TRIZ and Technology Roadmapping

Introduction

Technology Roadmapping is a form of technology planning and can help companies identify promising technology platforms for development. There are various ways of approaching the task, but essentially there are 7 steps:

1. Define the scope
2. Specify the system requirements
3. Define the major technology areas
4. Research their drivers
5. Explore alternatives and timelines
6. Recommend best course of action and
7. Create the roadmap.

TRIZ (Theory of Inventive Problem Solving) is a systematic approach to innovation and as such is ideally suited to managing complex data and brainstorming new options for technology intelligence. There are a number of TRIZ approaches that can be used throughout the roadmapping process, but the focus here will be for defining the major technology areas (step 2) and exploring alternatives (step 5).

Define Major Technology Areas

Tools that can be applied at this stage include Function Analysis and Systems Analysis.

Function Analysis

This tool is used to define the elements of a system, their relation to one another and whether that relation is effective, ineffective or harmful. An easy way to get started with this is to list out the elements and then fill in the table below (see *Table 1*).

A	Does this to	B	Analysis (Effective, Ineffective, Harmful)

Table 1 - Function Analysis Table

You can then build a model of the elements and how the relate to identify the 'sore points' for improvement (see *Fig 1*).

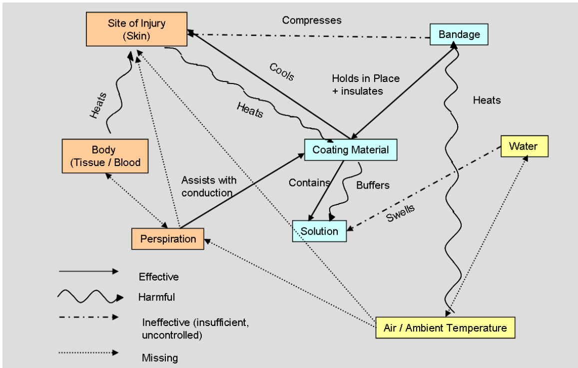

Figure 1 - Example of Function Analysis

Systems Analysis

Once we have defined the elements of a system we can start to build a picture of the current state of the technology. Starting with the system (e.g. plasma screen in *Fig 2* below), we can map the current available alternatives (competitive products). At the lower level (sub-system) we are looking to develop the relations between the system and its components (e.g. thin film transistors). In the other direction (super system and super^2 system if necessary) we are moving up the value chain. Here we record how the system fits into the next level, either as a component in another product or as an application (e.g. television).

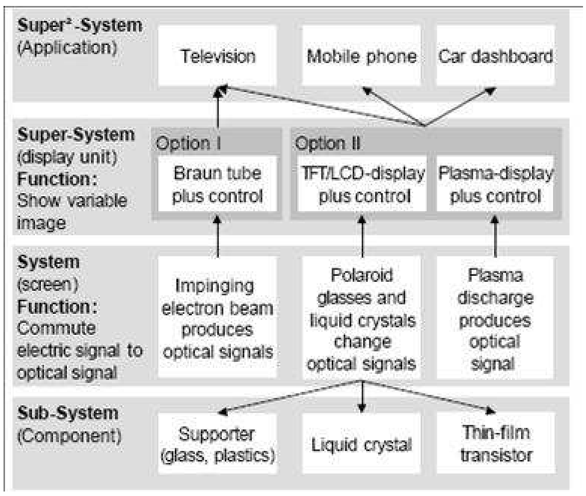

Figure 2 - Systems approach to analyse the environment and identify alternatives at all levels

Source: Schuh, TRIZ-based technology intelligence, 2003)

© True North Innovation 2007

Systems Analysis is a useful method of structuring the current information before mapping the future trends.

Explore Alternative Technologies

There are a number of TRIZ tools that can be used when it comes to looking at potential technologies for the future – Ideal Final Result, Function and Attribute Databases, S-Curve Analysis and Trends of Evolution.

Ideal Final Result

The concept of Ideal Final Result is to force you to think beyond the next generation to define what the ideal solution would be for your customer. There are many ways to define ideality, but one useful way is to visualise what would bring maximum value with minimum cost and waste:

$$\text{Ideal Final Result} = \frac{\text{(Perceived) Benefits}}{\text{(Cost + Harm)}}$$

If we assume that evolution should deliver more of the benefits, with fewer of the costs and harms, then the ultimate state would be *all* of the positive with *none* of the negative.

In the context of Technology Roadmapping, it is a useful exercise to start at the finishing line and say, "What would the ideal final result for this technology / product be?" This then forces you to stretch your imagination beyond the next, more obvious stage.

Function and Attribute Databases

One of the most useful tools is the Function Database by Creax (http://function.creax.com/). You select whether you are looking at Solid, Liquid, Gas of Field, and also your required function, e.g. Absorb, Breaks Down, Preserves or Detects. For example, if you were wanting to use a liquid as a cooling agent, the options listed are Air Flow, Conduction, Convection, Heat Exchanger, Peltier Effect, Phase Transitions, Ranque Effect and Thermomagnetic Effect. Creax are in the process of creating an Attribute database, which will help when identifying technologies for particular requirements, e.g. how to Change/ Increase/ Decrease/ Stabilise/ Measure a range of attributes such as Colour, Energy, Speed or Weight.

S-Curve Analysis

Any system can then be plotted on an S-Curve, which depicts the stages of a product's life cycle – birth, growth, maturity and decline. What stage your system is on this curve can be determined by a number of means:

- The main activity per time period (to begin with you are focussed on making your product work; this progresses through efficiency and then finally reducing cost (see *Fig 3*))

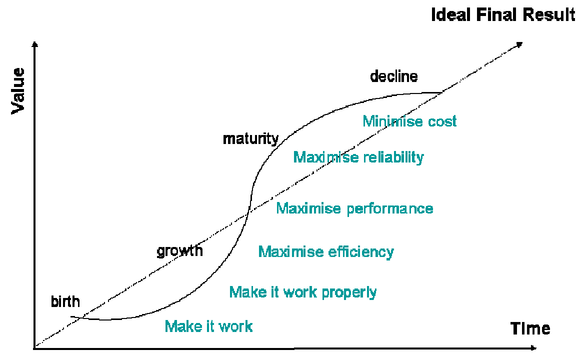

Figure 3 - S-Curve And Associated Activities

- Number of patents per time period (patent numbers tend to peak during the growth period and then again just prior to decline)

- Level of innovation (the level of 'innovativeness' of patents logged tends to peak during the growth phase and then decline.

- Performance level (the performance level tends to follows the S-Curve, so that should have moved to next generation before the performance levels off)

- Therefore, if you find yourself in a position where cost-reduction is your main priority and if the performance of your product has levelled off, then you should have already launched the next generation (the next S-Curve) of your product.

- In this way you can then identify where your system, sub-systems and super systems are on their respective S-Curves to see where there is still opportunity for growth and where there needs to be a step change to a new S-Curve.

Finally you can map the alternatives for a fuller picture (see *Fig 4*). This shows the stages of development of the systems and their sub-systems and super-systems and how the different levels evolve at different rates. This explains, for example, why aircraft industry designers were short-sighted in continuing to develop the engine while ignoring the airframe.

Systems Analysis is therefore useful in showing you where the potential for growth lies.

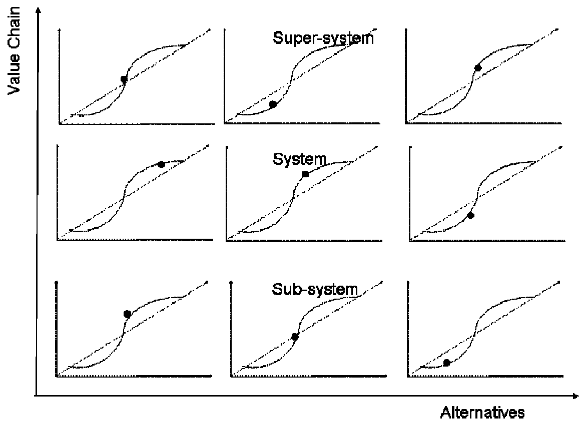

Figure 4 - Explorative Systems Roadmap

Trends of Evolution

Technological systems evolve according to set patterns, threads that are common across a wide range of systems in a variety of industries. These patterns are called the Trends of Evolution, and are one of the most powerful of TRIZ tools. Each trend follows a series of steps, each moving closer to the logical final step, the Ideal final Result.

There are over 30 Trends of Evolution, and for each of them you can identify where your system lies with regards to the Ideal Final Result. And, you can also use the Trends to see what the next step is and predict how your system could evolve. Therefore, the Trends of Evolution help profile the life curves of products and systems. The most useful trends for Technology Roadmapping are:

i) Evolvement toward more dynamic and controllable systems

This trend states that systems move from being rigid and immobile to more dynamic and controllable over time. Eventually the system is able to move and control itself. Examples can be found in home appliances, cars, temperature control systems and stock control systems. Examples in service are seen primarily in the increased dynamism between customer and provider – online accounts, email feedbacks, automatic messages, RSS feeds etc.

ii) Increased complexity followed by simplification

The next trend indicates that systems become increasingly complex in the desire to add new value for the customer, then becomes simpler. This can be achieved through automation or pattern recognition. For example, some businesses such as hairdressers will store your preferences, such as your preferred hair colour, choice of products etc. and can send out automatic special offers tailored to you.

iii) Evolution of matching and mis-matching elements

This trend states that first systems and their sub-systems are 'matched' to each other and their environment. The next stage is that one element is changed to bring about improved functionality. Finally, we have dynamic matching and mis-matching to optimise the system according to the situation. An example of this is the car suspension system, which initially moved in unison, then became independent front and back and now has individually adjustable shock absorbers.

iv) Evolution toward the micro-level

This pattern says that technological systems tend to move from macro- to micro-systems. This is evident in the increasing emergence of nano-technologies. This trend works in space (i.e. the physical size of objects) and also time (with events taking place in ever smaller graduations of time).

v) Evolution toward decreased human involvement

The drivers for decreased human involvement are common sense – decreased drudgery, increased accuracy, increased safety, reduced cost, etc. Examples include household appliances, touch-tone phone services, automatic warehousing systems, cars and manufacturing robots.

Summary

In summary, TRIZ is a powerful tool to help profile current technologies and identify the potential of future technologies when creating a Technology Roadmap.

Rowan Norrie
True North Innovation,
Auchter House
Bonkle,
North Lanarkshire
ML2 9QQ

Tel: +44 1698 389 456
Email: info@truenorthinnovation.co.uk
Web: www.truenorthinnovation.co.uk