TECHNOLOGY EVALUATION

Report produced for the EC funded project

INNOREGIO: dissemination of innovation and knowledge management techniques

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1 DESCRIPTION

1.1 A short history of Technology Evaluation

The roots of Technology Evaluation lie in the USA at the end of 1960s when large-scale applications of technology began to affect dramatically the life of citizens. However the origins of the field of Technology Evaluation can be traced to technology forecasting studies in the 1950s, where these studies attempt to forecast technological trends. These studies were basically intended to help large corporations and government agencies to adjust their technological investment schemes. Large think tanks, such as Rand and Hudson, made many technological forecasts.

In the same period, public interest in the negative effects of technology grew. Sometimes these effects only appeared long after the introduction of a technology. These negative effects were often unintended and unforeseen. A new kind of study was developed in the USA to assess all of the effects of technologies that were still to come. These studies were called Technology Evaluation or Assessment.

Industrialized countries have witnessed since World War II an ever-growing impact of technological developments on all aspects of human life. These developments, driven by market forces and governmental support, all had (and still have) the basic intension to change positively the quality of life. But very rapidly, questions were raised about possible secondary negative effects of new technologies on safety, health, employment and so on. Technology Evaluation in its original form was aimed at ‘’detecting’’ as soon as possible all unintended negative secondary effects.

Since then, the ideas about what technology evaluation can or should be have changed dramatically. Cronberg labeled this as the changing *discourses* of technology assessment, that is, the changing rules to understand and discuss technology evaluation. While the general issue for all technology assessment discourses has always been a focus on the societal implications of technology and technological change, changes have taken place on how these implications should be studied and on who should be implied in the process of technology evaluation. This has manifested itself in the emerging of different technology evaluation discourses and different technology evaluation practices.

Four main types of technology evaluation discourse are distinguished:

Type of Technology Evaluation	Description
Early Warning or Awareness	Forecasting technological developments and their impacts, to warn for unintended or undesirable consequences.
Strategic	Supporting specific actors or groups of actors in formulating their policy or strategy with respect to a specific technological development.
Constructive	Broadening the decision process about technological development, to shape the course of technological development in socially desirable directions.
Backcasting	Developing scenarios of desirable futures and starting innovation processes based on these scenarios.

1.2 What is the technique

Technology Evaluation, is a set of principles, methods and techniques/tools for effective assessing the potential value of a technology and its contribution to company's competitiveness and profitability. A thorough evaluation assesses the technology and its device's value from technical, market and consumer perspectives and reconciles the results within a valid methodology.

Technology Evaluation is one of the most significant techniques in innovation function, such as technology transfer and it is best utilized in screening new ideas, assessing innovative or not innovative technologies.

In other words, it's a powerful technique for an organization in examine new ideas, identifying and analyze causes or potential change, develop and plan possible solutions and finally select and implement the proposal technology.

The evaluation of a proposed technology must be very careful, considering and identifying all the *factors* that will affect the whole organization. These main *factors* are expected *financial benefits, competitiveness, added value* in its products and the impact upon the business as a whole.

The present technique can either be applied in small, medium or world class enterprises in order to evaluate mid and high tech technologies. Definitions about Technology Evaluation are given below:

1. Technology Evaluation is a class of policy studies, which systematically examine the effects on society that may occur when a technology is introduced, extended or modified. It emphasizes those consequences that are unintended, indirect or delayed.
2. Technology Evaluation is an attempt to establish an early warning system to detect, control, and direct technological changes and developments so as to maximize the public good while minimizing the public risks.
3. Technology Evaluation is a form of policy research, which provides a balanced appraisal to the policy maker. Ideally, it is a system to ask the right questions and obtain correct and timely answers. It identifies policy issues, assesses the impact of alternative courses of action and presents findings. It is a method of analysis that systematically appraises the nature, significance, status, and merit of a technological program.

Technology Evaluation is a process consisting of analyses of technological developments and their consequences as well as a debate on the basis of these analyses. Technology Evaluation should provide information that could help the actors involved in developing their strategies and that might define subjects for further Technology Evaluation analysis.

1.3 Objectives of the technique

The objectives of the present discussed technique are quite clearly and clarified. Independently of the kind and the size of the organization, either manufacturing or commercial, small, medium or wold class, *all* expect to be more competitive with increased profitability, as the result of the introduction of a new technology.

The basic purpose of the technology evaluation technique is to accomplish the above goals for the organization. So, the organization has to perform as far as possible detailed and punctilious examination of the proposed idea-technology.

In addition, the technology evaluation technique is used to introduce to the strategy of a company a methodology, which can enable the company to monitor and use various information sources, from which it is possible to get useful information.

The evaluation should be a continuous process with the possibility of terminating at any time in the light of additional information. It is not, of course, practicable to update all information at frequent intervals, but periodic major re-evaluations are also required when every aspect of the proposed technology can be reviewed.

1.4 Description / structure of the methodology / alternative solutions

In order to evaluate and select among different technologies the best fitted for the organization, some useful *steps/phases* are proposed that must be followed carefully and under potential review.

Following the proposed steps-methodology, it is very helpful to obtain acquire information about technology or technologies that could provide innovative or improved product or processes in the technology business.

Every step includes one or more technology management *tools*, which are essential and necessary for the implementation procedure. These steps can be summarized as follows:

Step 1: *Work Team Establishment* for a Preliminary Assessment.

Step 2: *Selection* or *Rejection* of the proposed technology, on the basis of the pre-evaluation made in step1.

Step 3: Identification of Areas where *Additional Information* is required.

Step 4: *Comparison* of *New Information* arising from step 3 with that used in the initial decision (step1).

Step 5: *Assessment* of possible *Conflicts*.

Step 6: Decision to *Terminate* or to *Proceed*, repeating steps 3-5.

Step 7: Detailed Evaluation considering:
- Corporate objectives, strategy, policies and values
- Marketing
- Financial criteria
- Production & Manufacturing criteria.

The technology management *tools* that can be used in each step are listed below:

1) Brainstorming
2) Delphi Method
3) Idea Advocate
4) Creativity Assessment
5) Venn Diagram
6) Cluster Analysis

7) Dendogram
8) Matrix Data Analysis
9) Factor Analysis
10) Opportunity Analysis
11) Reverse Brainstorming

In section 3, *Implementation procedure* and in the *Annex*, there is a detailed description about the usefulness of each tool its typical applications, and some examples of its implementations are illustrated.

The first step for the organization has to be the work team establishment with one or more managers that will have the responsibility to lead and guide the team through a successful evaluation process. According to the size of the company, the appointment of an expert experienced consultant can be achieved, depending on the difficulties of the project and the financial situation of the organization.

ALTERNATIVES
In essence there are no alternatives to Technology Evaluation techniques. An organization would decide to formalize and to implement technology evaluation to accomplish the right selection among proposed technologies, or to work randomly without any specific methodology. Work done individually will be based on specific tasks assigned to the individual and the outcome of the work would be joined by other pieces of work by other individual.

1.5 Expected results / benefits

The technology evaluation technique provides a methodology and a set of structured actions, which enables the enterprises to take into mind all the factors related with the proposed new technology.

Implementing the technology evaluation technique the organization will be able to identify improvement opportunities, innovation perspectives in products, processes and services.

The elegance of a new technology is of no value unless they result in a product people willing to purchase. So, while evaluating a new or an already used technology the organization has to look on how to produce more competitive products that will satisfy the consumers.

In addition, when a structured methodology is followed it will *cost* and *last* less more than working randomly without any plan, so recourses can be preserved for other activities of the enterprise.

1.6 Characteristics of firms / organizations and service providers

The firms / organizations who could be adequate to evaluate and select the best-fitted technology for an enterprise, have to perform some characteristics and specifications.

First of all the appointment of one or more experienced manager-s, in technology evaluation area, is the basic and the most critical step because the present technique is based mostly in human efficiency and talent, rather in "smart" devises (e.g. PC's) or related software. So the success or the failure of the evaluation is depended primarily on

the skillfulness of the team manager who has the responsibility of setting up the appropriate team.

After the first step, the team must have on hand some tools in order to perform the proposed actions/steps. The organization has to ensure the proper infrastructure, such as equipment, devices, and access to any necessary information, bibliography, papers, technical data, etc.

Such type of organizations in Greece are listed below:

- HIRC - Hellenic Innovation Relay Center
- FORTH – Foundation of Research and Technology Hellas
- ELKEPA - Greek Productivity Center
- MARTEDEC (EANT) - Marine Technology Development Company
- MIRTEC (EBETAM) – Metallurgical Industry and Research Technological Company.
- CERECO - Ceramics and Refractories Technological Development Company S.A.
- ETAT - Food Industrial Research and Technological Development Company S.A.
- CLOTEFI - *Clothing Textile and Fiber Technological Development S.A.*
- RC AUEB - *Research Center of Athens University of Economics and Business*
- PSP S.A. - *Patras Science Park S.A.*
- TTP / MDC - *Thessaloniki Technology Park - Management & Development Corporation S.A.*
- University Laboratories

2 APPLICATION

2.1 Where the technique has been applied (firms / organizations)

The technique has been applied mostly on high technology based firms, companies with strong infrastructure in innovation and technological development. Unfortunately no proper or official use to any traditional SME digits the fact that they do evaluate in their way (not as technology evaluation) the introduction of any new equipment and technique.

2.2 Types of firms / organization concerned

The present technique can either be applied in small, medium or world-class enterprises in order to evaluate mid and high-tech technologies.

2.3 Implementation cost (study and application in separate)

The implementation cost of the present technique cannot be clearly specified. It depends on complex factors concerning so much the organization itself as the nature of the proposed technology, either mid or high tech. Definitely the duration of the evaluation process increases the implementation cost so does the involvement of many experts.

2.4 Conditions for implementation

In order to implement the evaluation process there's absolute no need of excess equipment, devices, etc, and no modifications have to take place. As long as the company have her own business and action plans its implicit that the appropriate infrastructure been exist.

2.5 European organization supporting the implementation of the method

There are no specific European organizations specialized absolutely in technology evaluation technique. Though we can list below some organizations, R & D centers, Consultant Companies, Universities, etc, that are involved and promote innovation and technology transfer:

1. AIRI - Associazione Italiana per la Ricerca Industriale
2. APRODI – Association pour la promotion et le development industriel
3. Luxinnovation
4. Oxford innovation
5. TEKES – Teknologian kenittamiskeskus, etc.
6. FORTH – Foundation of Research and Technology Hellas
7. All the Greek organizations referred in paragraph 1.5.

(For more information see also: http://www.cordis.lu/imt.htm)

3 IMPLEMENTATION PROCEDURE

The implementation procedure has briefly discussed is section 1.3. In this section there is a detailed description of each step and the usefulness of the technology management tools, for each step.

3.1 Steps / phases

The proposed steps are listed below:

Step1: *Work Team Establishment* for a Preliminary Assessment. Usually the team can be constituted of 3-10 members. The primarily target of the team is to identify all the factors, such as financial benefits, competitiveness, impact upon the business as whole, relevant to the new technology. The determination of the rationale for the products (*market-place*), is the first target. So the team has to implement a pre-evaluation of the technology proposal in relation to these factors using quantitative information where available (e.g. previous implementations) or subjective quantitative judgments, where appropriate, when actual data is unobtainable. *Record* all assumptions and quantitative estimates as a control standard for future reference.

The proposed tools that can be used in step 1 are:

- Brainstorming
- Idea Advocate
- Opportunity Analysis

Step 2: *Selection* or *Rejection* of the proposed technology, on the basis of the pre-evaluation made in step1. In this step there may be used the same tools as in step 1.

Step 3: Identification of Areas where *Additional Information* is required and the recourses to obtain these data. After the first involvement of the company staff (team members) during the preliminary assessment phase, a more important involvement will take place when technical experts - consultants will be requested to participate and contribute to the evaluation process. Team members and consultants have to co-operate closely in order to obtain the most important information needed for the proposed technology, at the lower price for the company.

In that step the most important tools are:

- Delphi Method
- Creativity Assessment
- Opportunity Analysis

Step 4: *Comparison* of *New Information* arising from step 3 with that used in the initial decision (step1), hence the importance of *Recording* (*see step 1)* the earlier assumptions and estimates. Useful tools in this step are:

- Venn Diagram
- Cluster Analysis

Step 5: *Assessment* of the impact of any variances revealed in step 4, upon the continued viability of the technology. In this step we can define some possible *conflicts*, with other technologies used by the company or with other departments, products, etc.

The appropriate tools are:

- Venn Diagram
- Factor Analysis
- Cluster Analysis
- Dendogram

Step 6: Decision to *Terminate* or to *Proceed*, repeating in potential review steps 3-5, using:

- Idea Advocate
- Delphi Method
- Dendogram
- Reverse Brainstorming

Step 7: Detailed Evaluation considering:

1. Corporate objectives, strategy, policies and values
2. Marketing
3. Financial criteria
4. Production & Manufacturing criteria.

At this last step we can use some of the above-proposed tools and in addition:

- Matrix data Analysis
- Checklists
- Spreadsheets
- Flowcharts, etc.

At the stage of detailed evaluation we have to take into account of some important qualitative criteria, as reported below:

1. Corporate objectives, strategy, policies and values
   - 1.1 Strategy Planning
   - 1.2 Corporate mage
   - 1.3 Risk Aversion
   - 1.4 Attitude to innovation

2. Marketing
   - 2.1 Identifiable need
   - 2.2 Estimates sales volume - technology & product life
   - 2.3 Timescale and relationship to the market plan
   - 2.4 Effects upon current technologies & products
   - 2.5 Pricing
   - 2.6 Competition
   - 2.7 Launching cost

3. Financial criteria
   - 3.1 Cash flow

3.2 Effect upon other projects requiring finance

4. Production & Manufacturing criteria.
   4.1 Manufacturing capability
   4.2 Cost of manufacture
   4.3 Value added in production

3.2 Partial techniques and tools included in each step

At this section it is useful for the understanding of the technology management tools - mentioned above- to give a fully description and them typical applications:

1) Brainstorming

Description

Brainstorming is an idea-generating tool widely used by teams for identifying problems, alternative solutions to problems, or opportunities for improvement. This tool originated in 1941 by Alex F. Osborne, when his search for creative ideas resulted is an unstructured group process of interactive ‘’ brain-storming’’ that generated more and better ideas than individuals could produce working independently.

Typical application

- To unlock the creativity in teams.
- To generate a large list of ideas for problem solving or a list of problem areas for decision making or planning.
- To develop creative and alternative solutions.
- To identify improvement opportunities.
- To start innovation in processes, products, and services through team participation.

2) Delphi Method

Description

The Delphi method is a very structured approach used to acquire written opinion or to receive feedback about a problem on detailed questionnaires sent to experts. Used by the Rank Corporation during the 1950s, the use of questionnaires prevents interpersonal interaction that can often stifle individual contribution whenever some participants dominate the discussion. Participants’ anonymous responses are shared, and each participant can revise his or her response on the basis of reading other opinions. After repeating this process several times, the convergence of opinion will lead to team consensus.

Typical application

- To solicit opinions or ideas from a jury of experts, anonymously circulate questionnaires repeatedly for revisions and consolidation in order to arrive at a final forecast, choice, or action plan.
- To generate ideas by a group of experts, allow them to revise their own ideas after having read all other ideas, and finally have a summarized statement that reflects group consensus.
- To forecast trends in economic and technological forces that may affect the organization.

3) Idea Advocate

Description

First used by the Battle Institute of Frankfurt, Germany, the idea advocate is an excellent idea-evaluation tool. The team assigns the role of idea advocate to a participant who

promotes a particular idea as the most valuable from a list of previously generated ideas. The more an idea advocate promotes different ideas, the more powerful the selection process, since every idea is fully examined by the evaluation team.

Typical application
- To ensure fair examination of all ideas
- To give every presented idea equal chance of being selected
- To uncover the positive aspects of every idea presented.

4) Creativity assessment
Description
Developed by Leo Moore, the creativity assessment technique is applied as a sorting and rating process to a long list of brainstormed ideas. It should help teams with evaluation and categorization by selecting ideas on the basis of predetermined criteria.

Typical application
- To categorize a list of generated ideas using team-established criteria.
- To evaluate and sort ideas into groups.
- To screen ideas or solutions considered for implementation.

5) Venn Diagram
Description
A Venn diagram can be used to identify logical relationships, and it is very useful in displaying the union and intersection of events or sets. It can be graphically illustrate the mutually exclusive concept and other rules of probability or the outcome of an experiment.

Typical application
- To illustrate the relationship of events, sets, or behavior.
- To help understand the consequences when two events intersect or are combined
- To test the validity of a syllogism by applying logical thinking

6) Cluster analysis
Description
The cluster analysis tool is best utilized after a brainstorming session to organize data by subdividing different ideas, items, or characteristics into relatively similar groups, each under a topical heading. Mainly a discovery tool, it often surfaces perceived problem areas, concerns, or items that naturally belong together.

Typical application
- To classify data into natural groupings on the basis of similar or related characteristics.
- To identify most important characteristics to be considered in developing a problem specification.
- To develop a more homogeneous group of items from a large list of dissimilar items.
- To identify differences among customer, employee, or supplier groups in regard to quality perception and performance issues.

7) Dendogram
Description
The dendogram displays, in a tree-type classification format, clusters of characteristics or ideas to be analyzed for potential breakthroughs in product design and development. It

can also be used to detail possible solutions to problems or examine process improvement opportunities.

Typical application
- To search for potential product innovations
- To break down and classify large data sets.
- To review and question ideas for problem resolution or process improvement.

8) Matrix data analysis
Description
The matrix data analysis tool is essentially a display of data characteristics used by integrated product development (IPDT) to perform market research and describe products and services. Matrix data is arranged for easy visualization and comparisons. Relationships between data variables shown on both axes are identified using symbols for importance or numerical values for evaluations.

Typical application
- To determine the representative characteristics of customer or products.
- To perform market research.
- To verify the strength of relationships among variables.

9) Factor Analysis
Description
A factor analysis is an assessment technique that surfaces product, process, or service factors that may require immediate attention or further analysis. Similar to benchmarking, product and/or service factor ratings are compared to best in class or to one's own organization to determine competitive strengths and weaknesses.

Typical application
- To assess best in class processes
- To compare product and service ratings with those of the competition
- To identify problem areas for the assignment to problem-solving teams.

10) Opportunity analysis
Description
The opportunity analysis is an effective tool for a team to evaluate and select the most preferred opportunity among many. Similar to criteria filtering, identified improvement opportunities are rated against criteria such as organizational importance, feasibility of completion, and potential benefit against resources needed to implement the top-rated choice.

Typical application
- To identify and plan for implementing the most preferred improvement opportunity.
- To provide a structured approach for teams to select high potential change
- To determine and use criteria for profitable resource allocation.

11) Reverse brainstorming
Description
Reverse brainstorming can be used as a final evaluation technique(tool) through the critical questioning of the value or applicability of previously team-generated ideas. In addition, this process attempts to uncover potential problems or other serious consequences when an idea or proposed solution is implemented.

Typical application

- To minimize the risk prior to the implementation of an idea or proposed solution
- To reverse brainstorm ideas for weaknesses or serious consequences
- To criticize ideas for the purpose of reducing many to a few overall ‘’best’’ ideas.

3.3 Supplementary methods

Additionally three supplementary methods can be used for technology assessment:

1. Methods of analysis
2. Intervention methods, and
3. Reflective studies

Methods of analysis are used to analyze a specific aspect related to a technology assessment problem. These methods include forecasting, construction of scenarios, analyses of technological options, definition and analysis of impacts (such as life cycle analyses), market studies, policy studies, and etc. Parts of them are textbook methods. Such methods are used in the above-mentioned studies, but can also support the decision process in more process-oriented types of technology assessment.

Intervention methods serve as heuristics for interfering in the decision process on technology development (for example methods for interventions in innovation networks). These methods are exclusively used in process-oriented types of technology assessment.

Reflective studies concern the organization of the decision and development process itself. They focus on the optimal way to integrate societal influences in the development process and on ways to promote the development and implementation of technologies that respond better to societal desires than existing technologies. These studies are of a general socio-economic type, and have no particular repertoire of methods.

A second distinction concerns the scope of methods:

- Methods that serve as *Project Layout*.

These methods aim an integrating different perspective of the subject of study or of the decision process to be addressed. They mostly entail a complex set of actions to be performed.

- Methods that serve as *Tools*.

These methods serve as tools mostly as parts of larger projects.

	Type	
Scope	Methods of analysis	Intervention methods
Project Layout	Layout of study	Layout of interventions
Tools	Tolls for analysis	Interventions tools

3.4 Alternative Tools

1. LAYOUT OF STUDY

- Technological forecasting: it aims at developing pictures of the future development of technology. Sometimes particularly in ATA (Awareness Technology Assessment), these pictures are considered as predictions of future technologies. In CTA (Constructive Technology Assessment) forecasts also are carried out, but they

are generally considered more as probable futures (under "business as usual" conditions) or technological options) as specific conditions change). However, technological forecasts have considerable limitations, particularly if conceived in the strict predictive sense.

- Impact Assessment: Very elaborate impact assessment methods are scarce in the field of technology assessment. Within this field impact assessment has often had the character of impact identification, based on expert interviews, brainstorms and common sense. The proper analysis of impacts has been left to experts in the specific fields. The evaluation of impacts again is often the task of the technology assessor.

- Scenario analysis: Scenarios may be used to describe possible future states of society, including technological developments. Two types can be distinguished: (a) Scenarios which concern an organization or specific problem, and in which the environment of the organization or problem is modified. These types of scenarios are especially used in corporate planning. (b) Scenarios, which concern the society as a whole or larger parts of it. These types of scenarios are especially used for public technology assessment.

2. LAYOUT OF INTERVENTIONS

- Intervention in innovation networks: Analysis and adapting technology networks is one example. The network of actors involved in some way or another is assumed to constitute the course of technological development, including its direction. Adaptations of the network can modify this course into socially desired directions. An example of an intervention is organizing interfaces between research departments and other actors, particularly those representing societal interests.

- Connecting Separated Networks: This is in fact a specific example of an intervention in innovation networks. The study approach was developed in the study Environmental Design by Cooperation of the Dutch Technology Assessment Institute, in 1990. The study concerned recycling of cars. An analysis showed that two networks of actors could be distinguished in the life cycle of a car: the design and reprocessing context.

- Demand Articulation: Demand Articulation can be distinguished as the adaptations in the social-institutional system, necessary for the development and adoption of a new technology. Most recently, the same term has been used to indicate process to make manifest certain latent societal demands of a new technology.

3. TOOLS FOR ANALYSIS

- Trend Extrapolation: A well-known and generally used model as a foundation of these forecasts is the product life cycle. This model supposes that products had a "life", i.e., they were created, grew, flourished, and eventually became obsolete and were replaced by new products. The model can be used to forecast the diffusion of a product. A limitation is that trend extrapolation can only be performed when a new technology is already on its way. The longer the technology already exists, the better the forecast generally will be.

- Structured Interaction: Getting the opinions of experts or relevant actors is often very important. However, it is often important structured interactions with actors, and their mutual interactions. *Brainstorming* has been a very popular method to generate new ideas. Whether this method really produces new ideas is very questionable.

- Checklists: Checklists are a practical tool for not forgetting specific aspects of a technology assessment study. There are many types of checklists.

- Socio-technical Maps: Socio-technical Maps might be seen as types of checklists by which aspects of socio-technical development are captured. For example one kind of map focuses on:
  a) The hierarchy of variation and selection involved in technological development,
  b) The roots of innovations
  c) The actors involved
  d) Expectations of actors
  e) Effects of innovations
  f) Critical episodes in trajectories
  g) Developing episodes

4. INTERVENTION TOOLS

The *consensus conference* is mostly used in participatory technology assessment. Lay people are brought together in a many-day workshop setting to discuss a new innovation. They are entitled to call upon experts. In the end the lay people have to come to a conclusion on the subject at the stake. The method is appropriate for innovations, which involve ethical issues, for instance in genetic engineering or issues of birth control.

Criteria for choice
The question is what are the criteria for the choice of type of technology assessment, project outlay, and tools for the solution of a specific problem. Although this is an open question, some suggested criteria are given bellow:

1. Phase in the development
2. Degree of polarization
3. Origins of the problem
4. Type of technology
5. Position on the R&D Agenda
6. Time dimension

3.5 Related software (existing or being prepared)

The most common tools for this technique are statistical packets (SPSS), spreadsheets and databases. However the National Technology Transfer Center (NTTC) developed a specific software tool concerning the evaluation of an existing or been prepared technology. This called ***TOP Index Program*** (TOP).

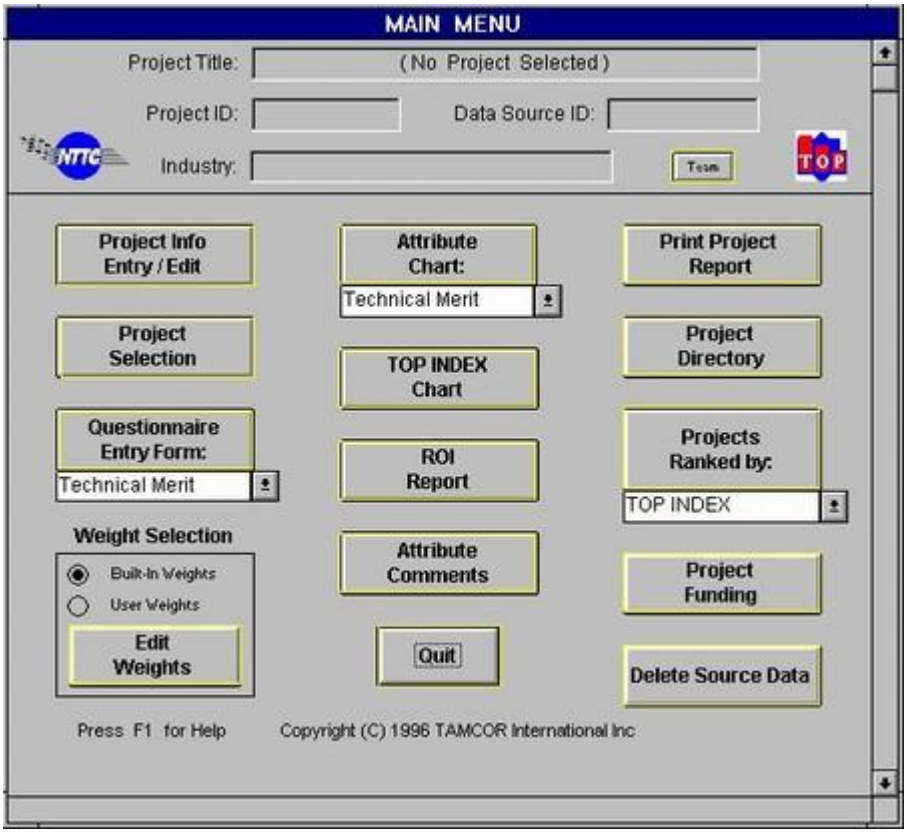
Some ey features are:

- Extensive reviewer questionnaire
- Easy to read graphic displays
- Technologies coupled to SIC code
- Built-in weights by industry
- Weights can be modified by user
- Financial analysis with Built-in industry values
- Project monitoring and prioritization capabilities
- Extensive project report and analysis printouts
- Complete user's manual included in on-line help

Application of the TOP index program
- Selection of patent candidates
- Investment decisions
- Prioritization of projects
- Development guide
- Project tracking and monitoring
- New product planning
- Teaching tool

Addressed Users
- Technology based corporations
- University Technology Transfer Managers (TTM)
- Federal laboratories
- Business development organizations
- Venture capital firms
- Investment bankers
- Funding agencies
- Patent law firms / licensing executives
- Business schools

The main menu window of the TOP Index Program presented below:



For more information see: www.ncct.edu

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URL's

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2. http://www.cordis.lu/imt.htm
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Annexes

Annex 1: Utilisation of tools in each step

	Tool 1	Tool 2	Tool 3	Tool 4	Tool 5	Tool 6	Tool 7	Tool 8	Tool 9	Tool 10	Tool 11
	Brainstorming	Delphi Method	Idea Advocate	Creativity assessment	Venn Diagram	Cluster analysis	Dendogram	Matrix data analysis	Factor Analysis	Opportunity analysis	Reverse brainstorming
step 1	■		■							■	
step 2	■		■							■	
step 3		■		■						■	
step 4						■			■		■
step 5					■	■	■		■		
step 6		■	■				■				■
step 7				■	■	■	■	■	■		

Annex 2: Examples of Partial Techniques and Tools Applications

1) Brainstorming

Step-by-step procedure

STEP 1 Form a team of approximately 6-10 people.

STEP 2 Communicate brainstorming guidelines and set time limit (approximately 15-20 minutes).

STEP 3 State purpose for session; discuss specific problem or topic. See example *Improve Quality*.

STEP 4 Establish a positive, nonthreatening setting and encourage all members to participate in a free-wheeling expression or ideas.

STEP 5 Record, on flip charts, all ideas generated; the emphasis is on quantity, not quality.

STEP 6 When the team has run out of ideas, review and clarify each idea (no discussion).

STEP 7 Allow some time for ideas to incubate.

STEP 8 Identify or prioritize useful ideas.

Example of tool application

Improve Quality

Flip chart 1	**Flip chart 2**
- More training - Short due dates - Inexperience - No communication - Missing information - What is a defect? - Constant changes - No inspections - Too much work - Many interruptions - Group conflict - Incorrect testing	- Lack of proper tools - Low job satisfaction - Specifications unclear - Lack of instructions - Low morale, motivation - Lack of metrics - Involve customers - Stressful work - Equipment problems - Lack of data - Need problem-solving teams - No procedures End of idea

2) Delphi Method

Step-by-step procedure

STEP 1 The first activity is to identify and select a team of participants. A trained facilitator coordinates this process and thoroughly explains the Delphi method's objectives and processes to the participants.

STEP 2 Participants, isolated from each other, are sent detailed questionnaires, problem statements, or preliminary forecasts for their response or opinion.

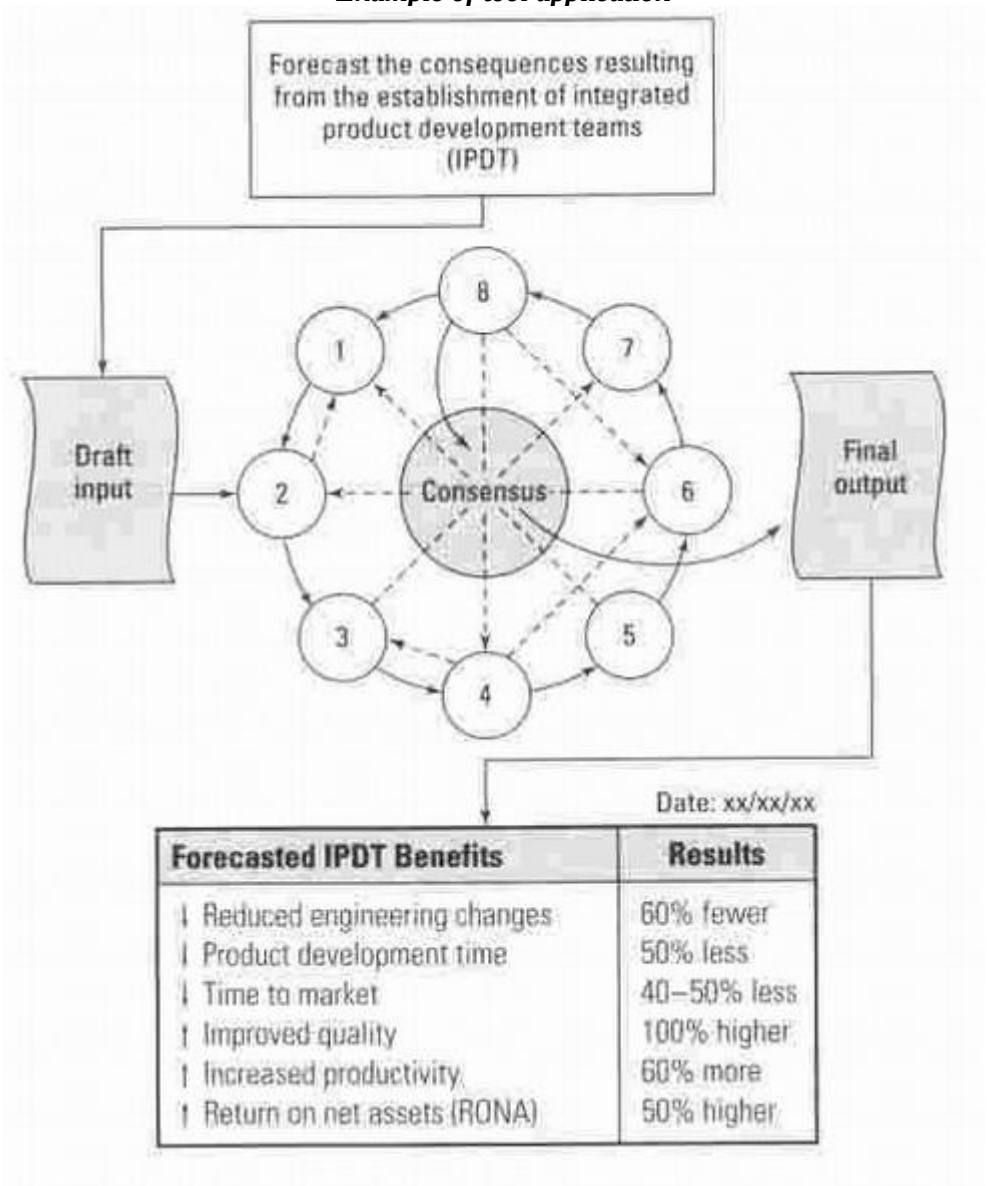
See example *Forecast the Consequences Resulting from the Establishment Integrated Product Development Teams (IPDT)*.

STEP 3 The completed questionnaires, problem statements, or forecasts are summarized by the facilitator and anonymously redistributed to the participants.

STEP 4 Participants read all the responses. Participants may or may not choose to revise their own response(s).

STEP 5 Steps 4 and 5 repeated until participants stop revising their own responses. At this point, team consensus is reached.

Example of tool application



3) Idea Advocate

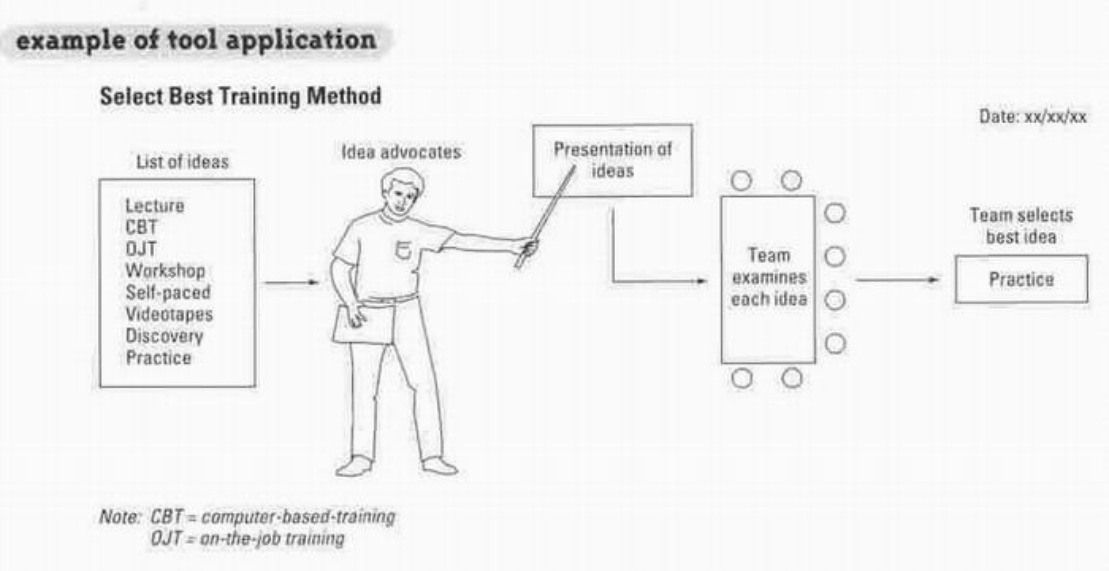
Step-by-step procedure

STEP 1 The team reviews a list of previously generated ideas.

STEP 2 The next task is to assign idea advocate roles to (a) the person who proposed the idea, b) the person who will implement the idea, and (c) the person who strongly argues in support of selecting the idea.

STEP 3 The team examines each idea as it is presented by an idea advocate who explains why selecting the idea makes sense and why the idea would indeed be the best among all others.

STEP 4 After all idea advocates have presented their ideas, the team reaches consensus on which idea has the highest potential to solve a problem or improve a process.



4) Creative assessment

Step-by-step procedure

STEP 1 The team's facilitator displays flip charts of previously brainstormed ideas. See example *Improve Quality.*

STEP 2 The participants establish the criteria for assessment. In this example the criteria are easy to do, hard to do, and most difficult to do.

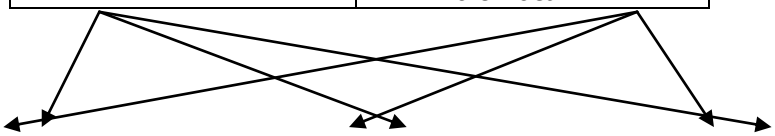
STEP 3 The facilitator writes the respective category headings on three flip charts, and participants evaluate and organize ideas into the three categories as shown in this example.

STEP 4 After all ideas have been categorized, the three resulting categories I-III are reviewed and dated.

STEP 5 Lastly, the team presents the three idea categories to upper management for further evaluation and action.

Example of tool application
Improve Quality

Flip chart 1	Flip chart 2
- More training - Short due dates - Inexperience - No communication - Missing information - What is a defect? - Constant changes - No inspections - Too much work - Many interruptions - Group conflict - Incorrect testing	- Lack of proper tools - Low job satisfaction - Specifications unclear - Lack of instructions - Low morale, motivation - Lack of metrics - Involve customers - Stressful work - Equipment problems - Lack of data - Need problem-solving teams - No procedures End of idea



I-Easy to Do	II-Hard to Do	III-Most Difficult to Do
- Missing info - No inspections - Too much work - Many interruptions - Incorrect testing - Lack of proper tools - Specifications unclear - Equipment problems	- More training - Inexperience - No communications - What is a defect? - Constant changes - Lack of instructions - Lack of metrics - Stressful work - Lack of data - Need PS teams - No procedures	- Short due dates - Group conflict - Low job satisfaction - Low morale, motivation - Involve customers

5) Venn Diagram

Step-by-step procedure

STEP 1 Identify events or sets and their relationships, interactions or outcomes that may be better understood using a Venn diagram. See example *Venn Diagram Applications*.

STEP 2 Construct a Venn diagram, designate the circles and provide explanations. Run-it-by others for their comments.

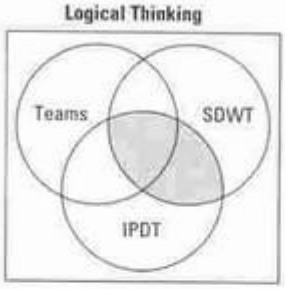
STEP 3 Display in training sessions or presentations to facilitate conceptual understanding.

STEP 4 Identify examples to illustrate the concept.

example of tool application

Venn Diagram Applications

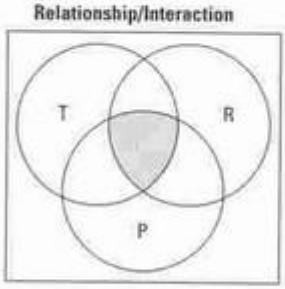
Logical Thinking



Testing the validity of a syllogism:
- No self-directed work teams (SDWT) are integrated product development teams (IPDT)
- Some teams are SDWTs
- Therefore, some teams are not IPDTs

The shaded area reflects that there are no SDWTs that are also IPDTs!

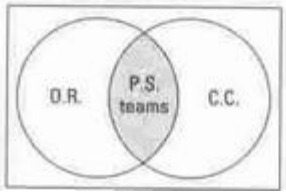
Relationship/Interaction



Illustrating the ideal learning approach.
- Theory (T)
- Research (R)
- Practice (P)

The shaded area reflects where all learning is greatly reinforced.

Problem Resolution



A call for action on the basis of:
- Experiencing customer complaints (C.C.)
- Organization's resources available (O.R.)
- Suggests problem-solving teams

The shaded area reflects an outcome of combining sets.

6) Cluster analysis

Step-by-step procedure

STEP 1 The team facilitator displays the flip charts of previously brainstormed data to the team. See example *Clustering Brainstormed Data: Improve Quality.*

STEP 2 The team looks at all items and suggests general or topical headings for similar items. They become the cluster names.

STEP 3 The facilitator records all suggested cluster names and ask participants to sort or organize items to be placed under each cluster name. As participants call out items, the facilitator designates the items on the flip charts with the first letter of the cluster name as shown in the example.

STEP 4 Once all items have been designated, a final chart of formed clusters (groups) is drawn.

STEP 5 The resulting cluster chart is dated and saved for future reference.

Example of tool application

Clustering Brainstormed Data: Improve Quality

Cluster Names	Flip chart 1	Flip chart 2
P = People I = Information T = Technical C = Causes S = Solutions	S - More training C - Short due dates P - Inexperience I - No communication I - Missing information T - What is a defect? T - Constant changes C - No inspections C - Too much work C - Many interruptions P - Group conflict C - Incorrect testing	C - Lack of proper tools P - Low job satisfaction I - Specifications unclear I - Lack of instructions P - Low morale, motivation T - Lack of metrics S - Involve customers C - Stressful work C - Equipment problems T - Lack of data S - Need problem-solving teams I - No procedures End of idea

Resulting Clusters **Date: xx/xx/xx**				
People	**Information**	**Technical**	**Causes**	**Solutions**
-Group conflict -Low job satisfaction -Low morale -Inexperience	-No communication -Missing info -Specifications unclear -Lackof instructions -No procedures	-Constant changes -Lack of metrics -Lack of data -What is a defect?	-Equipment problems -Lack of proper tools -Short due dates -Many interruptions -Incorrect testing -Lack of instruction -Stressful work -No inspections -Too much work	-More training -Involve customers -Need problem-solving teams

7) Dendogram

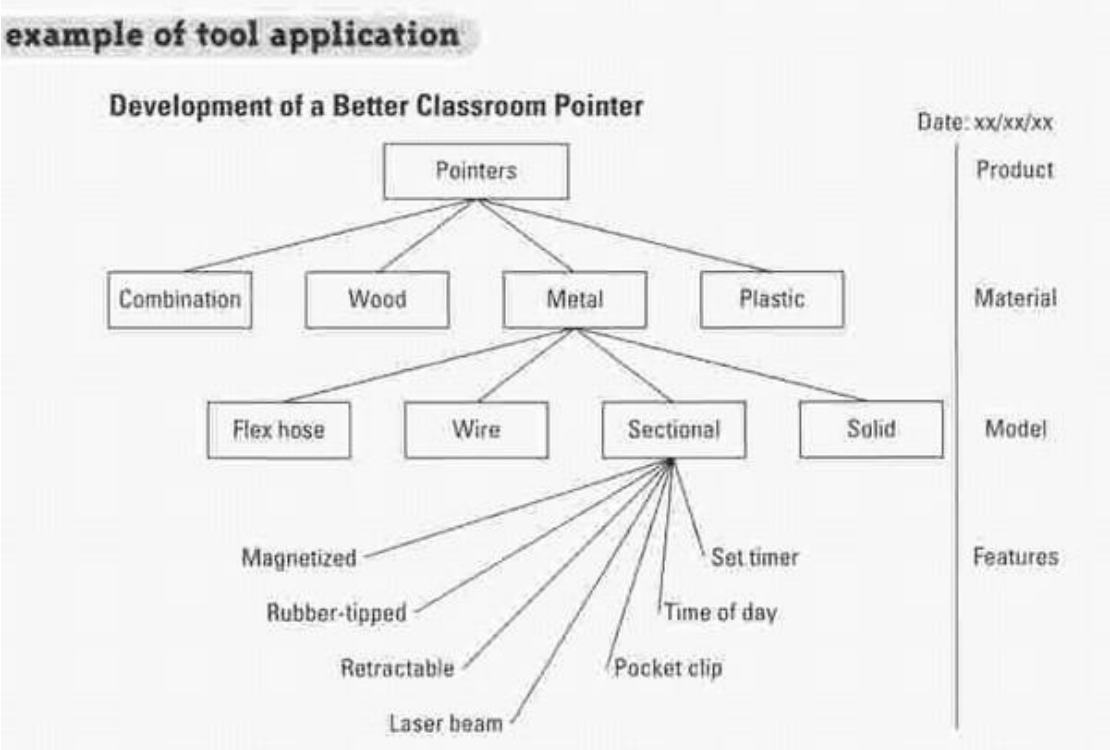
Step-by-step procedure

STEP 1 The team facilitator describes the use of a dendrogram and asks the team to brainstorm items within an area of interest. See *example Development of a Better Classroom Pointer.*

STEP 2 The facilitator draws the dendrogram on a whiteboard as the participants further break down a selected characteristic or idea.

STEP 3 The participants discuss preferred ideas and select one for product innovation or problem analysis, as shown in this example.

STEP 4 The participants review the flowdown of characteristics or ideas and date the dendrogram.



8) Matrix data analysis

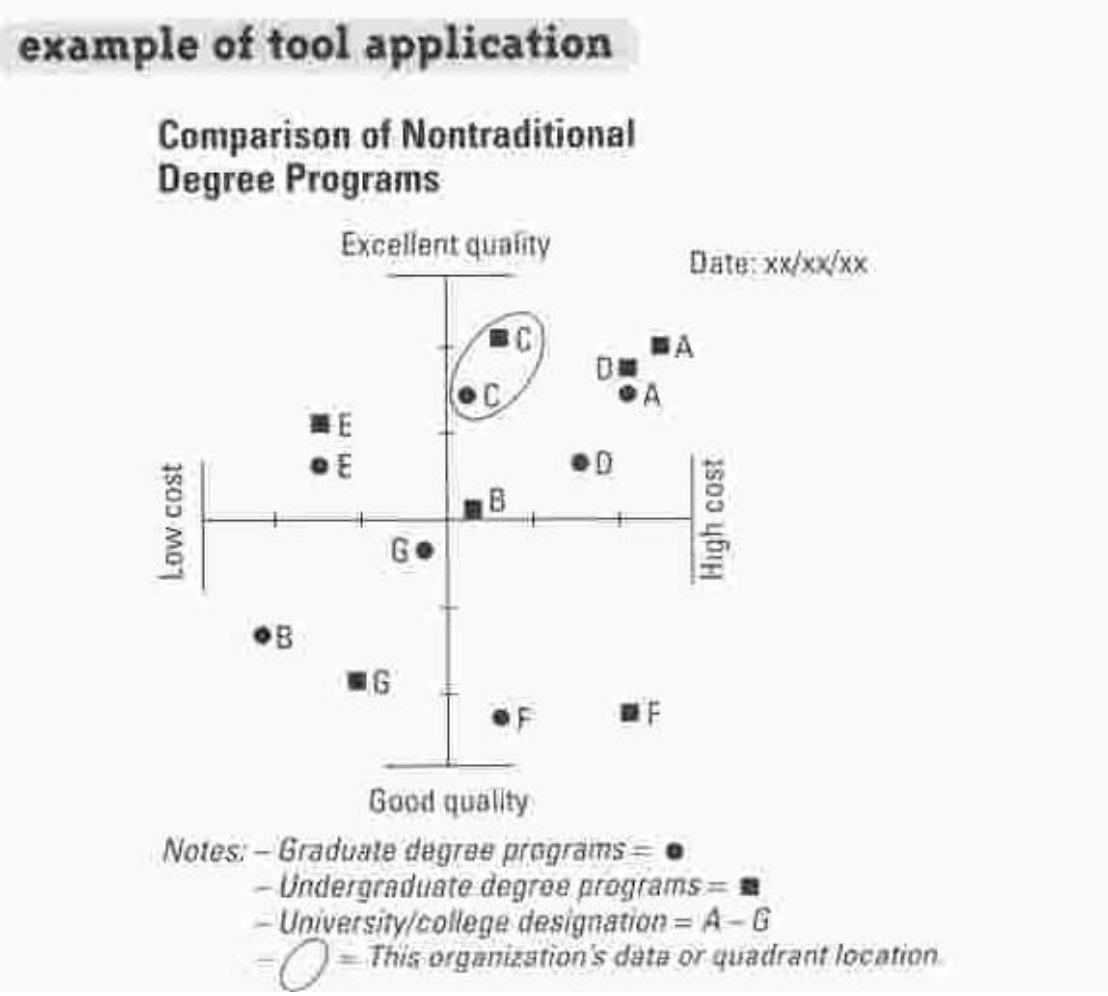
Step-by-step procedure

STEP 1 The team first determines what characteristics need to be analyzed. This process may be influenced by some product or service concern, loss of market share, or unfavorable benchmarking results. See *example Comparison of Nontraditional Degree Programs.*

STEP 2 A research and data collection process is performed to acquire the data to be charted on the matrix data analysis chart. Data may come from surveys, interviews, focus groups, historical records, benchmarks, or published sources. Ensure that appropriate scales are used to position or calculate data.

STEP 3 Next, tem consensus is required to plot the comparison data on the chart. Care must be taken to ensure the unbiased positioning of the organization's data, as shown in this example.

STEP 4 The completed chart is discussed, all relationships are reviewed, and a summary statement is prepared. Finally, the chart is dated and presented to the process owners.



9) Factor Analysis

Step-by-step procedure

STEP 1 An integrated product development team (IDPT) selects the most important product or service factors to be analyzed. See *example TV/Cable Providers-Service Factors Analysis.*

STEP 2 Next, competitors are identified for data collection on the selected factors. Sources of data are customer satisfaction surveys, benchmarking partnerships, secondary data, interviews, documentation, and others.

STEP 3 Data from competitors and one's own organization are verified, rated, and organized into category of factors grouping.

STEP 4 A factor analysis table is constructed and ratings recorded for each listed factor. Also, a category of factor average is calculated and recorded.

STEP 5 Finally, the factor analysis table is checked for completeness, dated, and presented to respective process owners.

Example of tool application

TV/Cable Providers-Service Factors Analysis

Date xx/xx/xx	**Service Provider A**				**Service Provider B**				**Service Provider C**				**Our Service**			
Service Factors																
Ordering/scheduling			(1.75)				(2.75)				(3.50)				(2.50)	
-Customer service			■			■			■					■		
-Product availability			■		■					■				■		
-Wait period				■				■		■					■	
-Flexibility			■			■			■						■	
Pricing/billing			(2.00)				(3.25)				(2.50)				(3.00)	
-Rate structure			■			■					■			■		
-Bundling			■			■					■				■	
- Info detail		■			■						■		■			
-Billing errors				■		■			■					■		
Installation/support			(1.50)				(3.50)				(3.25)				(2.25)	
-On-site visit			■		■						■			■		
-Ease of use				■			■			■						■
-Complaint handling				■	■				■						■	
-Repair service			■		■				■					■		

Notes: Service quality ratings : 4 = very high, 3 = high, 2 = medium, 1 = low
(1.75) = average category of factors rating (2+2+2+1+ divided by 4.7 - 4 = 1.75).

10) Opportunity analysis

Step-by-step procedure

STEP 1 As a first step, the team facilitator introduces the opportunity analysis process. Rating criteria and final ranking is also discussed.

STEP 2 A prepared flip chart listing all of the opportunities is shown for the team to review and discuss.

STEP 3 Next, all criteria is clarified in order to have full understanding for the rating of listed improvement opportunities. See example *Reduction of Defect per Unit (DPU) Level.*

STEP 4 The team evaluates (rates) each opportunity, reaching consensus in the process.

STEP 5 A final ranking occurs and the top-rated improvement opportunity is identified.

STEP 6 The final chart is dated and next steps are briefly discussed.

Example of tool application

Reduction of Defects Per Unit (DPU) Level

Date: 11/15/xx	**Organizational Importance**			**Feasibility of completion**			**Potential Benefit**			**Rank**
Improvement Opportunities	H	M	L	H	M	L	H	M	L	
1.Select best supplies		M			M			M		5
2.Involve the customer	H				M		H			2.5
3.Increase testing efficiency		M				L			L	7
4.Use parts of known process	H				M		H			2.5
5. Apply robust design principles	H			H			H			1
6. Reduce process variation	H				M			M		4
7. Provide SPC training			L	H					L	6

Note: Opportunity number 5 is highest ranked

Three Hs = 9 points = rank 1

11) Reserve brainstorming

Step-by-step procedure

STEP 1 The team displays a final list of previously brainstorming ideas that passed preliminary evaluation-a reduced list at this point.

STEP 2 One by one, all ideas are questioned or criticized for possible shortcomings, problems, weakness, or serious consequences if implemented.

STEP 3 After all ideas have been evaluated and the potential solutions to problem areas of each idea considered and analyzed, the team selects one (or more) "best" idea that would hold a minimum amount of risk when implemented.

Example of tool application

Increase Operator Job Satisfaction

Final List of Previously Brainstormed Ideas that Passed Preliminary Evaluation date:xx/xx/xx
1. Establish flextime for operators
2. Change to self management
3. More on the job training @
4. They perform equipment maintenance
5. They do their own job scheduling
6. Change assembly line to work cells
7. Provide optional 4/40 work week
8. Rotate job assignments @
9. Enrich the present job
10. Form teams for process improvement @

Final Doable List of Ideas After Exhaustive Critical Questioning and Analysis
3. More on the job training
8. Rotate job assignments
10. Form teams for process improvement

Consensus Reached on Best Idea for Immediate Implementation
8. Rotate job assignments

Annex 3: An example of technology evaluation

Polyvinylchloride (PVC)

After polyethylene, PVC is the most produced and used plastic material. It is used in thousand of products, ranging from everyday life products such as credit cards, toys, to professional building and construction materials, and high specialized applications such as medical equipment. However, notwithstanding its popularity, from its early commercial production in the 1930s, PVC has been the subject of repeated criticism because of health and environmental aspects. Influenced by the environmental movement, recent years have seen fierce debates between protagonists and antagonists of PVC. The PVC and chlorine industry is striking back hard on everyone who dares to accuse PVC. In spite of several endeavors to start a more constructive debate between the antagonists, they see not to be able to come to speaking terms. The discussion is characterized by many uncertainties concerning the precise nature and extent of possible impacts, technological (im)possibilities for improvement, the current and future performance and availability of alternative materials, etc. In fact, until now it has been impossible to give objective and rational answers to the question of whether we should continue and improve PVC production and consumption, or partly phase it out and switch to alternatives materials, for the sake of the so desired sustainable development.

The question is which technology evaluation method could contribute to the solution of the problem. If we look at the criteria mentioned before, the situation can be described as highly polarized, with increasingly quantitative debates (parties fire at each other with ever new facts and figures). The discussions concern specific technologies, which are generally mature, and have a non-systematic nature. In table 2 the PVC problem would have to be situated at the right and at the bottom (polarized/nature). Furthermore rather long-term decision and development processes are involved, whereas the scale of the problem differs to various parties mentioned (PVC producers will be more affected by a negative outcome of the decision process than PVC processors, which in turn will be more affected than end customers). The problem resides rather high on the political and societal agenda. As PVC industry makes it appear, the search for alternative materials or production business is not on their R&D agenda (although it is, of course, on the agenda of the alternatives materials producers). However the other (and their favored) future direction is the improvement of PVC and its production and processing occupies an important part of their R&D activities.

The most appropriate technology assessment approach for this problem would entail a combination of analysis and process oriented activities, the result of the first serving as a basis and input for the second. Technology assessment analysis might focus on development future scenarios, to gain insight in the various sustainable future options. Scenarios could be used to obtain more clarity on the differences and similarities between the development paths leading to these different futures. This could yield insights in which technologies and innovation options are useful in different futures, and hence are worth developing despite possible remaining uncertainties on which future is the most desirable (“robust” technology options).

However, more important, because the PVC debate apparently is based in differences in norms and values of the different parties involved, the technology assessment analysis has to be followed by constructive debates and decision processes between these parties. Because up until now every effort in this direction has failed, the process oriented technology assessment should primarily focus on starting up and facilitating (constructive) interaction, and on building mutual understanding between the parties. Only then will constructive debates decision processes become a possibility. Hence, the most appropriate general project layout seems to be participatory technology assessment. So far the most appropriate methods are in

accordance with Table 2. Moreover, when a certain level of mutual understanding is reached, a consensus conference might be organized to facilitate the actual decision-making process and the formulation of strategies.

Other intervention oriented project layouts that might be useful instead of complementary to the participatory technology assessment, are demand articulation and strategic niche management. On first sight demand for changes is clearly present, but in practice, PVC product suppliers often state that as long as the consumer wishes to buy PVC, they will continue to supply it. In fact this demand articulation is exactly what Greenpeace tried to work on in their PVC free Municipalities campaign. Strategic niche management could take the form of giving extra attention to already existing alternative materials (e.g. gathering data, developing improvement options), to bring these alternative options to a more equal knowledge and competition level with PVC.

Table 2 - Classification of methods According to face of the Technology and Degree of Polarization

	Degree of polarization	
Phase in development	Low	High
Idea	Delphi	Delphi
Design	Impact assessment Consumer CTA[1] Strategic niche management	Demand articulation Consumer CTA Participatory TA[2]
Market introduction	Impact assessment Trend extrapolation	
Maturity	Network manipulation	Citizens initiatives Scenarios Participatory TA

[1] Constructive Technology Assessment

[2] Technology Assessment