DISTILLATE

Project B: Option generation

Literature Review

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See separate document for Annexes

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1. INTRODUCTION

1.1 Context

The DISTILLATE Scoping Study[1] established that the tools and techniques currently available to transport authorities for the development of a broad range of alternative options are extremely limited. This is because (i) historically, transport planning has often been measure led (e.g. the objective is to build a light rail scheme), rather than problem led (e.g. the objective is to reduce traffic congestion in urban areas) and (ii) where options are being developed for transport strategies and schemes, the process is often considered to be self-evident and relatively straightforward. As a result, option generation has rarely been given the level of care and attention it deserves. Furthermore, the options that are generated are often narrowly based on a set of preconceived and largely unchallenged assumptions by practitioners about 'what works'.

This finding was borne out by the DISTILLATE baseline survey of the 16 transport authorities participating in this project, which included a set of questions regarding their current practices in relation to option generation for strategy and scheme design[2]. It was clear from the survey responses that, at present, authorities are heavily reliant on best practice examples, policy guidance, their professional judgement and stakeholder involvement, in roughly equal measure, to develop specific options for both strategies and schemes. Only seven indicated actual methods for option generation and/or that they had generated more than a single option, which would then be subjected to some kind of appraisal (i.e. financial, environmental, etc.). In most instances, the methods used are combinations of traffic models such as SATURN, which do not actually generate alternative options but predict their effects, professional and outside-expert judgement and local stakeholder involvement. The survey also revealed that respondents were more aware of deficiencies in option generation at the strategy level (a recent requirement) than at the scheme level.

This suggests that it may be more fruitful to turn to other disciplines to search for new techniques for option generation, which could then either be directly transferred to the transport setting or adapted for this purpose. For this reason, the initial stage of the research for Project B has involved an exploration of the available literature across a wide range of potentially relevant disciplines, including engineering, product design, artificial intelligence tool development, environmental planning and human decision-making process. Some examples from transport planning are included, where they have been found.

During our early discussions with local authority partners, it became evident that option generation is heavily prescribed by (i) the way in which the problem is formulated and (ii) the boundaries that are placed on the problem and its resolution. We have therefore decided to broaden the scope of this review – and Project B itself - to consider how problems are formulated/objectives set and the types of constraints or bounds that might be placed on the scope of the option generation exercise, both explicitly and implicitly.

[1] See SUE DISTILLATE WP4 Scoping Study Report.
[2] See DISTILLATE Questionnaire Analysis, Project B: Option Generation.

1.2 Aims and objectives of the review

The primary aim of this review has been to identify new techniques and approaches that may have the potential to assist transport planners and their partners in the generation of viable alternative options at strategy and scheme level, and in the overall framing of the scope and nature of the exercise.

More specific objectives include the development of a typology of option generation techniques, and an indication of the types of issues that they are best suited to address. For reasons noted above, this review has been expanded to look at methods for problem identification and objective setting as well.

1.3 Breadth of the review

The review has found there to be a fairly extensive literature dealing with aspects of option generation, once all the relevant disciplines with an interest in this area are considered. However, it is clear that much of this literature is actually irrelevant in the context of this research enquiry. For example, there is a wide body of literature on option generation within the field of psychology, particularly in connection with the mental development of children and the deterioration of mental capacity amongst older adults, which offers little more than some basic insights into the cognition process and is therefore too abstract to be of direct value to this project.

Researchers investigating the nature of human decision-making and organisational behaviour also concern themselves with option generation practices, but tend to focus on the cognitive processes underlying the practices, rather than the actual methods for option generation (e.g. Klein et al, 1995 and Johnson and Raab, 2002). Whilst this literature is useful in gaining an understanding of how the human brain works to generate options and can inform model and tool design, it is considered to be too general in its nature to be included in this review.

Carrying out this review has also found that much of the literature that is cross referenced under the headings of option or concept generation actually refers to option appraisal, i.e. frameworks, tools and methods for **evaluating the viability** of options against a given set of criteria, for example cost or value for money. (A confusion that has also been apparent within the DISTILLATE project itself.) So these references have also been omitted from this review.

The following sections, therefore, are not intended to provide an inter-disciplinary overview of the entire literature on option generation. Rather they extract only that information which can be used and/or adapted to assist in the development of new tools and techniques for option generation in the field transport and land use decision-making for sustainable development.

1.4 Review methodology

Most literature reviews involve a comprehensive search of the available published documentation relating to a given research topic. Even within a discrete subject area, the array of documentation can be vast, the process burdensome and the quality of outcome is highly dependent on the comprehensiveness and nature of the search. In

this instance, however, the problem is intensified due to the broad base within which, and the various guises under which, the option generation literature can be found. For this reason, it was decided that a formalised approach should be applied to the literature search, in order for it to be both systematic and transparent.

To achieve this aim, a computerised search of the Web of Knowledge was undertaken using the following key words: *option generation; concept generation; idea generation; creative thinking; lateral thinking.* The documents identified as potentially relevant to the research enquiry by these searches were downloaded as full documents where these were available and as abstracts where they were not. These documents were then scanned to identify their usefulness to the review and their reference lists examined to identify:

- Additional key words for further searches
- Additional publications that could be relevant to the review

Further searches were then undertaken based on this extra information using the following search terms: *decision-support tools; innovative product development; artificial intelligence planning; scenario-building* and *visioning*.

1.5 Structure of this report

Following this introductory section (**chapter 1**):

Chapter 2 provides a summary of the problem identification/objective setting and option generation processes, as they are currently applied in the field of transport and land use planning, and an assessment of their limitations.

Chapter 3 looks in more detail at the problem identification/diagnosis, study scoping/framing and objective setting processes, and some of the tools that might be used to facilitate this.

Chapter 4 contains a brief overview of some general principles and key approaches which have been applied to the development of option generation techniques across a range of disciplines, which could be applied at Strategy and/or Scheme level. These are then explored in greater detail in the following two sections.

Chapter 5 outlines a number of tools that have been used for generating options "inside" the box, across a wide range of disciplines, including transport where appropriate; these tend to be mainly quantitative/structured methods, some of which are more relevant at Strategy level and others at Scheme level.

Chapter 6 outlines several qualitative/unstructured methods, tools and techniques from across a similar range of disciplines, that are suited to generating options "outside" the box; this includes some transport examples where these are considered to be particularly innovative or novel.

Chapter 7 identifies some further academic findings regarding the development of problem identification/objective setting and option generation tools that were identified through the literature review; and

A series of **Annexes** illustrate, through practical examples, many of the tools briefly outlined in the main report. **Those covered in more detail in the Annexes are shown as bold/underlined headings.**

Three **companion documents** are in preparation, that focus on the links between option generation and other projects and interests within DISTILLATE:

- A literature review of the state-of-the-art in linking option generation methods with transport modelling, by the Project F team.
- A discussion note on the links between option generation and appraisal, by the Project G team, including the initial screening level.
- An overview of the technology-based tools that can be used to enhance the participation of groups in the option generation process, both in transport and elsewhere, with suggestions for a future research project.

2. CURRENT UK PRACTICE

2.1 Guidance Documents

Figure 1 provides a useful general description of the decision-making processes typically used for the development of a transport strategy or scheme. It is taken from the Guidance on the Methodology for Multi-Modal Studies (DETR, 2000), and also forms the basis of the Department for Transport 'WebTAG' guidance.

Problem definition

The initial definition of problems and the setting of objectives occupy the first four stages of the process, namely:

1. The setting of objectives, drawing both on national and local priorities;
2. Understanding the current situation, both in terms of patterns of demand and associated problems, and opportunities and constraints;
3. Understanding the future situation – how demands and problems are likely to develop in the future; and
4. Consultation, participation and information (part of) to assist in identifying problems, opportunities and constraints.

The WebTAG guidance note on 'Objectives and Problems'[3] stresses the need to be clear as to why a strategy or plan is being developed. It suggests that:

"The answer to this question can be expressed at varying levels of generality or detail, from broad statements of vision, through strategic objectives, to more specific objectives and lists of problems to be overcome."

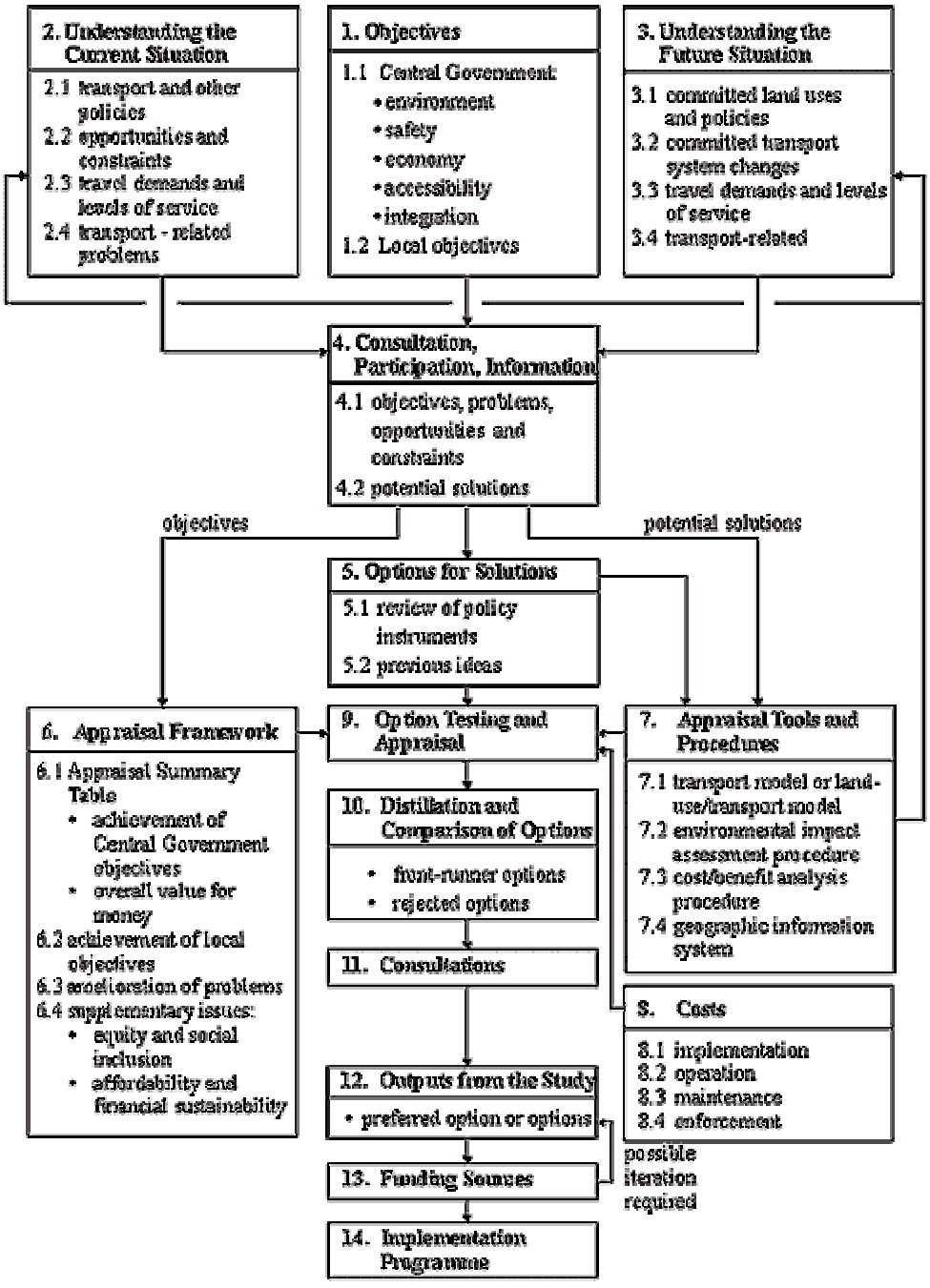
Most of the guidance note deals with the specification of objectives, but recognises that, in public consultation, it may be better to start with the problems that people face and feel need dealing with, and then translate these into objectives. However, other than listing objectives set by national government and various policy documents, little is said as to how objectives or problems might be identified (other than by auditing or consultation) in cases where the issues and requirements are not self evident. Also, nothing is said, for example, about the influence of decisions taken about the spatial extent of the inquiry, which can subtly affect problem identification and the types of solutions that are generated, as well as the balance of public opinion.

Both the recent Local Transport Plan (LTP) and Accessibility Planning guidance (DfT, 2004a; DfT, 2004b) clearly state that, in order to be effective, local transport planning needs to be set in its wider policy context and take on board all aspects of an authority's long-term vision and broader objectives for their area, both locally and at the regional level. The need for transport to support employment, local economic and housing policies are specifically mentioned in the new LTP guidance. Promoting social inclusion and enhancement of the local environment are also identified as important target areas for future local transport policy.

[3] Objectives and Problems, TAG Unit 2.2, DfT, December 2004.

The current policy agenda suggests that new and more radical transport strategies and schemes need to be developed in order to meet the significant social equity and environmental challenges of the present system of transport delivery in the UK. A growing number of guidance documents refer to the importance of generating a wider set of options and exploring a range of alternatives to address people's travel needs and reduce the impact of road traffic

Figure 1: General description of the process for establishing a transport strategy or plan.



Source: Guidance on the Methodology for Multi Modal Studies (Department of the Environment Transport and the Regions, 2000).

Option generation

Option generation is explicitly identified as stage 5 of the overall process (Options for Solutions) and may also include outputs from the stakeholder engagement exercises undertaken in stage 4. The GOMMMS Guidance (DETR, 2000) places emphasis on the need to generate:

"*…a number of options aimed at addressing the problems within the study area*"

With each option being:

"*…a collection of quite specific and individual interventions*".

Since 2004, local transport planning guidance has required that authorities devise and deliver integrated transport packages that are designed to meet their strategic objectives over a five year period. The process requires the generation of options for both strategies and schemes. Guidance on proposals for major schemes within Local Transport Plans (i.e. those costing more than £5 million), demands that several alternative options be sought, with authorities being asked to provide:

"*evidence that a number of realistic alternative options have been seriously considered*".

(DfT, 2003).

As a minimum, it is recommended that both a preferred option and a lower cost alternative should be submitted for assessment in the formal appraisal process. For larger schemes (i.e. costing more than £20 million) a "*next best*" option may also need to be identified. As a consequence of these requirements, it is necessary that a range of alternative options is provided. However, little guidance is available on ensuring that all of the options presented are of high quality.

The imperative for a more systematised approach to option generation is made more urgent in the light of new policy requirements laid down by recent planning guidance; such as the EU Strategic Environmental Assessments (ODPM, 2003), Sustainability Appraisals (ODPM, 2004), the Scottish Transport Appraisal Guidance (STAG) (Scottish Executive, 2003) and the latest guidance on Accessibility Planning (DfT, 2004). Each of these explicitly or implicitly require that a range of:

"objective-led alternative options should be identified and explored in the development of both over-arching transport strategies and specific projects and programmes".

Three main general sources identified within GOMMMS for generating options:

(i) The outcomes of public participation,
(ii) Previously used or considered options, and
(iii) A supplied reference list of policy instruments.

However, none of these documents explicitly proposes specific methodologies to promote improved option generation.

2.2 Limitations of current practices in option generation

STAG (Scottish Transport Appraisal Guidance: Scottish Executive, 2003) outlines several problems associated with current approaches to option generation in transport planning. The first of these is that options are generally identified to address a specific problem, for example traffic congestion on a particular road, rather than to meet a broader planning objective, for example to reduce car dependence. In addition, the options considered may be restricted by the limitations of available modelling capability in a particular area, with more easily modelled projects such as infrastructure changes likely to be given priority over 'soft' policy measures.

It is also possible that viable options may be largely overlooked, simply because others have already undergone detailed examination. Difficulties in identifying the 'best' options for appraisal are increased in the larger studies, where it is likely that a combination of options will be required to meet objectives. The document stresses the need not to constrain ideas, whether to the geographical area of the study or to the mode perceived to cause the problem, and to ensure the allocation of sufficient resources to the generation and development of options to a level allowing adequate identification and comparison.

In terms of broad approaches to option generation, STAG recommends using:

- The experiences of previous practice;
- Outputs from structured decision-making,
- Internal generation of ideas by the planning team,
- Statutory transport and land use planning processes and
- Outcomes of public participation.

As previously noted in the scoping study for this project, each comes with its own set of strengths and weakness, as summarised below.

<u>Using the experiences of previous practice</u>

In the absence of structured methods for the generation of a broad set of options for a specific design problem, there is a tendency for engineers or planners to rely on their own previous experience or that of their team, as demonstrated in the baseline survey for this study (Project A). While past experience is clearly valuable, this will tend to limit and bias the options or solutions suggested to those previously used (Stone *et al*. 2001). In addition, to search for previously used options that could be adopted or amended to meet the present requirements (either through a patent search or a comprehensive search of previous planning options) can be an extremely time-consuming and inefficient process.

The reference lists provided by GOMMMS outline the available instruments to address problems using land-use, infrastructure, traffic management, information provision and pricing measures and emphasise the need for integration between measures. This is valuable in encouraging the consideration of a wide range of instruments, drawing on past experience, but further support for the actual generation of options is required.

Outputs from structured decision making

Options may also emerge from, or be heavily influenced by, the chosen decision making frameworks and processes. For example, the requirement to contribute to the fulfilment of national and regional targets may lead to the inclusion of particular instruments, just because they have been adopted elsewhere for that purpose. Other factors relating to decision-making and funding structures may influence the set of options short-listed for consideration in the appraisal process. In particular, with local authorities receiving larger budgets for capital expenditure on transport but reporting a shortfall in revenue funding, it is less likely that projects or schemes that are heavily revenue dependent will be given full consideration.

Internal generation of ideas by the planning team

Clearly, if the skills and knowledge of the planning team are to be fully utilised, steps should be taken to maximise the scope for innovative options being generated, both by individuals and by the team as a whole. Specific tools can be used to increase the range of ideas generated, but professional facilitation is often required to encourage an open and supportive environment.

Statutory land-use and planning processes

Some transport scheme or strategy options may be introduced directly as a result of the need to meet regulatory requirements. Conversely, statutory considerations may prevent otherwise acceptable options from being considered further.

The outcomes of public participation

Public participation provides a potential source of options, by drawing on a wide base of knowledge and practical experience. Those resident or employed in an area may have a detailed understanding of the problems and issues associated with current transport infrastructure and operations at a local level, and may be able to make a useful contribution to the identification of possible solutions. However, the use of public participation as a source of generating design options requires careful management of the engagement process and its outputs, to enable suggestions raised to be formally developed as options for consideration. Indeed, Nunamaker et al, (1991) caution that:

"*….30 years of research has found groups to be quite ineffective at generating options."*

(Nunamaker, et al, 1991 p.1325)

This suggests that the participative methods that are currently being utilised need to be revisited and adapted to be more effective in this respect, and/or that new tools and techniques need to be developed and introduced.

3. PROBLEM IDENTIFICATION, STUDY FRAMING AND OBJECTIVE SETTING

3.1 The issue

The solutions devised for any given situation depend crucially on the nature and breadth of the problems that have been identified, or the questions that have been asked. For example, defining a problem in terms of 'insufficient traffic capacity' may lead the analyst to think of very different types of solution, compared to presenting the problem as 'too much traffic'. Solutions are also strongly influenced by the way in which the exercise is framed; for example, whether 'low public transport patronage at night' is addressed purely in terms of improved public transport provision, or whether the whole journey chain between home and destination is taken into account.

Science routinely advances in a very structured way, through experimental procedures that encourage the very precise wording of questions in the form of hypotheses. However, major scientific advances and paradigm shifts (e.g. the Archimedes Principle, the Double Helix) usually arise from addressing broad issues, in much less structured environments. Thus, it is important to be open to a broad range of interpretations of the problems or issues that trigger the search for solutions.

Discussion in the broader literature

Writing from a **marketing research perspective**, Chapman (1989) notes that problem definition is the most important stage in the whole research process, but that it is "seldom accorded the complete respect it merits. A general presumption seems to exist that marketing problems are known, easy to define, and clear to all concerned. Experience suggests just the opposite, however". He advocates the adoption of a structured and systematic process, in which a clear research objective is first formulated, which provides the framework for a set of specific research questions; both are developed in conjunction with the client and may subsequently be modified during the course of carrying out exploratory research. This research objective should both encapsulate the problem/question, and delineate the study boundary (by defining the geographical area, population group, etc.).

Issues of agenda setting and problem definition have been addressed by several authors in the context of **policy studies**. Here it is seen as a more complex, lengthy iterative and interactive process. Hogwood and Gunn (1984) see problem definition as encompassing:

"the processes by which an issue (problem, opportunity, or trend), having been recognised as such and placed on the public policy agenda, is perceived by various interested parties; further explored, articulated and possibly quantified; and in some but not all cases, given an authoritative or at least provisionally acceptable definition in terms of its likely causes, components and consequences".

Thus, problems are not 'objective' and context neutral, but emerge from the prevailing social and cultural contexts and are influenced by the relative strength of different interest groups; they are 'malleable' and can change form over time.

Rochefort and Cobb (1993) identify four major themes in work on problem definition in the policy studies literature:

- 'Causality': what caused the problem? Where did it come from? Here different parties may ascribe the problem variously to technology, poor management, etc.
- 'Image': problems may be compressed into symbolic terms (e.g. nuclear power may be characterised in terms of 'efficiency and progress' or 'danger and cost').
- 'Solution-led' definitions of problems. Both in the sense of a solution looking for a problem (e.g. new technology seeking a market), and the unwillingness to recognise a problem that appears not to be solvable.
- 'Problem ownership': who claims ownership of the problem and its definition?

Ellwood (1989, p. 8) illustrates the difficulty of pinning down the causes of a problem, in a complex modern social and economic environment:

> *"Suppose we find that a two-parent family with three children is poor even though the father is working full time. What is the cause of the family's poverty? One could say that the father's wages are too low, that the mother is not willing to work, that the family cannot find affordable day care, that the couple was irresponsible to have children when they could not support them, or that the father did not get enough education or has not worked hard enough to get a 'good' job. Even if we talked to the family, it is possible that we would not be able to agree on just one 'true' reason."*

While Portz (1996) illustrates how different problem definitions around issues relating to public education in Boston were formulated by various interest groups, each vying for political attention and public resources. He concludes that three factors are crucial in determining which definitions/interpretations of problems achieve prominence on the policy agenda: problem visibility, political sponsorship and viable solutions.

Transport and land use planning

In transport and land use planning, the trigger for problem formulation is often provided in the form of a formal policy objective setting phase. However, when engaging with the general public and other stakeholders, it may be more appropriate to talk about 'solving problems' and adopting a more open and qualitative approach to establishing what needs to be done.

Transport Analysis Guidance Unit 2.2 provides advice to UK local authorities on how to determine what a transport strategy or plan is designed to achieve (see: http://www.webtag.org.uk/webdocuments/2_Project_Manager/2_Objectives_and_Problems/index.htm). This has recently been augmented through a pilot study designed to look at how better to identify problems and opportunities, and select objectives, as part of preparing an SEA (Strategic Environmental Assessment) for a Local Transport Plan (TRL, 2004).

In the TRL study, the main sources of information consisted of existing planning documents, consultation with external bodies and agencies, and professional judgement. In other areas of study, a range of more formal techniques has been developed to help frame problems and identify problems/objectives, some of which

are quite open in nature, and others more structured. In the remainder of this chapter, examples are provided of different techniques that can be used:

(i) To define specific, current problems, and
(ii) To develop longer term scenarios.

In both cases, the techniques are presented in increasing order of structure, with the most open ones first.

3.2 Addressing current problems

Brainstorming

In professional contexts, brainstorming can be used a very useful tool to prepare a list of everything that is felt to be important relating to a given subject area, however tenuous the link may seem. Ensuring that a wide range of professional interests are represented in the group will help to lead to a broad assessment of the problem, though in some cases it may be helpful to employ some of the 'outside the box' techniques outlined in Chapter 6.

However, brainstorming sessions tend to generate qualitative data, that is often difficult to quantify and present within a formal, logical framework. It may therefore require some further effort after the exercise, to develop more precise descriptions of problems, objectives and targets.

The Policy Delphi technique

The Policy Delphi technique is used to generate a set of views relating to current or future issues and/or options by collating the opinions of a diverse group of experts in the field. It uses a series of rounds of questionnaires in which participants fill them in anonymously, and are then invited to review and respond to the results obtained from the group as a whole. The alternative opinions relating to a policy issue or problem are collated, evaluated and revised, with contributions from people from a range of backgrounds and perspectives (Linstone and Turoff, 1975). Unlike the conventional Delphi technique, which seeks to reach a consensus among those consulted, the Policy Delphi seeks to identify the breadth and diversity of opinion.

It can be used as a complement to committee-style discussion, to ensure that time and resources are more efficiently used. Here the Policy Delphi method is used to identify the different positions, arguments and options associated with the issue under discussion. Once this information has been obtained, it can be passed to a smaller and more manageable committee to resolve and determine actions, than would otherwise be required to ensure representation of all views.

Fishbone technique

Often referred to as the Ishikawa diagram, this is a structured process of problem identification that incorporates elements of brain-writing and mind-mapping. It starts with a general problem, and then 'fleshes it out' in greater detail. The procedure is as follows (see www.mycoted.com):

- On a broad sheet of paper, draw a long arrow horizontally across the middle of the page pointing to the right, and label the arrowhead with the title of the issue to be explained. This is the 'backbone' of the 'fish'.
- Draw spurs coming off the 'backbone' at about 45 degrees, one for every likely cause of the problem that the group can think of; and label each at its outer end. Add sub-spurs to represent subsidiary causes. Highlight any causes that appear more than once – they may be significant.
- The group then considers each spur/sub-spur in turn, taking the simplest first, to decide on the relative importance of each contributory factor.

3.3 Developing future scenarios

Transport visioning

This exercise normally involves a combination of techniques, with the overall aim of first developing a vision for the future, and then considering how it might be realised, through a series of possible solutions. It thus begins at the policy strategy level, although it may then move on to look at some particular larger schemes in greater detail.

The event may last for one day, or over a weekend. It begins by considering the current problems experienced in the study area and how conditions might evolve in the future. Groups of participants then develop a series of visions of how they would like to area to become in the future, and what measures would need to be taken to achieve this outcome. Different views are shared and debated, leading to a draft strategy for the study area, with perhaps some particular schemes being discussed in greater detail.

PEST analysis

This technique is a useful aid to scenario building when looking at 'big picture' issues. It helps the problem-solver to explore the context in which a problem or issue arises and take into account the broader dynamics associated with that context (see www.mindtools.com/pages/article/newTMC_09.htm). It was developed in the business world and seeks to encourage an understanding of the forces that drive change, using the four trigger words of 'PEST':

- Political: governance, regulation, etc.
- Economic: employment, disposable income, economic growth, etc.
- Socio-cultural: population growth, health, social attitudes, etc.
- Technological environment: internet and telecommunications, technology transfer, etc.

Foresight for Transport

This was a specific application of a PEST-type approach, funded by the European Community (see ICCR *et al*. (2004) and www.iccr-international.org/foresight). The main objective of the exercise was to "organise and run a strategic dialogue in the

form of a foresight exercise on the influence of non-transport factors and policy on mobility and transport". It involved convening thematic expert panel workshops and a Delphi survey of 165 experts around Europe.

Eight types of 'external development' were identified, that could influence transport systems, transport demand and transport policy (both for passenger and freight). These were: demographics, attitudes, social (policy) developments, institutional arrangements, science and technology, politics, the environment and the economy.

The Urban Futures Game

Cooper and Platt (2004) describe a game, developed for CABE and the RTPI, to encourage local communities to look ten to twenty years ahead to establish future aspirations for their neighbourhood. It represents a more structured form of the transport visioning approach.

It begins with individual, open interviews with local policy makers, service providers and community members, in which they are asked about their experience of change and their hopes and fears for the future. The key concerns and aspirations that are identified from this process are transferred to sets of standard playing cards. These are then introduced into a workshop, largely involving the same people, where they act as a stimulus for further discussion and ideas. At the end of the session, participants are provided with dots, to mark those cards that best reflect their own concerns and priorities.

SCUF

One structured way of generating scenarios to explore possible futures involves using the SCUF (Scenarios for Critical Uncertainty Framework) technique. The methodology starts a stage earlier than many, by identifying the themes that are important to the affected group(s). It then goes on to identifying driving forces and select critical uncertainties, in order to create a scenario framework within which the options can be explored. The scenario narratives can be created with participation from the group and the group can select their own indicators and trends. What makes SCUF different is the way that it takes participants through the process up to the selection of indicators and trends (see Barrett, 2005).

It consists of the following stages:

1. Identifying Themes
2. Identifying Driving Forces
3. Selecting Critical Uncertainties and Creating a Scenario Framework
4. Elaborating the Scenario Narratives, and
5. Quantification: selecting indicators and trends

Formal scenario-building techniques

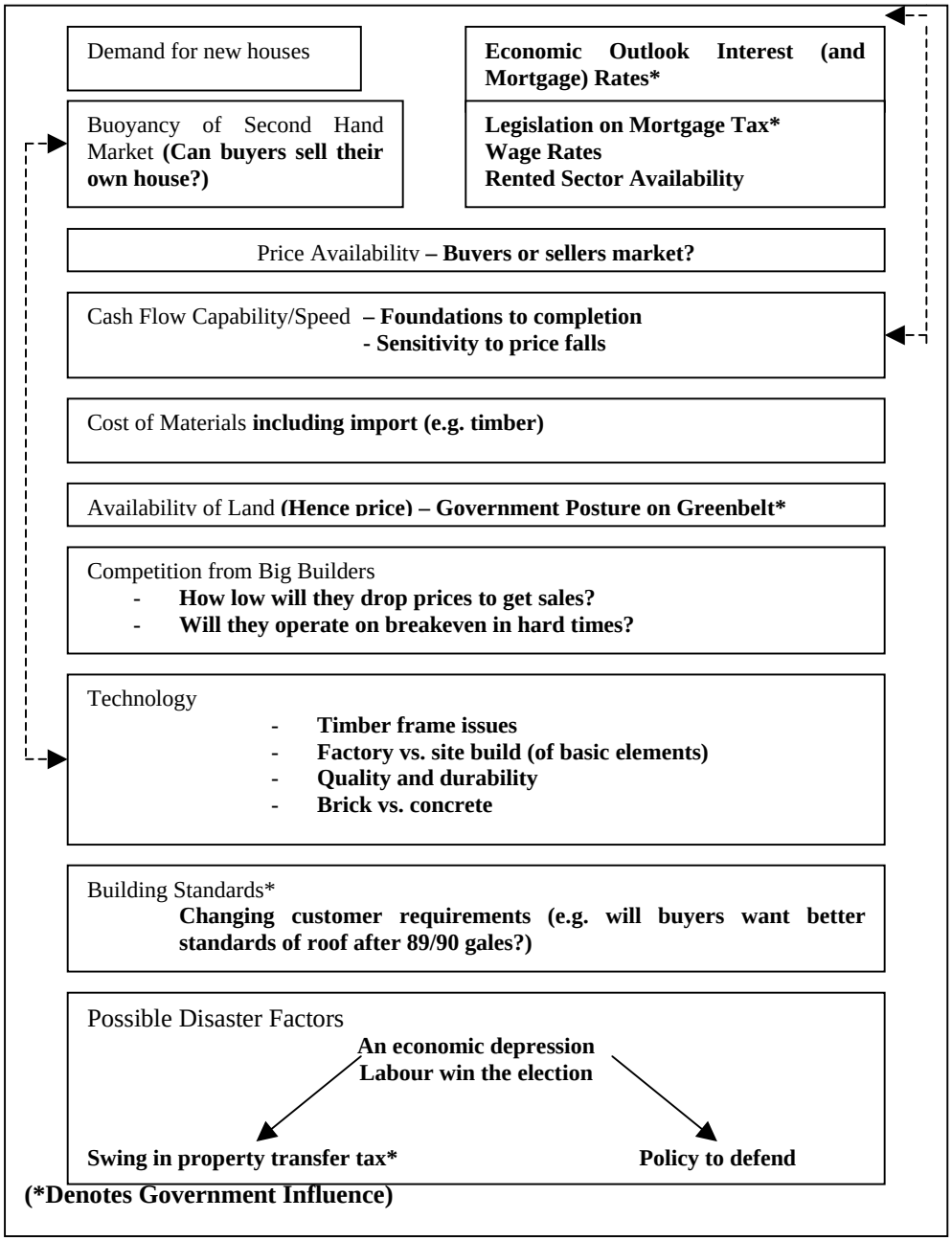
Creating alternative future scenarios to inform longer term decision-making is common in industry, business, planning and community development circles. Four

scenarios are usually developed: worst case, 'surprise free'/do minimum and two paradigm shift/ visionary scenarios (Bezold, 1999).

The first phase of the exercise generally involves identifying all kinds of factors that will or may influence the future position, and characterising these as a set of variables. This is generally undertaken as a group exercise involving all key stakeholders (the people who will be affected by the future plan, strategy or programme). Brainstorming and idea generating techniques can be combined with expert/outsider knowledge and forecast models to facilitate this process.

Foster (1993) offers a simplified example of a scenario framework that was developed for a small building firm in the South East of England, as shown in the Figure 2.

Figure 2: Matrix of scenario factors for the house builder



The second step requires an analysis of the relationships and impacts between these variables, usually expressed in matrix form. This is often known as the 'MICMAC' method (Godet, 2000), which roughly translated from the French is the Matrix of Cross Impact Multiplications as Applied to Classification. Variables should be set in a hierarchy of importance and the past development, logical trend curves and potential breaks that could interfere with these identified for each. This can often be a painstaking process and may be better undertaken by one or more experts, away from the public domain or group setting.

Backcasting

Backcasting is an unusual scenario-based approach, in that it starts from an agreed, sought-for end point and, working backwards, uses a 'reverse-scenario' to determine how we might get from where we are now to where we want to be. It combines elements of problem definition and option generation, in an iterative manner

The agreed target is used to determine what questions are relevant. For example, the problem may be set as 'an 80% reduction in CO_2 emission by 2050'. This target then forms the basis for suggesting an image (or several images) of the future that meet(s) this criterion. Then one, or several, paths need to be developed to get from where we are now to this desired future situation, and the process of doing this raises several further specific questions. Expert assessments and expert knowledge can be called in to assist the procedure at any point (see Tuinstra *et al* 2003:182*ff* for further details).

This approach has also been used in an OECD study that developed future scenarios for environmentally sustainable transport, and then set out to see how they could be achieved (OECD, 2000).

3.4 Assessment

Most of the more open and participatory approaches seem to begin with a process of problem identification, often in association with scenario building in order to consider alternative future conditions, and then to translate these into more formal objectives, as the basis for developing alternative options. The more restricted approaches start with lists of existing sets of policy objectives, and then assess which of these are likely to be relevant in the local context.

Either way, objective and target setting now seems to be the primary starting point for developing transport strategies and schemes in the UK, forming the basic input to option generation and option assessment. This whole process is closely linked to the development and measurement of indicators, which is being explored in detail in DITILLATE Project C.

However, the objectives that are formulated are often quite broad, and give only limited guidance for the option generation process. In particular, they are rather poor at targeting actions either spatially or socially. In addition, effective option generation also needs information about the local context and any binding constraints – objectives, on their own, are not enough.

4. OVERVIEW OF OPTION GENERATION TECHNIQUES

4.1 Understanding the cognitive process of option generation

While in our everyday experience new ideas often appear to come from nowhere, 'knowledge science' has identified complex interactions between the quantity of knowledge and wisdom we possess and the level of our curiosity and enthusiasm or our reluctance to engage. The challenge in developing tools for option generation in any applied field is to create an environment where these seemingly random processes can be stimulated and made rational, systematic, transparent and accountable.

According to Klein et al (1995), people usually rely on their recognition of what is typical in a given situation and make their decisions on this basis. Klein refers to this method as the Recognition-Primed Decision Making model (RPD). This suggests that it is more likely that they will select something that is already familiar to them (i.e. known problem => known solution), than to 'think-out-of-the box' to generate a completely new concept or idea. In his study of chess players, he found that both student and expert players tend to limit their catalogue of moves to an extremely limited set of possible moves, considering only those that they consider to be 'leading contenders'.

The DISTILLATE survey suggests that many transport planners are employing similar strategies and techniques, i.e. narrowing down their selection of potential options to one or two based on their past experience of 'what works'. Whilst there is not necessarily anything wrong with such an approach in everyday life, in situations where a significant step-change in policy-making and travel behaviour is required, more innovative and radical solutions may be necessary.

This literature review has thus attempted to include a range of techniques that encourage 'out-of-the-box' thinking, while also including the more common structured and systematic approaches to option generation

As with all inter-disciplinary enquiries, providing an overview of the research in this area is far from straightforward. The difficulty largely arises not from the complexity of the research itself, but rather because of the different languages being used to describe the same concepts, ideas and approaches by the different disciplines. This problem is often compounded, because poor or incomplete explanations of the theories and methodologies that have been employed are given by the research team, on the assumption that anyone wishing to read about it will already have prior expert knowledge in this particular subject area.

This chapter therefore provides the authors' own interpretation of a wide range of literature, in an attempt to place it within a common framework, in a form that will be of value to those working on option generation in the areas of land use and transport planning.

4.2 Different approaches to option generation

An overview of the literature suggests that the option generation activities that have been documented can generally be characterised along three main dimensions:

1. Whether they generate options by recycling or redefining existing concepts and components, or by developing radically different options that include new ideas and elements;
2. Whether option generation is carried out in a structured/exhaustive manner (using more 'quantitative', usually computer-based approaches), or in a systematic but much more heuristic manner, using more 'qualitative' approaches working with individuals or groups of people; and
3. Whether each technique is described in a generic way, at a general level, or in the context of an application to a specific problem.

These three dimensions are largely independent of each other, so that a particular technique can combine either of the two states from each dimension, except that the structured approaches in 2 rarely give rise to radical new out-of-the-box options in 1.

Klein et al (1995) find that most structured, quantitative techniques adopt a filtering approach, whereby a potentially very large set of all possible options is sifted down and refined until a superior option is found (see Janis and Mann, 1977), or a smaller number of options are identified and evaluated to select a preferred one (see Gettys *et al*, 1987). In general, qualitative techniques tend to result more in the generation of wholly new and creative or 'blue-sky' ideas, facilitated through the active participation of individuals and/or groups in the design and decision-making process; this may involve collaboration between interdisciplinary groups of experts, or may be extended to include other stakeholders and members of the general public. However, more qualitative approaches can also be used to search through or generate options from a set of predetermined components.

Based on the above, Figure 3 provides a general framework for examining option generation, both by placing this process in the wider decision making context, and by outlining the main approaches to option generation that are described in the remainder of this review.

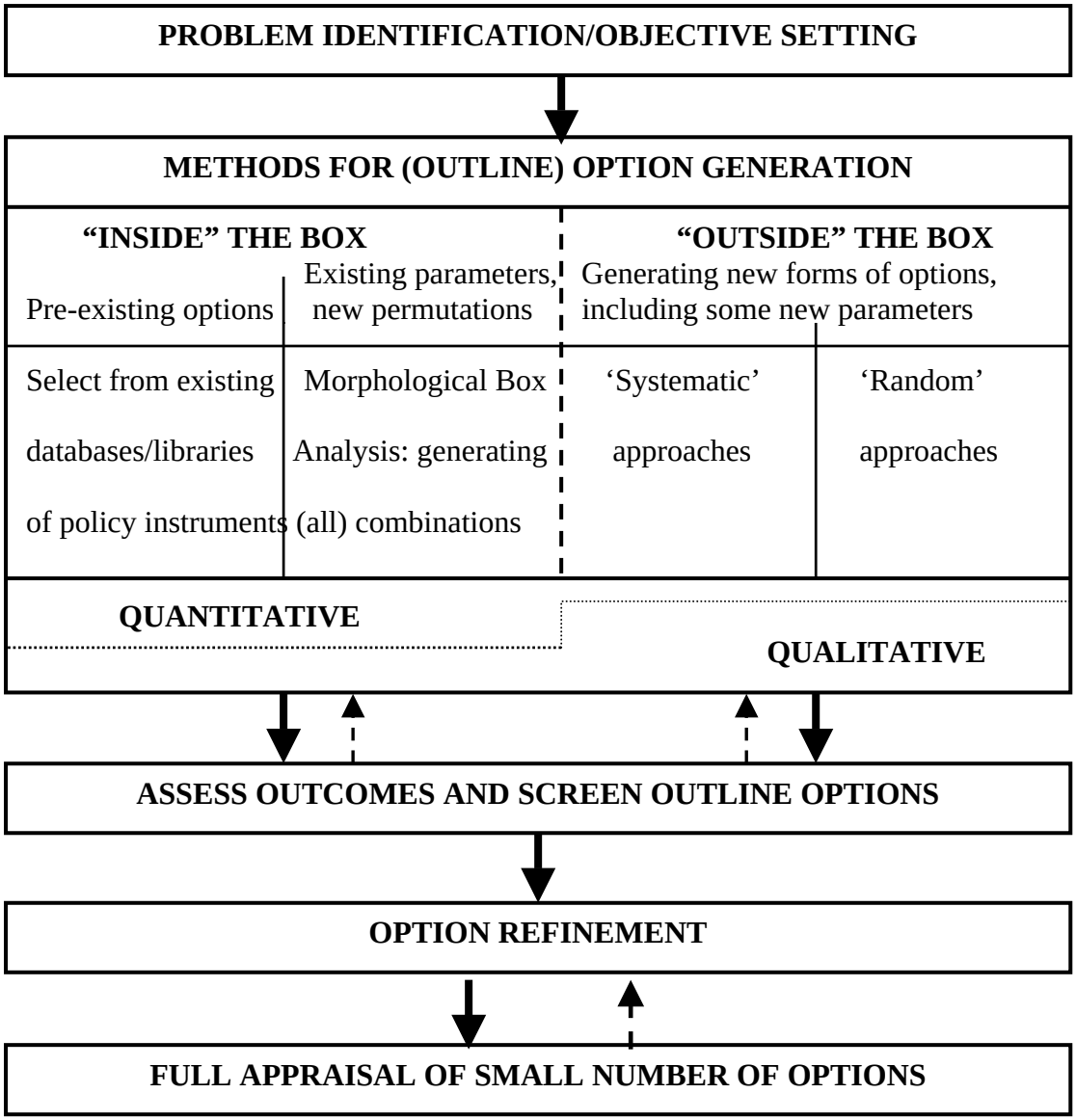
Option generation is framed by two other stages of the decision making process, which represent precursor and successor activities. As previously noted, preceding option generation is the identification of problems and the setting of policy objectives, which largely provide the specification for the search for suitable options. Subsequent to option generation – and sometimes carried out iteratively with it – are techniques for option appraisal. It is also quite common for option generation to be carried out as a two stage process (particularly at the scheme level), first with the generation of a set of broad based, outline options, followed by a pre-screening option appraisal stage, after which a smaller set of options are fleshed out in greater detail, during an option refinement stage.

A crude distinction is made in Figure 3 between methods that generate options "inside" or "outside" the box. The distinction intended here relates to the nature of the option itself and not the local context of its application. That is, according to the kind of option that is being generated and whether it is 'new' in some generic sense (e.g. the first construction of a diagonal pedestrian crossing), and not whether the proposal would be a 'first' in that particular location. Thus, the introduction of the Area License Scheme in Singapore in 1975 was an 'outside the box' pricing solution to a traffic congestion problem, but any subsequent similar applications around the world

– although novel in a local context – for the purposes of this analysis would be regarded as being 'inside the box'.

Note also that an 'outside the box' option generation process might lead to the generation of some options that turn out to be 'inside the box'. But the contrary situation, where an 'inside the box method' produces an 'outside the box' option is, by definition, not possible.

Figure 3: Context and Approaches to Option Generation



Methods for generating options 'inside the box' take existing knowledge and either directly apply it in new contexts (using a 'library' type of approach), or use the 'raw' parameters of existing solutions to systematically generate new groups of options from this same parameter set, by exploring (all) possible permutations and combinations. The latter approach is commonly referred to as a 'morphological box' analysis.

The literature review has found that most (semi) quantitative techniques operate within this inside-the-box domain, by focusing on the development of improved algorithms and/or models that can identify, sift, collate and present a single instrument option, or package of 'best practice' options, from a pre-screened set or library of instruments and packages of instruments. New options – based on original combinations of existing design elements - can be generated through morphological box analysis, but quantitative techniques do not seem to be suitable for generating wholly 'new forms' of option.

Library searching and a form of morphological box analysis can also be carried out in a more qualitative and heuristic way, by getting individuals or groups to work directly with these methods. For example, some techniques use a simplified form of morphological box analysis directly with stakeholder groups, in which participants are provided with different components of a scheme (or strategy), at different levels of implementation (e.g. km of cycle lane) and an associated 'cost'. They are then invited to generate their own combinations to produce complete transport schemes (or strategies) that have been constrained to an allocated budget to be spent on improvements.

While some qualitative techniques are designed to produce options 'inside the box', most qualitative techniques are particularly suited to generating completely new ideas or 'blue-sky options' in response to a given scenario, problem or set task, using a variety of gaming techniques. For example, brain-storming and de Bono's Six Thinking Hats (de Bono, 1985; 1991).

As previously noted, rather than seeing 'inside the box' and 'outside the box' methods as leading to the generation of fundamentally different kinds of options, as is implied in Figure 3, it is probably more accurate to regard the former as being contained within the latter, as shown schematically in Figure 4.

Figure 4: Relationship between options generated by 'inside the box' and 'outside the box' methods

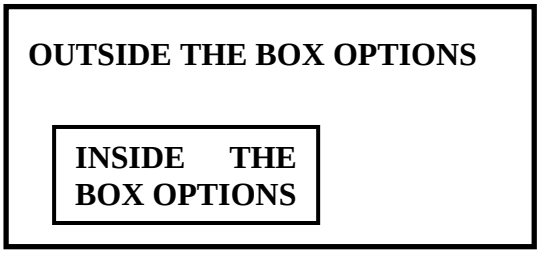


Figure 3 also shows a recursive phase between the generation of outline options and the preliminary screening of these options, before going on to work up some of the options in more detail, in preparation for a full appraisal process. In some of the methods we review in chapters 5 and 6, we find that a preliminary screening/sifting process is an inherent part of the method.

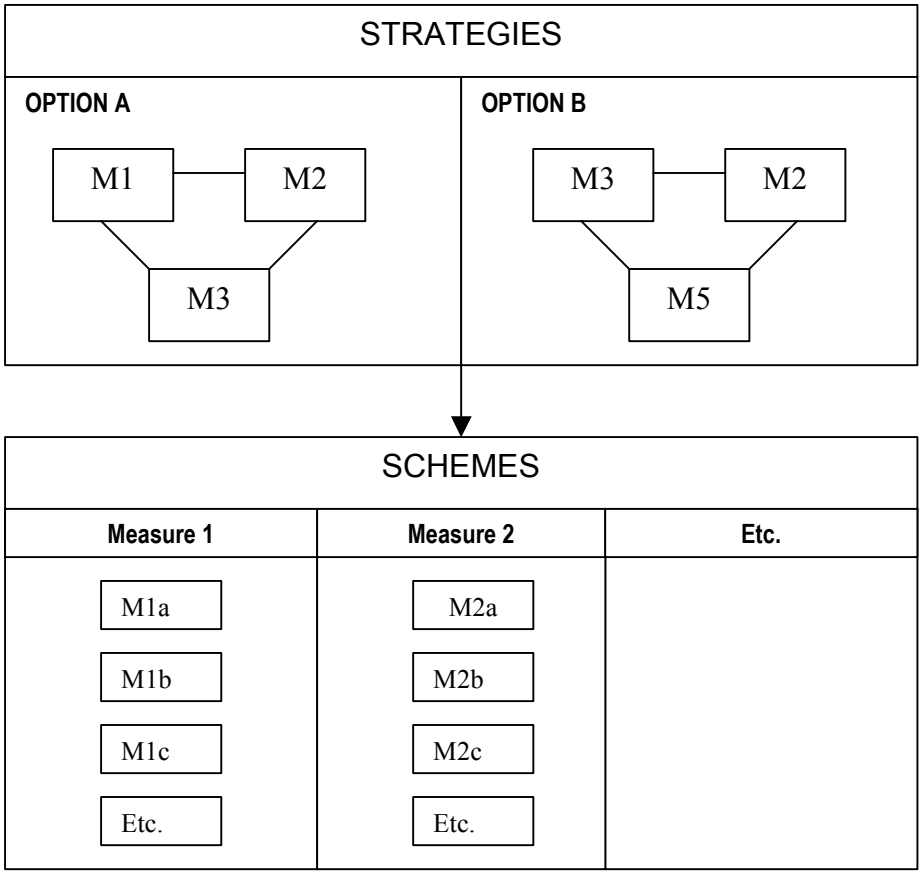
Note also in Figure 3 that modelling is likely to be associated particularly with providing inputs to the full appraisal of a small number of refined options, by estimating their likely impacts on behaviour. This might, in turn, lead to the

generation of further/modified options, once the impacts of particular options have been estimated.

4.3 Option generation at strategy and scheme levels

Looking at the whole transport and land use planning decision making and implementation process, option generation appears at two stages in the process, in different guises, as shown in Figure 5. At the initial stage of Strategy Development, an 'option' refers to a broad approach to meeting a given policy objective or set of objectives, for example to reduce traffic congestion and air pollution. Clearly, a combination of instruments may be needed to achieve this policy aim; for example, one package might combine road user charging with park and ride and traffic management. Here each different combination or package of measures represents a distinct 'option'.

Figure 5: Use of option generation techniques at two stages in the transport planning process



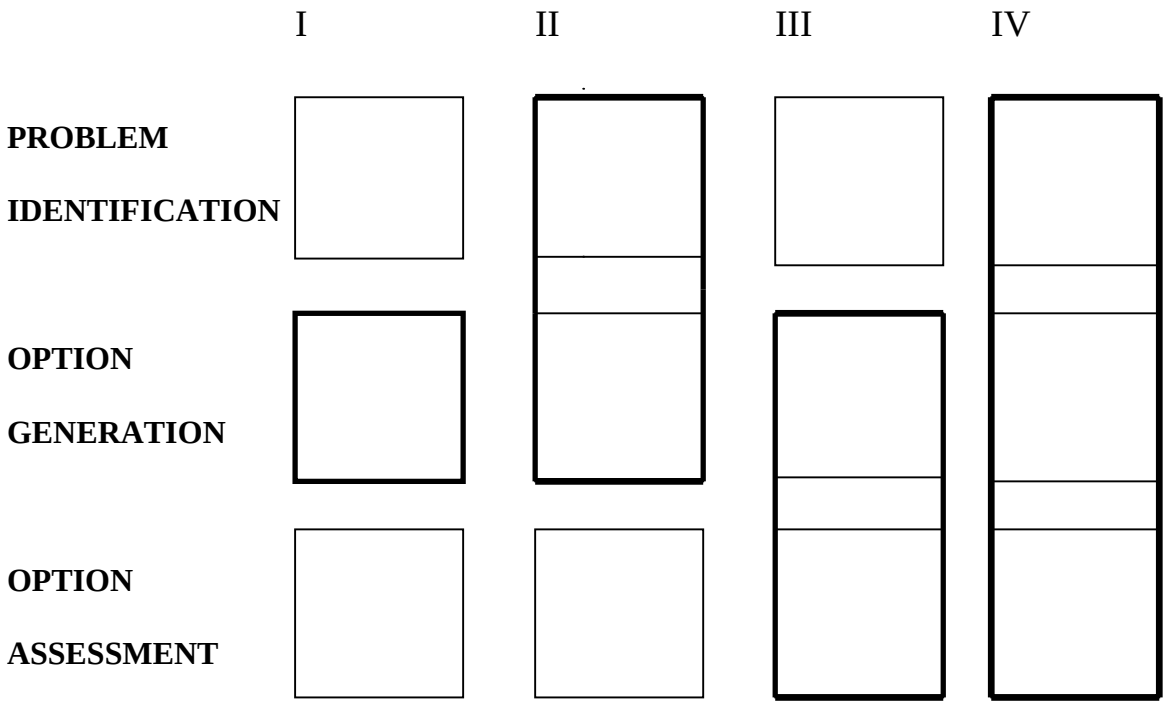
At the subsequent more detailed level of Scheme Development, there will be different 'options' for delivering each component or instrument of this strategy. For example, road user charging can be based on cordons, area pricing or distance pricing, and different time restrictions and charging regimes can be applied. Here each 'option' consists of different combinations of components for a particular transport/land use instrument.

4.4 Combining different stages of the decision making process

Although the emphasis in this review is on techniques for option generation, quite often particular techniques combine option generation with preceding or successive stages, or both, as represented schematically in Figure 6.

For example, some of the more qualitative, out-of-the-box techniques ask people to first scope out the existing situation/problem, as a platform from which to explore possible solutions. In other cases, option assessment is carried out iteratively with the option generation phase, as a means of filtering down a large number of potential option combinations.

Figure 6: Coverage of various 'option generation' techniques



There are also complex inter-relationships between problem identification, option generation and option assessment, since the criteria for all three stages share certain commonalities. For example, option assessment is concerned (among other things, such as ensuring value for money), with establishing whether problems have been adequately addressed by proposed solutions; similarly, option generation needs to work largely within the space created by problem identification and option assessment. This, not only are the types of option generated constrained by the way in which the problem is specified, but also by the way in which assessment is formulated.

5. METHODS FOR GENERATING OPTIONS 'INSIDE' THE BOX

5.1 Library-based approaches

Here the designer looks for options that might address a particular problem, or meet a set of agreed policy objectives, by referring to past practices through access to a suitably annotated library of good practices. Such an approach can be useful both at the strategy level (i.e. proposing combinations of measures to address a set of problems/ objectives), and at the more detailed scheme level.

Design-a-Trial (DaT) and Trial Planner

Medical interventions require the development of randomised control trials (RCTs), followed by ethical approval of their design and procedures, before they can be accepted under the general medical protocol. Due to a combination of the complexity of these protocols and the limited research experience of many trial designers, bad design is common. This has prompted the development of artificial intelligence decision support tools to assist in the design of medical protocols for RCTs. In their paper, Modgil and Hammond (2003), describe the parameters of such a tool, which they have named 'Design-a-Trial' (DaT). The tool consists of a database of generic principles concerned with the safety and efficacy of medical procedures, abstracted from previous medical plans and protocols, and validated through expert advice encoded as constraints in the execution software.

The user describes his/her proposed trial design by completing a series of computer-based forms within the DaT. The tool then formulates these as 'obligations' encoded as 'Prolog' rules, which can be queried to generate advice and suggested plan revisions that comply with safety and efficacy requirements. However, because the DaT knowledge may be deficient regarding certain aspects of the trial design (most notably, where there is an incomplete historical knowledge base), it is combined with an additional specialised meta-interpreter called the Trial Planner, that enables the user to specify the safety and efficacy principles in an interactive manner.

Here the user selects individual goals to be resolved until the natural language version of the principle is at the right level of detail for inclusion in the DaT protocol document. Should the goal fail due to incomplete knowledge, the user can include a symbolic representation of the partial solution with a corresponding textual clause in the protocol.

Transport Example: KonSULT

KonSULT, the EPSRC/DfT/RJRF funded Knowledgebase on Sustainable Urban Land use and Transport, provides information on the performance of some 40 policy instruments, with a further 20 identified for potential inclusion. It adopts a consistent structure, comprising the following main elements:

- A description of the policy instrument and its mode of operation;
- Summary of potential impacts on demand, supply, costs which is related to a pre-specified list of policy objectives and problems;
- Review of a number of relevant case studies, to identify actual recorded impacts;

- Summary of the potential of the instrument to contribute to achieving each of the pre-specified objectives and to overcoming each of the pre-specified problems, highlighting the resulting gainers and losers and the barriers to implementation;
- Identification of the contexts in which the instrument is most appropriate, again from a pre-specified list of contexts; and
- A list of those policy instruments which might complement the instrument in question, by reinforcing its impact or overcoming barriers to implementation.

KonSULT already contributes to option generation in two ways. The first is the listing of complementary instruments, which suggests to the user interested in one policy instrument the others that might appropriately for part of a policy package. The second is a filter search process, which enables the user to specify the context in which they are interested (objectives, problems to be overcome, type of strategy, type of location) and receive an ordered list of the most promising instruments, generated from unweighted scores for the instruments in the case study summaries.

KonSULT is designed as a tool to assist in the development of transport/land use strategies, rather than schemes, though in principle much more detailed libraries could also be developed to assist in scheme option generation.

Other Library-based examples presented in Annex II include:

- PROSPECTS
- On-line planning resource
- VTPI
- NHS Direct
- New house/job selection

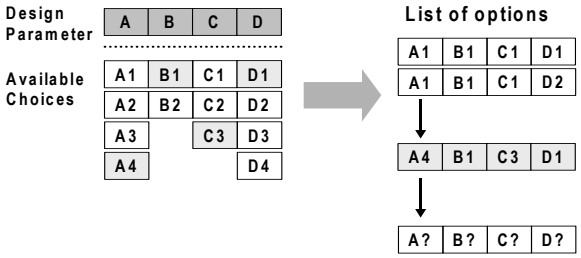
5.2 Options generated from new permutations of existing attributes: Morphological Box Analysis

Morphological analysis techniques involve the systematic creation of options by generating a set of (all) permutations of attribute levels for a set of design parameters. They are normally used for developing new products, and thus there is most experience of using the method for scheme-type option generation; however, in principle, the method could also be applied at the strategy level.

Thus, for a particular type of scheme, each design parameter (attribute) is identified, along with the potentially available levels for each parameter. Each level on each parameter is then combined with each level on each other parameter, to create a set of permutations that collectively combine every conceivable combination.

A simplified and partial representation of this process is shown in Figure 7, which illustrates the generation of options for a scheme in which there are only four parameters (A-D), with between two and four levels available for each parameter. The left hand side of the diagram shows the full set of attributes and levels, while the right hand side shows just four values from the set of permutations that can be generated from these initial conditions.

Figure 7: Simple representation of the morphological technique.



By identifying the gaps in current practice (i.e. where certain generated permutations do not correspond to an existing object or concept), the method reveals potential new options for consideration.

This type of approach ensures that all conceivable options are considered. While this potentially leads to a very large number of permutations, in practice the selection of a particular level for one parameter can limit the feasible range of levels for other parameters, so that the number of practical options may be far fewer than the total number of theoretical combinations.

New propulsion systems

This approach was first proposed in the literature by Zwicky (1947), who applies the technique to the example of an aircraft jet engine, mapping all the available potential options for new propulsion systems and identifying new combinations (for example a nuclear powered, ceramic fan-jet).

The Futures Group (1994) has built on this approach to develop a hierarchical method called the "Relevance Tree". This describes the concept or product to be developed in increasing levels of detail, starting with broad themes and then sub-dividing these into more precisely defined independent elements, which can then be used for the morphological box analysis process.

Ritchey (2003) describes some recent applications of general morphological analysis in the field of policy analysis, where many of the parameters are non-quantifiable. He notes that in defining a realistic 'solution space' (i.e. a feasible sub-set of combinatorial options), three types of constraints can be identified:

- Logical contradictions: 'those based on the nature of the concepts involved';
- Empirical constraints: 'relationships judged to be highly improbable or implausible on empirical grounds'; and
- Normative constraints: 'relationships ruled out on, for example, ethical or political grounds'.

Since inconsistencies often arise between certain combinations of parameters (rather than just between certain combinations of attribute levels), it is possible to rule out many rows or columns in the matrix, by making such pair-wise comparisons. He suggests that, typically, 90% or more of potential combinations are ruled out during this process.

Other examples provided in Annex II include:

- Mobile payments
- Swedish bomb shelter program
- New types of electric scooter

Transport Example: RUC Option Generation

Kocak *et al* (2005) describe an application of the morphological box approach that forms part of a web-based tool designed to help local authority professionals develop Road User Charging (RUC) schemes for their local area. The RUC Option Generator has three primary components or matrices: Charging principles, Administration/ Operation, and Technology.

Charging principles is the most comprehensive of the three, with ten design parameters (e.g. RUC area, time period, level of charge) and between two and fourteen possible states or levels for each one. The analyst works through the parameters in a prescribed order. Once certain states (cells in the matrix) are selected, this automatically rules out some of the states relating to other parameters; for example, with an 'area licence', it would not be practical to have variable charging rates.

The tool also has some links between the three primary components; since decisions about technology and administrative structures also affect which charging principles can be applied.

5.3 Hybrid Approach: Concept Generator

The concept generator (Stone et al., 2001) is a computerised adaptation of the "design by analogy" method, which uses a database of existing designs as a resource for developing a new design that meets the required objectives. It thus combines features of the Library and Morphological Box approaches, and is a computational tool intended to allow new options to be generated by drawing on the existing body of design knowledge in a particular area, in this case for the engineering of consumer products.

Components of existing designs are related to the functions they perform within that design. From this information a matrix of empirical design information can be constructed, where a positive integer indicates a relation between the component (row) and function (column). This matrix is combined with an 'identity' matrix that describes the functions required from a new product design, and this results in the output of a list of the components that could assist in meeting the desired functional profile of the new product.

5.4 Constrained option solutions

In some cases, the generation of options using a morphological box type approach needs to be constrained, for example to prevent the production of options that offer the best of everything (i.e. combining the highest attribute level for each parameter).

This is best achieved by 'costing' the elements of the options, using some appropriate metric, and then imposing an overall budget constraint.

The Priority Evaluator

An early example of such an approach in the planning field was the Priority Evaluator, first developed by Hoinville (1971) as a means of gauging community preferences. The original exercise presented respondents with a set of environmental features, such as 'fumes from traffic' and 'travel time to work', and different levels on each, varying in their cost. Each feature/level combination was depicted using a simple form of visual sketch and words. Each feature had a zero cost for the base (worse) condition, with increasing costs for successive improvements from this baseline, costing up to eight 'pegs' for the highest level in cases where this would be very expensive (e.g. providing off street residential parking). Respondents were given a total budget to allocate among the features, in the form of a number of pegs that could be slotted in next to the appropriate sketch of a particular feature/level combination.

The Priority Evaluator was not developed primarily to develop constrained option sets, rather it was designed to estimate community trade-offs, but it could equally be used with the former objective in mind. It would seem to have application at both the transport/land use strategy and scheme levels.

Transport example: Strings and Ribbons

This is a consensus building game developed in the USA that allows people to develop a transport strategy for their community, in the form of a package of transport improvements to be implemented over a 20-year period (see www.vcmpo2025.com). But it includes built-in budget constraints.

Participants are divided into groups of 5-8 players per table, with a facilitator. Each group is given a large-scale map of the relevant area, and each participant is given a sum of 'money' to buy various transport improvements. These can include a broad range of potential instruments, such as: new roads, road widening, bridges, bus services, commuter rail services, pavements, bicycle lanes or streetscape improvements.

The various measures are represented physically, in the form of strings (depicting bicycle and pedestrian facilities), ribbons (roadway facilities), stickers (for other types of improvement projects). The length of string or ribbon allocated to participants gives an indication of how much can be afforded with an equivalent of twenty years of funding.

The technique seems most suited to cases involving constrained option generation at the strategy level.

Transport example: ARTISTS streetspace design aid

This streetspace allocation design tool was developed as part of an EU-funded project that was concerned with redesigning urban arterial streets, as part of developing more

sustainable urban areas. Unlike the other examples, here the design constraint is spatial rather than monetary.

Participants (usually local residents and businesses) are invited to consider how to reallocate highway space along a section of mixed use, urban street. The components of the design options include varying the amount of space allocated to pavements, kerbside parking and loading activities, bus and cycle lanes, general vehicle traffic lanes and space for a median strip (e.g. to create a boulevard-type street scene). The exercise is based around a 1:200 base map of the street section, and the various design options are drawn to scale on acetate strips.

The acetate representations of the design components provide a stimulus to thinking about what might be needed in the street, and because each component is drawn to scale, it is easy to see which combinations could or could not be accommodated within the available space. Note that this is slightly different to the other methods that have been described, in that respondents have the option of excluding some of the components from their design solutions (e.g. by not including a cycle lane).

For further details and sample materials see www.tft.lth.se/artists

The technique is principally suited to certain types of scheme design.

6. METHODS FOR GENERATING OPTIONS 'OUTSIDE' THE BOX

6.1 Introduction

Here we review a set of mainly qualitative methods that can be used to directly generate options, although as part of this, some may also contain procedures for framing the problem and/or the preliminary screening of options (i.e. Cases II to IV in Figure 6).

Very few of these techniques either originate or have been applied in the transport planning field, although most are potentially applicable at both strategy and scheme levels. Much of the literature and thinking has come from the business world ('Innovation Tools'), with an emphasis on product innovation, with the constant development and competitive ideas that market driven thinking brings; and most of these new ideas and techniques originate in America and Japan. Other important sources of ideas come from the creative industries (e.g. IMBOOT magazine, and web sites such as Charles Cave's Creativity Web), and from the education sector.

In their literature review of 'concept generation' methods, King and Sivaloganathan (1999) list five general techniques for generating ideas, namely brainstorming, brain-writing, mind-mapping, sketching/model-making and database/knowledge-base searching. Some of these adopt structured approaches to option generation, while others use more random and open stimuli.

The latter distinction is emphasised by Frantz (1996), in the context of visioning exercises (for either future scenario development or innovative product design). He refers to the first as the 'evolutionary' or 'ground travel' approach and the second as the 'discontinuous leap' or 'space travel' approach. With the evolutionary approach, participants inquire into 'what might be' on the basis of the best of 'what is' (see for example Wilson, 1992 and Stewart, 1993); whereas the discontinuous approach asks them to break free from existing reality with its usually known constraints and assumptions in order to maximise creativity. One way of approaching the latter is to use the 'random entry' technique; this prompts a forced analogy between the problem at hand and an unconnected random word or picture, in order to open up new perspectives and generate completely new ideas.

6.2 Structured approaches

Mind/cognitive-mapping

Mind mapping is very similar in concept to a spider chart, and was developed as a systematic method for externalising new ideas quickly and easily. A large piece of paper is used to record all the ideas around a central topic, with connection lines between linked ideas, to form a mind map or current state of knowledge. The method formed a key part of the SODA (Strategic Option Development and Analysis) study (Hjortso, 2003), used as part of a forestry study.

For each participant, a cognitive map is produced describing his or her thought processes on the subject under discussion. These maps are then merged by the facilitator to form a single map, with the objective of comprehensively describing all

aspects of the issue under consideration, including suggested options and their positive and negative consequences.

Hjortso presented the collective group mind map, which included over 500 concepts and 17 themes, in an 'idea and debate catalogue' and distributed this amongst all council members and planning staff. Of the 108 ideas for action that emerged from the group mind map, the councillors evaluated 20 as being 'new and meaningful'.

Computer-based tools such as the Decision Explorer (Banxia, 1996) have been developed to assist in the construction and manipulation of cognitive mind maps, in an electronic format.

Market oriented, quasi-experimental designs

As a part of new product development, several research projects have introduced a sample of customers or potential end-users to a new technology-based product and have asked them to try it out either under experimental or 'real world' conditions, in order to generate ideas about how the product could be improved. These studies have found that innovation and improved value is more likely to be forthcoming when it is co-created with the customer, and that trying to obtain their input through surveys and focus groups is less productive than these 'value-in-use' experiments.

One example involves a recent experiment with a mobile communications product based on SMS, which was undertaken by Matthing *et al* (2004). Participants were given a mobile phone with a special account that gave them access to new text services. They were asked to use the product over a 12-day period, and told to imagine that these current services could be added to; they recorded in a diary their ideas for new and improved uses, based on their experience of its current use. Cash prizes and free cinema tickets were offered for high-quality contributions.

The authors describe one particularly interesting outcome. One participant, who was worried about his personal finances, suggested that it would be useful if his mobile phone could text him a daily reading of his current bank balance. The idea came to him as he was walking passed a McDonald's outlet and he thought that the text could be signalled to him using a McDonald's jingle, which could potentially act as a sponsor. Thus two new product ideas were generated from one latent 'real-world' need.

Six Thinking Hats

The 'Six Thinking Hats' technique (de Bono, 1985, 1992) is based around the systematic exploration of a problem and possible solutions, by using a progression of six types of thinking ('hats'). The thought processes are managed by a facilitator, and the time spent on each type of thought is strictly controlled. In this way the role of negative, analytical thinking (Black Hat) is prevented from dominating discussion, and the importance of positive thought (Yellow Hat), new ideas (Green Hat) and instinctive emotional responses (Red Hat) can be reflected in the overall outcomes. Consideration of the available information is undertaken during the White Hat phase, with overall control of the problem and management of the thinking process in the

Blue Hat phase. This approach helps to ensure that, for example, creative thought is not suppressed by critical instincts, or by the fear of embarrassment or ridicule.

Culvenor and Else (1997) applied the Six Hats technique to engineering for workplace safety and found that it increased the ability of engineering students to generate appropriate options for safety solutions, despite the lack of subject-based safety training. This structured approach encourages creative ideas and prevents 'blue-sky' ideas from being rejected before they have been fully explored and evaluated. In their follow-up evaluations of the quality of the health safety options that were generated during the Six Hat exercises, they found a high level of correlation with the optimum rank score.

Laddering

Laddering is a method of encouraging people to think laterally, by moving from a specific position up a 'ladder' to increasingly abstract levels and then, having arrived at a very abstract/general concept, to work back down the ladder again to very practical/specific ideas. The laddering technique involves using 'why?' on the way up and 'so what?' on the way down.

One interesting variation of this approach, described in Lucas and Psaila (2005) uses the concept of Snakes and Ladders, to investigate issues relating to neighbourhood environmental inequalities, for the Environment Agency. This exercise was run following a more general brainstorming session, with the Snake representing steps of decline and the Ladder potential steps of improvement.

6.3 Unstructured approaches: verbal stimuli

Brainstorming

Numerous studies refer to brainstorming exercises as a method for generating new ideas and options in relation to a given set of problems or scenarios. King and Sivaloganathan (1999) attribute the technique to Osborne in 1939, which involves three key stages to 'storm' the brain to originate new ideas, as follows:

1. Suggestion: Each member of a team is encouraged to suggest various ideas on how a concept can provide for a given function;
2. Discussion: The ideas from stage one are discussed by all group members, to improve their clarity and eliminate any non-viable concepts;
3. Agreement: The group consolidates a number of concepts to be taken forward.

Brainstorming sessions may involve professionals who are already familiar with the nature and parameters of the problem, or non-professional interest groups, such as communities experiencing that problem or organisations involved in the frontline delivery of programmed interventions (Zwetsloot and Askouunes, 2003). Whilst brainstorming can be a useful early stage technique for generating new ideas in groups, it usually then requires some form of structured gaming technique to formalise and build consensus around these ideas.

Electronic Brainstorming Systems (EBS)

EBS is operated within an Electronic Management System, and allows a themed question to be sent to each participant, who is asked to enter up to five lines of initial comments in response. These comments are then randomly sent to some other participant. The original participant receives a file with whatever comments it has already attracted from the other participants, to which (s)he adds more comments and sends the file to another participant for further comment.

The main advantage of EBS is that participants are able to enter ideas at their individual computers as they think of them, rather than in a formal, sequential process (Potter and Balthazard, 2004). This encourages many separate and randomised lines of communication and trains of thought to be developed simultaneously and passed around the group, with the aim of facilitating 'blue-sky' thinking around the given theme. The effectiveness of the EBS tool was measured in terms of (i) the number of unique options that were generated by the process, as separately counted by two independent raters and (ii) the total quality of those options, as judged by independent task experts in this field.

Open space event

The technique was developed by Harrison Owen, during the nineteen eighties, as a formalisation of the unstructured coffee break – where people freely exchange information and, in that environment, often generate interesting ideas. It is best suited to engaging people on general issues, where the detailed design stage has not yet been reached.

Typically, a wide range of stakeholders is invited to attend. In an initial plenary session, people suggest issues/topics that they would like to discuss (e.g. problems for cyclists), and the more popular ones form the basis of a set of parallel workshops, where solutions are discussed. Initial results from each workshop are summarised on a central notice board, and people are then free to move to other workshops, to add any new ideas that they might have.

The outputs are brought together in a final plenary session, where the various ideas are collected and collated, and proposals are prioritised.

Lateral and creative thinking techniques

Numerous 'gaming' techniques and stimulus materials have been employed across a range of disciplines, with the aim of stimulating lateral and creative thinking with both lay and professional participants. Beckett (2005) has compiled a comprehensive list of techniques on his website. Most are designed to provoke a fundamental shift in the mindset of the participant in order that (s)he is able to 'think outside the box' to generate wholly new and radically different ideas. Some of the more interesting examples are described below:

Synectics is a technique formally introduced by William Gordon (Hall, 1996). It requires the introduction of an apparently unrelated analogy or metaphor into a discussion in order to provide new insights into a defined problem (de Bono uses

words randomly selected from a dictionary for this purpose as one element of his Six Thinking Hats approach).

Trigger method is based on the use of repetition. The problem is defined, debated and ideas noted. A selection of these ideas are collected, then 5 – 10 of these are randomly chosen, displayed and used as 'triggers' to generate more ideas. One idea triggers another and so on, until as many thoughts as possible are generated.

Provocation requires a deliberately 'stupid' statement to be generated (a provocation) about something that is usually for granted, e.g. 'Houses should not have roofs'. Once the statement is made a checklist is used to examine all its aspects:

- The consequences of the statement
- What the benefits would be
- What special circumstances would make it a sensible solution
- The principles needed to support it and make it work
- How it would work moment-to-moment
- What would happen if a sequence of events was changed

The Provocation technique often helps to generate completely new ideas, e.g. houses with opening or glass roofs, making it possible to lie in bed and look up at the stars.

Keeping a Dream Diary: Everyone dreams every night, but most of our dreams are forgotten. A dream diary is a way of retaining the information longer, and helps to better recall dreams by being more aware of them. Psychologists have demonstrated that regular discussion of dream diaries, and any themes and ideas running through them, can help build new understandings and lead to creative solutions to problems.

6.4 Unstructured approaches: visual stimuli

Many of the more established methods to encourage 'out-of-the-box' thinking, like brainstorming, the trigger method, provocation and synectics, all tend to rely on language and verbal stimuli.

Recently there has been considerable development of techniques that avoid the use of language and aim to stimulate the visual and associative memory: "The lower the command a person has of language the more common sense dictates that it will be difficult for the person to solve problems requiring creative insights where the use of language is involved" (Proctor, 1997). More visual techniques are being encouraged, targeting our iconic memory or special visual information store.

Sketching/model making

This tends to be more appropriate in the field of product and or building design and is really a variation of the brainstorming technique using images (pictures or models) instead of words to communicate ideas. Demirbilek and Demirkan (2004) describe the use of sketching and modelling as an element of their participatory design method. Their design sessions combine brainstorming, scenario-building, idea writing and sketching, unstructured interviews with clients, with written and oral parts, sketches and gestures to promote active dialogue.

Ferguson (1992) identifies three kinds of sketches used for generating alternative options in design and engineering circles:

(i) Thinking sketches – used to assist designers in the thinking process
(ii) Talking sketches – used to share ideas and support group discussions and help explain technical points
(iii) Prescriptive sketches – used to communicate design decisions.

It is the first two that are the most appropriate to option generation. Another function of sketching is that it can assist the transition from general descriptive knowledge into more specific depiction. In addition, pictures can act as powerful tools for providing a shared visual context to stimulate creative ideas in discussion groups.

Planning for Real

This is a planning-related application of model making and was first developed in Britain in the late 1970s by the Neighbourhood Initiatives Foundation, as a technique to engage local communities in the redevelopment of their local areas. It is based around the development of a large, three-dimensional model of the local area which is built by the local community (e.g. as a school project), and which is then used in community meetings as a basis for people to:

(i) Identify areas where they feel that there are particular problems (e.g. accident risk, fear of crime, litter), using cards or sticky labels; and
(ii) Record what they would like to see happen, by using suggestion cards.

It thus combines aspects of problem identification and option generation (i.e. situation II in Figure 6), in a sequential process. Planning for Real is best suited to engaging people in connection with the planning of physical design schemes, rather than ones that mainly involve management/enforcement initiatives, or that are concerned with the development of general strategies. It has been used successfully in Essex, for example, to look at options for traffic calming along a newly by-passed series of villages, and is best suited to the scheme rather than the strategy level.

‘Eureka’

Eureka is an example of a ‘Forced Fit’ technique, that presents participants with unrelated objects or ideas, and asks people to find a significance or association in their juxtaposition (Townsend and Faviour, 1991).

The process involves:

- Listing attributes or associations that are connected with three randomly chosen images that have nothing to do with the problem or decision to be made; for example, a disabled sign, a smiley face and a paper clip.
- A list of attributes is compiled that might be associated with each of the three objects; then one is taken from each column and force fitted together.

These are then related back to the topic of concern (e.g. urban traffic congestion), to see how these attributes might be applied to this unrelated topic.

7. GENERAL FACTORS AFFECTING OPTION GENERATION

This chapter briefly summarises some academic studies that have explored either how the framing of the problem, or the presentation the task to respondents, affects the type and range of options that are generated.

7.1 The effect of different contexts and objectives

Adelman *et al* (1995) tested the hypothesis that the type of information presented to people will significantly affect both the options they generate and the one they rate as being most appropriate to solve a given problem. Their experiment varied the information stimuli given to twenty engineering students at a university. Their task was to recommend a solution for the university's parking problem, with which they were familiar, and were told to generate as many options as possible before opting for a preferred solution.

Ten participants were asked to generate options for the more efficient use of the available parking space, and ten asked to generate options for increasing the amount of parking space. Half of each group were given a particular reason for the problem (i.e. management inefficiency in the first scenario, and the rapid expansion of the university in the second), while the other half was given no explicit reason for the task. Participants worked independently.

The experiment found that providing explanations for the need to tackle a problem resulted in the generation of fewer and the selection of different types of options than if no reasons were given, but that the differences were not as strong as the researchers had anticipated they would be.

7.2 The number of objectives set at one time

In a study of undergraduate students, Butler and Scherer (1997) found that they were more likely to generate significantly more options when the objectives were presented one at a time.

When more than one objective was presented at once, there were more constraints to be satisfied and so fewer options could be produced which satisfied all the objectives – which limited creativity, from the start. Their study also found that the way in which the objectives were stated, and the level of emotional involvement of the participants with the delivery of these objectives, influenced the option generation process.

7.3 The diversity of group members

A number of the studies have advocated the importance of group diversity. For example, O'Higgins, (2002) found in a study of company directors that board members representing minority groups or interests have the potential to stimulate divergent thinking, by offering alternative perspectives that challenge conventional thinking and hence encourage consideration of a wider range of options.

Similarly, Verganti (1997) advises that team working and the early involvement of a wide range of stakeholders is important in innovative product development.

However, as Hjortso (2002) found in the SODA study quoted earlier, this can also lead to a greater likelihood of group conflicts and greater difficulties in reaching consensus decisions.

7.4 Alternative Focus Thinking *versus* Value Focus Thinking

Leon (1999) notes that the traditional method of generating strategy options has been through considering alternatives to the current strategy, referred to as 'alternative-focused thinking' (AFT). This has been criticised because it restricts the thinker to the alternatives that are available and known. 'Value focus thinking (VFT), on the other hand, starts by stating the values or objectives that underlie the need to generate the strategy and uses this as the basis for generating options.

In order to see whether adopting a VFT approach leads to more imaginative options, 28 final year psychology students were each randomly assigned to either VFT or AFT experimental conditions. Participants in the VFT group were given an open-ended questionnaire with 17 questions about the objectives and values that needed to be satisfied and told that the objective was to form a structure of objectives for choosing amongst course subjects. The AFT group participants were asked to analyse their preferences in choosing advanced courses based in the subjects they themselves had chosen that semester. They were told to generate objectives that later allow them to make comparisons in the light of their own experiences.

A list was made of all the objectives of each group using common terminology. It was found that the VFT method produced a greater number of alternatives, that these were more hierarchical in their structure and had more points for assessment.

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