

Democracy is the basis of modern Western society. Its basis in freedom, fairness and equity has been cherished and fought for over the centuries. Now it faces a new challenge, a positive one. The growth of the Internet and pervasive telecommunications is promising an era of electronic democracy, e-democracy for short. We will be able to vote by phone or text message, on the web, through interactive televisions. There are moves across Europe and elsewhere to explore new ways of voting, initiatives to develop mechanisms of e-government and generally there is an expectation that our

Towards Electronic Democracy: Internet-based Complex Decision Support (TED)

An ESF scientific programme



Democracy is 'government of all the people, by all the people, for all the people.'

Theodore Parker

Democracy is the worst form of government – except for all the others'

Winston Churchill

What government is the best? That which teaches us to govern ourselves.

Johann Wolfgang von Goethe



We have many icons of democracy from the campaign for universal suffrage to the great parliamentary assemblies of our nations and the European Union.

democratic institutions will evolve into the new Information Society.

Despite the excitement brought by the technology, many of the current visions for its use are almost entirely conventional: political discussion and debate may become more inclusive of all the electorate through the growth of electronic discussion forums; opinion polling easier, faster and cheaper via the web; voting may not involve a cross on a piece of paper, but rather a click on a web-site or the sending of a text message. To a large extent e-democracy is simply envisioned as articulating the political and democratic procedures of the nineteenth and twentieth centuries through the mechanisms of modern information and communications technology. Yet there are mechanisms that enable a much more substantive implementation of democratic ideals. It is now possible for the public to be involved in societal decision making in many more ways. It is this broader vision that the TED programme will explore.

Our intention is to draw on the modern methods of decision analysis and group decision support, deployed over the WWW, in order to involve the public in decisions that affect them. More than electronic referenda, our vision sees stakeholders helping to shape options, sharing perspectives, discussing and evaluating pros and cons, facing up to uncertainty and moving towards a balanced conclusion.



The European Science Foundation acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan and implement pan-European initiatives.

The present ...

Most major societal decisions have impacts, usually uncertain impacts, on many stakeholders apart from those who are directly responsible for the decision and those who benefit from its outcome.

In such cases, many disparate perspectives

Stakeholder. *Anybody who as an individual or as part of a larger group may or believe they may be impacted by the potential consequences of a decision.*

need to be brought together and balanced if an agreed course of

action is to be reached and implemented.

The decisions may concern major local, regional, national or multi-national issues. Sometimes the decisions relate to the 'normal working of society'; other times to the 'return to normality' after some major event, perhaps a flood or a spill from an oil-tanker, like the recent *Prestige* crisis in Galicia. The stakeholders may include local communities, unions or workforces, industry, organisations such as environmental or consumer groups and, in a variety of guises, the general public. At the national and regional levels, a government regulator or planning office is often involved in approving or co-ordinating the decision. To reach such decisions in an inclusive,

democratic way, there is a need for debate between all the stakeholders as to the merits and disadvantages of various policies and on the uncertainties involved.

Democracy means government by discussion, but it is only effective if you can stop people talking.

Clement Atlee

Yet currently the decision process is far from inclusive. Generally the process will begin with a small group getting ideas together and deciding on a way forward. For instance, a company may wish to build a waste site. The planners with the company will screen several possibilities, focus on one or two and analyse the advantages and disadvantages of those from their own viewpoint. A decision on which one to 'go for' will be made and then a case developed for the regulatory body or regional government, which we say call, as shorthand, the authorities. The authorities will first examine the case to see if it fits (or comes close to fitting) legal requirements and if it does, then and only then will discussion become more open and inclusive. The result of this is – in social and political terms – a process which almost inevitably becomes confrontational, because of what has gone on already 'behind closed doors' and – in rational decision making terms – a process which is almost certainly lacking in creativity, because only one perspective, the company's, enters into the problem formulation phase. By the time that more varied and potentially catalytic views can come into play, entrenched positions are likely to have been taken. In other circumstances, the decision making will be in response to some unforeseen issue, perhaps an

environmental disaster. Usually it will still fall to a small group of individuals to chart a way forward before ‘going public’ and consulting stakeholders. In real emergencies there is little else that can be done, given the need for timely and resolute decision making; but in plenty of cases there is time for more consultative, inclusive ways of working, certainly in the aftermath when decisions on restoration and prevention of future events are needed.

There is a limit to the application of democratic methods. You can enquire of all the passengers as to what type of car they like to ride in, but it is impossible to question them as to whether to apply the brakes when the train is at full speed and accident threatens.’

Leon Trotsky

In current societal decisions, it is often the case that in any public debate two issues are muddled, namely, the likelihood of a particular impact occurring and the scale and importance of that impact. Some stakeholders may think an event so unlikely that it does not merit debate, whereas others may believe that the event would be so significant for them personally that it is an issue of vital importance.

The vision ...

The WWW and other communications infrastructure provide a mechanism for involving stakeholders much earlier in the process. The envisaged methodology is based on a common WWW tool-set to provide decision support and a communications infrastructure to support stakeholder interactions. It recognises that citizens not only wish to be informed

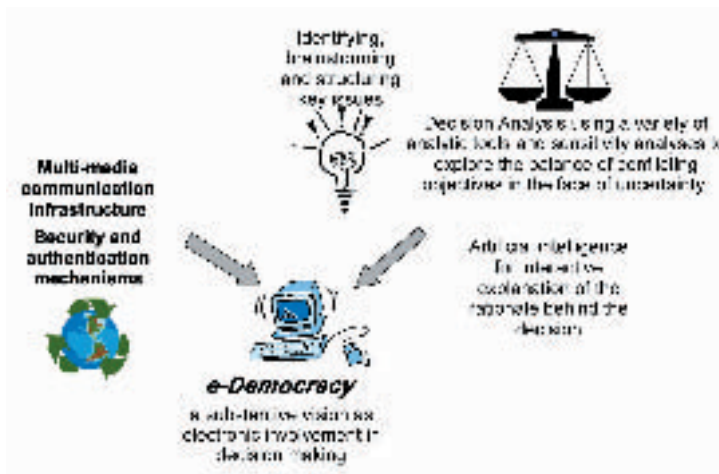
about major issues, but wish also to articulate their opinions in a way that can affect the decision making process. The tools will both help all parties understand issues and also build a shared understanding between the stakeholders.

In particular, they will support:

- identification and structuring of the key issues, providing separate complementary perspectives on the uncertainties and the scale of possible impacts;
- recognition of the various stakeholders and the characteristics of their interests;
- identification of experts who may contribute to understanding the uncertainties;
- construction of an outline analysis, capturing initial perceptions of the problem;
- discussions between stakeholders to explore their perceptions and values;
- construction of a comprehensive analysis drawing together uncertainties and value judgements, including expert advice and different stakeholder views;
- exploration of possible consensus via a comprehensive sensitivity analysis, thus pointing to a balanced decision;
- communication throughout the process with all parties, avoiding the use of fright factors, jargon, paternalistic and other misleading language;
- maintenance of appropriate levels of security, which may vary during the decision making process from complete secrecy to complete openness; and, finally;
- documentation of the process in a way which both explains the rationale behind the final decision and lets all stakeholders explore the decision and understand the reasoning.

In short, in the words of Levy, our vision is one of substantive *e*-democracy:

“It’s not a matter of allowing masses of individuals to vote instantaneously on simple questions posed by telegenic demagogues, but to promote collective and continuous elaboration of solutions and their co-operative solution, as close as possible to concerned groups.”



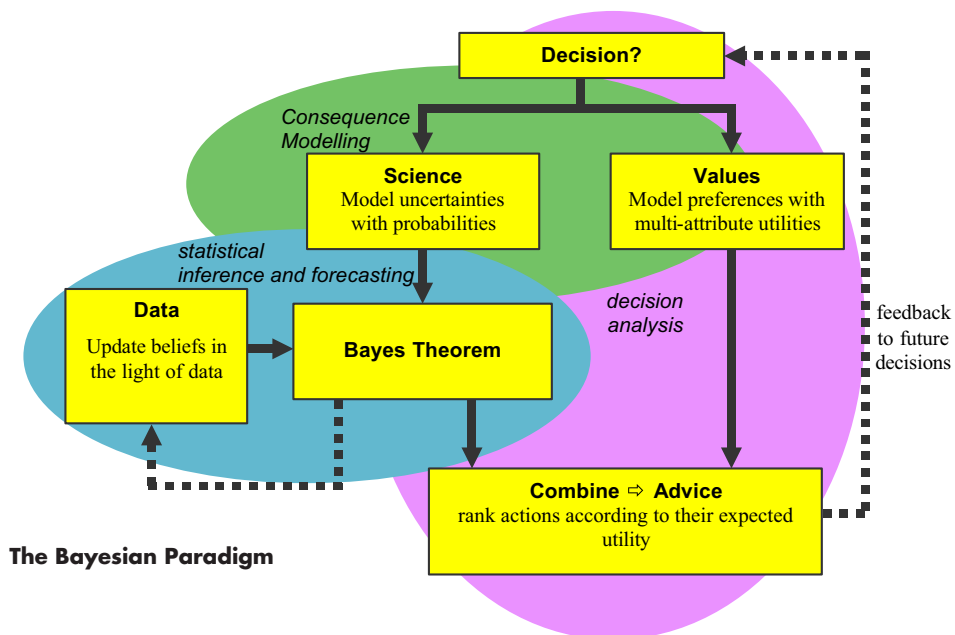
The TED vision

Decision analysis

Over many years, decision science research has provided an understanding of how people should make decisions, how they do make decisions and how they might be supported to make better, more informed decisions. In particular, Bayesian decision analytic methodologies have been developed to provide the core tools for such support: e.g. decision trees, influence diagrams, uncertainty modelling, the synthesis of expert judgement and data, multi-attribute utility modelling and sensitivity analyses of all of these. The impact of Bayesian methods is clear from perusal of articles in general journals like *Science* or *The Economist*. The methods explicitly address the inherent subjectivity in the decision modelling, which naturally arises because

many issues cannot be defined unambiguously. Decision analysis is *not* about prescribing a choice of action; rather, its aim is to uncover and explore the implications of subjective assumptions, and to provide a framework for discussion. Decision analysis and decision support tools have advanced sufficiently that it is straightforward to support strategic decision making within a single group of decision makers with reasonably common objectives. Such decision makers are commonly supported in their task by a process in which:

1. Analysts work with the decision makers, structuring the problem, exploring issues and clarifying objectives, uncertainties and possible strategies.
2. Analysts build a decision model which embodies the decision makers’ developing understanding of its structure.
3. The model is populated with quantitative data and quantitatively encoded judgements elicited from the decision makers themselves or from expert advisors.
4. The model is analysed to provide preliminary guidance on the choice of a strategy. However, this guidance is moderated and enhanced through extensive sensitivity analysis which leads the decision makers to a deeper understanding of the issues facing them and shows them how best to balance these through the choice of a strategy.
5. As a result of this understanding, the decision makers select a strategy to implement and communicate this to the various stakeholders.



The Bayesian Paradigm

This process is, of course, far from linear with iterations of model elaboration and further data collection and judgement elicitation being common. The five stages draw on skills from a variety of disciplines from the mathematical and computational sciences – e.g. in relation to the algorithmic aspects of the methods – to the behavioural and cognitive sciences – e.g. in relation to the understanding and communication of the key issues. However, the key points for the core developments within the TED project are:

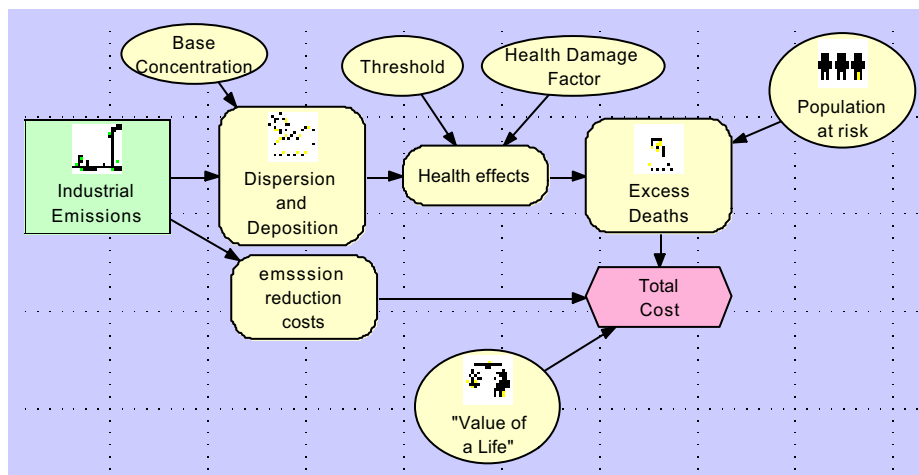
- most of the recent progress in decision analysis has focused on steps 2, 3, and 4 (see next section);
- little emphasis has been given, in step 5, to communicating with the stake-

holders in sensitive, effective ways and, indeed;

- little or no emphasis has been given to the incorporation of wider stakeholder values.

The last point is of particular concern in the case of public bodies which have an obligation, legal and/or moral, to be responsive to the values and concerns of all the constituencies that they represent.

In parallel to these methodological, mathematical and software developments, there has been a growing recognition in many circles of the importance of clear, sensitive communication between the public and government, regulatory and other bodies on matters relating to risk



Balancing the costs of regulating industrial discharges

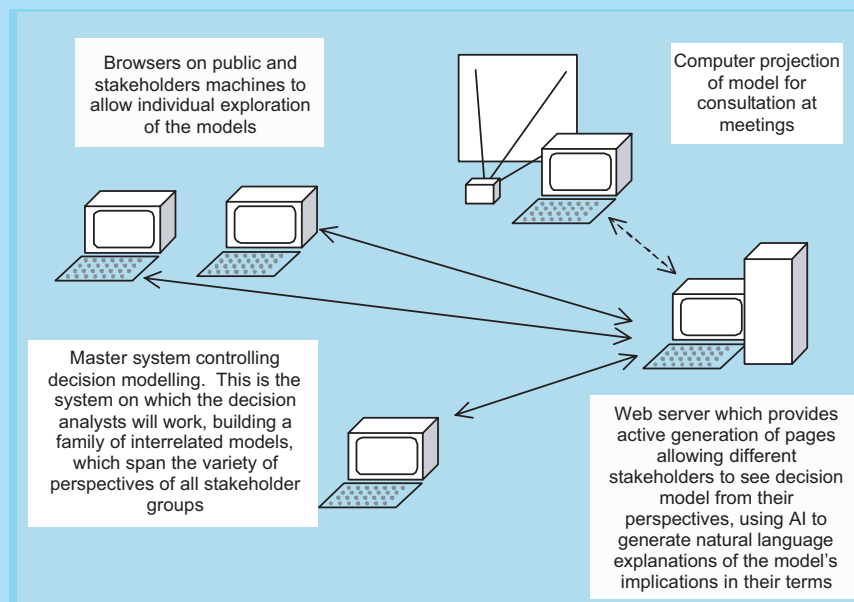
Example: Deciding on a by-pass

Planning decisions on by-pass roads have seldom been without controversy. Those living in the town to be by-passed usually favour the proposal strongly because of the decrease in traffic and increase in safety it will bring their town. But often the environmental impacts of proposed routings are such that other stakeholders oppose the plans. While we recognise that there are no guarantees, we do believe that the process outlined below is more inclusive and likely to lead to more reflective and constructive debate and – perhaps – a consensus decision.

As general discussion of the need for a by-pass begins, the planning authorities establish a public web-discussion to gather thoughts from across the community, identify issues, possible routings, alternatives such as traffic management schemes in the town, various pros and cons of the rough outline routings and of continuing the *status quo* of no by-pass. Drawing on the issues identified and also on standard planning guidelines, the authorities build a preliminary decision model to compare several alternatives with the *status quo*. The model involves evaluation criteria reflected in the debate so far and rough weightings of these. Using the model the authorities come to a first decision on the way to proceed and post this along with the model on the web-site. The model is interactive and the public can explore it inputting their own weightings and discovering the effect of these on the ranking. Public meetings may be held and discussion supported via computer projection of the model to allow further exploration using sensitivity analytic techniques. The local media report the discussion using the intuitive graphics found in modern decision analytic software. Throughout the planning authorities enter into the debate openly.

After a suitable time, the decision is revisited in the light of comments gathered through the public's and stakeholders' interactions with the model. A more elaborate model may be built and details of the higher ranked alternatives refined. The planning authorities use the revised and elaborated model as a basis for their decision and, maybe, enter a further round of discussion with the public.

Throughout the process, the use of the models, which of course need to be supported by clear explanations, seeks to build a shared understanding of the issues between the stakeholders and allow them to see the arguments more clearly.



The technology supporting TED's vision

and, more generally, on the greater involvement of a wide variety of stakeholders in decision making processes. And, of course, there has been a move towards 'e-government' and 'e-democracy': viz. greater involvement of the citizen through the use of the WWW. Our project recognises that the growth in computational power and graphical web-based environments together with the growth in access to the Internet provide the means to take the understanding provided by decision support tools outside closed rooms of decision makers, enabling, at the very least, the reasoning behind decisions to be conveyed to different stakeholders and, at best, greater involvement of stakeholders in the decision making itself. A first vision of what might be possible is available at the Decisionarium web-site (<http://www.decisionarium.hut.fi>), which includes some ideas of e-democracy,

but does not involve uncertainty issues frequent on major decisions. We foresee the development of a decision support and communication infrastructure referred to earlier, which will enable multiple analyses to be conducted to enable a variety of perspectives on the issues to be explored and compared, thus identifying where the values and perceptions of different stakeholder groups agree and where they differ.

In short, the TED project proposes a timely development of Bayesian methods to support societal decision making via the mechanisms of the WWW: a true step towards e-democracy rather than the e-administration techniques that so far have lain at the heart of e-government initiatives.

Relevant research areas in decision analysis

The following topics in decision analysis remain areas for fertile research and are very relevant to TED's objectives. We expect our debates and discussions to draw on the latest developments in these, and indeed to stimulate further work on them.

Problem structuring

Modelling and structuring the decision makers and stakeholders' perceptions of a decision context, their value systems and beliefs, and the various options available remains one of the 'arts' of decision analysis. However, over the past two decades a variety of 'soft OR' methodologies have been developed to help in eliciting the structure of appropriate models such as influence diagrams, evaluation networks and

decision diagrams. Any participative approach to e-democracy will need to draw on these methodologies to allow the issues to be represented and explored in the Internet-based analyses and in the interactions between stakeholders.

Therefore, we will compare methodologies to determine their relevance for e-democracy; explore the use of software modelling tools such as V·I·S·A, Web-Hipre, DPL; and draw on experiences of other teams such the ELVIRA project. There are often several alternative formulations of a decision problem, especially when there are several decision makers and stakeholders. Thus, we shall investigate methods to check the sensitivity of the solution to problem structure; explore model selection and model mixing

among several decision models for the same decision problem.

Uncertainty modelling

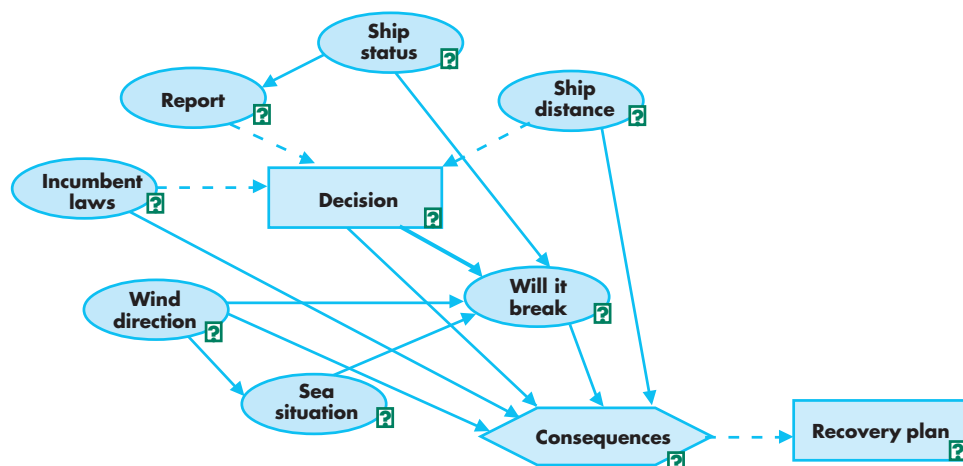
Much remains to be done in determining methods to elicit from experts their beliefs and assessments of uncertainty and to combine their often contradictory opinions. We shall analyse what is available, paying attention to the many cognitive issues. Complex phenomena can be hardly described by simple models. Thus there is a need for models capable of adequately describing complex behaviour yet, at the same time, being relatively straightforward to specify and analyse. Choice among several plausible models is another key issue in modelling uncertainty.

Dependence and independence structures are key to the representation of uncertainty in probability models. Several formalisms have been developed to represent these in computationally tractable ways which allow the dependence structure to be elicited efficiently from experts. We note belief nets, influence diagrams and, the more recent, vine models. These dependence modelling techniques have the benefit of

being essentially graphical in nature, leading to intuitive graphical interfaces within modelling software. Thus we expect these formalisms to be essential in explaining the models underpinning the analyses to all stakeholder groups.

Preference modelling

Preference modelling theory has run somewhat ahead of application in that many more potential preference structures can be represented and explored than practice has demanded. But practice has called for preference modelling for small coherent groups of decision makers, and the methodologies of value focused thinking suggest that in such cases there is a certain freedom in developing the model which may obviate the need for complex dependencies. Also the elicitation processes within decision analysis are reflective in which the analysts and decision makers continually pause, discuss and remove incoherencies. Within the framework that we envisage, while the process will still be reflective, the greater distance between the analyst and stakeholder will necessitate the use of error models for preference judgements to allow for possible misrepresentation of stakeholder



An outline influence diagram for dealing with leaking oil from a sunken ship

preferences. It is likely that many of the recent developments within sensitivity and uncertainty analysis will be pivotal in addressing these issues.

Expected utility maximisation

For many contexts, we shall face complex stochastic sequential optimisation problems, whose solution will require novel ideas and algorithms. Also the multiple decision maker multiple objective nature of the many societal decisions, with inevitable imprecision in preferences and beliefs will undoubtedly require further developments in the computation of Pareto frontiers.

Sensitivity analysis

TED aims at spreading awareness on the need for *comprehensive* sensitivity analyses within the scientific community. We shall present methods to analyse sensitivity and seek to stimulate the development of efficient, user-friendly software whose absence is probably the major cause of the scarce practical application of the wealth of methods presented in the literature. Cross-fertilisation between groups working on sensitivity methodologies and those involved in multi-agent theory will be sought. We will look to stimulate developments in integrating approaches to sensitivity analysis, e.g. applying Sobol' sensitivity indices to identify which components of a multivariate prior distribution are more influential on the analysis. While sensitivity techniques for many analytic models and computer codes have been developed, methods for the graphical tools of decision analysis are not so advanced. Sensitivity methods are needed in such tools because of their importance in allowing the visual exploration of conflict and consensus of opinions.

Risk assessment and communication of issues

Much work has been undertaken by psychologists, behavioural scientists and others to understand the public's response to risks communicated via the media, but very little of this work has been used to inform the development of risk communication strategies. We shall draw on this work to inform our presentation of the issues within a decision analysis to the variety of stakeholders who will explore the analyses. Thus our workplan will bring together the more mathematically and computationally based designers of the techniques and graphical presentations with those skilled in the social psychology of risk perception.

Development of a web-based software infrastructure for decision analytic support

Central to all the methodological developments is the need for a web-based software infrastructure on which all the decision analytic tools and methods can be explored by a wide variety of stakeholders. We shall, therefore survey the relevant decision analytic software, and explore common input formats and identify how they may be drawn together into a coherent, secure web-based environment.

The TED project

While our overall objective is clearly too large for a single programme, our specific goals are more focused. We shall seek to develop methodologies and tools to support the analysis at the heart of our vision, specifically:

- develop methodologies which enable multiple decision analyses to be communicated, explored and, indeed, built over the WWW, thus providing the mechanism by which stakeholders may be drawn more closely into the decision making process;
- address relevant technical issues arising in the application of the Bayesian decision analytic paradigm to *e*-democracy in areas such as:
 - problem structuring,
 - uncertainty modelling,
 - preference modelling,
 - expected utility maximisation,
 - sensitivity analysis,
 - prototype software and interfaces for achieving this;
- evaluate the tools and methodologies in the context of ‘hypothetical’ scenarios which exhibit many of the complexities of real issues but are simple

enough to be explored within the timescale and resources of the programme;
and, generally;

- promote rational, inclusive and participative approaches to societal decision making.

We emphasise that while our tangible goals relate primarily to mathematical, decision analytic and computational developments, we view this project as essentially multi-disciplinary. The tools and methodologies will not work if we lose sight of the political, cultural and social contexts in which they will be used or of the behavioural and cognitive characteristics of the users of the system.

Through our programme we expect to:

- demonstrate and evaluate more general, web-based decision analytic tools;
- promote debate on *e*-democracy methodologies and technologies;
- develop bridges between several research communities;
- help educate a generation of young scientists via summer schools and institutional exchanges;
- maintain Europe’s leading role in thinking about the Information Society.

Funding

The programme

The TED programme will network and draw together researchers from across Europe who share this vision. Over four years several activities will promote and develop the TED vision:

- 2 general conferences;
- 2 summer schools;
- 3 small workshops per year on specialised topics such as:
 - Structuring decision making problems
 - Interfacing the software
 - Developing scenarios
 - Environmental decision making
 - Interfacing multi-agent theory and Bayesian methods
 - Computational methods for complex decision analysis
 - Risk communication
 - Sensitivity analysis for complex decision making.
- 5 x 12 days visits per year for exchange of senior researchers between participating institutions;
- 5 x 3 months postdoctoral visits at participating institutions per year;
- A web site describing TED activities, supporting the technologies (including database of tools, scientists and papers) and letting visitors get involved in “let’s pretend” experimental decisions;
- A TED report series and an electronic TED newsletter.

Contacts will be made with industry, business, media, government bodies and politicians in participating countries.

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For the latest information on this programme consult the *TED* home page: www.esf.org/ted

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