IAJ The Integrated Assessment Journal
Bridging Sciences & Policy
Vol. 6, Iss. 4 (2006), Pp. 143–164

Integrating Backcasting & Decision Analytic Approaches to Policy Formulation: A Conceptual Framework.

Charlie Wilson
Institute for Resources, the Environment and Sustainability
#413—2202 Main Mall, University of British Columbia, Vancouver BC V6T 1Z4 *

James Tansey
Chair in Business Ethics, Centre for Applied Ethics and Sauder School of Business
6356 Agricultural Road, Vancouver BC V6T 1Z2†

Sean LeRoy
Institute for Resources, the Environment and Sustainability
#429—2202 Main Mall, University of British Columbia, Vancouver BC V6T 1Z4‡

Abstract

Backcasting is a normative scenario method used to help decision makers deal with the inherent uncertainty of the distant future. While backcasting has been shown to be useful in identifying and characterising plausible yet structurally distinct alternative futures, it is often weakly linked to policy-making in the present. This paper argues for a methodological refinement to backcasting which addresses this weakness by integrating the value-focused thinking approach to decision making into the final step of the backcasting process. While the proposed conceptual framework was designed to support a specific research endeavour, the Georgia Basin Futures Project, it is fully transferable to other backcasting applications with different problem contexts and participant profiles.

Keywords: Backcasting, decision analysis, value-focused thinking, policy formulation, sustainable futures.

1 Backcasting: An Overview

Scenario methods have been used in various forms to enable decision making in the face of uncertainty. Proponents recognise that uncertainties about the future may be irreducible and that beyond a short timescale, a number of contrasting

*E-mail: cwilson@ires.ubc.ca
†Corresponding Author. E-mail: james.tansey@ubc.ca
‡E-mail: sean.leroy@ceaa-acee.gc.ca

futures may be equally plausible. Scenarios can be developed using qualitative and quantitative data but many methods use a combination of both. As a scenario method, backcasting—the approach elaborated in this paper—involves the articulation of desirable endpoints and the assessment of the steps necessary to achieve them.

The term 'backcasting' (Robinson, 1982*b*) describes an approach first used in soft path energy studies, in the aftermath of the oil shocks in the 1970s (Lovins, 1976; Robinson, 1982*a*). These studies took experts' articulation of a desirable future and analysed how feasible such goals were. The purpose of the analyses was to shed light on the policy and resource implications of different sectoral end-points by describing the trajectories required to connect the current state-of-play with the desired future.

The conceptual basis of backcasting lies with a recognition that the distant future is inherently unknowable, particularly in problem contexts like sustainability. This is because intentional decision making and behavioural change can create a desirable future which is not necessarily the most likely based on past and present conditions (Robinson, 2003). Policy choices in such contexts are oriented by goals which require substantive change from current trends. These discontinuities are not typically resolved by forecasting approaches concerned with extrapolating what is most likely (Granger Morgan et al., 1999; Hojer & Mattsson, 2000). Rather than focusing on identifying the most likely future state of a social or environmental system, backcasting explores the feasibility of desirable futures. Analysis is framed by a problem context in which current problems are resolved in the future through choice rather than one in which solutions are constrained by dominant current trends (Robinson, 1988; Dreborg, 1996). Backcasting applications share the methodological steps represented on the left side of Figure 1, which draws on a summary paper by Quist (2004).

Backcasting comprises four principal steps: strategic problem orientation; articulation of values and generation of desirable future scenario(s); backcasting of trajectories; identification of interventions to implement or initiate backcast trajectories (see also Figure 1). Strategic problem orientation involves bounding the problem context, setting normative assumptions, identifying stakeholders, considering scale issues and so on (step 1). The next step in backcasting is to construct a future vision of solution(s) to the problem in hand (step 2). The future vision is a characterisation of what is desirable. Consequently it reflects the values of the participants involved in the process. Once defined, trajectories are backcast from the future vision (step 3). Trajectories refer to the development pathways from the present system state to the desired future. Whether these pathways are genuinely worked back from the future, or outlined from the present with the end-point in mind depends on the details of the methodology employed. Backcast trajectories are typically described in terms of first-order economic, social, technological and institutional milestones and changes. These in turn inform the types of policy measure and behavioural shifts upon which the trajectories would be founded. Backcasting provides a framework for identifying the interventions or actions required to implement, or more modestly, to initiate the trajectories which would lead to the desired future (step 4). Steps 3 and 4

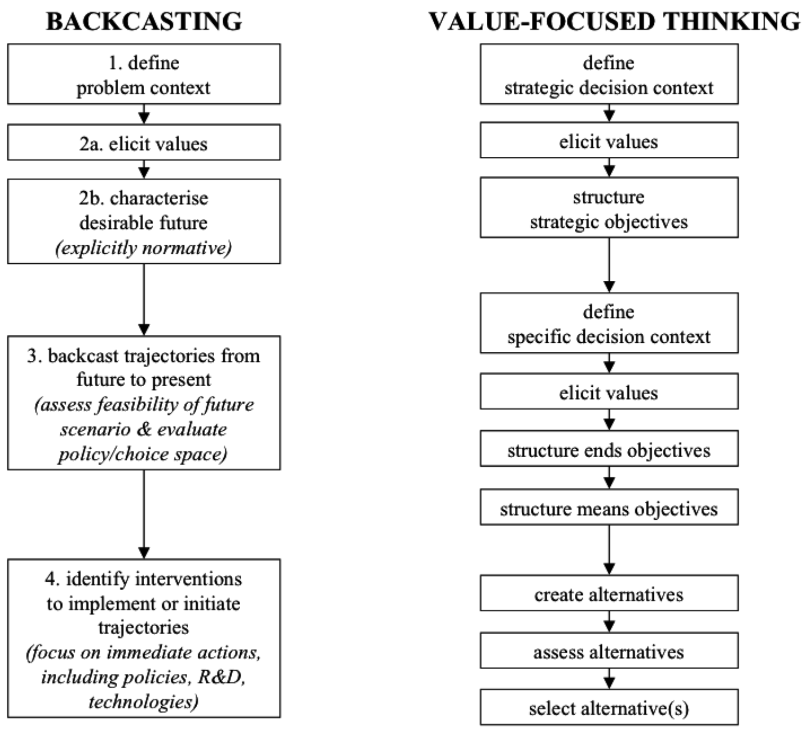

Figure 1: Backcasting & value-focused thinking: Key methodological steps.

of the backcasting methodology are thus closely inter-related. Interventions are often discussed as part of the trajectory backcasting step, for example, by identifying targets or obstacles to be overcome. A supplementary final step involves embedding and implementing the action agenda and is germane to those backcasting applications that seek to drive (as well as understand) change (Quist, 2004).

2 Identifying Interventions in Backcasting

Backcasting methods have been used in a number of studies, a selection of which are summarised in Table 1. The Dutch 'COOL' project was designed to explore national pathways for implementing technological response options to climate change (van de Kerkhof et al., 2003). Backcasting within the Sustainable Technology Development ('STD') programme, also in Holland, was similarly structured around technology adoption pathways, but with explicit attention given to co-evolutionary cultural and socio-economic conditions (Weaver et al., 2000). 'SusHouse' was a multi-country EU funded project exploring the co-dependent changes in technology, culture, and society required to achieve sustainable household functions (clothing care, shelter, and food) (Green & Vergragt, 2002).

The empirical basis for this paper is provided by 'GBFP-Strategies', the fourth project cited in Table 1. The Georgia Basin Futures Project ('GBFP') was a five-year inter-disciplinary research project that considered sustainability at a bioregional scale around Vancouver on the west coast of Canada (Robinson et al., 2000; Tansey et al., 2002). GBFP-Strategies was a component of this broader GBFP project in which local and regional policy-makers were invited to explore development scenarios with the aid of a participatory integrated assessment model, and then develop action strategies toward a more sustainable future.

Each of the four studies described above and in Table 1 shared an emphasis on the identification of interventions (step 4) as a practical outcome of the backcasting exercise. While much has been written on the theoretical merits of backcasting, its relationship to other problem-solving methods, and on the first three methodological steps (steps 1–3 in Figure 1), less attention is paid to how interventions are identified (step 4) (Dreborg, 1996; Holmberg, 1998; Quist, 2004). In part, this is because backcasting is often applied in exploratory processes of visioning, value elicitation or revelation, and social or institutional learning (Robinson, 2003). Visions of a desirable future are considered useful starting points for policy-makers, determining the freedom of action in a policy sense, rather than as a detailed structuring device for formulating specific interventions (Dreborg, 1996).

In the case of the COOL, STD, and SusHouse projects, detailed consideration of specific interventions formed a key part of the overall backcasting study. The applicability of their methodology to the GBFP-Strategies project is limited however by substantive differences. Most importantly, GBFP-Strategies approaches sustainability from an integrated rather than a sectoral perspective.

Table 1: A Methodological Comparison of Selected Backcasting Studies. Sources: COOL: van de Kerkhof et al. (2003); Sustainable Technology Development: Weaver et al. (2000) SusHouse: Young et al. (2001); Green & Vergragt (2002); Quist (2004) GBFP-Strategies: Robinson et al. (2000); Tansey et al. (2002)

Backcasting Steps	COOL	Sustainable Technology Development	SusHouse	GBFP-Strategies
1. Strategic Problem Context	• climate change • 80% reduction of GHGs by 2050 • national scale (Holland)	• sustainable technology adoption by 2030–50 • national scale (Holland)	• sustainable households by 2050 • household scale (EU)	• sustainability in 2040 • regional scale (British Columbian watershed)
2. Value Articulation & Futures Definition	• two different future images (market dynamics & social adaptability)	• future visions based on solutions to the 'factor 20' challenge	• 'design-orienting scenarios' • products, services & their impacts and benefits	• value-based choices • future visions created by integrated assessment model • iteration for learning about trade-offs
3. Trajectory Backcasting	• technology adoption pathways • major obstacles / opportunities & ways of overcoming / exploiting them	• technology adoption pathways with co-evolutionary cultural and socio-economic conditions • descriptions at time intervals	• social innovation pathways & their acceptability to consumers • economic & environmental impacts	• projected by integrated assessment model • described by a range of environmental, economic, and social indicators
4. Identification of Interventions	• addressing single most significant challenge • key actors	• research programmes, innovation networks & social alliances, business opportunities	• design options for products, services, systems and social arrangements	• policy formulation
Other Aspects				
Participants in Backcasting	Government, business, civil society, ENGOs	Government, business, research bodies, public interest groups	Non-governmental stakeholders	Government
Research Duration	2 years	8 years	2.5 years	6 months

Consequently, backcasting in GBFP-Strategies is framed around environmental, economic and social indicators at an aggregated level across a wide range of sectors and domains, rather than disaggregated technology adoption pathways. This integrated approach allowed for the understanding of trade-offs between different backcast trajectories to be made central to the study's objectives. A further substantive difference is GBFP-Strategies' restricted focus on government policy as a specific type of intervention.

In the context of the GBFP-Strategies project, therefore, the research question arose: how can normative scenarios backcast in the distant future be linked to practicable policy interventions for the here-and- now? In particular, the GBFP-Strategies research team sought to develop a methodology which: (i) carried the integrative approach of backcasting in a broad problem context through to the identification of interventions; (ii) focused on policy formulation in a multi-stakeholder process.

In moving from steps 3 to step 4 (see Figure 1), we shift from an open and deliberative process to a more focused and technical analysis that identifies interventions and proposes policies. This paper proposes a conceptual framework for structuring this final step of the backcasting process as a decision problem. Lessons learnt from the implementation of the conceptual framework in a workshop format with groups of policy-makers is described and evaluated in a further paper (Wilson et al., Submitted). The proposed methodology includes an important innovation by drawing on value-focused thinking, a prescriptive methodology for making decisions in a structured and systematic way (Keeney, 1992). Value-focused thinking:

- provides a framework for analysing the trade-offs that may be required between multiple and potentially conflicting objectives;
- facilitates productive and unconstrained consideration of decision alternatives;
- mitigates common decision biases and heuristics that lead to poor judgement in complex decisions;
- allows for multiple stakeholders to participate equitably in a single decision process.

The remainder of the paper is organised as follows. In Section 3, value-focused thinking is described in more detail, and its applications to-date contrasted with those of backcasting. A more detailed examination of the two approaches, however, reveals myriad methodological similarities. Having established potential synergies between backcasting and value-focused thinking, Section 4 then sets out a means of integrating the two to structure the final step of the backcasting process as a decision problem to identify concrete policies to implement backcast trajectories. Section 5 describes this integrated methodology in the context of the GBFP-Strategies project, which provides the empirical context for this paper. Two key advantages of the integrated methodology are discussed in detail: understanding trade-offs in an integrated decision context; and evaluating alternatives. Section 6 then concludes with the proposed methodology's broader benefits, and applicability to other backcasting studies.

3 Value Focused Thinking: Applications & Methodologies

Value-focused thinking comprises a set of prescriptions for effective decision making developed by Keeney (1992) within the broader field of decision analysis. At its centre is the idea that values (i.e., what is important) should be articulated as objectives to frame a decision problem. Rather than decision alternatives or options driving the decision process (alternatives-focused thinking) as is commonly the case, alternatives can be derived and assessed against the clearly stated decision objectives.

Value-focused thinking is a member of a family of decision analytic processes that share the same general form. A decision context is defined to bound the decision problem. Objectives for the decision are identified (what is the decision trying to achieve?), and decomposed into ends and means objectives. The attainment of means objectives represents progress towards (rather than achievement of) the fundamental goals for the decision. Ends and means objectives can be structured, therefore, in a hierarchy. The objectives hierarchy frames the creation of decision alternatives, which are oriented towards the goals for the decision. Alternatives are assessed against decision criteria, which are based on the ends objectives. The alternative which performs best overall against the decision criteria is selected. The stepwise process is iterative, allowing for improvement where analysis reveals omissions or misrepresentations. Methodological texts within the decision analysis literature include: Keeney (1982, 1992); Hammond et al. (1999); Clemen & Reilly (2000), and for strategic decision making, Kirkwood (1997).

A cursory review of backcasting and decision analysis applications suggests the two approaches bear scant resemblance. Backcasting has been applied to complex problems and involves projecting far enough into the future that desirable futures can be described, free from the constraints of current trends and structural relationships. Decision analysis is used to devise optimal alternatives to identifiable decision problems faced in the present, recognising both the need for implementation and prevailing agent hierarchies. Backcasting problem contexts tend to be broad, complex, rife with externalities and contingencies, and over long enough timescales for intentional choices to bring about discontinuous change (Dreborg, 1996; Granger Morgan et al., 1999). By contrast, the characteristics of decision contexts in which decision analysis is used are simpler and more immediate. Typically, they involve a single decision maker (albeit responsive to a wide range of stakeholders), clearly-defined decision problems, short timescales, and incremental solutions. Uncertainties are mitigated methodologically according to the form and detail of available data (Granger Morgan et al., 1999). Further points of comparison are summarised in Table 2, together with illustrative references to applications of both backcasting and decision analysis from the literature.

It should be clear from Table 2 that backcasting and decision analysis are not competing methods, rather they have been used to solve quite different problems. Decision analysis focuses on improving the quality of incremental decisions moving from the present into the future. Backcasting envisions structurally distinct futures first and then seeks to identify the steps necessary to achieve them. Nonetheless, we argue that in order to enable actual, rather than imaginary change, backcasting must also specify the incremental steps necessary to achieve a desired future. It is at this point, when the future is reduced to present choices, that we believe value-focused thinking can make an important contribution.

Figure 1 places the methodological steps in value-focused thinking and backcasting side-by-side. In this section we describe the similarities and differences between the two approaches in more detail.

3.1 Problem Context / Strategic Decision Context

Aspects of the backcasting problem context (e.g., the scope, timescale and physical scale) are typically bounded in advance. Within these bounds, the problem remains open for definition, with participants unconstrained in their choices for creating scenarios or future visions. The strategic decision context tends to be bounded in a similar way by the researchers or the decision maker in a decision process. Keeney describes strategic decision contexts as the set of all possible options, including dynamic decision strategies, available to the decision maker (Keeney, 1992).

Strategic decision considerations are not always used or referenced explicitly in decision analysis applications. Their inclusion is generally dependent on the facilitators of the decision process and the nature of the decision. In participatory decision making processes, a broad decision context is essential in enabling all stakeholders to agree on the terms of reference for the decision (Gregory & Keeney, 1994), in the same way that a broad problem context enables stakeholder buy-in to the backcasting process.

In cases where the strategic decision context is defined, participant values can be used to structure strategic decision objectives (although this can also occur as part of the specific decision process). These may be longer-term or more general than the ends objectives for a given decision problem, or the ends objectives may comprise a sub-set of the strategic objectives.

3.2 Articulating Values

The values of participants are central to both backcasting and value-focused thinking. Within the broader decision analysis literature, value-focused thinking prescribes values as the ultimate drivers behind any decision (e.g., Keeney, 1992; Arvai et al., 2001). This ensures that the alternatives are devised and assessed relative to what stakeholders consider to be important, as discussed above. The strongly normative orientation of backcasting also stresses the role

Table 2: Contrasting Features of Backcasting and Value-Focused Thinking.

Problem Context	Backcasting	Value-Focused Thinking (Decision Analysis)
Scope of Problem Context	• broad • poorly-defined • multiple sectors or domains	• narrow (though strategic context can be broad) • well-defined • single sectors or domains
Examples of Problem Contexts (+ *see below*)	• sustainability • climate change • energy sector	• capital allocations / business decisions • resource planning • technology evaluation & siting • risk assessments
Physical Scale	• national • regional • firm, e.g., Natural Step (Holmberg, 1998)	• depends on the decision maker (e.g., a utility service territory)
Timescale	• long-term (e.g., >30 years)	• short-term (e.g., <5 years)
Typical Solutions	• non-marginal • discontinuous • multiple agent	• marginal • largely continuous • single agent
Uncertainties	• underpin the approach • not addressed	• manageable • addressed methodologically
decision maker	• multiple or • undefined	• usually single • defined
Outcomes	• social learning • backdrop for policy-makers and other decision agents • technological / social innovation • explore possibility space for future trajectories	• select preferred alternative for a given decision problem
Participant Stakeholders	• traditionally experts and decision makers • more recently a wide range of stakeholders from government, civil society, and business	• traditionally experts and decision makers • more recently other stakeholders affected by / interested in the decision
Examples of Applications (with references)	• energy sector strategic planning (Robinson, 1982*a*,*b*; Anderson, 2001) • sustainable technology development (Weaver et al., 2000; Jansen, 2003; Quist, 2004) • sustainable households (Green & Vergragt, 2002) • technological responses to climate change (van de Kerkhof et al., 2003) • firm-level strategic orientation and planning (Robinson, 1992; Holmberg, 1998) • regional sustainability (Tansey et al., 2002; Robinson, 2003)	• power plant technology evaluation (Fischoff et al., 1984) • integrated resource assessments and planning (McDaniels, 1995) • ecological risk assessment (McDaniels, 2000) • water use planning (McDaniels et al., 1999) • demand-side management for a gas utility (Hobbs & Horne, 1997)

and influence of values in guiding the choices made in defined problem contexts (Robinson, 1992). Generating scenarios of a desirable future is a value-based exercise since the focus is on what is important to the participants (or in the case of The Natural Step's approach, the participants' principles). As the deliberate intent of backcasting is to remove constraints of current trends, economic relationships, technologies and social arrangements when generating a desirable future, the resulting future vision is inherently driven by preferences rather than predictions. The visioning exercise itself can be seen as a way of drawing underlying values to the surface and making them explicit. A useful distinction can be made between 'archaeological' value-revelation that may characterise immediate and familiar problems (in value-focused thinking), and the 'architectural' value-elicitation that characterises backcasting (Gregory et al., 1993). In the case of the GBFP, for example, an array of choices about the future is presented to participants, and serves as a structuring device for eliciting values (Carmichael et al., 2004). The kind of problem context that is typical of backcasting helps participants articulate their values by recognising the constructed nature of their preferences (Gregory & McDaniels, 1987; Slovic & Gregory, 1999). By contrast, value-focused thinking can treat values as given or sovereign, although a range of value-elicitation and objectives-structuring techniques are available (Clemen & Reilly, 2000).

3.3 Characterising the Future Vision / Objectives

Values are used in backcasting to generate a future vision, and in decision analysis to define objectives. The future vision can be seen as a solution to the problem framed by the problem context. Similarly, attainment of the decision objectives would mean the decision taken was wholly successful, as criteria by which the decision is assessed are derived from the objectives. Although both the future vision and the attainment of decision objectives are hypothetical, there is some correspondence between the two.

Characterisation of the future vision as a whole corresponds with strategic objectives for a strategic decision context. The more detailed components of this vision correspond with ends objectives for more specific decision contexts. How the whole (future vision) is organised and presented depends largely on how the backcasting is framed, and specifically, on the starting points for the trajectories (remembering that these work from the future back to the present). Typically, these starting points reflect the values or choices that were articulated to generate the future vision. In the COOL backcasting study, for example, the components of the future vision were characterisations of different technologies that together solved the problem of reducing greenhouse gas emissions by 80% (van de Kerkhof et al., 2003). Each of these characterisations corresponds to the end objective for a technology-specific decision context.

However, there is a key structural difference between the characterisation of the future vision in backcasting, and objectives in a value-focused thinking process. Decision objectives are values that are clearly and consistently structured with an object (e.g., greenhouse gas emissions) and a direction of preference (e.g., minimise). A value articulated as 'it is important for us to stop contributing to climate change' would be structured as the objective 'minimise greenhouse gas emissions'. A consistent structure for objectives helps ensure consistency, clarity, and interpretability (Keeney, 1992). The process of characterising the future vision in backcasting varies greatly from one application to the next. In the GBFP, for example, future visions are characterised by a series of quantitative environmental, economic and social indicators.

3.4 Future Vision / Decision Frame

Value-focused thinking emphasises the importance of a decision frame comprising a decision context, and a clear and transparent set of objectives (Keeney, 1992). While the decision context contains the full set of possible decision alternatives, the objectives capture the most important values. The decision frame—as its name suggests - provides the framework for the creation of decision alternatives. The alternatives are assessed according to whether they fulfil the objectives.

Consider, as an example, a strategic decision context of 'mitigate climate change'. Relevant strategic objectives might include 'minimise GHG emissions', 'minimise adverse impacts of climate change', 'maximise adaptability of human systems', and so on. A specific decision context might be 'mitigate anthropogenic interference with climate' with an associated ends objective of 'minimise anthropogenic GHG emissions'. This is a subset of the strategic objective of 'minimise GHG emissions'. Specific decision frames nest within the broader strategic decision frame. In both cases, however, the decision frames play the same role: orienting and constraining the creation and assessment of alternatives towards the objectives for the decision. The future vision in backcasting serves a similar function to the decision frame by acting as a framework for the trajectory backcasting and intervention identification steps of the methodology (see steps 3 & 4 in Figure 1).

3.5 Backcast Trajectories / Means Objectives

As discussed, each trajectory within a backcasting exercise has a defined starting point (its characterisation in the future vision). How the trajectory is then backcast varies from study to study. Two common approaches are to identify major obstacles and opportunities on the way (e.g., COOL), or to identify technological or institutional clusters which may be required to achieve the future vision (e.g., SusHouse). In GBFP-Strategies, the backcasting is carried out by an integrated assessment tool which projects (backwards) a series of indicators describing the bioregion based on an assessment of how the users' choices for the future interact with biogeophysical processes (Carmichael et al., 2004).

Describing or characterising the trajectory through any of these methods is analogous to setting milestones en route to the trajectory's starting point, whether these milestones are overcoming obstacles, exploiting opportunities, creating clusters, attaining certain indicator values, and so on. The trajectory characterisation is based on intermediate requirements for the future vision, much as the achievement of means objectives are intermediate requirements for the ends objectives. Just as the characterisation of the future vision, broken down into its component parts, corresponds with ends objectives for specific decision contexts, the characterisation of trajectories within those specific decision contexts is analogous with means objectives. The main difference, as discussed above in relation to ends objectives, is that means objectives are consistently structured, whereas trajectory characterisations can vary widely.

For example, if a component of a future vision is the widespread adoption of a given technology, then a backcast trajectory of its adoption pathway may be described by an increased R&D effort (short-term), a fiscal policy framework to stimulate its diffusion (medium-term), adaptive patterns of consumer behaviour (medium-to-long-term) enabled by institutional innovations (short-to-medium term). These aspects of the trajectory may be considered as means to the ultimate end, which is embedded in the future vision. They can be structured as means objectives ('maximise R&D effort', 'maximise fiscal incentives') to the end objective of widespread technology adoption ('maximise technology adoption'). The means and ends objectives can be organised into a hierarchical network which reflects the chronology of the trajectory. This process is illustrated in Table 3 with an example using solar PV (photovoltaic).

4 Integrating Backcasting and Value-Focused Thinking: A Proposed Methodology.

The value-focused thinking framework for creating, assessing and selecting decision alternatives comprises a decision context, values structured as ends objectives, and means objectives which are milestones that need to be completed en route to the fulfilment of the ends objectives. The first three steps of backcasting similarly provide a problem context, values characterised as components of a future vision, and backcast trajectories comprising milestones marking the route between a future vision and the present (see Figure 1).

This paper proposes that the fourth step of backcasting—the identification of interventions for implementing or initiating the trajectories—can be appropriately structured as a decision problem: i.e., what are the best alternatives (interventions) for reaching the objectives (future vision)? This linking of backcasting to value-focused thinking was developed and evaluated empirically as part of the GBFP-Strategies project in response to the absence of methodological specifications in the backcasting literature. This is particularly germane to contexts in which policy is formulated to initiate sectoral trajectories while respecting cross-sectoral objectives.

The integrated methodology follows the first 3 steps of backcasting, before shifting to a value-focused thinking approach to the identification of interventions (step 4). The methodological similarities between backcasting and value-focused thinking, discussed above, underpin this synthesis which is illustrated

Table 3: Correspondence between Backcasting and Value-Focused Thinking Methodologies.

Backcasting	Example	Value-focused thinking	Example
Future vision	• Widespread adoption of low carbon technology reducing GHG emissions	Strategic decision context	• Reducing GHG emissions
		Strategic objectives	• Maximise low carbon technology adoption • Minimise GHG emissions
Component of future vision	• Solar PV on every roof	Specific decision context	• Reducing GHG emissions from building energy use
		Ends objectives	• Maximise numbers of solar PV on roofs
Trajectory backcasting	• R&D effort to develop breakthrough solar PV technology or componentry • Scale-up of domestic solar PV manufacturing • Fiscal incentives for solar PV integration into new homes	Means objectives	• Maximise R&D effort • Maximise investment in manufacturing plant • Maximise fiscal incentives for solar PV integration

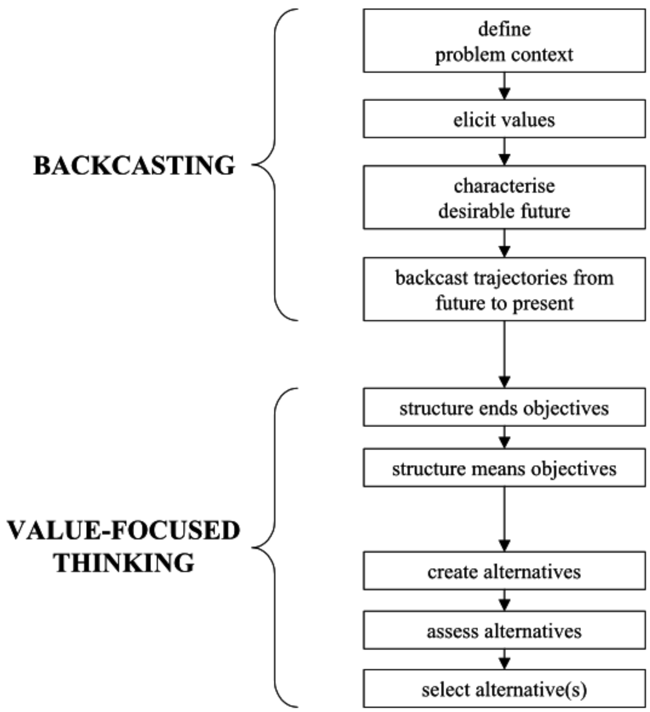

Figure 2: The integrated backcasting & value-focused thinking approach

in Figure 2.

Firstly, components of the future vision are treated as ends objectives for a decision problem. Secondly, the backcast trajectories are treated as a network of means objectives. To link to value-focused thinking, the ends and means objectives need to be appropriately structured into clear directional preferences following decision analytic prescriptions. Interventions can then be treated as alternatives for fulfilling decision objectives. The creation of alternatives within a clear decision frame facilitates broad-ranging objectives-oriented thinking which confers a number of advantages over unstructured alternatives-focused discussions (see below).

5 Application of the Proposed Methodology in GBFP-Strategies

Given the policy-making profile of the groups that participated in the GBFP-Strategies project, interventions focused on policies. The approach for formulating policies in GBFP-Strategies: (i) bases objectives on participant values; (ii) treats the backcast trajectories as policy pathways with multiple objectives; (iii) pursues an integrated approach by explicitly considering the trade-offs between objectives in alternative trajectories; (iv) focuses on immediate policy alternatives within the mandates of each participant group and allows for clear assessment of alternatives devised. As the first two of these methodological characteristics have been discussed above, only the latter two are elaborated further here.

5.1 Trade-Offs

A core objective of GBFP-Strategies is to facilitate learning about the trade-offs inherent in the transition towards sustainability. Trade-offs are manifest in the future consequences of value-based choices in broad problem contexts like sustainability. These in turn will result in competing and potentially conflicting objectives embodied in different backcast trajectories. Consequently, the identification of interventions in GBFP-Strategies needed to be framed by aggregated and multi-sectoral backcast trajectories to ensure that understanding of these trade-offs was not lost.

To this end, GBFP-Strategies was able to draw on GB-QUEST, a participatory integrated assessment tool (Tansey et al., 2002; Carmichael et al., 2004). GB-QUEST elicits users' values through a series of structured choices covering aspects of human activity across a wide range of sectors (e.g., energy, urban planning, water) and domains (e.g., technological, institutional, social, environmental). GB-QUEST then assesses the users' choices using simplified but highly integrated models of biogeophysical processes to construct explicitly normative scenarios which reveal the consequences of choices made. Parameters of human activity are exogenised to the extent that the model architecture resembles an accounting tool for the physical transformation of energy, land, materials, etc, given user-supplied assumptions. GB-QUEST does not attempt to represent the full complexity of human and natural systems, but concentrates on the higher-order consequences of human activity over the next 40 years. A more detailed description of GB-QUEST can be found elsewhere (Robinson et al., 2000; Carmichael et al., 2004).

In GBFP-Strategies, therefore, backcast trajectories are built around different sectors and domains. A trajectory in the land use sector might have as its starting point (characterised in the future vision) 'contained urban sprawl', while a trajectory in the social domain might have as its starting point 'high personal freedom of choice'. Following the proposed integrated methodology, alternatives devised in the decision context framed by the objective 'minimise urban sprawl' may perform poorly against the objective 'maximise personal freedom' (with respect to choosing where to live or work) in a different decision context. In assessing alternatives, therefore, trade-offs are required between potentially competing objectives embodied in different backcast trajectories.

In the case of GBFP-Strategies, where participants are drawn from policy-making entities with sectoral mandates, this means that policies (as a specific type of intervention) are assessed not just against narrow sectoral objectives but against broader multi-sectoral and longer-term objectives associated with sustainability, which are generated through the earlier steps in backcasting. This ensures that there is explicit recognition of trade-offs in the creation and assessment of alternatives.

In general terms each decision problem in the proposed methodology is nested within a strategic decision context (or problem context in backcasting). Interactions with, influences on, and trade-offs between other decision problems must be addressed as an integral part of the process of identifying and assessing interventions. Decision analytic tools including objectives networks, and influence diagrams can be used as cognitive aids in this regard. Under the proposed methodology, each decision problem (for each trajectory) is structured in the same way, facilitating comparability. Formal trade-off techniques such as multi-attribute trade-off analysis described in the decision analysis literature (e.g., Clemen & Reilly, 2000) are also appropriate, but may require too great a level of detail for a backcasting study.

5.2 Assessing Alternatives

The assessment of alternatives against objectives is an integral part of the trade-off analysis described above. In a decision context, criteria for assessing alternatives should be derived from the ends objectives for the decision. Treating the identification of interventions as a series of decision problems with clearly structured ends objectives enables such criteria to be developed.

In GBFP-Strategies the future consequences of choices made by participants are characterised by the integrated assessment tool, GB-QUEST, through an array of environmental, economic, and social indicators. For example, choosing to encourage the use of clean fuels for electricity generation may result in reduced GHG emissions per capita, reduced employment in extractive energy resource sectors, and so on. In some cases, these indicators are also criteria by which objectives can be evaluated. For example, if a choice is made to 'reduce our contribution to climate change', a derived ends objective may be 'minimise GHG emissions', and an indicator may show 'GHG emissions per capita'. In this case, the indicator is suitable as a criteria to assess different policy consequences with respect to the ends objective in the specific decision context of reducing contribution to climate change. However, as the primary function of the GB-QUEST indicators is to characterise the future vision, in some cases this issue of compatibility with assessment criteria may not arise. In such cases, criteria would need to be devised to measure performance against the ends objectives.

Interventions in backcasting may address either the implementation or the initiation of backcast trajectories, although the latter is more common. In the proposed methodology, hierarchies of ends and means objectives within specific decision contexts will broadly reflect the chronology of trajectories. Where interventions are focused on initiating trajectories, more immediate means objectives may be more suitable as the basis for developing assessment criteria. However, shorter-term proxies for long-term ends objectives can also be included in the decision frame, both as an orientation for generating alternatives, and as a basis for deriving assessment criteria. Recent work on the analysis of climate change policies develops this proxy objective approach (Keeney & McDaniels, 2001).

Including proxies for long-term objectives recognises path dependency in the trajectories. Thus an alternative may perform well against means objectives in its decision frame, but its overall assessment will be impacted if it does not also progress towards the ultimate ends for the decision. This is a step towards easing the inherent tension between the long-term perspective of backcasting, and the need to formulate immediate policy actions (or other interventions):

> "backcasting analyses have tended to steer an uneasy course between the Scylla of vagueness, where everything looks feasible over a long enough time-horizon, and the Charibdis of rigidity, which leads to policy recommendations reminiscent of five year plans."
>
> (Robinson, 1982*b*)

6 Conclusions: Benefits and Applicability of The Proposed Methodology

The proposed methodology for structuring the identification of interventions in backcasting as a decision problem using prescriptions and techniques from the decision analysis literature offers a number of benefits. The first is a formalised structure for considering trade-offs between objectives as integral to the process of creating and assessing interventions. In problem contexts typically addressed by backcasting, competing objectives are the rule rather than the exception. Trajectories backcast from future visions of broad scope are often disaggregated along sectoral or technological themes. Interventions created to implement or initiate individual trajectories may have synergistic or antagonistic influences on other trajectories. A disaggregated approach risks omitting these influences, or leaving them to be considered as a postscript when trajectories are re-aggregated at the end of the backcasting process. The proposed methodology allows for trajectories to be disaggregated into specific decision contexts to facilitate the identification of interventions, while ensuring that resulting interventions are coherent in terms of moving towards the aggregated future vision.

The second benefit of the proposed methodology applies to structured value-focused decision processes in general. When compared with unstructured methodologies in which values are used as criteria for evaluating a limited set of alternatives, value-focused thinking helps (Keeney, 1992):

- make values explicit from the outset ensuring that the reasons behind the ultimate objectives for the decision are clearly understood, both individually and in relation to each other;
- focus the decision context on what is important for the decision (objectives) rather than what the options might be (alternatives);
- avoid the anchoring of alternatives on pre-identified or self-evident options within a narrow decision context, overcoming decision heuristics which constrain creativity and bias outcomes towards information-rich, familiar or initially-considered alternatives (Kahneman et al., 1982);
- provide an overall decision framework to encourage careful thinking and to structure relevant information which makes complex problems more readily understood (Arvai et al., 2001).

Finally, decision structuring has proved successful in facilitating the participation of multiple stakeholders with different values and perspectives in a common decision process (e.g., Hobbs & Horne, 1997; McDaniels et al., 1999). Value-focused thinking allows for alternatives to be evaluated against clearly-stated but competing objectives in a transparent and systematic manner, facilitating constructive engagement in the process by participants (von Winterfeldt, 1992). This is central to GBFP-Strategies where research is characterised as strongly interactive with respect to its relationship with stakeholders (Robinson & Tansey, 2006).

This paper was developed to address a gap in the backcasting literature, which has been largely silent on the issue of identifying interventions in the present. While the framework proposed here, integrating backcasting and value-focused thinking, was designed to support the GBFP-Strategies project, we believe it is fully transferable to other backcasting applications with different problem contexts and participant profiles. This synthesis applies a tried-and-tested decision analytic method to help orient backcasting outcomes towards concrete interventions for the implementation of desirable futures. We feel confident about the logic of this synthesis and have evaluated the framework empirically. The results of this evaluation are described in a companion paper (Wilson et al., Submitted).

7 Bibliography

Anderson, K. (2001), 'Reconciling the electricity industry with sustainable development: Backcasting - a strategic alternative', *Futures* **33**, 607–623. 151

Arvai, J., Gregory, R. & McDaniels, T. (2001), 'Testing a structured decision approach: Value-focused thinking for deliberative risk communication', *Risk Analysis* **21**(6), 1065–1076. 150, 160

Carmichael, J., Tansey, J. & Robinson, J. (2004), 'An integrated assessment modelling tool', *Global Environmental Change* **14**, 171–183. 152, 153, 157, 158

Clemen, R. & Reilly, T. (2000), *Making Hard Decisions*, 2nd edn, Duxbury, Pacific Grove, CA. 149, 152, 158

Dreborg, K. (1996), 'Essence of backcasting', *Futures* **28**(9), 813–828. 144, 146, 149

Fischoff, B., Watson, S. & Hope, C. (1984), 'Defining risk', *Policy Sciences* **15**, 123–139. 151

Granger Morgan, M., Kandlikar, M., Risbey, J. & Dowlatabadi, H. (1999), 'Why conventional tools for policy analysis are often inadequate for problems of global change', *Climatic Change* **41**, 271–281. 144, 149

Green, K. & Vergragt, P. (2002), 'Towards sustainable households: a methodology for developing sustainable technological and social innovations', *Futures* **34**, 381–400. 146, 147, 151

Gregory, R. & Keeney, R. (1994), 'Creating policy alternatives using stakeholder values', *Management Science* **40**(8), 1035–1048. 150

Gregory, R. & McDaniels, T. (1987), 'Valuing environmental losses: What promise does the right measure hold?', *Policy Sciences* **20**, 11–26. 152

Gregory, R., Lichtenstein, S. & Slovic, P. (1993), 'Valuing environmental resources: a constructive approach', *Journal of Risk and Uncertainty* **7**(2), 177–197. 152

Hammond, J., Keeney, R. & Raiffa, H. (1999), *Smart choices: A practical guide to making better decisions*, Harvard Business School Press, Cambridge, MA. 149

Hobbs, B. & Horne, G. (1997), 'Building public confidence in energy planning: a multimethod MCDM approach to demand-side planning at BC gas', *Energy Policy* **25**(3), 357–375. 151, 160

Hojer, M. & Mattsson, L.-G. (2000), 'Determinism and backcasting in future studies', *Futures* **32**, 613–634. 144

Holmberg, J. (1998), 'Backcasting: a natural step in operationalising sustainable development', *Greener Management International* **23**, 30–51. 146, 151

Jansen, L. (2003), 'The challenge of sustainable development', *Journal of Cleaner Production* **11**, 231–245. 151

Kahneman, D., Slovic, P. & Tversky, A. (1982), *Judgement Under Uncertainty: Heuristics and Biases*, Cambridge University Press, New York. 160

Keeney, R. (1982), 'Decision analysis: an overview', *Operations Research* **30**(5), 101–136. 149

Keeney, R. & McDaniels, T. (2001), 'A framework to guide thinking and analysis regarding climate change policies', *Risk Analysis* **21**(6), 989–1000. 159

Keeney, R. L. (1992), *Value-focused thinking: a path to creative decision-making*, Harvard University Press, Cambridge, MA. 148, 149, 150, 153, 160

Kirkwood, C. (1997), *Strategic Decsion Making*, Duxbury Press. 149

Lovins, A. (1976), 'Energy strategy: The road not taken?', *Foreign Affairs* **55**(1), 65–96. 144

McDaniels, T. (1995), 'Using judgement in resource management: a multiple objective analysis of a fisheries management decision', *Operations Research* **43**(3), 415–426. 151

McDaniels, T., Gregory, R. & Fields, D. (1999), 'Democratising risk management: Successful public involvement in local water management decisions', *Risk Analysis* **19**(3), 497–510. 151, 160

McDaniels, T. L. (2000), 'Creating and using objectives for ecological risk assessment and management', *Environmental Science & Policy* **3**(6), 299–304. 151

Quist, J.N. Vergragt, P. J. (2004), Backcasting for industrial transformations and systems innovations wowards sustainability: Relevance for governance?, *in* K. Jacob, M. Binder & A. Wieczorek, eds, 'Governance for Industrial Transformation', Environmental Policy Research Centre, Berlin, pp. 409–437. Available at `http://web.fu-berlin.de/ffu/akumwelt/bc2003/proceedings/4090quist.pdf`. 144, 146, 147, 151

Robinson, J. (1982*a*), 'Bottom-up methods and low-down results: Changes in the estimation of future energy demands', *Energy: The International Journal* **7**(7), 627–35. 144, 151

Robinson, J. (1982*b*), 'Energy backcasting: a proposed method of policy analysis', *Energy Policy* **10**(4), 337–344. 144, 151, 159

Robinson, J. (1988), 'Unlearning and backcasting: Rethinking some of the questions we ask about the future', *Technological Forecasting and Social Change* **33**, 325–338. 144

Robinson, J. (1992), 'Of maps and territories: The use and abuse of socio-economic modeling in support of decision making', *Technological Forecasting and Social Change* **42**(2), 147–164. 151, 152

Robinson, J. (2003), 'Future subjunctive: Backcasting as social learning', *Futures* **35**, 839–856. 144, 146, 151

Robinson, J. & Tansey, J. (2006), 'Co-production, emergent properties, and strong interactive social research: The Georgia Basin Futures Project', *Science and Public Policy* **22**(2), 151–160. 160

Robinson, J., Rothmans, D., Tansey, J., VanWynsberghe, R. & Carmichael, J. (2000), 'The georgia basin futures project: Bringing together expert knowledge, public values, and the simulation of sustainable futures.', *SDRI Working Paper*. 146, 147, 158

Slovic, P. & Gregory, R. (1999), Risk analysis, decision analysis, and the social context for risk decision making, *in* J. Shanteau, B. Mellers & D. Schum, eds, 'Decision Research from Bayesian Approaches to Normative Systems: Reflections on the Contributions of Ward Edwards', Kluwer. 152

Tansey, J., Carmichael, J., VanWynsberghe, R. & Robinson, J. (2002), 'The future is not what it used to be: Participatory integrated assessment in the georgia basin', *Global Environmental Change* **12**(2), 97–104. 146, 147, 151, 157

van de Kerkhof, M., Hisschemoller, M. & Spanjersberg, M. (2003), 'Shaping diversity in participatory foresight studies: Experience with interactive backcasting in a stakeholder assessment on long-term climate policy in The Netherlands', *Greener Management International* **37**(March 2003), 85–99. 146, 147, 151, 152

von Winterfeldt, D. (1992), Expert knowledge and public values in risk management: The role of decision analysis, *in* S. Krimsky & D. Golding, eds, 'Social Theories of Risk', Praeger. 160

Weaver, P., Jansen, L., van Grootveld, G., van Spiegel, E. & Vergragt, P. (2000), *Sustainable Technology Development*, Greenleaf Publishing, Sheffield, UK. 146, 147, 151

Wilson, C., Tansey, J. & LeRoy, S. (Submitted), 'Lessons learnt from a participatory integrated assessment: Policy strategies for sustainability in the Georgia Basin Futures Project'. 148, 160

Young, W., Quist, J., Toth, K., Anderson, K. & Green, K. (2001), 'Exploring sustainable futures through 'design orienting scenarios': the case of shopping, cooking and eating', *Journal of Sustainable Product Design* **1**(2), 117–129. 147