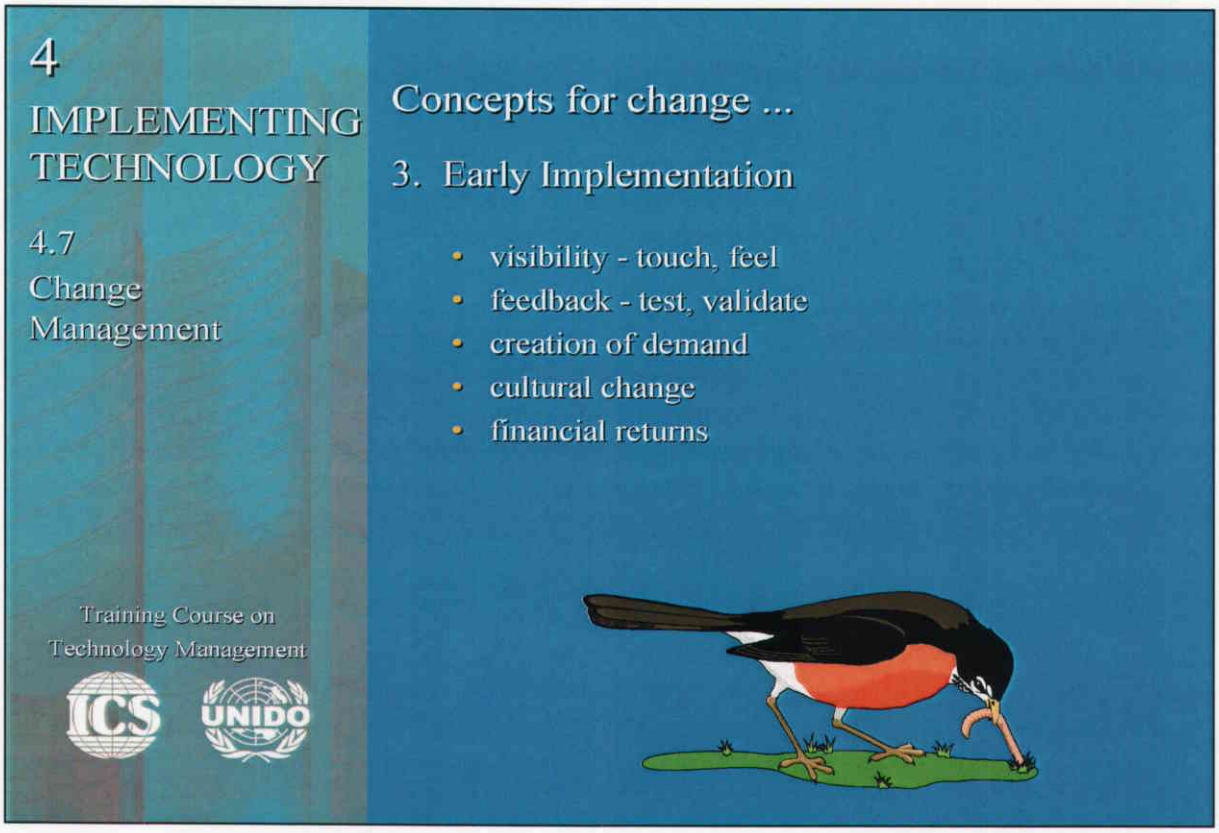

The nature of change dictates that traditional ways of working are often inappropriate. To be effective, an integrated approach is required, which leads to the obvious conclusion that changes must be carried out in many areas of the organization at the same time. The larger the effort the more planning is needed to manage the scope of the exercise. However, even though the final destination can be defined and even some steps along the way, change often requires working forward into the unknown. In fact, change by definition is moving from known, comfortable ways of doing things into the unknown. Management must learn how to keep the change process moving forward without forcing people to go too far beyond their depth. The concepts discussed in this section will help develop this skill.



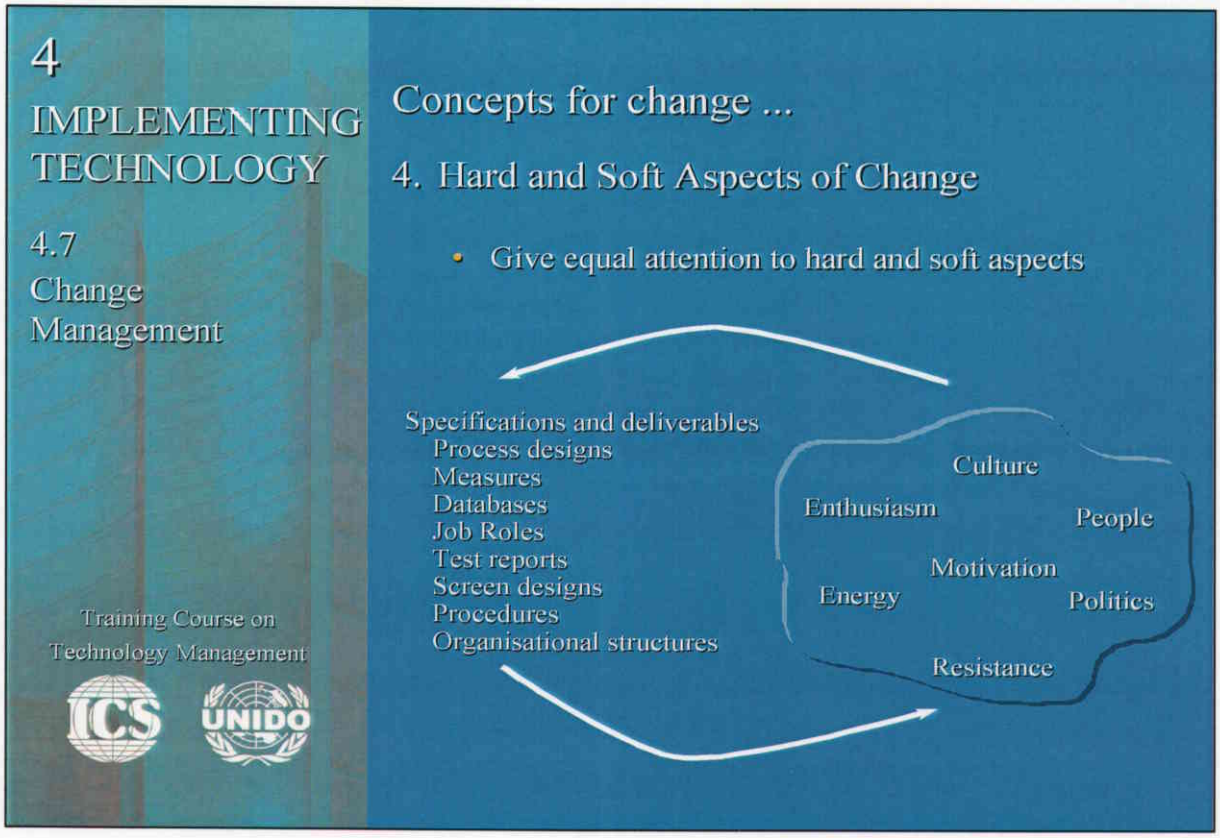

Parallelism, as we have learned in the section on parallel implementation, is not easy, but has many benefits. It enables the organization to address the need for change in many parts of the organization at once. Parallelism is a significant shift from the traditional approach to change. We used to change one area, say the organization structure, first, which drove the change in the next area such as customer service next, and so on. Parallelism reduces the overall time to complete the change. It also creates the environment that everything is changing which helps breakdown the pockets of resistance. Since everything is undergoing change, it is often necessary to proceed on the basis of assumptions. If the assumptions prove to be wrong, some rework may be required. Since the final outcome is specified and overall plan is known, rework happens much less often than the traditionalist would expect. Parallelism requires that the people driving the change be able to solve problems as they go rather than be provided with a full road map of how to handle each aspect before they start.



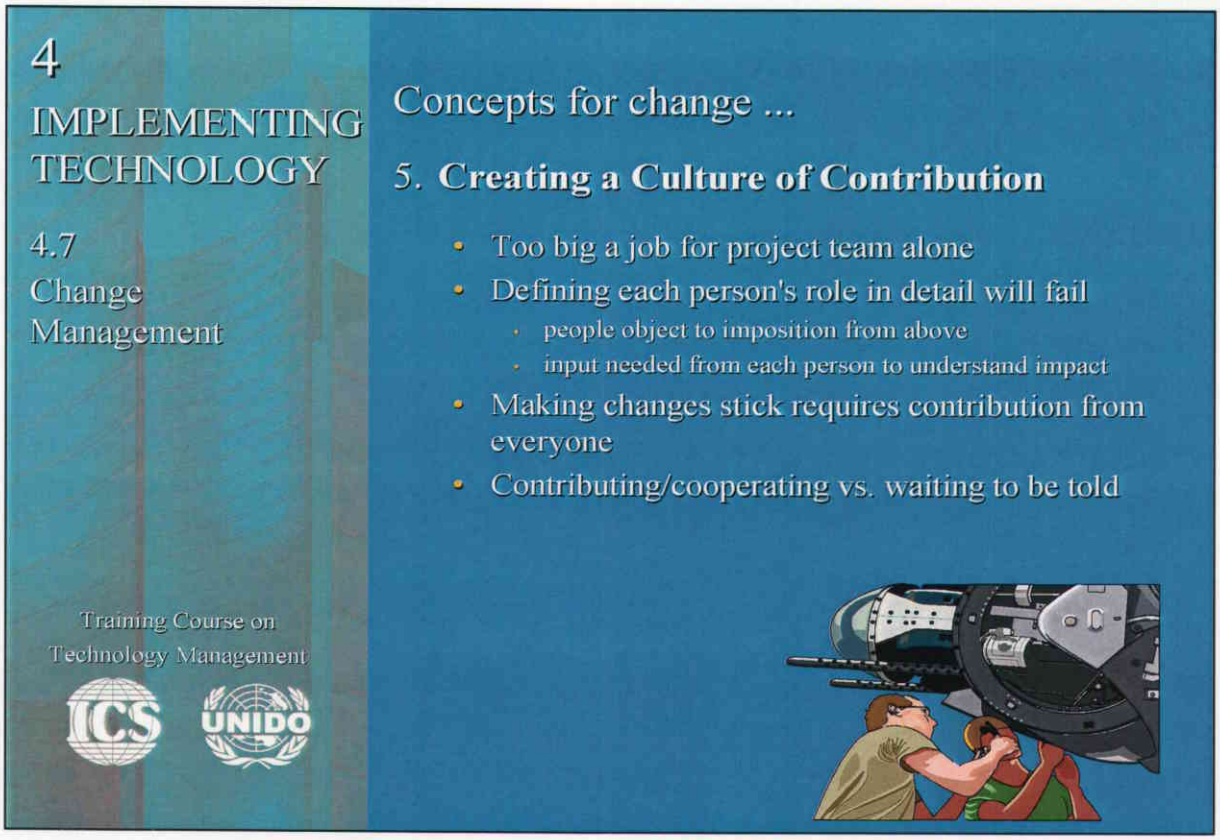

A change program results in the company's people living on the brink of chaos. Once the change process begins, everything is effected — people, systems, procedures, and measures. The environment is hectic with constant upheaval creating an air of chaos at the same time as the company tries to cope with business as usual. The company must learn how to proceed with the program at a rate that is fast but not too fast. The key is to keep the program on, but not over, the edge. There are no rule books, no easy check lists. Management must be sensitive to how the people are coping and react accordingly. Communication is central to success. Continually remind people of the benefits that the change will achieve make the upheaval worth it. Also let them know that you know how difficult it is and that their efforts are appreciated. People respond to praise. Once the change process begins, management's role changes from planner to cheerleader.



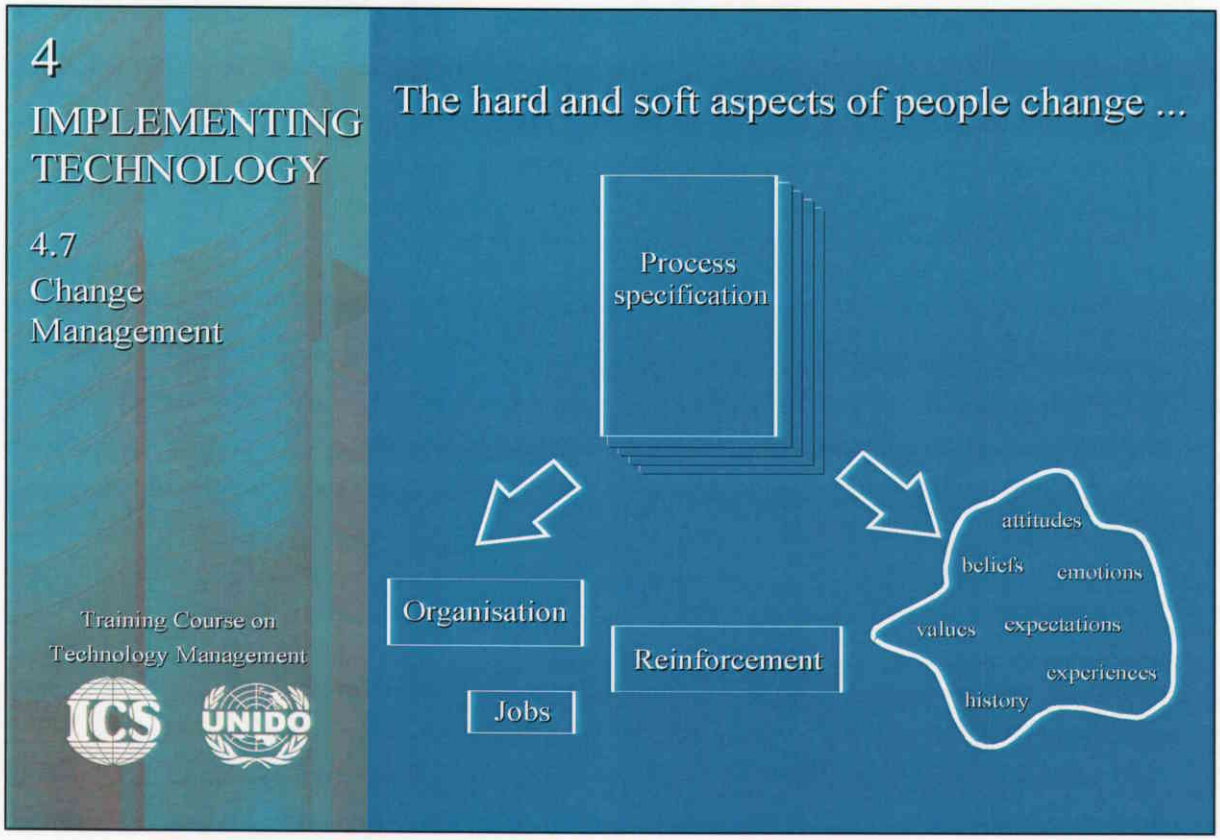

An effective concept for motivating people and encouraging them to continue is early implementation. This is introducing and using one aspect of the change as soon as possible after the change process has begun. One reason why this works is the visibility it brings to the project. It is a tangible demonstration that the change is happening, which is especially useful for encouraging those that the change has not touched yet. Early implementation of some aspect of the change provides an opportunity for feedback on the process. At least part of the theory has become a reality and that can be tested to see if the changes can lead to the benefits hoped for. A successful early implementation creates a demand for the change to spread to other parts of the company. The taste of the final product that comes from a successful early implementation begins the process of cultural change that is essential for the total change to have its real impact. No matter how well the change has been explained and how much it makes sense, it is still a theory until something tangible exist. Tangible things affect our experience in a way that theories cannot. Cultural change is best led by experience. Finally, the initial implementation may create the opportunity to earn some money. Even a small financial return is a welcome change to those that manage the finances. The project to this point has only cost money, so any revenues are welcome evidence that the change will be effective.



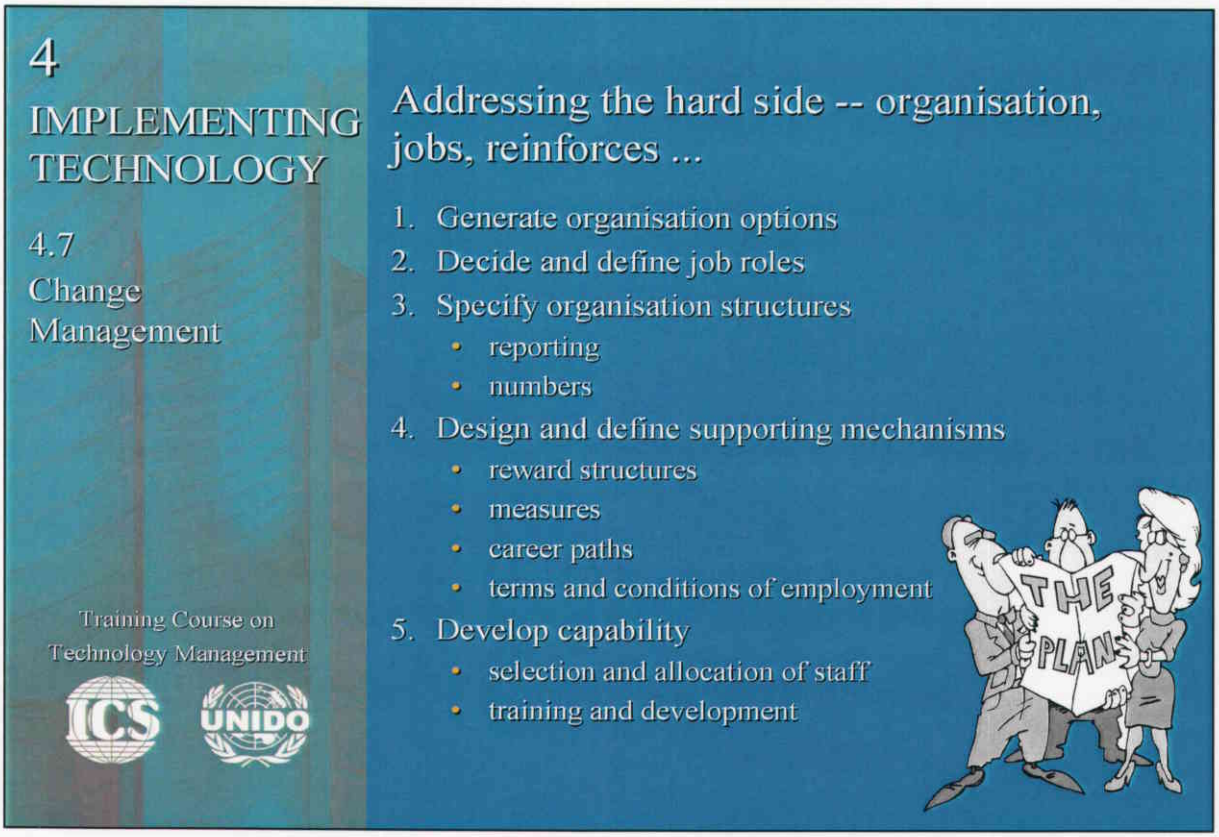

Equal attention must be given to the hard and soft aspects of change. The hard aspects, the deliverables, are the building blocks of change. They, especially in the case of technological change, are the reason why the change process was begun. They can be controlled as part of a project plan. They are concrete and measurable. However, the hard deliverables are only half the story. If change was only about producing deliverables then any organization with project management capability could achieve it with far less effort than it actually takes. The other side of the change coin, the soft aspects, cannot be specified. They are the people things like culture and politics that must be sensed and felt. Change can be driven entirely by deliverables, but it will happen with more speed, more commitment, and lasting effectiveness if the project management activities are accompanies by a sensitive and appropriate response to the human aspect.



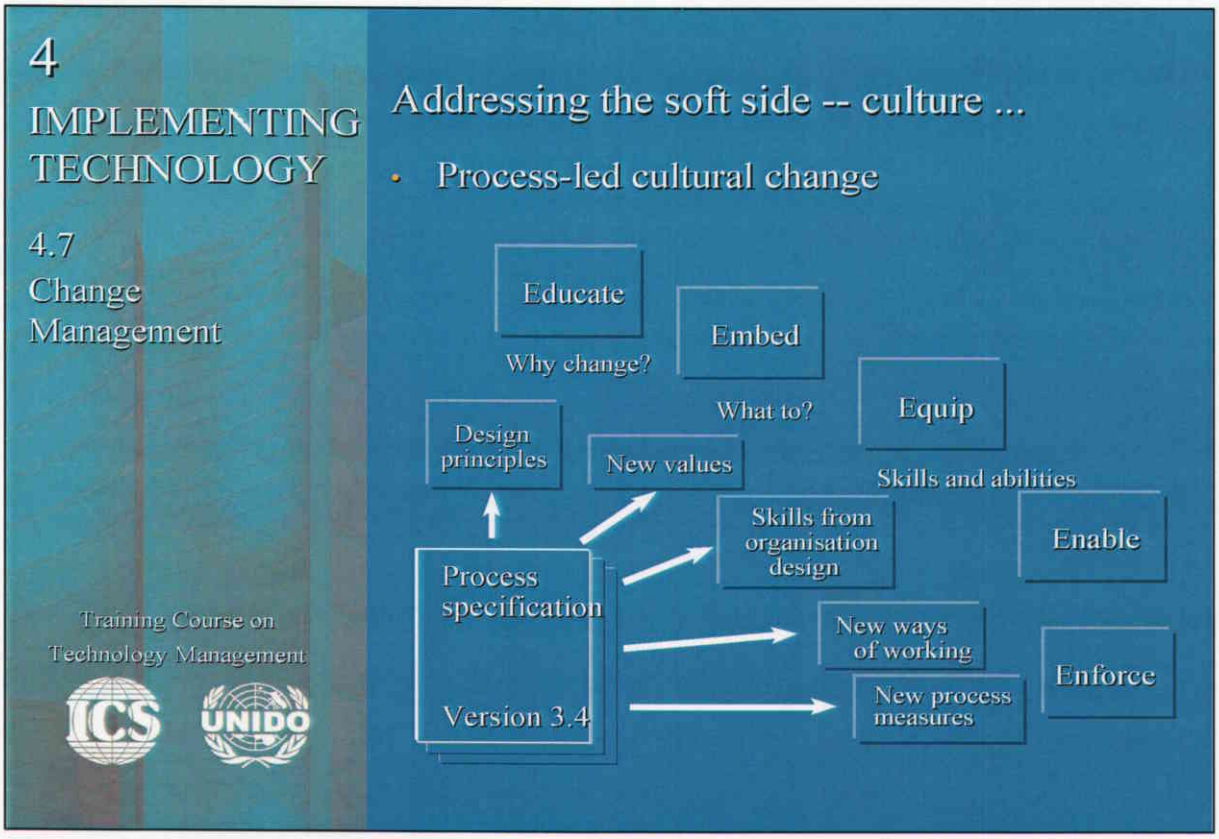

The last concept of change to be discussed here is the need to create a culture of contribution. Making changes that stick and have the impact on the organization that they are designed to achieve require active contribution from everyone from the president to the floor sweeper. Designing the new company in a vacuum, without permitting or encouraging input from those affected is the way to discourage a culture of contribution. Using this approach results in the plan being called "Their Plan" (i.e. Management's Plan), and its absolute best possible achievement will be to attain the plan. Since people are not supporting the plan, it will likely achieve far less than envisioned. Actively soliciting people's contributions and handing over responsibility with the goal specified but without a road map encourages people to take ownership of the plan and contribute to it. The result of a culture of contribution will be greater than that envisioned by the plan. The plan moves from being "Their Plan" to being "Our Plan."




Just as there are harder and easier aspects to change itself, there are hard and specifiable aspects of people change. The hard side of people change is changing the people management (human resource) systems. Human resource systems, either by design or by default encourage some behaviour and discourage others. Changing the systems to reward behaviors consistent with the organization after the change, and to discourage those that are counterproductive is essential. It is essential, but not sufficient. The soft side must be addressed too. People have emotions and attitudes, values and beliefs, history and experiences. All of this gives them expectations about what life at work should be. If an organization wants to introduce a change that impacts any of these non-concrete areas (and any change will impact most of these areas), then it must introduce actions to help people adapt to new expectations.

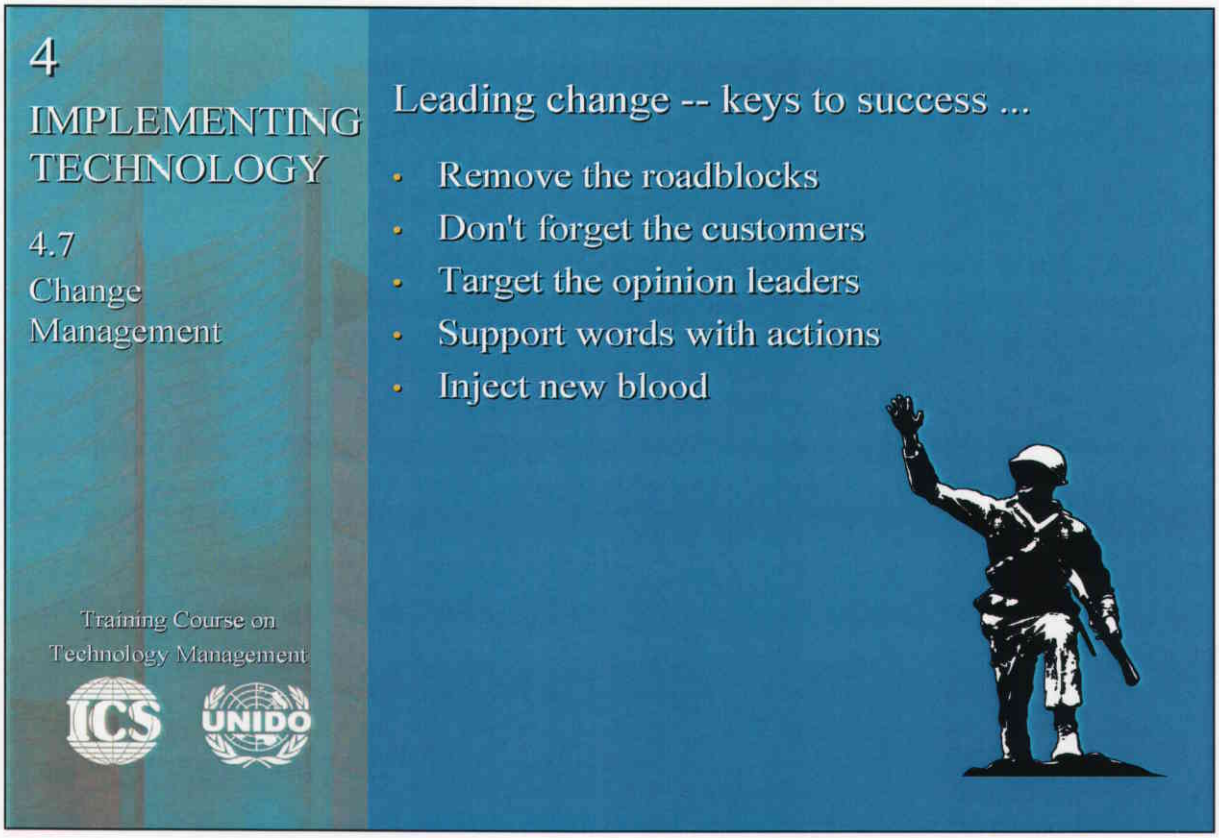



The hard side of people change is as straightforward as any project. A project team should generate organizational options, define job roles, specify structure, design support mechanisms, and train staff in the use of the new systems. The overriding principle must be to develop systems that encourage the desired behaviour. Some decisions are easy, such as deciding to have a profit sharing scheme. This will help the employees work hard to make the changes have a positive outcome because they will share in the benefits. Others are not so easy. Rewarding individuals for individual performance has the positive effect of encouraging excellence because it sends the message that if a person does well, he/she will be rewarded regardless of how poorly his/her colleagues do. On the other hand, this also encourages competition among people that the company want to work together as a team. A reward that encourages excellence while discouraging teamwork may not be a good thing. Each process must be designed in light of the present company culture and the culture the company hopes to have in the future. Use of teams of affected individuals is especially useful in the development of new human resource management systems.



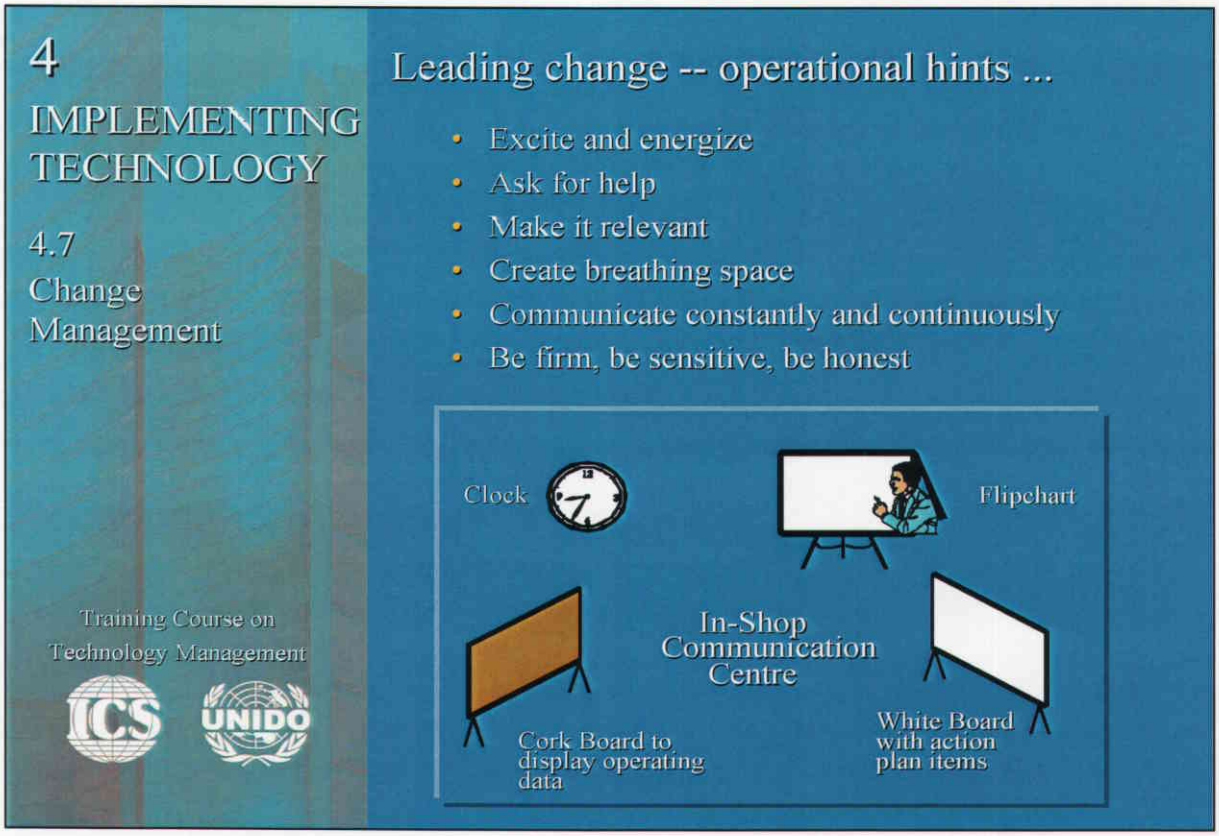

The soft side of people change, culture, is not so straightforward. However, it can and must be addressed. The starting point is specifications of the change, the hard aspects of the technology being implemented. This will contain design principles, intrinsic values, people skills required, technical skills required, and new ways that successful performance will be measured. These things are discussed in terms of the technology and the outputs expected from it. They are not likely outlined in terms of the cultural characteristics of people, but soft attributes like beliefs, values, and expectations can be deduced from what the technology is expected to deliver. This, along with the reasoning that resulted in the decision to acquire new technology, should be used to educate people about why the change was necessary. The education process is the beginning of embedding some new values into people. The new HR systems will further embed and reinforce the values that the new company, the company after the change, will expect. The new technology specifications will also make clear what new skills are required. Training must be made available to equip people to operate with the new technology in the new environment. The HR systems and the reporting structure must be such that they enable the employee to operate in the desired way. Do not tell an employee that he/she is empowered to make operational decisions and still have a system in place where every expenditure must be signed by his/her supervisor. Finally, management has to work at reinforcing the message of company values and how the new technology relates to them.

Managers must be prepared for the fact that some employees cannot accept the new values. If they cannot change to the new culture, it is better for the company if they leave so they do not have a negative impact on the others. When employees are causing excessive trouble in relation to the changes, establish the reason. Be sure that all efforts have been made to educate, equip and enable them. If these have been done and the employee is still fighting against the system, it is because he/she has a significant value mismatch. This employee must be let go for the sake of the entire change process. If the problem is only a skill issue, another place in the company can be found. However, if the employee is opposed to the new methods of doing business, placing him/her anywhere in the company will have a negative impact on the project.

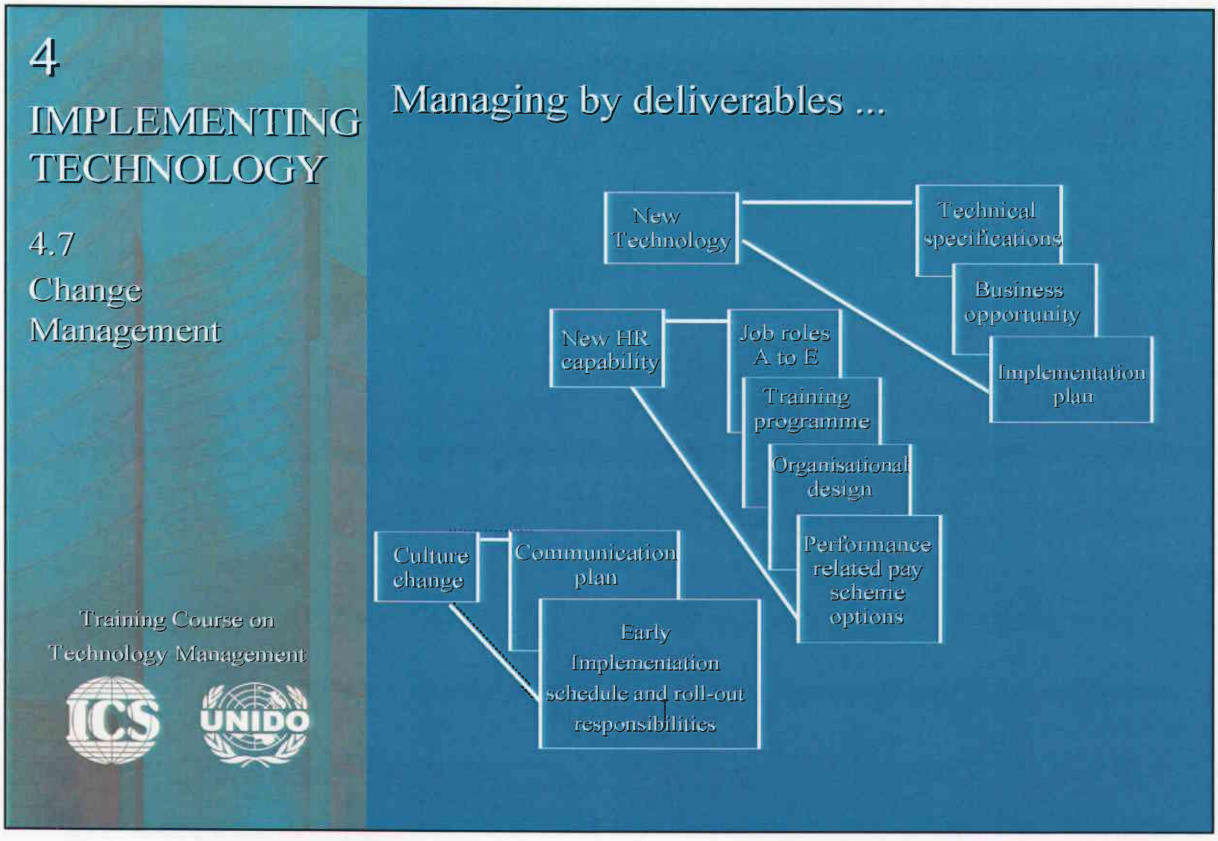



Do not assume the change will happen without a concerted effort from everyone. The project manager and the core team members have to be on a constant lookout problems and deal with them before they grow. Roadblocks, any impediments to change, have to go. These are often holdovers from the old way of doing things. For example, a policy that was designed for control has to be removed when introducing a change that requires empowerment. A manager that is still exercising control over a team member that used to be under his/her authority must be corrected. Work the hardest on opinion leaders. If they can be won over they will help sell the change to others. If they cannot, the sooner this is established the better so they do not negatively impact others. Hire or transfer people with new outlooks and enthusiasm into the new technology area. New blood helps to renew those that have become stagnant. Above all, practice what you preach. If the project leader is asking people to spend time on the shop floor to be sure that the situation there is well understood, then he/she had better put in a few shifts too.

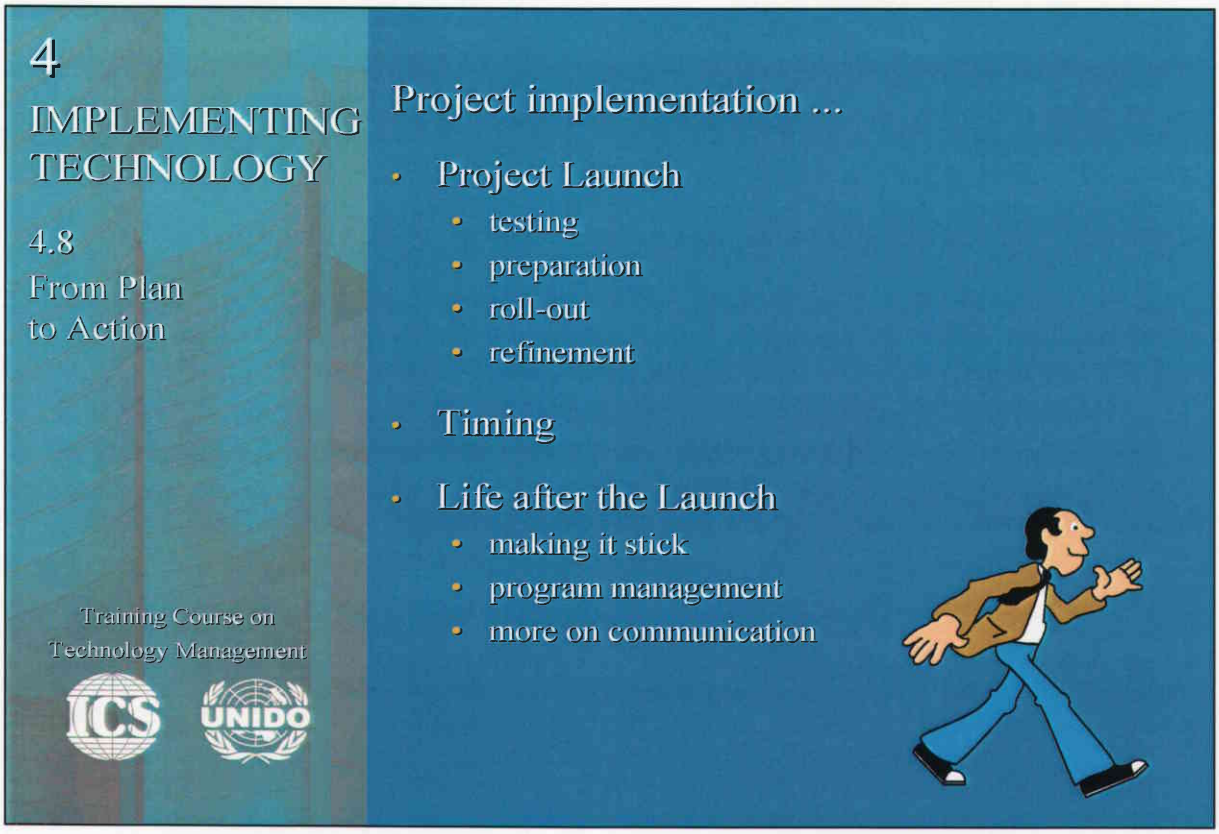
The company's customers must not be ignored. The changeover may affect the company's ability to deliver in the short term. Inform customers of the positive aspects of the change, especially how they will benefit in the future. Identify solutions to deal with short-term problems such as stockpiling extra product at the company's expense to keep the customer supplied during the changeover period. If stockpiling is not possible due to inadequate capacity or perishable goods, offer to acquire product from a competitor and deliver it during the change period. This has the risk that the customer might switch to the competitor, but the benefits of the new technology and the fact that company went out of its way to make sure the customer was not left stranded, should enable the company to win them back.



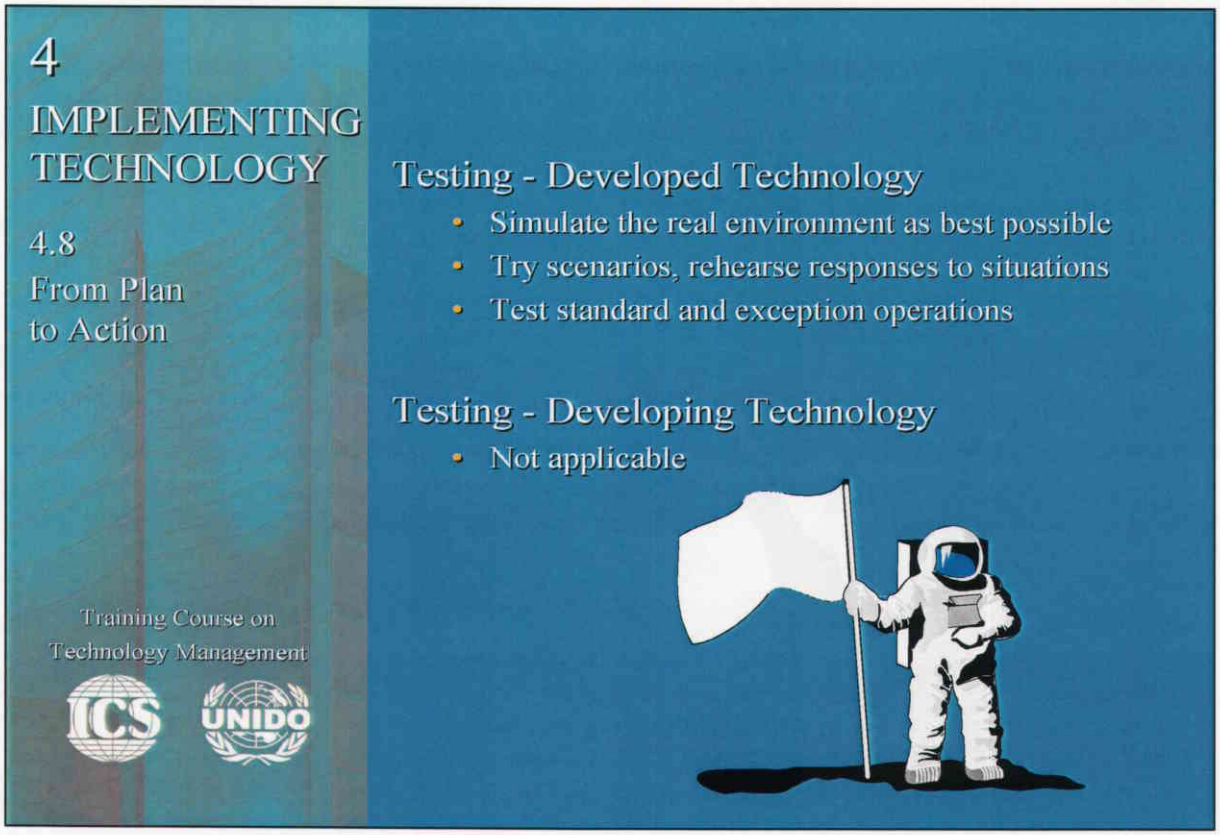

Leading change is not scientifically or intellectually challenging. It is mostly hard work and attention to detail. Some practical hints will help. The project leader and the core team must be able to excite and energize others. If they are truly enthused about the change and its benefits, it will rub off onto others regardless of the person's ability or lack of ability to motivate through captivating speeches. Project leaders should encourage everyone to ask for help and have to be willing to ask for help when they need it. Communicate information in a way that people understand how it is relevant to them individually, to their unit, and to the entire company. People respond to relevant activities and resist activities that appear to them to be irrelevant. Project managers must find a balance between rapid transformation and the time it takes for people to accept and adapt to new ways. They must be willing to give people time and space to make personal adjustments. Be firm, not wavering from the goal, at the same time as being sensitive to the needs of the individuals. Address all issues with honesty. It will build trust. Never stop communicating. People need to know the progress to date and the plans for the future to maintain their interest in the process.




Managing by deliverables is a good method for keeping the project on track. If makes the project manager better able to measure progress and to demonstrate to others that change is, in fact, happening. In a technology implementation project, the primary deliverable is the installation of the new technology itself. However, this deliverable can be broken into several subdeliverables such as the creation of the technical specifications, description of the business opportunity, and the development of the implementation plan. The deliverable of changes required in the HR system can be subdivided into job descriptions, training programs, organizational design, and the design of reward schemes. Cultural change, the hardest deliverable to measure, can still be given some concrete action steps that can be measured as having been done or not. Examples of this would be creation of a communication plan and early implementation schedule. Project management tools like Gantt charts and S-curves can then be used to manage even soft activities like cultural change.




Throughout Module 4 we have been talking about moving from plan to action. The technology has been acquired, the implementation plans have been made. Now it is time to talk about stepping off the cliff, launching the implementation project. Launch consist of testing, preparation, roll-out, and refinement. Testing is a simulation exercise to help people get ready for the real thing. Preparation is getting everything ready for the changeover (communications, data migration, physical site, documentation, and publicity). Roll-out is the moment of truth. The new equipment is started, the old is shut down. Refinement is the process of tuning the new technology and working out the bugs. In the longer term it consists of continuous improvement activities. An important thing to consider in planning the launch is its timing. Finally we will look a little at life after the launch, how to make the change (that has just begun) survive and thrive into the future.




One thing that must be done as the time of the launch of developed technology approaches is to conduct a test of the use of the new equipment. The test is an attempt to simulate the real environment. It gives the operators of the new technology opportunity to try different operating scenarios and to rehearse responses to a variety of situations. It should investigate normal operation and abnormal situations. It could be done on the new equipment if it is available before start-up. Another way this can be done would for the supplier of the new technology to arrange for operators to train on a similar piece of equipment installed in another factory. These people could then return to the company and explain their experiences to others that will be interacting with the new technology. Those supplying material to and taking processed goods away from the new technology also need to practice their roles. If it is not practical to train these persons on existing equipment in other plants because of costs or a different layout, then a mock set-up can be created and a person familiar with the technology's operation can coach the people while they go through their motions as if they were dealing with fully-operational technology.

The implementation of a technology development project does not require any prelaunch test because there is nothing to test. Once the budgets, plans, and commitments are place, and the facilities where the project is to be conducted are ready, the project begins.

4

# IMPLEMENTING TECHNOLOGY

4.8
From Plan
to Action

Training Course on
Technology Management

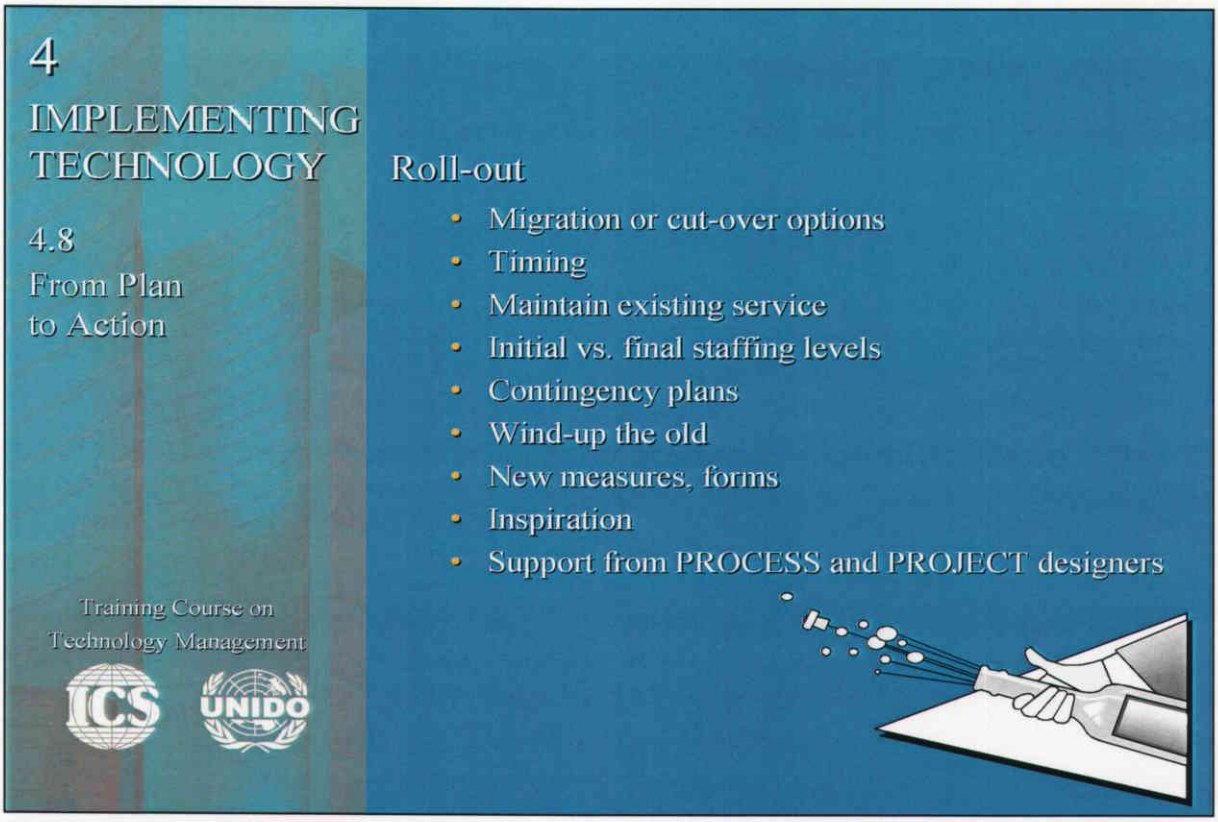
ICS UNIDO

## Preparation - Developed Technology

- Communication to customers - no surprises
- Data migration
- Physical layout
- Work flow documents
- Publicise - internal and external

## Preparation - Developing Technology

- Physical layout
- Work flow documents
- Publicise - internal

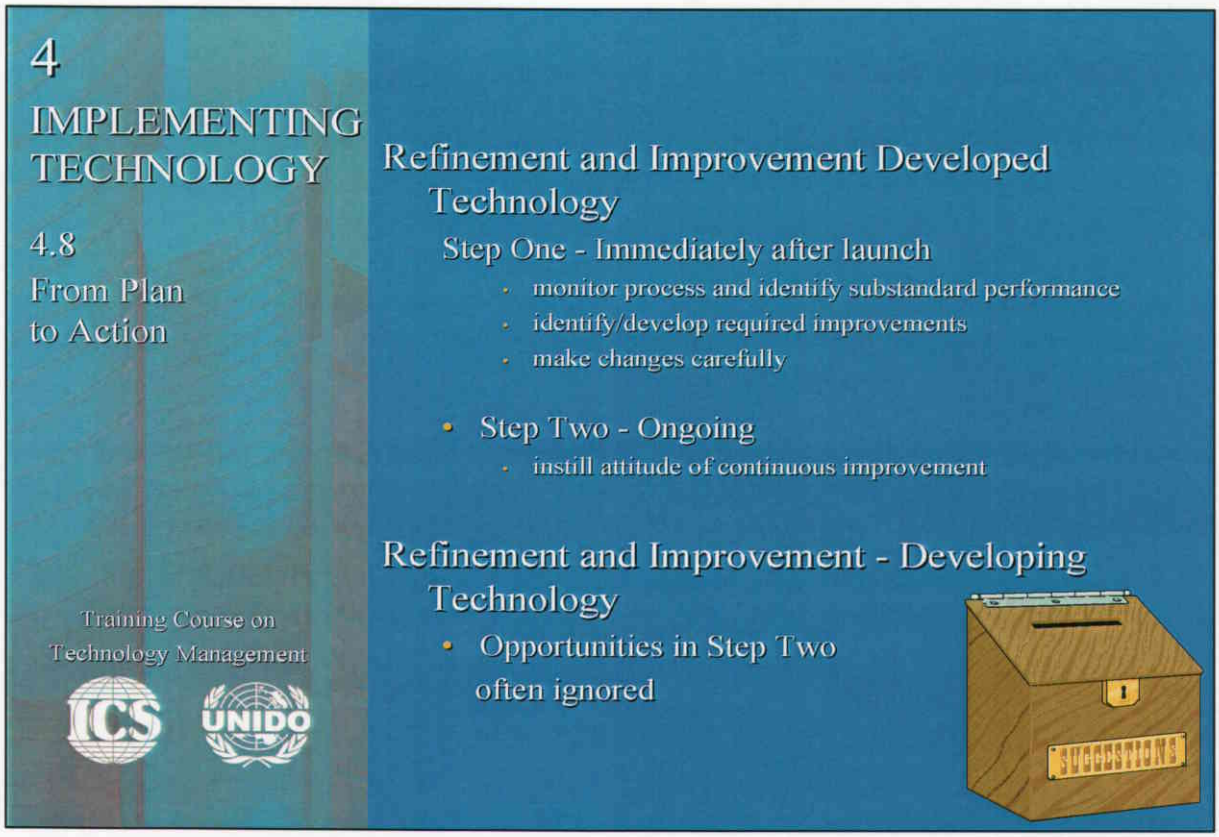



The actual roll-out or start-up of the new technology requires a few things to happen at once. There has to be a migration or cut-over from the old process to the new. The manner in which this is done depends entirely on the company's constraints. If the company has the luxury of setting up the new equipment in a new area it can keep material flowing to the old process until the new one is running smoothly. If the new process has to be conducted in the same space the old occupied, migration will not be so smooth. There will be a very hectic shutdown of the old process and last minute installation and start-up of the new one. If this is the case, very careful planning will be required to make the transition go as smoothly as possible. Timing of the start-up day depends on many factors. Everything needed for the start-up must be in place. A peak season for the product or any time the company is focused on another major event like year-end accounting is not good time. The people in the company must be prepared for beginning the new ways of operating. This includes new process measurement systems and the processing of the data from those systems.

Keeping the customers satisfied during the changeover time is very important. Obviously the shorter the changeover period the better. Being able to run the old and new processes simultaneously is an advantage, although extra personnel are needed. Conducting the start-up in the off-season is also a good way to avoid customer dissatisfaction. Contingency plans are needed if unexpected problems arise. If the old technology is still available, production could continue on it. If it has been removed an arrangement to acquire product from another source until the problem is solved is needed. Also experts from the technology supplier must either be on site or available at short notice.

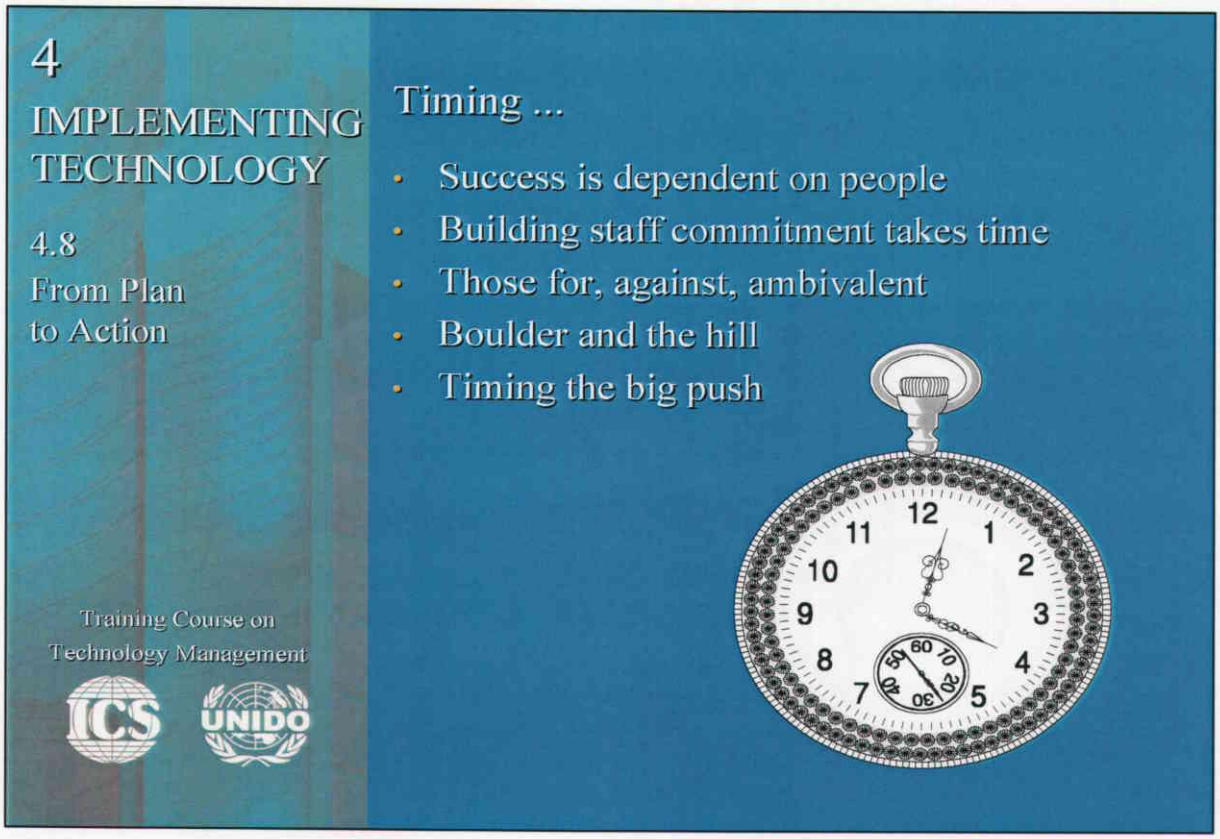
Inspirational support from management and the project team are essential in the early days of start-up. Enthusiasm and commitment to the project will go a long way toward smoothing over the gaps and glitches that occur, no matter how well everything is running. Technical support must also be available from internal and external experts that understand the technology and how it is supposed to work in the application. People with in-depth operating experience are a tremendous asset to the newly-trained workers operating the new process for the first time.

Roll-out of a development project is normally done without much fanfare. It is good to have a small announcement meeting with a pep-talk from the company president for those involved in the project. It lets the project team know that the company is behind their endeavors and is expecting results.



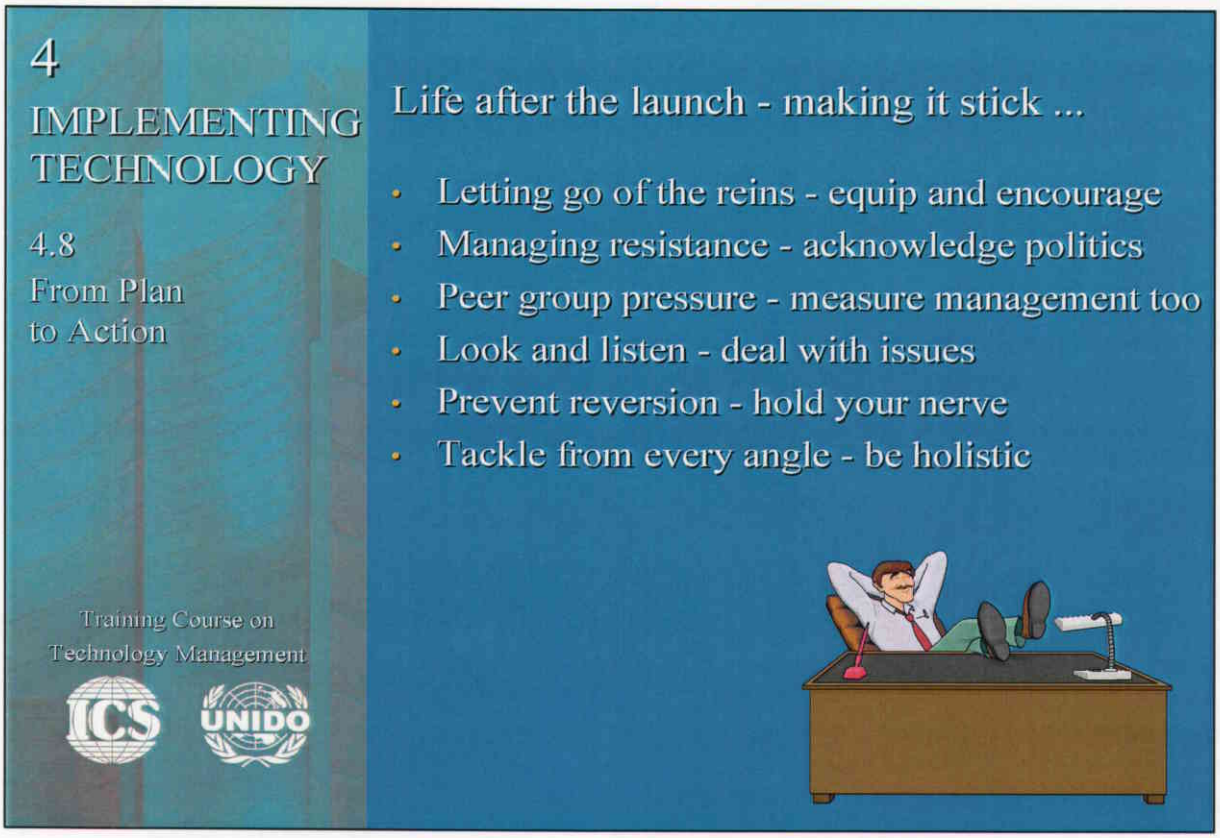

In the days immediately following start-up, a process of refinement and improvement of the new technology takes place. This is a time of fine tuning. The process is monitored closely and any substandard performance is identified, the cause isolated, and the problem rectified. The cause could be technical, with the technology itself, or it could be due to inadequate training. Whatever the cause, it needs very careful attention until the technology is producing product according to the specifications in the contract with the technology supplier. The refinement and improvement process does not end there, however. The company must continually work toward achieving an attitude of continuous improvement. It must never be satisfied with the level of production and quality that its equipment and personnel provide.

There are opportunities for refinement and improvement of the technology development process as well. Instilling an attitude of continuous improvement in those responsible for technology development projects would result in reduced time to produce, better quality and reduced development costs. The parallel implementation concept was the result of someone's continuous improvement efforts.



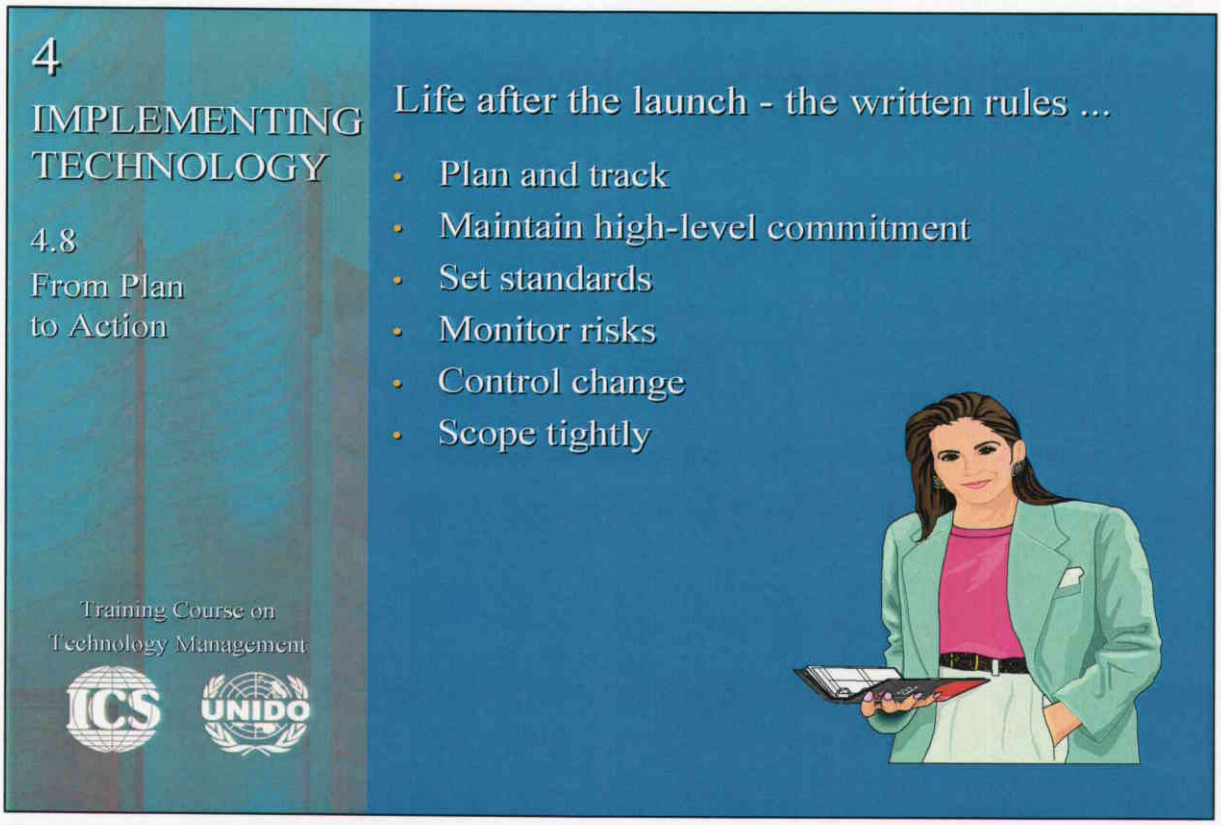

Successful technology implementation is ultimately about people. Enough people in the organization must agree with and want the changes to happen badly enough to go through the changeover period. The start-up period will have teething problems and the people have to be committed enough to stick it through these final hiccups. Building commitment takes time. There will always be those who are "gung ho" about the change, those who are opposed, and the majority who are ambivalent. The change process is analogous to pushing a boulder up a hill. It is a long hard slog to inch the boulder to the top so it can be released down the other side. There comes a moment when a final heave will push the boulder over the top and set the change in motion. This final push is a chance to pull the ambivalent ones on board so they can feel like they were involved in the initial introduction of the new technology. The big push is saying "we have come this far, now let's get together and make this thing work".

The timing of the big push has to be judged carefully. It may be after a successful pilot or when a company-wide process is about to be introduced. Too soon and the people will not be ready and it will tend to backfire. Too late, and the people will feel like nothing is happening. The timing is almost entirely a "look and feel" judgment. The main indicator is level of support for the new technology. There must be enough people with influence who are familiar with and supportive of the new ways of working who go along with the new technology to carry the laggards.




Change is difficult. Making changes stick after the excitement of the launch is even tougher. One of the biggest barriers to change is lack of ownership. When people feel like the change has been forced on them, they resist. On the contrary, when they have had an input into designing the new process and participate in the introduction of the solution they feel like the process is theirs. After the launch, this attitude can be continued if individuals are given the freedom to continue to improve the process. The secret is letting go of the reins. Giving control to those who work in the environment every day, although it has some risks, will be far more effective than retaining control. Once people have tasted controlling their destiny through participation in the launch, they will be even more resistant to change if the control is pulled back.

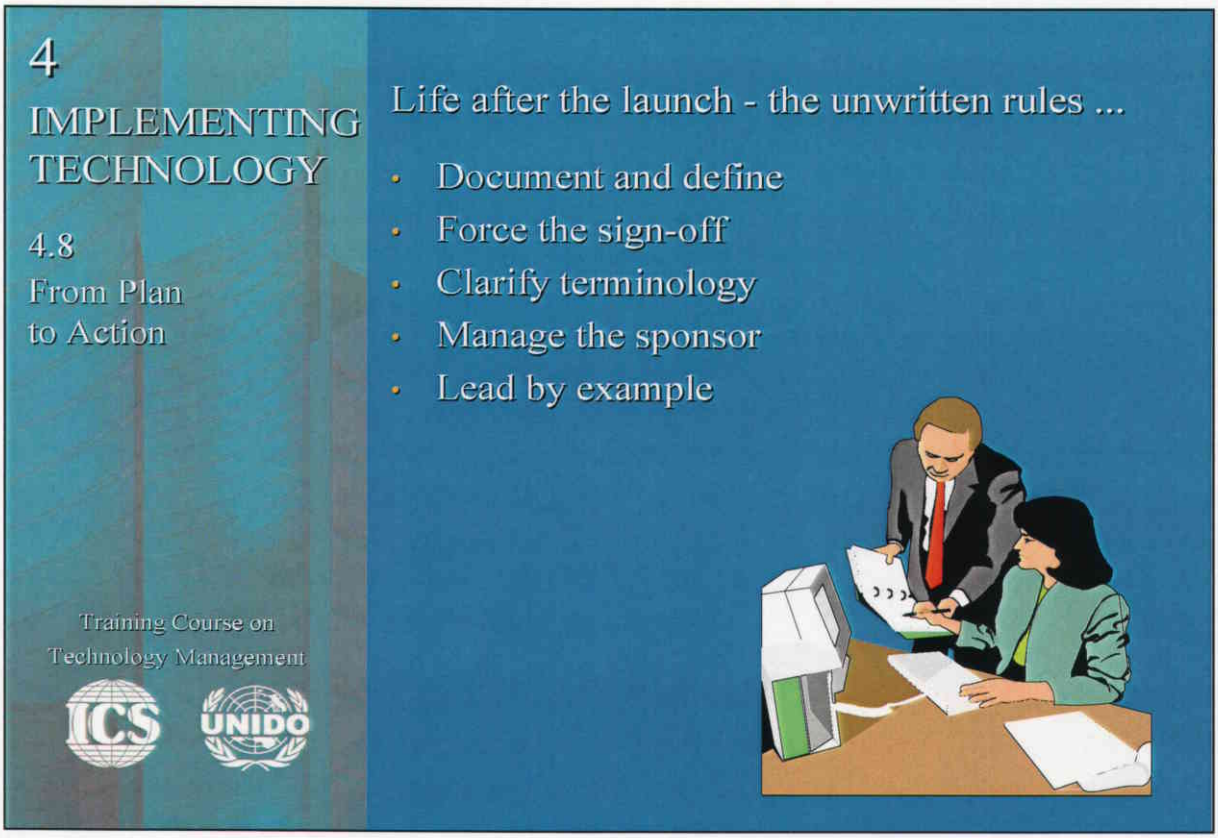
No matter how well the project has been conducted, resistance will still be there. Management must manage the resistance. It must get at and deal with the root of the resistance. If further education or training is needed, it must be provided. If there are fears about the future, they must be dealt with honestly. However, if there are persons who are just resisting for the sake of resisting, they must be removed. Peer pressure can work for or against change. If key leaders in the peer groups are involved in the project implementation, they will influence others to be excited about rather than resisting the new technology. Management must be constantly on the alert for problems on the soft side of the equation. When trouble is spotted it must be addressed. The momentum developed in the launch must not be squelched by reversion to the old ways. Tackle problems in a holistic manner. Lead with design, inspire with a set of design principles, devolve ownership with early implementation, use prototypes to demonstrate new ways of working, reward with new compensation systems, enforce with procedures, and show significance by removing roadblocks.



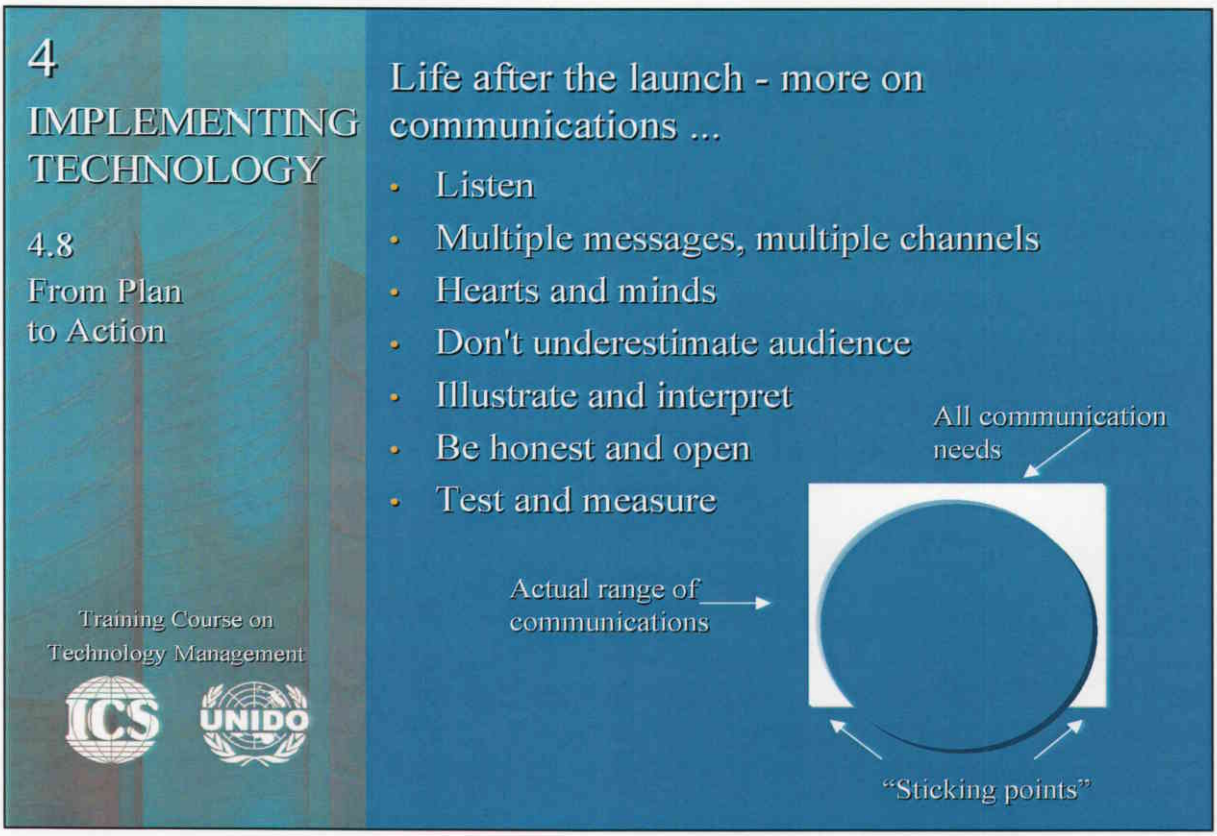

The project team's job is not complete until long after the launch. Much later, when the new technology has been in place long enough, it is considered to be "the way we have always done it." The project team has to ensure all the project's deliverables have been delivered. They still have to coordinate implementation activities that are not yet completed. They monitor progress against the desired goals and deal with problems. Progress at this stage is no longer measured against the time schedule or the budget. Now the primary indicators of success are the production capacity and quality levels of the new technology versus the target that was set when the decision to implement was made. The project team needs to maintain the standard at the original target and report actual results in relation to the target. For example in the early days after start-up the technology may have a production capacity of 90% of target with a quality level of 93% of target. As the equipment and its operators get tuned, the capacity may increase to 107% of target with a quality level of 101%. The project team also has the responsibility to continue to promote the new technology. They will work with communications people to develop programs that communicate successes and keep enthusiasm up.

The heart of managing the technology implementation project after the launch is another planning and tracking exercise. The project team needs to develop a plan for activities to be conducted after the launch that lead the company into full implementation and the state of continuous improvement. Targets and schedules are set for degrees of change and rates of improvement. Measurements are put in place, progress is monitored, and adjustment made as required. Key to success of this step, just as before the launch, is the encouragement of free and open discussion. Again, without employee participation and buy-in, targets cannot be met. High-level commitment to the process must be visible and continuous. This could include a senior management person on the implementation team, presentations to the staff by the company president, and frequent visits by senior managers to the site of the new technology.

The project team is responsible for monitoring risks. This consists of identifying risks (things that threaten the success of the implementation), analyzing their impact, determining a response, implementing it, and tracking the results. It is also responsible for change control. This is to address requests from the users or others to modify the newly-implemented technology process and its related processes developed so the technology can interface with the rest of the company. Finally, the project team's official list of postimplementation responsibilities includes the scoping of issues and solutions. Tight scoping is required so that it is clear if an issue has been addressed or not.

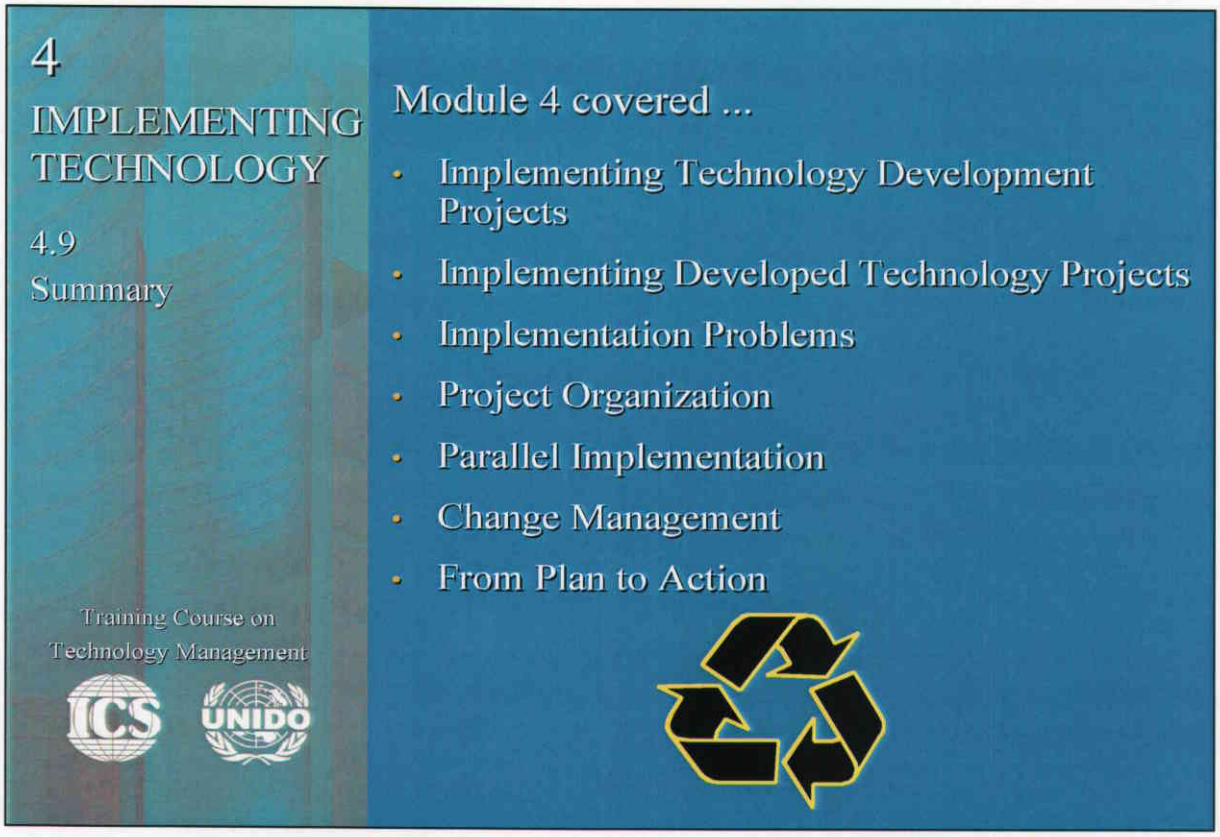



The project team has another set of unofficial functions to fulfill. The first is the need for documentation and definition. Someone has to record what has happened and what needs to happen in language that all can understand, and place the information in a place where it is accessible. This task, or at least responsibility to see that it gets done, generally falls to the project team. Another area that the team manages is the need for there to be a sign-off signifying that a task was completed satisfactorily. Sign-offs are needed for project management and for communication to the company at large about the project's progress. The job of identifying that a task has been completed and acquiring the appropriate signature for verification in most cases falls to the project team. The team also continually clarifies terminology. The best teams actually develop, update and keep a glossary of officially-approved definitions. This is used to avoid confusion and settle disputes. The team manages the sponsor (key authority figure that approves and promotes the project). Managing the sponsor means planning his/her activities in a way that will help the project. Finally the team members have to lead by example.




The final words go to a reminder of the main weapon available for assisting in conducting technology implementation projects, communication. The most important aspect of communication is that it is, by definition, two-way. Universally, companies and people are better at talking than listening. Those that master the art of listening will have success in any endeavor that has communication as a major component. More than one channel of communication is needed to reach all people and to address the various levels of detail required by various kinds of people. Different channels have different characteristics. Some are suited for straightforward simple messages to mass audiences (events, brochures, newsletters), while others are more suited for discussions of complex issues (interactive presentations, one-on-one meetings). Selecting the most appropriate channel is as important as the message being sent.

Communications have to address feelings as well as concrete things. Fears and doubts about the unknown are not as difficult to manage if a person knows that he/she is not alone and that the company is working to address those issues. One way to instill confidence and trust is to be open and honest. Companies should never underestimate their employees by sending sugar-coated communications. Employees can see right through messages that say everything is fine when they are not. In spite of their skill at recognizing smoke and mirrors in communications, employees can get lost if the messages are too theoretical and abstract. Translate the theories into practical examples. Use facts and realities rather than concepts. Illustrate with examples the audience can relate to. Finally, communications that are intended for a wide audience to be delivered via a channel that only allows one-way communication need to be tested on a small group in a controlled environment. If the message is not understandable, the confusion or misunderstanding that result can be corrected in the controlled group. The message must be adjusted until it conveys the intended meaning to the target audience.




Implementation is critical. If implementation is not handled well, all the signal processing, strategic analysis, decision making and planning will be wasted. Worse than that is the fact that considerable financial resources have been committed, and failure at this stage risks losing those resources and sometimes even more. Companies must pay special attention to the technology implementation process. They must realize that launching a technology implementation project is launching into a change management process and act accordingly.

This module provided information, structure, process and techniques that will help ensure success. However, the most important factor in success is effort. The company must be willing to put in the hard work, the extra hours and the enthusiasm to successfully take advantage of new technology.

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