European Centre for the Development of Vocational Training

EN

Understanding technological change and skill needs

Technology and skills foresight

Cedefop practical guide 3

CEDEFOP

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The **European Centre for the Development of Vocational Training** (Cedefop) is the European Union's reference centre for vocational education and training, skills and qualifications. We provide information, research, analyses and evidence on vocational education and training, skills and qualifications for policy-making in the EU Member States.

Cedefop was originally established in 1975 by Council Regulation (EEC) No 337/75. This decision was repealed in 2019 by Regulation (EU) 2019/128 establishing Cedefop as a Union Agency with a renewed mandate.

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Foreword

Cedefop has been at the forefront of developing robust skills anticipation methods and skills intelligence tools for the European Union for more than a decade. The European skills forecast and the European skills and jobs survey shed light on how the labour market, skill needs and jobs are developing and help signal potential skills bottlenecks. Cedefop's big data analysis of online job advertisements provides detailed and real-time skills intelligence capturing which skills have currency in job markets. Cedefop has used skills foresight to develop stakeholder-backed policy roadmaps aimed at strengthening national skills anticipation and matching systems. Complementing quantitative skills analysis and intelligence, qualitative insight on skills policies and measures also contributes to evidence-based policy-making.

The continuing development of national skills intelligence systems and approaches has helped strengthen the feedback loops between the labour market and vocational education and training (VET) and skills policy. In the coming years, we need to be more ambitious. Our vision for Skills intelligence 2.0 is information that is more actionable: detailed and relevant, better contextualised, timelier, and better communicated. Making sense of trends and fostering capacity to act on them means combining sources and approaches – skill surveys, skills forecasting, skill foresight, big data analyses, and others – and exploring synergies. This gives policy-makers the means to separate noise from signal and supports employers and citizens in making decisions in line with the new realities in the world of work.

It is no surprise that skills intelligence is a key priority in the 2020 European skills agenda. Reliable and fit-for-purpose labour market and skills intelligence has enormous value in times of rapid change and transformation. In a context of fast-paced digital advancements, such as artificial intelligence and advanced robotics, and other megatrends, such as population ageing and the green transition, VET and skills policies should become more proactive. To prepare new generations of learners and to support people in making and shaping career transitions, reliable skills intelligence is indispensable.

This publication is the third in a series of practical skills anticipation guides for policy-makers and analysts. The guides present a rich mosaic of conventional and emerging methods for identifying technological change and its impact on skills. Systematically presenting the merits and disadvantages of different methods, they show no single approach can provide all the answers. Apart from reliable data and sound methods, creativity, holistic thinking and using collective wisdom to shape the future are key building blocks of skills intelligence 2.0.

This third guide focuses on participatory methods of anticipating changing technologies and skill demands: technology and skills foresight. We trust the practical insights it provides will prove to be useful in your context.

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CHAPTER 1.

Technological change and skills intelligence

1.1. Technological change and skill needs

The impact of technological change on jobs and skills has been at the forefront of both popular media and the policy debate, with concerns about job automation becoming accentuated as a result of the Covid-19 pandemic. Much of this discussion has centred around predictions that almost half of all jobs in advanced economies are susceptible to replacement by machine learning algorithms (Frey and Osborne, 2013; 2017). Recent studies, that have called into question the reliability of such estimates, have noted that automation is typically targeted towards the replacement of certain tasks, as opposed to occupations as a whole. Accounting for task heterogeneity within occupations reveals that the number of occupations at high risk of displacement is significantly lower, affecting about 9 to 14% of all jobs in advanced economies (Pouliakas, 2018; 2021; Nedelkoska and Quintini, 2018; Arntz et al., 2017).

McGuinness and colleagues (2019) also note that the technological alarmism that has entered into the policy debate is unwarranted. They show, using Cedefop's European skills and jobs survey data, that only 16% of EU employees affected by technological change think their skills will become obsolete in the near future and 5% are afraid of technological unemployment. Their analysis provides evidence that technological change and innovation is not only about automation: it tends to have a positive impact on the task content and skill complexity of jobs and hence tends to be associated with dynamic upskilling of workers (Deming and Noray, 2020; Acemoglu and Restrepo, 2019; Freeman et al., 2020).

Digitalisation also transforms the nature of the employment relationship, for example via the rise of platform work or, more recently, telework (Cedefop, 2020a). Cedefop (2020b) shows that social dialogue and participatory human resource management methods can have a critical role in facilitating non-disruptive adoption of new technologies by organisations and workers.

Several other macro-trends drive the future demand for skills, notably climate change and the green transition, demographic change and migration; but looking at how technological progress and innovation impacts skills needs is important, as it is widely viewed as the most dynamic megatrend shaping the future of work (Brynjolfsson and McAfee, 2014). In the wake of the Covid-19 pandemic, policy has also become increasingly concerned with (digital) skill gaps affecting workers' job prospects and the need for stepping up investment in lifelong learning to mitigate inequalities due to the ever-present, yet growing, digital divide (Cedefop, 2016; Sostero et al., 2020).

1.2. Skills assessment and anticipation methods

To understand the extent to which technology is transforming the world of work, it is necessary to measure its magnitude and impact on skills demand. Labour market and skills intelligence (LMSI, often referred to as skills intelligence) provides such information and – provided it is based on sound approaches and methods – can serve the needs of those responsible for reacting to changing skill needs.

While analysts and experts have a range of different skills assessment and anticipation methods at their disposal, identifying and anticipating the pace of technological change in labour markets – particularly in times of rapid change – is challenging. With the process of predicting the future becoming more complicated and perhaps less certain, the range of methods and tools available to those involved in such exercises has become more varied and sophisticated.

Table 1 summarises some of the main methods that can be used to gather information on skills needs. Four are particularly important. These are those that:

(a) rely on putting questions to key stakeholders (questionnaire surveys of employer and employee skill needs and experience of technological change);
(b) produce quantitative estimates of future skill demands, by extrapolating past trends and modelling expected developments;
(c) source big data on new technologies and skills from a variety of online sources (including job portals, CVs, social media, patents, scientific databases);

Table 1. **Tools for carrying out skills assessment and anticipation**

Type of activity	Data collected
Descriptive statistics/ stock taking	Estimates of overall demand and supply of skills and technology use, often based on collating data from various sources (e.g. sector skill studies)
Quantitative forecasting	Forecasting or projecting future demand for skills, typically using econometric modelling
Skills and jobs surveys (questionnaire surveys)	Assessments of demand for, and supply of, skills and technology use, usually with an assessment of the extent to which demand and supply are in balance
Graduate tracer studies	Using matched administrative data sets or surveys to track people through education and the labour market to see how the former influences the latter
Qualitative research	Use of non-quantitative techniques to gauge in-depth information about current and future skill demand/supply and technology trends, e.g. via company case studies, use of focus groups
Foresight	Critical thinking about the future of skills supply/demand and technology trends, using participatory methodologies
Big data	Use of web sourcing, combined with text mining and machine learning approaches, to collect and classify data about skills, vacancies, technologies, etc.

Source: Cedefop classification.

(d) use non-quantitative techniques, relying mostly on participatory stakeholder approaches to gather in-depth information about the state of current and future skill demand and supply.

1.3. Purpose of guide

This third Cedefop practical guide on understanding the impact of technological change on skill demand focuses on participatory methods for analysing current and emerging technologies and skill needs: technology and skills foresight.

The goal of technology and skills foresight is to identify a set of major areas of technology – usually emerging technologies – which are of particular strategic importance to an economy, a region or an organisation and their associated implications for skills. Such techniques use various methods to collect and bring together data and qualitative information that can

provide insight into the impact of technological change on skills demand. Opening up the discussion on technology and skills to stakeholders, puts them in the driving seat of the data generation process. In this respect, skills foresight fundamentally differs from conventional skills assessment and anticipation methods (such as skill forecasts, skills surveys, big data analyses), where the focus is on producing findings without systematically and fully engaging stakeholders in all stages of the work. Participatory skills foresight is particularly useful when the focus is on identifying new or emerging technologies, such as information technologies, biotechnologies and nanotechnologies.

This third Cedefop 'how-to' guide ([1]) builds on the first two on conventional and automated skills assessment and anticipation methods. Skills surveys and skill forecasts typically rely on methods based on the collection of representative labour market information and analysis, using statistically robust techniques. Big data and AI-driven analyses apply automated knowledge extraction and machine-based techniques to source information on technologies and skills from mostly unstructured online sources.

The guide is structured as follows. Chapter 2 provides an overview of the use of participatory methods in skills foresight. The chapters that follow review two types of commonly used participatory foresight tools. Chapter 3 looks at tools mainly relying on interviews and surveys (including Delphi techniques), while Chapter 4 provides an overview of tools collecting insight via workshops and other meetings. The guide introduces approaches, such as brainstorming, STEEPV (social, technological, economic, environmental, political and values) and SWOT (strengths, weaknesses, opportunities and threats) analysis, scenario development and simulations. Chapter 5 reflects on methods for generating policy action plans based on foresight results. Chapter 6 concludes with a review of the advantages and pitfalls of foresight methods. It also provides reflection on which skills anticipation methods are most suited in particular situations and the reasons why this is the case. The complementary insight that participatory approaches can add to conventional skills analyses and forecasts is considered, and the advantages of engaging users in the foresight process are emphasised. Throughout the guide, practical illustrations of applying foresight in areas related to technological and other changes affecting employment, work and skills complement explanation of the methods.

([1]) This guide is the third of a series. See Cedefop, 2021a and 2021b for the first two guides.

Box 1. **Cedefop's 'how-to' guides on understanding technological change and skills demand**

The purpose of Cedefop's short 'how-to' guides is to provide those charged with a responsibility for undertaking skills assessment and anticipation with the means to deal with the uncertainty of technological change and its impact on skill needs.

As the process of predicting the future becomes more complicated and less deterministic, the range of tools available to those involved in skills anticipation has become more varied and sophisticated. The Cedefop guides aim to showcase to policy-makers and interested analysts how various techniques or methodological tools can be readily applied by carefully considering the associated pitfalls and rewards of doing so.

The guides provide targeted information on how interested analysts can adopt and implement conventional labour market and skills intelligence methods, such as skills surveys and skill forecasts; automated methods reliant on big data and artificial intelligence techniques; or technology foresight methods. All can be used to detect emerging skill needs related to technological change. Implicit in the guides is recognition that no one methodology is likely to provide all the answers and the challenge for analysts is to bring together outputs from different approaches to skills anticipation.

The guides build on the existing compendium of guides on skills anticipation produced by the ETF, Cedefop and the ILO ([2]), as well as several previous Cedefop reports on skills anticipation methods ([3]). But they are distinct from previously published methodological handbooks or guides, in that they are explicitly concerned with the process of identifying technological (digital) change, a key driver of changing skill needs.

Source: Cedefop.

([2]) See also Sudakov et al., 2016.

([3]) For instance, see Cedefop, 2013; 2015; 2019a; 2019b and Cedefop project Anticipating and matching skills.

CHAPTER 2.

Participatory skills anticipation methods

2.1. What is foresight?

There is much confusion in the policy and academic discourse about what the term foresight means. The term was barely used before the 1990s, when so-called technology foresight programmes were launched in western Europe and elsewhere. These programmes quickly became standard tools for policy-making in science, technology and innovation (STI) (see Miles, 2010).

In these programmes, foresight went beyond the mere anticipation of future prospects. It included concepts, such as prudence and preparedness for the future. Even with this wider understanding of the concept, foresight was criticised. The emphasis on precautionary activities (as in risk management) at the expense of actively identifying opportunities (in an entrepreneurial approach) was seen as overly restrictive. Despite this, foresight programmes in the 1990s were innovative in the sense that they applied many different methods, engaged large participant groups and aimed at influencing major decisions in STI policy.

The most successful foresight programmes in the 1990s were different from most preceding exercises in three respects (Georghiou et al., 2008). They were more prospective (applying methods to appraise long-term future challenges and opportunities), more policy-related (strong orientation towards informing decision-making via conducting and communicating work in relation to policy actors, processes and timetables), and more participatory (engaging a wider group of stakeholders and experts).

Foresight exercises typically go beyond the deskwork that is part of futures studies and conventional forecasting and/or modelling in demography, economics, climate studies and other areas. The prospective dimensions of foresight programmes often use such approaches or draw on the evidence they produce. Extrapolations or more sophisticated examinations of economic structures and trends, population dynamics, technological trajectories and climate change impacts are commonly used. Foresight

goes beyond limited planning approaches with restrictive timescales and accounting frameworks to consider stakeholder interests, their strategic orientations and their possible contribution in achieving policy aims.

The participatory dimension of foresight goes beyond consulting a small stakeholder group and subsequently producing results for wider dissemination. In some cases, it involves a public conversation or consultation (the latter being more demanding). Substantial involvement of experts from a much wider pool is what distinguishes foresight from other forecasting and planning activities ([4]).

With the proliferation of technology foresight programmes in the 1990s, many practitioners engaged in activities such as technology horizon scanning; forecasters started to view their work as being part of foresight. This rebranding in recent decades has resulted in the term being used more widely to also capture activities that are better considered components of more extensive foresight exercises.

The term fully fledged foresight was introduced to characterise exercises combining participatory and other activities to appraise longer-term prospects, inform and orient strategies, and ease short- and medium-term decisions. As the design of an exercise depends on objectives, context and resources, not all foresight is fully fledged. Foresight can take many forms, and there is no standard set of tools. What is common to all foresight activities is a process involving several steps, which link initial scoping to analysis to result dissemination and implementation.

This guide presents a range of foresight methods, which may be implemented in various ways. While many overviews of foresight are available ([5]), the discussion draws on the framework outlined in Miles and colleagues (2017).

Although they have been considered in several foresight exercises, skills and occupations are not often the primary interest in STI-oriented programmes. There is therefore scope for further development of foresight to shed light on the decline/increase in demand for occupations, on the emergence of new skills and job tasks (and new skills/tasks combinations) and on trends in organising and managing work.

([4]) For an overview of foresight approaches to skills issues, see ETF et al., 2016. The review of issues and methods presented here draws on the account presented in Miles et al., 2017, which covers STI applications more generally.

([5]) For instance, Georghiou et al., 2008; Kuosa, 2012; Waverley consultants, 2017. A convenient overview of technology forecasting methods is Roper et al., 2011.

2.2. The participatory element in foresight

The participatory dimension of foresight programmes gives a wide range of stakeholders the opportunity to influence policy-making. This involves going beyond the usual suspects – expert panels and advisors – who in the past were commonly consulted in decision-making processes. The participatory nature of foresight also builds democratic legitimacy, which is seen as particularly important in debates and decisions about potentially transformative STI and other key policy domains.

The wider involvement of stakeholders helps overcome challenges related to constraints on public budgets, challenges in understanding the impact of new or emerging technologies (for example information technologies, biotechnologies, nanotechnologies). Stakeholder involvement in discussions on their implementation and their skill implications also helps address concerns about the societal impacts and possible by-products of scientific and technological progress: the ethics of biomedical applications, the employment consequences of automation and artificial intelligence, and the health hazards of nuclear power and industrialised agriculture. The potential benefits of wide stakeholder participation in terms of foresight inputs and outcomes are summarised in Table 2.

In practice, a foresight exercise often has multiple aims. It may seek to achieve a better-grounded and more politically legitimate set of priorities, while at the same time exploring opportunities to link different parts of an innovation system better. Foresight goals are typically reflected in the design of the participatory approaches the exercise employs ([6]).

Wide stakeholder participation is possible at different foresight process stages. These include scoping (what is the exercise to address), literature/material review (what has already been said and done about this issue) and trend analysis and horizon scanning (what is liable to happen in this field). Subsequent stages explore and appraise alternative prospects, identify possible actions (for example recommending priorities) and follow up on proposals (for example via involvement in implementation).

([6]) For further discussion see Amanatidou, 2017; Himmrich and Suss, 2017; Saritas et al., 2013. Among more general discussions of participatory methods is Slocum, 2003.

Table 2. **The benefits of wide stakeholder participation in foresight: inputs and outcomes**

Impacts on inputs	Impacts on outcomes
Access to a wider range of technical knowledge and professional expertise than is possessed by any single person or organisation	Greater legitimacy from a process that has drawn upon a broad range of stakeholders and taken account of points of view other than those of insiders
Easier identification of information relevant to the goals of the foresight exercise	Establishing new relationships between participants, potentially linking together players and enabling more progress in different fields of STI
Better understanding of the strategic orientation of stakeholders, and their likely responses to possible contingencies: this may reveal both opposing and supporting factors that will shape patterns of development	Establishment of a pool of participants with in-depth understanding of the process and its results, who can apply them in future actions and communication and are able to translate the implications of the exercise to their own stakeholder communities
More creative thinking achieved by bringing together new sets of people and encouraging knowledge exchange and shared creation	Informing participants as to the topic dynamics and empowering them to assess better the implications of future developments
Participants may articulate their expertise in direct relevance to others and be informed about the wider implications of the issue of interest	Engaging members of user organisations (in addition to that commissioning the exercise) in activities
	Triggering, or at least increasing the feasibility of, subsequent foresight exercises among participants and others exposed to them
	Encouraging a more forward-looking and more participatory orientation among key decision-makers

Source: Cedefop.

In practice, foresight stages often overlap and do not necessarily follow a fixed sequence. Every stage in the process can be participatory, involving stakeholders and/or experts beyond the core groups who design and run the project and disseminate its results. Participants can validate or critique results from earlier stages and examine and assess their implications for their own organisations.

Table 3 lists typical stages of a foresight process (Miles et al., 2017) and describes possible participatory and other activities for each.

Table 3. **Participatory activities across stages of a foresight exercise**

Stage/phase of foresight process	Examples of forms of participatory foresight	Examples of other foresight elements
Initiation: scoping exercise, determining main foci, intended uses and users	Involvement of experts in determining topics for examination, consultation and face-to-face meetings	Steering group decisions, interviews with experts and stakeholders, stakeholder analysis, identification of key participants
Intelligence: literature reviewing, horizon scanning, trend analysis, etc.	Workshops where participants of various kinds (members of a single organisation or drawn from a range of bodies) seek to identify main drivers of change; Delphi-type survey work	Literature review, algorithmic analysis of bodies of material, such as news sources, patents, academic literature, official statistics
Imagination: establishing understanding of linkages between issues and using creativity to explore implications	Discussion and assessment of effects of drivers of change and of trend impacts in workshop settings	Statistical analysis of relationships in data sets and big data analytics of less structured material; cross-impact analyses (involving feedback by experts)
Integration: development and appraisal of possible futures	Scenario workshops; Gaming	Computer modelling
Interpretation: identification of strategies and prioritisation of actions	Roadmapping workshops, strategy workshops, success-scenario workshops; Delphi-type policy and goals surveys	Cost-benefit analysis, optimisation in models
Intervention: discussion of proposed strategies, priorities and next steps with key actors	Dissemination activities ranging from public conferences to seminars within stakeholder organisations	Producing reports, priority lists, etc.
Impact: evaluation of impact of work, follow-up activities specified	Engaging stakeholders (researchers, educators, businesses and others) in developing follow-up plans, designing research projects and teaching programmes, developing competitions to support innovative activities	Evaluation projects by expert teams

NB: Material obtained from participatory activities may be fed into non-participatory activities. For example, judgements made in workshops or surveys may be used to calibrate a statistical model's parameters and relationships. Outputs of non-participatory activities may be fed into participatory events; for example a computer model may be used to give workshop participants immediate estimates of the results of their choices. See Giaoutzi and Sapio (2013) for a discussion on interrelating qualitative and quantitative approaches in foresight exercises.

Source: Cedefop.

Participatory and non-participatory methods at any stage of the foresight process can be closely related. The foresight carried out by Nesta and colleagues (2017) explored the future of skills to 2030. Expert and stakeholder groups were asked to discuss major trends, and then group members were asked to forecast prospects for specific occupations. After discussion, where individuals had the opportunity to revise their forecasts, the workshop results were fed into a machine learning system, which used an algorithm to model how skills and other factors drive these occupational prospects. This information was used to select additional occupations, which were referred back to the group and, after another discussion round, the group work was again fed into the system ([7]). After several rounds, the system was capable of producing expert judgements and forecast trends for a set of occupations going far beyond those that had been considered in the initial rounds. The team conducting the study subsequently compared the results with other studies.

The extent of participatory activities in foresight may vary, in terms of activities carried out over the course of a project, time and resources spent, and participant numbers (from tens to potentially several thousands) ([8]). Although in-depth exploration of a particular topic may take months or years to complete, in a context of scarce resources and with a need to get policy debates underway, it is an option to organise a foresight activity requiring relatively less time and resources. This typically involves less effort in organising a literature review, eliciting expert opinions and organising consultation meetings. With practical constraints often making it challenging to carry out all foresight phases in a complete or ideal way, it is often necessary to rely heavily on readily available research and analysis.

Participatory activities also vary in terms of how intensive they are. Some activities are little more than gathering feedback on presentations, some solicit information and opinions, while others involve substantial dialogue which plays a crucial role in shaping the content and structure of results. Typically, more extensive activities are less intensive ones, and vice versa, although use of modern information and communication systems and tools can weaken this link somewhat (Table 4).

([7]) A visual representation of this process is *Human and machine intelligence hand-in-hand*.

([8]) Popper and colleagues (2007) mapped the scale and variety of foresight activities undertaken in the early years of this century.

Limited participation in scoping, horizon-scanning and planning is the norm in many conventional business and government decision-making processes that make no claim to constitute foresight exercises. In many activities that have been described as foresight (but not the 'fully fledged' kind), consultants, academic groups, and in-house planning departments rely almost exclusively on non-participatory approaches, such as literature reviews, statistical trend analysis or computer modelling or simulations. The so-called BOGSAT (bunch of guys sat around a table) model can also be found in many organisations, where, for example, applied research and development (R&D) decisions are at least in part made by a panel relying on information from its academic and business members and expert interviews ([9]).

Table 4. **Typology of foresight activities by process duration, participant engagement and consultation scale**

	Brief process duration		Lengthy process duration	
	Few participants	**Many participants**	**Few participants**	**Many participants**
Low participant engagement	interviews reviewing project outputs; conventional seminars with Q&A	conventional surveys; public consultations		soliciting and collating occasional reactions to material posted online
High participant engagement	scenario workshops; roadmapping workshops preparing proposals for implementation and follow-up activity	Delphi surveys	consensus conferences; citizen juries	online gaming

Source: Cedefop.

([9]) For example, in the UK, applied R&D decisions are at least in part made through a panel that takes into account information from academic and business members, and from irregular reviews of Technology Innovation Futures largely drawn from interviewing key experts; see https://www.gov.uk/government/collections/technology-and-innovation-futures

This guide focuses on the more intensive methods. It concentrates on participatory elements in the generation and appraisal of future prospects and developing recommendations for action. It is acknowledged throughout that available resources (what technical skills for conducting foresight are available, what funds are available for organising meetings, need for consultancy work) and the context in which foresight takes place determines which participatory methods are suitable. Examples of context are openness of a culture to consultation and dialogue, the extent to which views are polarised, and the availability of solid evidence on the topic.

2.3. Recruiting foresight participants

One category of participants involved in foresight exercises is experts. Sometimes these have foresight expertise, as is the case with futurists. As well as providing advice on process design, they can also use their expertise to be provocative in workshop discussions, suggest possible wild cards to stimulate out-of-the box thinking and reflect on the wider implications of the issue at hand.

Domain experts – knowledgeable members of research or practitioner communities with relevant experience – are more commonly involved. They should be recognised as experts by other members in their professional community and be willing and able to cooperate with experts in other fields. It is desirable that they participate based on their own knowledge rather than as representatives of a body, as this limits their *marge-de-manoeuvre* and creative thinking.

Domain experts are often identified from their publications and presentations, recommendations from professional or other relevant associations, or via personal networks. It is good practice to maximise diversity among the invited expertise, by involving promising younger professionals and underrepresented groups; these often have unique insights into emergent issues others may lack.

Stakeholders form a second category of foresight participant. Stakeholder analysis is typically used to identify key organisations and social groups that may be affected by the issue at hand and by recommendations emerging from the foresight activity. Some organisations may be selected because

they play an important role in ensuring the feasibility and implementation of the foresight process and its results ([10]).

Where there are many broad stakeholder groups (for example blue-collar workers, small business owners, young people), it may be appropriate to involve participants who have a good overview of these groups and the issues they are confronted with, such as trade unions and professional association representatives and voluntary association leaders. It is crucial to involve participants who are not constrained to voicing the official positions of the organisation they represent.

Foresight is intended to inform action. If the exercise is simply box-ticking (for instance, to provide proof a foresight was undertaken), its effects are likely to be limited. Institutions or bodies commissioning foresight often do so in the context of their own strategy development. To ensure messages are really accepted and set the grounds for further action, it is particularly important they engage their members. Foresight particularly benefits from a 'champion', who fully understands the process and underlying reasons and rationale for the results achieved, as well as being able to articulate their relevance.

The number of participants to be engaged depends on the scale of the exercise. While a typical workshop might involve 20 participants, much larger groups can be accommodated. This requires effective management, which can entail, for example, splitting a large group into subgroups. A large-scale survey or consultation might involve thousands of participants.

Recruiting and motivating participants can be challenging. The more input is expected, and the more extensive the other commitments of the people to be enlisted, the greater difficulties can be. A major intrinsic incentive for participants is the belief that they are contributing in a meaningful way to a process that will affect an issue they care about and/or are engaged with regularly (for instance, as part of their work).

A request to participate in a survey is often persuasive only for a small share of those invited. Personalisation of the request and statements about importance by a credible authority are often used to boost participation. Willingness to participate also depends on the quality of survey design, the ease of the task and the number of questions. Taking part in a workshop requires time commitment and may be daunting to those unfamiliar with this type of practice. It is important to explain clearly what the exercise entails and

([10]) Many tools and frameworks for conducting a stakeholder analysis (stakeholder mapping tools) are available online.

to point out how participants themselves may benefit. In conclusion, several factors jointly determine success in recruiting foresight participants (Table 5).

Table 5. **Factors influencing foresight participant recruitment**

Factor	Crucial questions/issues
Clarity of requests to engage with the exercise	How well is the exercise explained or expectations for the participant outlined? What contribution is expected?
Customisation of requests	Extent to which the requests are tailored to the person addressed, rather than being clearly part of a widespread 'trawling' exercise. The latter strategy runs the risk that recipients will have the impression other participants may be representative of people with spare time rather than experts.
Expected impacts of the exercise	Is the activity purely academic, or does it have to influence the policy discourse or management decisions? What opportunities are foreseen to comment on process and outcomes? Does the exercise have the support of leaders of important organisations?
Personal benefits	What might the participant gain by way of knowledge, early warnings (including early access to results), social contacts, prestige? Will expenses of attending meetings be covered?
Required effort	Roughly how much time is required? Over what period? How flexible are these arrangements?

Source: Cedefop.

CHAPTER 3.

Interviews and surveys

Many technology foresight exercises aim at identifying major technologies – usually emerging technologies – which are of strategic importance to economies or organisations. Mixed method approaches, combining non-participatory techniques (for example, literature reviews, bibliometrics or patent analysis, web-searching) and participatory methods (surveys, workshops), are commonly used. Often non-participatory tools are used to identify and group areas of technology, while participatory ones are employed to assess their significance in terms of competitiveness, economic growth, environmental quality, health and safety in the workplace and other potential outcomes.

The result will generally be a list of technologies (or areas), outlining their perceived importance, and other elements such as urgency and risks. To assess capabilities and risks associated with various technology fields, surveys, interviews, and/or panel workshops are often used. Such participatory techniques are also well-suited to identifying implications for action.

Such critical technologies foresight analysis should also consider other types of innovation, including social innovation. Critical technologies foresight studies have been criticised because they prioritise thinking about technological opportunities rather than considering the scope for broader social or economic interventions. An example of such a broader approach is identifying critical skills a society needs to invest in to ensure that the implementation of existing and new technologies is compatible with environmental sustainability ambitions ([11]).

Expertise on key aspects of the subject matter is the backbone of insightful foresight. Some experts may contribute in a non-participatory mode, for example by providing literature reviews or calibrating computer simulations. Others will participate more broadly, for instance via interviews and surveys.

([11]) For instance, it should be possible to estimate the required numbers of people with skills relevant to establishing solar or wind-based power generation facilities, retrofitting buildings with more effective insulation or natural ventilation systems and so on.

Such methods are particularly appropriate for engaging technical experts and well-informed stakeholders.

3.1. Horizon scanning: interviews and opinion surveys

Surveys gathering expert opinions on important developments in their areas of expertise may be carried out by post, telephone, online or face to face. Such surveys can be used to shape Delphi studies or scenario workshops (discussed in more detail in Section 3.2 and Chapter 4).

One approach is asking respondents to provide open-ended answers to questions on the major drivers and shapers in their area of expertise. This provides opportunities for reflecting on the problems and needs they create, solutions and innovations that might be considered, and research, knowledge, or capability needed to achieve them.

This approach makes it possible to engage people beyond the core foresight team or panel and benefit from their insights and reflective inputs. Careful question design and selection and motivation of respondents are drivers of achieving high-quality responses. Sufficient time and expertise must be allocated to process and analyse the significant volume of qualitative data generated.

The Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) used interviews to inform foresight on future employment, occupations and skills (Hajkowicz et al., 2017). A series of 'convergent interviews' ensured that, as the foresight progressed, the questions became more rigorous and detailed. Probe questions were used to converge towards shared insight. The opening question was: What are the key trends that you can see emerging that will influence the future of work over the coming 20 years – so out to 2035? The interviewer abstained from contributing content and insight, using other prompts to continue the conversation, and sometimes posing questions to validate points made in previous interviews. Workshop materials, generated based on a modified version of the interview approach, complemented the face-to-face and telephone interviews. The result was a list of major trends, which could be classified using the STEEPV framework (as described in Chapter 4) and used in shaping and developing scenarios.

Cedefop's skills governance reviews, carried out in several EU countries (Box 2) ([12]) used a similar approach. After identifying key insights into success factors and bottlenecks in the national skills anticipation and matching system, stakeholder interviews helped develop more detailed understanding on challenges and opportunities. This was used to develop Delphi-style consensus-building exercises (Section 3.2.2) which were carried out to shape stakeholder-backed national policy roadmaps (Cedefop, 2020c; 2020d, 2020e; 2020f).

3.2. Delphi and other survey methods

3.2.1. **Surveys**

Surveys allow large numbers of people to be involved in providing information at their own convenience, without having to attend a meeting. Sometimes, workshop or conference participants are invited to complete a survey during a meeting, but this usually involves short and simple surveys.

Recruiting appropriate types of respondent can be challenging. Busy people receiving many survey invitations may reject such requests because they have no time to participate in all of them. Making a survey attractive and meaningful to respondents can encourage participation. Using incentives and endorsements from influential and respected figures are other common motivation mechanisms.

Surveys require people to express opinions (for example: how soon is it likely that these tasks will be completely automated?), attitudes (how important is it to increase equality of opportunity in terms of access to these jobs?), or state facts (how many people are employed in this firm?). Use of standardised categories and Likert scales to allow respondents to tick boxes to indicate level of agreement with statements, or the range that they fall within, results in relatively structured data (see Cedefop, 2021a). Although such information can be valuable in assessing the extent of viewpoint divergence in a community, it does not provide the rich information that can be captured using open-ended qualitative methods.

Nevertheless, structured information can help situate and contextualise more detailed information obtained from interviews, site visits and other methods. Surveys can also be structured to explore the roots of differences

([12]) See Cedefop's Anticipating and matching skills project for further details.

in viewpoints. They may, for instance, reveal that people in particular age cohorts or employed in certain industries or professions think differently about the extent or impact of change from others.

Box 2. **Cedefop's skills governance stakeholder interviews**

As part of Cedefop's country support initiative to improve EU Member States' skills anticipation and matching systems, stakeholder interviews were carried out in four EU countries (Bulgaria, Estonia, Greece and Slovakia) in 2017-18. The stakeholder interviews were based on a generic questionnaire which helped develop in-depth understanding about the key elements in Cedefop's skills governance analytical framework:

- regulatory framework: the role of organisations in labour market and skills intelligence according to regulation, its practical implementation and suggested improvements;
- institutions: stakeholder participation in LMSI, the functioning of bodies of exchange and relevance of external experts;
- LMSI management: collection of labour market information (organisations, organisation role, stakeholder involvement), own experience with stakeholder collaboration and evaluation, involvement in the interpretation of results, involvement in policy actions, difficulties in engaging with stakeholders, practical collaborations of agencies, conflict resolution;
- LMSI tools/methods: methods used in LMSI, suitability of data and methods, sufficiency of detail collected, suggestions for improvement;
- LMSI dissemination: obtaining LMSI information, targeting LMSI information, LMSI customisation, LMSI presentation and dissemination;
- sustainability and reputation: confidence in the existing skills anticipation and matching system or practices, key limitations of existing system, view on necessary future development, planned developments.

A wide range of mostly open-ended questions on each topic was asked during semi-structured face-to-face interviews. To obtain a minimum degree of generalisability based on the findings, findings were aggregated in analysis by type of stakeholder. Representativeness was ensured by confirming that opinions about particular issues were shared and possible development opportunities widely supported (or at least not refuted) by most participants or at least by a critical subgroup of the most important stakeholders.

Source: Cedefop, 2020c; 2020d; 2020e; 2020f.

The information technology revolution study (Rush and Miles, 1989) used a survey to examine varying viewpoints in a population. Around 100 experts were asked to assess the extent to which a range of technological trends would develop in the next two decades. Issues covered included occupational polarisation, teleworking, and the proportion of the workforce required to undergo two or more phases of retraining in their career.

After identifying a wide diversity of viewpoints, statistical analysis revealed that respondents' expectations largely varied in terms of two underlying dimensions: how fast change would happen and whether its impact on the working population was broadly positive or negative. These dimensions were used to construct four scenarios, based on the average expectations of outcomes.

In studies conducted by Nesta and colleagues (2017), participants in workshops were invited to complete surveys. Two workshops were held that brought together 12-13 experts from industry, government, academia and sectoral representatives in the UK and USA. Participants received extensive information on major trends, including those concerning population ageing, industry 4.0 and sustainability/climate change. A session then used creativity techniques to stimulate participants' thinking about possible implications for existing and new jobs. Following this, they received information on employment in 10 occupations: job titles, tasks and skills required, and data on employment trends and top industries in terms of employment in the occupations.

Participants used an online system to rate occupational prospects (for 2030). They were asked two questions which used three-point scales. The questions were:

(a) what will happen to the share of total employment held by this occupation (higher share, same share, or lower share)?
(b) what will happen to the number of people employed in this occupation (grow, no change, or decline)?

They also indicated how certain they were about their judgements and were given the opportunity to contribute in writing anything they considered necessary to qualify these judgements.

During the group discussions that followed, people could change their responses. The expert judgements the workshops helped shape were used in a machine learning algorithm, which was later used to estimate impacts for many more occupations and for 120 typical skills associated with them.

Combining sophisticated participatory and non-participatory techniques led to results that are less apocalyptic about the employment impact of new technologies than those produced by many other analysts ([13]).

By requesting more open-ended input than is common, some surveys mimic the information collection process of interviews. As part of the 1995 UK technology foresight exercise, expert respondents were requested to describe the most important trends in their area of expertise, problems encountered and technological innovations that might either help overcome them or lead to new challenges. The information was used in the development of Delphi surveys during follow-up stages of the work.

Demanding questionnaires run the risk of achieving low response rates and need a lot of effort to encourage participation. While open-ended surveys can give respondents more time to reflect on their answers and lead to more insightful information, this needs to weigh against the risk of them being set aside or not (fully) completed due to survey fatigue.

It is for these reasons that open-ended questions tend to be more appropriate for interviews and group discussions in workshops (see also Chapter 4). Workshops also give participants the chance to be inspired by each other's views. One of the advantages of survey methods is that they reduce the risk of some respondents exerting too much influence on the discussion, because of seniority, personality or presentation style. Delphi-style methods can be a good compromise between encouraging in-depth exchange of views among a pool of respondents, while avoiding disproportionate influence of one or more of them.

3.2.2. **Delphi**

Delphi surveys involve more intensive expert or stakeholder participation, not only because of the possibility of open-ended questions but also because they typically use multiple iterative rounds. This critical feature which makes it possible to construct feedback loops, also gives respondents the opportunity to reflect on their own views in light of other participants' contributions. Typically, this involves questions probing whether participants wish to modify their responses. A less used approach is to formulate questions considering responses to questions posed earlier.

([13]) For a readable summary of the workshops (and some of their results), see: https://medium.com/@wendyinfutures/forecasting-jobs-and-skills-2030-98d26008f808

There are many types of Delphi survey ([14]) and practice is evolving as more online tools become available. With modern Delphi tools, results can be updated in real time. The method can be applied to elicit opinions, such as when a certain development will occur. It can also be applied to set goals (which skills should be prioritised in large-scale training programmes?) or assess the impact of various courses of action (how does it impact sectoral growth or employment levels?). Anything that can be presented in the form of a concise and unambiguous question, that can be answered with sufficient degree of precision, can be a subject in a Delphi survey.

By far the most familiar application of Delphi is forecasting. Typical core questions concern the anticipated time horizon of a specific development ([15]). Alternatively, questions can probe the extent to which a particular development will have materialised by a given date ([16]). Formulating such core questions requires considerable effort. Survey designers may be inspired by earlier surveys.

In addition to forecasts, many Delphi surveys ask respondents to provide other information. This can include questions on factors that might inhibit or accelerate developments, such as cost, technical difficulties, ethical issues, resistance from consumers/workers/managers and skill shortages. Questions may also be used to help participants reflect on possible impacts of changes: for instance, whether the development would lead to job losses or gains, upgrading or deskilling of work, more or fewer opportunities for specific categories of employees (such as people with physical disabilities). Respondents may also be requested to provide opinions on whether developments increased or decreased demand for particular skills sets (physical dexterity, numeracy, interpersonal communication skills). It would be unwise to treat the answers to such queries as conclusive and complete assessments about such impacts. They do, however, shed light on the degree of consensus or disagreement among experts.

([14]) The classic overview of the Delphi method is Linstone and Turoff (1975).

([15]) An example question is: at which of these dates would you first expect a majority of the workforce to be continuously providing data on their location, tasks, breaks, etc. by means of mobile communications?

([16]) For example, in 2025, what share of construction workers will be working alongside robots in the erection of office buildings in cities?

Box 3. **Eurofound's Euforia project: Delphi exercise example**

The Euforia project (Loveridge et al., 2004) was carried out to explore the implications of the development of the knowledge society for working and living conditions. The project was undertaken in three countries. A total of 32 statements were generated on topics related to the knowledge society. A Delphi survey was then conducted. Significant problems (for example translation issues, computer scripting) had to be overcome, as is typically the case in cross-country studies.

A key question was whether respondents found the statements to be a plausible characterisation of the development of the knowledge society in their own country. Table 6 features examples of statements that were found to be 'about right', meaning reasonable characterisations. Additional questions focused on soliciting opinions on whether the development would have a positive, negative or neutral impact on each of the main features of concern, should they be realised.

Rich and extensive results were obtained, with national differences and interesting viewpoints about topics seen as overstatements. For instance, among topics with major impacts, lifelong learning was believed to improve all three industrial relations factors (employer-employee relations, economic growth/wealth creation and entrepreneurship and innovativeness), improve employee autonomy and responsibility, and create more jobs and strengthen social cohesion. There is uncertainty in the type of impact that lifelong learning will have on work-life balance, social exclusion and disagreement concerning sustainability and environmental quality.

Source: Loveridge et al., 2004.

Box 4. **Cedefop's skills governance country reviews: an example of Delphi exercises**

As part of its skills governance country support initiative, and following the completion of the stakeholder interview phase (Box 2), Cedefop used an online Delphi method to carry out consensus-building exercises in four EU countries. A first step was to secure the involvement of main national institutions and stakeholders involved in the skill anticipation and matching system. Three sequential rounds (Table 7) were then carried out using questionnaires in the respective language, with several open and closed questions administered online. Participants received extensive guidelines and were asked to complete the questionnaires on their behalf and the institution they represented. Each round lasted between two to three weeks. Full confidentiality and anonymity were guaranteed. A summary of results from each round was presented before each subsequent round.

Source: Cedefop.

Table 6. **Euforia Delphi (2002): selection of topic statements seen as 'about right' for characterising 2015 and views as to their impact**

Topic category	Topic statement	Impact assessment
13: Industrial relations	A major increase occurs in my country in the use of electronic networks for remote supervision of new kinds of work (teleworking, mobile working), and new atypical forms of work.	Social cohesion: ?? Social exclusion: ?? Environmental quality: + Industrial relations: ?? Growth/wealth creation: + Entrepreneurship/innovativeness: + Employee autonomy/responsibility: + Work-life balance: ?? Job creation: +
18: Living conditions	Harmonisation of educational standards (including certification) across the EU increases trust and transparency in my country's educational system.	Social cohesion: + Social exclusion: - Environmental quality: +? Industrial relations: +? Growth/wealth creation: + Entrepreneurship/innovativeness: +? Employee autonomy/responsibility: 0? Work-life balance: 0 Job creation: +
24: Sustainability and development	Europe has developed into a leading force in the area of sustainable development and the use of environmental technologies.	Social cohesion: + Social exclusion: -? Environmental quality: ++ Industrial relations: 0? Growth/wealth creation: + Entrepreneurship/innovativeness: + Employee autonomy/responsibility: 0? Work-life balance: 0? Job creation: +

NB: ++: strongly increases
+: increases
0: no effect
-: decreases
?: some uncertainty (little consensus)
??: very uncertain (bimodal distribution).

Source: Loveridge et al., 2004.

Table 7. **Delphi rounds carried out as part of Cedefop's skills governance country reviews**

Round 1: Prioritisation
An online questionnaire was developed outlining a number of potential focus areas related to the main areas of interest for each country's skill governance review. Respondents were asked to prioritise these and clarify their positions (i.e. why was an issue selected; main challenge to be resolved; suggestions for improvement).
Round 2: Deepening of stakeholder positions
This round focused on the priority issues of stage one and sought to work towards a shared problem analysis. Possibilities were explored with the aim to agree on possible feasible solutions, to identify steps required to implement them, and to explore how different institutional players can contribute towards common solutions.
Round 3: Achieving consensus
The final round aimed at defining follow-up steps and setting a concrete timetable for the actions stakeholders reached consensus on.

Source: Cedefop.

In early Delphi practice, respondents were typically asked to indicate why they were expressing particular points of view, possibly prompted by having recently seen a newspaper article or project findings. Although extracting such open-ended information is relatively uncommon nowadays, due to the additional load posed on respondent memory and the subjectiveness of assessments, online techniques have made it possible to acquire rapid insight into extreme responses and feed this back to the group. What is common is to ask respondents to rate their expertise, or their familiarity with a particular field. It is then possible to compare results between more and less expert respondents.

Designing and administrating Delphi studies is time-consuming and labour intensive, but they contribute to more thorough analysis and insightful results. Findings generally lend themselves well to graphical representation (for example bar charts, infographics) of expectations regarding the relative pace of development of different technologies in different applications, impacts on skills and working conditions and others. One of the main problems of visual images based on Delphi is they tend to be overly persuasive: they cannot transfer the complexity and varied argumentation and reasoning present in complete qualitative results, such as the proceedings and outcomes of expert workshops.

Box 5. **Delphi focused on critical technologies and emerging skills**

Ahlqvist (2003) presents an example of an exercise combining Delphi, critical technologies and other approaches to explore expert opinions on emerging skill and occupational needs. Having established the importance of information technology, biotechnology, and nanotechnology/materials technology, major trajectories and emerging areas in each were assessed using a survey. These were then rated, in terms of their likely introduction in the medium-term future (at the time, by 2015), with leading examples: targeted medicines; sensors (for example monitoring hazardous changes in environmental conditions); biomedical, photonic and intelligent (self-repairing) materials; and 3G and virtual reality systems (which can be used to enable distance working and delivery of healthcare and other services).

Given these developments, respondents were then asked to assess the employment impact in 12 occupations, ranging from architects and biochemists/biologists to office and manufacturing blue-collar workers. The respondents were also asked to reflect on new professions that might emerge. Suggestions ranged from artificial organ designer, AI consultant and gene therapy consultant, to smart home designer and social network analyst.

In the final step, ratings were elicited as to how far these suggestions were plausible, and, if so, when they would become reality. Most respondents viewed all new professions proposed as plausible reality in the next 10 years. Artificial organ designer, AI consultant and gene therapy consultant were among the slowest to be realised. Social network analysts were seen as most rapidly maturing towards a well-defined profession. Other roles seen as rapidly emerging included cool consultant (providing advice on fashion and changing tastes), virtual doctor, geo-informationist, and cybrarian (specialising in monitoring and locating online resources).

Source: Ahlqvist, 2003.

3.2.3. Cross-impact analysis

A weakness of many Delphi-type surveys is that the questionnaire attempts to collect views on a range of topics, with little or no exploration of how these might be related. Survey responses can always be examined to see the statistical relationships between expectations about different topics, but this approach is imprecise because it does not provide full understanding of relationships in a system. Cross-impact analysis can be used to deal with this problem. It involves going beyond requesting respondents to rate the likelihood of various events occurring by a point in time, questions usually addressed in a Delphi or similar survey. Cross-impact analysis is possible by asking participants to indicate the relationship between different events,

for instance how likely is it that event A will happen if event B happens? And how likely is it that event A will happen if event B does not happen ([17])? The result is a matrix depicting interrelationships between sets of events, which can be seen as systemic representation of the relationships that are explored.

The resulting information can be used in several ways. Some events may turn out to be critical in terms of their impact on others. Cross-impact method practitioners frequently derive a set of basic scenarios, representing every possible combination of occurrence/non-occurrence of each event, with probabilities assigned to each ([18]). But such information is based on many difficult judgements about combinations of events participants have to make, which rise rapidly as the number of events increases. In practice, few events can be considered without overloading respondents, which is a serious limitation of the approach. Unless a small number of critical events can be sensibly identified, the method is of limited practical use. Other approaches are needed to examine the wider implications of events and the factors driving them.

([17]) Usually, these probability ratings are made on simple scales, for instance a five-point scale where 1=very low probability and 5=extremely high probability.

([18]) The standard way of calculating the probability of each scenario is via some form of Monte Carlo simulation, taking the cross-impact matrix as a computer model which is run repeatedly, so that a sample of scenarios is produced. See Godet,1975.
Also see Banuls and Turoff (2011); Scapolo and Miles (2006) for descriptions of the literature combining and contrasting cross-impact and Delphi approaches.

CHAPTER 4.

Workshops and meetings

4.1. Ground rules and good practice

Workshops are used in many foresight exercises, to facilitate and provide a structure for face-to-face encounters between participants. Physical presence is particularly effective in terms of engaging people in participatory dialogue and in achieving collective learning outcomes.

4.1.1. **Designing effective workshops and follow-up**

As ensuring wide participation in discussions in larger groups is difficult, larger foresight workshops or conferences alternate plenary activities and small-scale workshops. Provided they are well-facilitated, such break-out sessions can be effective means of exchanging views on typical skills and technology foresight issues, such as emerging technologies, drivers, scenarios, professions and skills. Reporting back workshop deliberations in plenary is common, and in the context of foresight such reports often aim at providing a convincing account of collective understanding or beliefs ('selling' results).

Where case workshop outcomes prove surprising or contentious, clarification requests are likely and a debate may follow. To gain insight into what larger audiences think about the outcomes of small group discussions, voting may be used. Alternatively, workshop findings may be taken as they come, and used to inform follow-up activities, such as constructing scenarios based on identified key drivers of change.

In larger foresight exercises, it is common for workshops or break-out groups to have a scribe tasked with note-taking and a designated rapporteur who reports findings and ideas to the plenary.

As well as a report summarising a foresight workshop for participants and/or the sponsor(s) of the exercise, additional structured analysis can be provided. Mind maps – visual representations of links between concepts and ideas – are a useful tool. They usually start from a central idea which is

then linked to other main ideas; these linkages may reflect the relationships between concepts that emerged in the workshop discussion ([19]).

4.1.2. **Workshops: do's and don'ts**

Workshop participants should be given the opportunity and encouraged to state their point of view, and treated with respect when doing so. The fact that some participants may be more expert on specific topics than others does not mean that they should be dominant in all matters.

A good facilitator helps participants voice their own views and share their knowledge while treating others with different viewpoints with respect. Facilitation requires a wide spectrum of social and interpersonal skills, ability to use support tools effectively (for example flip charts/post-its or their digital equivalents), and, ideally, also some prior experience on the topics discussed. Skilled facilitation involves dealing with conflicting opinions, encouraging less articulate and more reserved group members to voice their views and concerns, providing space for expressing minority or contentious views, and controlling the more dominant and less well-mannered ones.

Capturing ideas as they are presented is useful, because this helps establish a record of the discussions that may be used for follow-up stages or report preparation. The approach also helps transmit the message to participants that their inputs are valued and noted and makes it possible to refresh the collective memory and quickly return to points made earlier. It can be helpful to have a space where ideas (for example wild cards) can be 'parked' for later discussion.

A facilitator who is fully aware of the main do's and don'ts (Table 8) contributes greatly to the effectiveness of workshops and to the quality of the results they can achieve.

4.2. Decision-making

In many workshops and similar events, decisions must be made. Typically, not all generated can be fully considered. While selection may be necessary, it is important to retain ideas that had to be put aside. Recording them,

([19]) On historical antecedents to mind maps, see: https://www.mind-mapping.org/blog/roots-of-visual-mapping/. There are many software products available to support mind mapping. For a list see: https://www.mind-mapping.org/index.php?title=Main_Page

Table 8. **Workshops in foresight: do's and don'ts**

Do	Don't
Explain how the insight and materials generated will be used (including confidentiality of personal information) and address any disagreement beforehand	Deviate from the Chatham house rule – the principle that participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed
Explain ground rules for open communication at an early stage	Leave room to believe potentially disruptive or uncivil behaviours are acceptable
Promote a climate of respect and trust	Allow participants to criticise openly and put down others
Encourage all participants to express their view freely	Give some participants or experts opportunities to dominate the discussion
Allow participants to challenge ideas and disagree politely	Allow combative discussion or interaction styles (e.g. dismissive, sneering responses)
Promote creativity by stimulating out-of-the-box thinking and valuing every idea or suggestion	Engage in discussion or debates before a critical mass of ideas has been collected

Source: Cedefop.

for possible presentation in workshop documents or progress reports, will make participants who developed them feel acknowledged. Almost all ideas, including non-short-listed ones, are useful to follow-up work. The exception is ideas that cannot be retained because, for example, they are factually inaccurate or seriously flawed or unacceptable in ethical terms. What to retain or not should be a conscious process. Sometimes ideas that appear unrealistic at first sight may turn out to be plausible after all. Moral objections can be based on misapprehensions.

In situations where participants overwhelmingly favour or reject an idea, group decisions can easily be made. With many ideas on the table, this is less likely, and voting is commonly used to aid decision-making. Polls can ask participants to nominate, for instance, the three most important factors driving employment or skill demand, within a given time horizon. They can also be used to ask participants to reflect on the likelihood that particular technology trends will take off or if there are barriers (for instance, skill shortages) to their wider implementation.

Opportunity for dialogue and exchanging views is a key advantage of workshops. They allow participants to gain insight into the underpinnings of assumptions and points of view. When voting is seen as stifling views, especially among participants with deep expertise or strong feelings about

specific issues, the added value of workshops over questionnaire-based surveys may be diminished. On the other hand, voting can also be a way to avoid highly articulate individuals (or worse, those with a bullying or dismissive attitude towards others) hijacking group discussions.

Opportunities to use polling are numerous and rapidly growing with the proliferation of digital tools for laptops, tablets and smartphones. Such tools incorporate sophisticated rating scales and innovative ways of expressing relative preferences. More conventional tools often involve giving participants several votes to be used to indicate preferences (perhaps using post-it notes, stickers, markers). They may use lists of ideas on thematic flip charts covering the social, technological, economic, environmental, political and values factors often considered in foresight exercises (see Section 4.4). Presenting options and/or alternatives in terms of technologies, professions, scenarios or policy actors is another widely used approach.

Colours may be used to characterise specific aspects, choices or assessments, such as importance, positive/negative impact, and highly probable/uncertain. Voting set-up can be tailored to different circumstances. This concerns the number of votes allowed, whether it is possible to cast multiple votes for one idea, and whether participants are discouraged from voting on their own or group ideas. Other set-up decisions relate to whether participants are asked to distribute votes equally across several flip charts, whether it is mandatory to use equal numbers of votes for each colour in a three-colour system and others. There is little guidance as to which approaches work best. Experienced facilitators will often sense whether using more complicated approaches has benefits.

Unless IT-based solutions are employed, the voting methods described in Sections 4.1 and 4.2 have several drawbacks. They do not allow participants to vote anonymously and – because earlier votes are visible to those voting later – results may incorporate a degree of social influence.

Following the vote(s), the facilitator must point out which ideas have greater support and request the group to focus on them. When several ideas have similar levels of support, they may be connected. In other situations, it is more appropriate to ask the group to help in making a more definite choice (for example, by show of hands after a brief discussion). The group should always be reminded about the uncertainties or implications of the ideas that ultimately were not selected, particularly those that received substantial initial endorsement.

4.3. Brainstorming

Brainstorming is used to unleash creativity in a group and to ease generating new viewpoints. The philosophy of brainstorming is allowing participants to present ideas freely without being influenced by comments or value judgements by others. Ideas are evaluated after brainstorming, when a sufficient number and diversity have been contributed. Participants must have equal status and equal opportunities to share their ideas and this principle has to be clearly communicated at the outset. Reminders may be needed during the brainstorm.

After explaining the rules of the process, the facilitator explains the brainstorm topic to be addressed. This could entail posing questions, such as:

(a) what are the main factors driving or inhibiting the introduction of new technologies in one or more professions or workplaces?
(b) what skills will be required if these technologies are to be adopted for particular applications?
(c) what risks and wild cards might be encountered?

It is important to be clear about the focus of question(s). If the interest is in the impact of new technologies on future skills demand, two brainstorms might be needed. The first would be about identifying factors that could influence the pace of adoption of these new technologies; this step would require clarity about the definition of the technology. The considerable ambiguity in terms like artificial intelligence and robotics or digitalisation in practice shows how important this step is. It is also important to be clear about time horizons, as trends and prospects five years ahead differ markedly from those looking 20 years into the future. After factors influencing the pace of technological change have been identified, in the second brainstorm the focus can be on the implications of adopting technologies for work organisation, jobs and skills.

In brainstorming sessions, participants are asked to articulate ideas relevant to the question(s) posed. This may be achieved without explicit prompting, or a framework like STEEPV may be used to stimulate ideas in different areas and to ensure no important area is overlooked. Aiming to provoke ideas in a wide range of areas might be appropriate for topics such as technology adoption and skills supply. On the question of skills demanded by types of work, it might be more effective to prompt ideas in skills areas, such as professional skills, manual skills, technical skills, teamworking skills and others.

In face-to-face brainstorm sessions, the usual approach is to ask participants to share their ideas verbally and record them on a whiteboard, flipchart, or computer display; this may be the task of a facilitator or member of the support team. Ideas may be reinforced or further developed in the process.

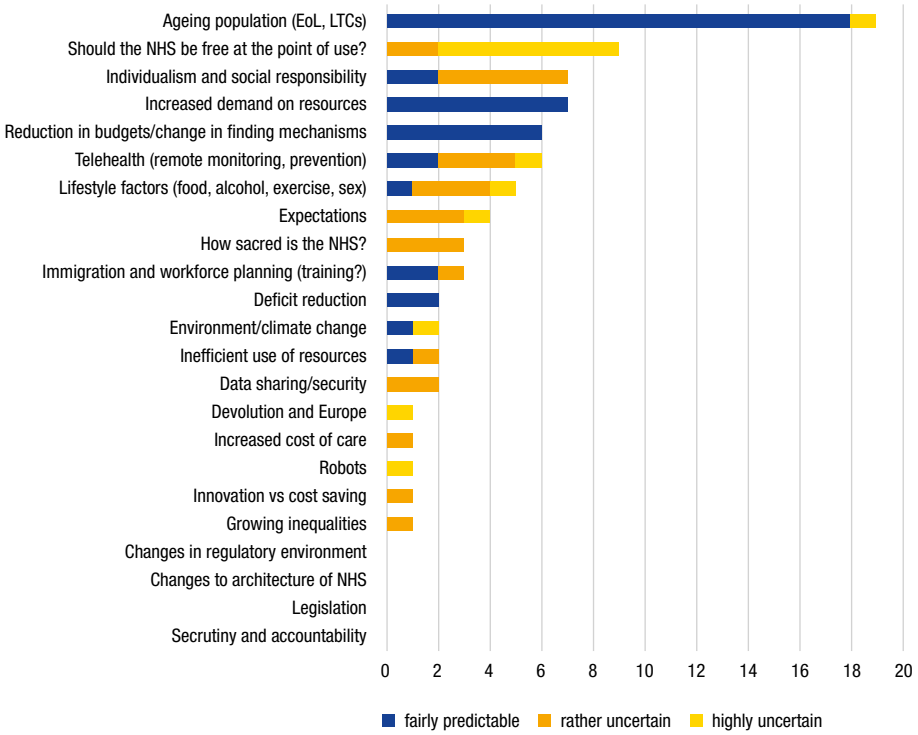
A variant of this approach is to allow people some time to write their ideas on post-it notes or to do so using computer software. They may be able to consult ideas submitted by others when adding their own. After the time allocated has lapsed, participants may be given the chance to present their ideas to the group. It is good practice in both approaches to discourage critical reactions to ideas during brainstorming, so as not to inhibit creative reflection. Questions should be limited to requests for clarifications.

Usually, the goal of the discussion following the collection of ideas is to decide whether to rule out some and how to group and prioritise the remaining ones. Ruling out some ideas does not mean abandoning them forever. Unless the owner of the idea concedes that it is inappropriate or irrelevant, it may still be reported. Ideas that are retained can often be clustered in groups, either because they are slightly varying formulations of the same basic point or complementary elements belonging to the same broader idea.

When many ideas remain part of the discussion, establishing which ones are most important is a widely applied approach. For example, following a brainstorm on relevant policies or changes in curricula or training methods, participants may agree to focus on the feasibility of various ideas and their potential impact. In scenario analysis, it is common to use brainstorming to identify drivers of change with important but highly uncertain effects. In a skill forecasting exercise, drivers might include a reduction in prices and/or increase in capabilities of technology, and the uptake of management approaches easing work organisation and organisational knowledge management.

Figure 1 displays the results of an exercise aimed at helping UK health service managers think through issues that could impact their work and skills needs in the future at an early stage in their careers. The exercise followed a brainstorm aimed at identifying drivers of change (for example ageing populations and budget constraints). The bars indicate the extent to which participants believed different factors are important, and the colours give an impression about how certain they were about these factors materialising.

Figure 1. **Factors influencing management work in health services in the future: views on topics identified in brainstorming**



Source: Notes from workshop, conducted in 2010.

4.4. The STEEPV framework

The acronym STEEPV (social, technological, economic, environmental, political and values) refers to a convenient way of investigating and classifying phenomena and encouraging the generation of ideas that cover a wide range of areas ([20]).

([20]) The term STEEP is also frequently encountered as a reduced version of STEEPV. There is a family of such approaches, with other members known by acronyms, such as political, economic, social and technological (PEST), political, economic, social, technological, legal and environmental (PESTLE), or technological, economic, environmental, political, social and ethical (TEEPSE). Often a modified list of these terms is used to ensure adequate coverage of a particular topic. For further information regarding such foresight frameworks see Loveridge, 2002.

The aim of using STEEPV elements is not precision, but wide coverage. When asking participants in a workshop to brainstorm on drivers of change, the potential impacts of change, or the strengths, weaknesses, opportunities and threats (SWOT) associated with a particular policy, asking for ideas under all STEEPV headings can help the participants break away from a unidimensional focus or silo thinking.

Grouping ideas about drivers of change under the STEEPV headings, for instance using posters arranged on a wall, helps visualise and structure the collective wisdom of a group. As a follow-up, participants can use stickers to indicate which change drivers they consider most important and (by using different colours) to provide an assessment of how likely it is different drivers of change will become dominant and impactful trends. Such an approach can greatly reduce the time needed for a group to agree on a set of critical issues.

STEEPV has been widely applied in studies on technological change, employment and skills (Box 6).

Box 6. **Foresight studies using STEEPV framework**

A study of e-skills in Europe (CEPIS, 2006) identified many factors influencing supply and demand for such skills, and considered their implications, as follows:

- social: improved education levels; expectations of higher wages; population ageing trends; efforts to compromise systems/growing concerns about information and communications technology (ICT) security;
- technological: improved user interfaces; adoption of software engineering and more disciplined approaches; enhanced telecommunications infrastructure and services;
- economic: economic growth within the EU; increased start-up rate for small and medium-sized enterprises (SMEs); commoditisation of ICT products/services; increasing global competition;
- environmental: acceleration of global warming; pressure/effort to replace transport with telecoms; emphasis on reduction of ICT and electronic waste;
- political: variation of skilled worker migration flow(s) into EU; pressure exerted on employers to reduce/limit offshoring; growing geopolitical instability; extension of retirement age;
- values-related: declining interest of young people in undertaking technology-related courses/qualifications; demand from workforce for more satisfying jobs; resistance to surveillance/privacy invasion through ICT at work and in services; growing concern about health hazards of ICT.

Source: CEPIS, 2006.

4.5. SWOT analysis

SWOT (strengths, weaknesses, opportunities and threats) analysis is a useful approach to encourage workshop participants to break out of a mindset that overemphasises dangers or negative impacts of a development, or commercial prospects linked to it. SWOT involves asking people to examine systematically the arguments or possibilities associated with points of view different from those prevailing in their organisation or (professional) community. This helps identify issues that need to be taken seriously and counters any reflex to dismiss them without serious consideration. SWOT analysis is used to inform strategic planning and foresight activities, often those with a shorter-term focus. SWOT features can also readily be built into Delphi-type surveys or expert interviews.

SWOT results are often presented in a 2x2 matrix, with strengths and weaknesses considered more internal and opportunities and threats more external factors. The strengths and opportunities cells are usually mainly positive, and weaknesses and threats refer to mainly negative aspects. Table 9 presents an example of a SWOT analysis of a vocational training scheme involving formal school-based and on-the-job factory-based learning.

Table 9. **An illustrative SWOT analysis of a VET scheme**

Strengths	Weaknesses
• Regular supply of highly skilled employees • Ensure sustainability of recruitment needs • Knowledge retention • Promoting new standards of education • Good experience in promoting VET	• Lack of tutors due to retiring age • Lack of good dual education programme and system of education solutions
Opportunities	**Threats**
• Proximity to school • Possibility of obtaining public funds • Good example and opportunity with other schools • Cooperation with public organisations, e.g. Voluntary Labour Corps which is organising various forms of combatting unemployment and social pathology	• Students' skills mismatch • Education programme mismatch • Low prestige of the apprenticeship education • Lack of training for teachers • Lack of well-prepared workshops in schools

Source: Vocational education and training – A renovated tradition in Poland.

Many tools for framing SWOT matrices, to help appraise possible futures and develop strategies, are available online. The SWOT matrix may be populated by an expert team, based on broader views obtained via a workshop. Sometimes analyses are predominantly based on desk research and data obtained via less participatory approaches, such as one-to-one stakeholder interviews.

A common approach to processing the ideas present in the matrix is to prioritise strengths and weaknesses in terms of how influential each factor may be and opportunities and threats in terms of impact and probability. SWOT is widely regarded as a useful starting point in strategic planning, provided that those contributing ideas and perspectives are prepared to go beyond simply recycling conventional wisdom and/or repeating banalities, and willing to engage in fundamental work. Applying a STEEPV framework to stimulate thinking about possible factors may encourage reflection on a wider choice of issues.

4.6. Collective creativity

There are many techniques to encourage participants to be creative and contribute ideas about phenomena, events and actions that might not come to the fore in more routine discussions. Brainstorming is one of these but not all groups can use it effectively without preparation. While some groups spontaneously come up with quite original ideas in response to a request to think out of the box or imagine a really different outcome, in others this is not so straightforward and loosening-up activities are needed to encourage participants to feel free to construct new lines of thought.

Creativity techniques range from asking participants to complete a simple task (for example ‘come up with as many uses for a brick as you can’), to more elaborate ones, such as role-play. One creative technique – the lotus blossom – is a framework of ever-widening ‘petals’ which are visualised using a set of flip charts or white boards. Workshop participants begin with a central theme, at the heart of the flower which is used to trigger new ideas and themes, which then become new central themes (Box 7).

Lotus blossom, like many other creativity techniques, is a tool to explore various aspects of a problem or issue in an inclusive and systematic way and to go beyond discussions fixated on just one problematic aspect, issue, or stumbling block. In practice, limited time makes it challenging to examine

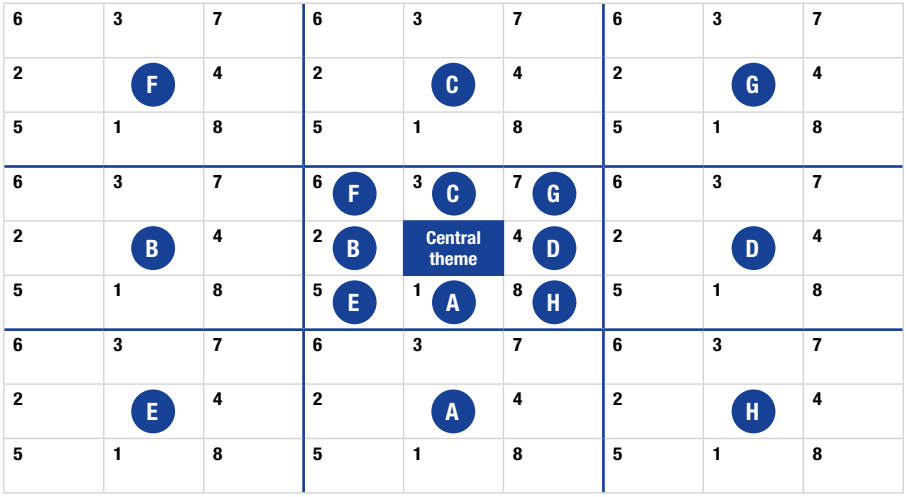
all facets or dimensions a creativity technique may identify. A pragmatic solution is to shape exercises so that they balance exploring new ideas and examining more familiar ones.

Box 7. **The lotus-blossom technique**

Figure 2 shows the set-up of a lotus-blossom flower exercise applied in a workshop on higher education. Its central aim was to develop ideas on how to create a truly flexible version of a training programme. Break-out groups worked on different goals. The first sub-themes to be developed on the basis of the central theme reflected different dimensions for achieving the main goal, for instance allow evening and weekend classes, pay on a modular basis for training, relaxing constraints on course duration. Each group was encouraged to develop up to eight subthemes. For each of these new themes, participants were asked to suggest again up to eight actions. Suggestions included making scholarships more visible, addressing load transfer issues, and changing [specific aspects of] regulations and reward structures.

Source: Unpublished 2015 study, conducted for UK university.

Figure 2. **Schematic representation of the lotus-blossom technique**



NB: Sub-issues triggered by a central idea are captured in the circles A to H on the primary chart (represented by the matrix in the middle of the diagram), and these are transcribed onto the secondary charts (surrounding the central chart).

Source: Cedefop.

CHAPTER 5.

Imagining and shaping futures

5.1. Scenario workshops

The term scenario is sometimes used loosely and appears to have different meanings in various contexts. The results of running a quantitative model several times with different assumptions or parameters can be labelled scenarios. Different points of view across different population groups, identified via survey research, may also be considered scenarios. In the context of scenario workshops, the term refers to more articulated accounts of future states of affairs and/or paths of development. Such workshops aim to develop internally coherent visions of possible future prospects. In foresight, the purpose of identifying and outlining scenarios is to capture the implications of plausible developments and courses of action. To reflect uncertainties about a topic, issue or trend, foresight scenario exercises generally consider a range of possible outcomes.

A brief presentation or set of presentations on the topic of the exercise starts off most scenario workshops. This is followed by systematic discussion of issues, trends and drivers that are likely to influence future prospects; brainstorming and STEEPV are commonly used tools to structure such discussions. Apart from acquiring knowledge, deep immersion in key issues and adjacent topics of interest, this also gives participants the opportunity to learn more about other participants' expertise and interests. In break-out groups, alternatives can be explored in some detail. Usually every break-out group considers one scenario: one course of development and its outcome. Some scenario approaches ask participants to assume that one or more trends are driving developments, and to reflect on how this might happen and what the consequences will be. Other approaches ask participants to imagine a particular state of affairs in the future. They are then asked to explain what processes may have led to this outcome and to reflect on how the future will likely unfold.

As it is practically impossible to work through all possible scenarios, the challenge is to find exemplary ones. It is important to ensure that these are not only seen as plausible prospects, but as states in a wide spectrum of possibilities. The dimensions in this spectrum may not be the ones that turn

out to be most significant. Most participatory scenario exercises work with three or four alternative scenarios.

In foresight studies, two types of scenario workshop are widely used. Many exercises use a 2x2 driver approach, which leads to four scenarios. This requires identifying two drivers which are seen as particularly important for the topic and, at the same time, highly uncertain in terms of development and/or impact. For each of the two drivers, polar directions of development are identified; each of the four scenarios represents one combination of the two sets of directions.

While the second type of scenario workshop may also be preceded by a discussion of major drivers, the scenarios are not built based on alternative driver development paths. Participants are instead provided with a set of very basic alternative outcomes and asked to envisage the drivers and events that could have led to these outcomes. Subsequently, they reflect on what the outcomes would possibly look like in more detail. The outcomes could be based on alternative end-points established in earlier work, for example centralised/decentralised, public/private, technology/social-innovation based.

As part of a 2006 study, several scenarios on supply and demand for e-skills across Europe, developed through deskwork and supported by computer modelling, were presented at a workshop (CEPIS, 2006). Participants were asked about factors influencing the alternative paths of development. One generic approach that proves useful in many circumstances is to set up three (or four) archetypes: future states of affairs that are better than expected, worse than expected, different than expected (and/or radically different than expected). It is not uncommon for the different options to result in a major shift in participants' understanding of the prospects for evolution ([21]).

All scenario approaches have the common aim to generate scenarios that participants consider plausible. Rapporteurs from breakout sessions will typically present the group's scenario to the plenary, trying to 'sell' it as being something that workshop participants and decision-makers should take seriously into account.

([21]) For example, in one exercise where the prospects for a particular type of network technology were being examined, the participants had been focusing on the extent to which the strategies that could be adopted by the major existing players would succeed in their intended aims of reaching large user bases and encouraging new applications. The result of the scenario exercise led them to consider seriously the possibility that a disruptive newcomer could provide an alternative set of facilities that would completely change the situation.

The process aims to capture as many alternative scenarios as possible, reflecting on which drivers operate, how, and with what outcomes. The framework used should facilitate comparisons between alternatives, possibly using tables, graphs or charts. Such comparisons can be useful in communicating uncertainties and avoiding a focus on business as usual or most likely expectations. Alternative scenarios can be used to examine the robustness of policies. Often a scenario workshop will culminate in participants being requested to suggest early warning signs and actions that might be necessary should one or another scenario emerge.

The development of action recommendations typically focuses on the organisation/group benefiting from the exercise, and/or a wider stakeholder group needing to prepare for and respond to alternative futures. The descriptions of the scenarios, and the factors leading to their development, can be used effectively to convey results of the foresight exercise to a wide audience. They may be illustrated with vignettes (accounts of events or experiences in the future), cartoons, or other visual aids.

It is also possible for scenario work to be closely linked to personal choices of participants. Those with a particular occupation or engaged in a certain sector may be asked to reflect on what different scenarios might mean for their own career and the skills and training they will need.

In scenario workshops, wild cards collected during discussions could be retained for future reference and can be useful for risk appraisal exercises. Representing events unlikely to occur, wild cards are not usually pivotal in constructing plausible scenarios: the future is likely to look like a mixture of different scenarios. Scenario workshops should help clarify what underlies these possibilities and what factors may shape their future development. While many practitioners will ask participants to estimate the likelihood of alternative scenarios, it may be more appropriate to ask what the future may look like according to one or another scenario or resort to voting. While elements from some scenarios tend to be more prevalent, all will have some features that are thought to be indicative of the shape of things to come.

Scenarios produced from desk research and other non-participatory methods, or in earlier scenario workshops, may be presented at workshops to be validated or elaborated. This may entail reflecting in more detail on the implications of trends for specific occupations, industries and related areas (such as training systems). Often a workshop convened to develop strategic recommendations can build on prior scenario work and a desirable scenario or roadmap can be constructed from it.

5.2. Simulation gaming and role-playing

Computer simulations are a widely used tool for modelling future developments. Most are developed by expert teams; in some, participatory elements are present in building them. Since the 1970s, teams of experts developed such models. These were presented to national policy bodies and experimenting was encouraged to use the models to see the impact on their policy decisions.

Today's commercial and educational computer games are based on sophisticated models and allow users to visualise developments. Some teach players how economies, for instance, operate. Large-scale multiplayer online games allow large numbers of people (present in workshops and remotely) to participate in simulations and to build (virtual) future worlds. In fields like urban planning, using such games can be a real value-added.

In practice, simulation gaming in workshops often encourages participants (or groups of participants) to act out certain roles. In the context of technology and skills foresight, this may involve imagining being users of a specific technology and considering how to deploy it. The role-playing tools and approaches commonly used in psychotherapy, counselling, and related areas can be adapted for use in a skills context. Participants could, for example, be asked to imagine:

(a) what it would be like to be a person of a particular age and occupation, with a particular life history, confronted with a particular technology;
(b) what the challenges are in using that technology;
(c) what skills are required;
(d) what may incentivise the choice of investing in different skills ([22]).

Gaming in futures studies developed out of war-gaming exercises in military contexts, where players take opposing sides in a conflict situation and explore consequences of choices and reactions to these choices. To model social phenomena, simulation exercise can assign participants:

(a) the roles corresponding to those of social groups in situations of interest;
(b) the motives and information available to these roles;
(c) the options for action they have.

([22]) The persona approach is commonly applied in marketing studies, service design and open policy-making.

With participants performing the roles of key agents within a structured framework, possible responses to emerging circumstances can be explored. Interactions between the strategies of different agents can be examined. So far, there is limited experience in using these methods in a foresight context. It may be that their main functions are educating participants about contingencies and motives, so that they develop insight that can feed into other foresight activities and outputs.

5.3. Actions, decisions and recommendations

5.3.1. **Suggesting and developing action plans**

Suggestions for possible actions emerging from a foresight analysis are often made in the concluding stages of workshops. Developing actions and action plans may also be undertaken in dedicated workshops following earlier foresight work.

Ideas may be developed using the methods described, such as brainstorming and the lotus-blossom approach. These techniques encourage development of creative ideas for action, while systematically considering the complexity of many objectives.

Action plans are lists linking actions to stakeholders that have (or could have) capacity and responsibility for executing them. The carousel method is sometimes used: this involves workshop participant groups rotating between flip charts or white boards representing different stakeholders and actors. In the process, they inspect the contributions of other groups and add their own suggestions for actions that stakeholders or actors might undertake to realise a particular goal (or simply a more desirable future). This allows different groups to express their own viewpoints and perspectives, as well as giving participants the opportunity to use their legs, which is often much welcomed after being seated for many hours.

Effective action plans are not just wish lists of desired end points. They are specific and, alongside the detail, explain how intended outcomes can be achieved. Providing measures or indications of how to monitor progress (or problems) and targets to be achieved is beneficial. Some practitioners recommend setting ‘stretch’ targets, which have to be ambitious but attainable, provided sufficient effort is made. It is important to avoid unrealistic actions and goals, particularly in a context where sudden impressive

performance is unlikely. Examples are lack of resources, insufficient political will to accomplish something, or a history of institutional failure.

Sound knowledge about institutional capabilities and interests is important. It enables formulating actions that are reasonable and attainable, which can be presented to decision-makers. It is helpful to include participants who are familiar with the organisational culture, language, procedures and timetables of key institutions. Proposals for action must respect current norms and practices, avoid treading on the feet of key stakeholders and actors, and should not replicate policies and programmes which have been shown not to be very effective. Knowing how actions might fit into political and policy cycles is valuable. Proposing several new activities to an organisation which has just revised its strategic planning may be of limited value. In other situations, suggestions for change or innovation may be exactly what is required.

5.3.2. **Open policy-making and policy labs**

The open policy-making approach was developed in the UK civil service to encourage more rapid and creative development of policies, including those related to changing skill needs in an increasingly digital world. As in participatory foresight, open policy-making aims to meet user needs through collaborative approaches that inform policy thinking based on a broad range of expert inputs. These complement data-driven and evidence-based approaches relying on new analytical techniques and digital tools. Prototyping and iteratively improving policies are used to meet complex and changing user needs ([23]).

One of the methods employed is the Policy laboratory in a day. This method involves:

(a) setting the challenge: participants use post-its or similar tools to express hopes and fears and then identify the challenge that is being confronted. Voting is used to identify the key challenge that will be the focus of the discussion;

(b) understanding the policy landscape: break-out groups capture key issues about data and evidence (what is available, what is most important/interesting/surprising, where are there evidence gaps?), users and stakeholders (who is targeted, which other key stakeholders are there?)

([23]) For a toolkit of such methods, and links to other resources, see: https://www.gov.uk/guidance/open-policy-making-toolkit

and existing policies aimed at addressing the challenge. These are discussed to map comprehensively the current policy landscape and to identify possible desired interventions;

(c) understanding the users: break-out groups develop personas (types of actor influenced by the policy challenge), their 'journeys' (experiences and needs related to the policy areas), and how these might influence the policy challenge;

(d) generating ideas: break-out groups brainstorm about major ideas for policy actions, prompted by change cards. These are clustered and the top three are selected. Ideas are visualised through drawing, for instance in the form of a service journey depicted as a cartoon and pitched to the whole group;

(e) planning next steps: groups explain immediate next steps (in terms of hours and days rather than weeks) and what is needed to achieve them; for example, the people who will need to engage, further work needed to understand better the policy challenge and the users. Timing and key milestones help map an action plan with timetable.

Box 8. **The UK foresight project on skills and lifetime learning**

The UK foresight project on skills and lifetime learning used a version of the policy-laboratory-in-a-day approach in its Lifetime learning in the digital age summit. Accepting that changing technologies raise the uncertainty of future digital skills requirements, participants expressed hope that such skills will be acquired in more inclusive and accessible ways in the future. Three broad topics were considered: the incoming flow of skills from workforce entrants; skills for those already in the workforce; and demand for skills from employers. After review, actions were proposed for each.

In terms of incoming skills flow, actions were identified complementary to current policies.

- Teachers should be offered training to address their skills gap.
- Industry-provider partnerships, where firms articulate their digital skill needs and providers respond to them.
- Targeting underrepresented groups for computing degrees, including women, ethnic-minority groups, disabled people and individuals from neighbourhoods with low participation rates, by ensuring the education system provides opportunities to improve diversity in uptake of subjects, such as maths.

- Improving the digital competence of higher education students in all subjects, for example by including digital content in degree programmes.
- Building work-readiness into computer science or science, technology, engineering, mathematics (STEM) degree programmes.
- Increase sandwich courses and work experience options.

For those already in the workforce.

- Encouraging and supporting employers to provide better workplace learning.
- Codification/accreditation, for example digital badging, so that individuals, employers and education providers can transfer learning from outside the formal system and between workplaces.
- Developing self-identification skills so that individuals are more able to diagnose which skills they need, lack and can acquire.
- Supporting self-learning of technology through community groups.
- Supporting learning at or around significant life stage transitions which influence participation, and can contribute to learning motivation (including childbirth, changing job, redundancy, children leaving home, bereavement, retirement).
- Supporting intergenerational and family learning. Older adults are often motivated to learn to support their children.
- Improving the provision of part-time digital courses at higher levels (further or higher education) where the recent trend is a reduction in the number of part-time programmes.

Demand for digital skills from employers.

- Improving information on which digital skills and capabilities are available for employers, including how they could help their organisations become more productive and grow.
- Emphasising the importance of technology 'translators' in organisations: staff members who are able to bridge the gap between understanding new technologies and the possible impact they may have on value generation.
- Intermediaries can share and promote understanding of digital skills requirements between employers, providers and employees.
- At the regional level, local government and local enterprise partnerships can develop a more detailed understanding of digital skill requirements. There could be opportunities to link universities, colleges and other education providers to local employers, and design training programmes geared to the needs of the local economy.

Specific policies to support skills development for the digital and creative industries.

- Further development of specialist technology institutions and applied research, learning from institutions like MIT, Pohang (in South Korea) and ETH Zurich.

- Attracting high-skilled international talent to specific sectors.
- Improve the links between digital SMEs and education and training providers, for example assisting graduate integration into local SMEs via placements and on-the-job training programmes.
- Developing creative digital skills (not just digital skills) in line with research suggesting digital employers increasingly want individuals with a mix of technology and creative skills.

In summary, the open policy lab concluded that 'interventions will be required across the digital skills landscape' (Government Office for Science, 2017, p. 12). If such interventions are to achieve the needed improvements in the skill framework, there will need to be much collaboration across the various organisations involved on both sides: supplying skills and employing them. This key finding fed into the more general analyses of the foresight project.

Source: Government Office for Science. 2017

5.3.3. **Roadmapping**

As with many other terms in foresight, roadmap can have various meanings in different contexts. In some projects, the general framework, developed based on discussions on pursuing a set of policy goals, is called a roadmap (Box 9). Most foresight outcomes referred to as roadmaps do not systematically deploy the methodology of this foresight technique.

Box 9. **The European roadmap**

The European roadmap, produced by the Straighten basic skills (SBS) project, aims at increasing 'participation in the public consultation on questions related to the strengthening of work-related basic skills, and the training participation of low-qualified employees and unemployed in adult education' (SBS, 2017, p. 1). It documents the implementation of basic skills education in European countries and outlines 'key factors of social, economic and cultural elements which contribute to the success of work-related basic skills provision' (SBS, 2017, p. 1). These are framed in terms of success indicators, generated by desk research and discussions in a practitioner workshop. The European roadmap is a general framework, which can be used to shape more detailed national roadmaps.

Source: SBS, 2017.

Roadmapping is best known though its application in developing technology or policy roadmaps. It begins with a core objective, typically a statement that a given state of affairs will be achieved by a certain date. Roadmapping looks into how actions could be sequenced. Different layers, referring to different types of action or actors, are used to structure the analysis. For instance, in the case of technology roadmapping, layers can refer to research and development, the regulatory framework, consumer markets or user applications and skills requirements.

The outcomes of different actions (for example development of technological capabilities, establishment of regulatory or other standards, take-off of markets) are related and some are dependent on others. A roadmap diagram visualises these actions and outcomes as they evolve over time across layers. A roadmap may reveal that objectives are insufficiently or overly ambitious, in terms of how progress or impact is to be achieved at a given point in the future.

In practice, a range of approaches can be used to develop roadmaps. Some are produced by small expert groups. Others take a wider approach or are informed by the results of Delphi surveys, which can help in assessing when various developments are expected to occur and when they are likely to become mainstreamed. Participatory approaches, such as workshops, are particularly useful because they bring together expertise and knowledge relevant to different action layers.

Several tools, including computer-aided and pen-and-paper ones, are available for roadmapping exercises, to support understanding of the interdependencies in complex systems. As a fully fledged roadmapping exercise is laborious and time-demanding, in practice many roadmaps are developed using abridged versions of the approach.

Using the success scenario technique, which involves setting a stretch target for the topic at hand, is a pragmatic solution. This technique considers the actions needed to achieve the target and the success indicators implied in different fields or across different (groups of) stakeholders ([24]).

Employment and skills can be incorporated into technology roadmaps, with possible layers reflecting training provision and uptake and skills utilisation in different roles and phases of the technology cycle. Most technology or industry roadmaps tend to be produced independently at first,

([24]) Such an approach has been used, for example, in a workshop used to develop a strategic appraisal of the UK's potential in nanotechnology. See Advisory Group on Nanotechnology, 2002.

with a subsequent focus on the implications of technological drivers for skill supply and demand ([25]).

5.3.4. Choosing among actions

At the end of a workshop, there may be many great ideas or relatively few. These may include creative proposals for actions to be undertaken, risks to be aware of, topics to be further investigated or issues to reflect in education and training curricula. It is unlikely that all ideas have similar importance. The target audience is also likely to have limited attention and absorption capacity. While it is desirable to present a wide range of creative ideas, many decision-makers will not react positively to a long list of possible options ([26]).

A key problem with using simple voting or polling (see also Chapter 4) is that what is put on the ballot may vary in terms of quality. A broader formulation will often gather more support than a narrower one. Before engaging in a voting exercise, it is crucial to review formulations carefully, to eliminate redundancies and repetitions, reduce ambiguities, and, as far as possible, achieve similar levels of abstraction across topics, issues and trends.

It can be challenging to define the categories to be used to indicate choices. One common approach is to contrast ideas in terms of few summary criteria (drawing upon several sub-criteria). In practice, workshop participants are often asked to cast judgement using two or three categories (for example yes/no, small/moderate/large, or negative/neutral/positive). More detailed judgements may be collected by using rating scales; this tends to be complicated in workshop settings, unless IT-based solutions can be used.

Criteria typically used in collecting information aimed at understanding how stakeholders view particular issues or ideas include:

(a) impact on one or more objectives or issues of concern;
(b) feasibility of, or costs associated with, activities;
(c) originality or novelty of ideas.

Figure 3 illustrates how such criteria can be used in practice. In a foresight exercise on challenges in higher education, participants were requested

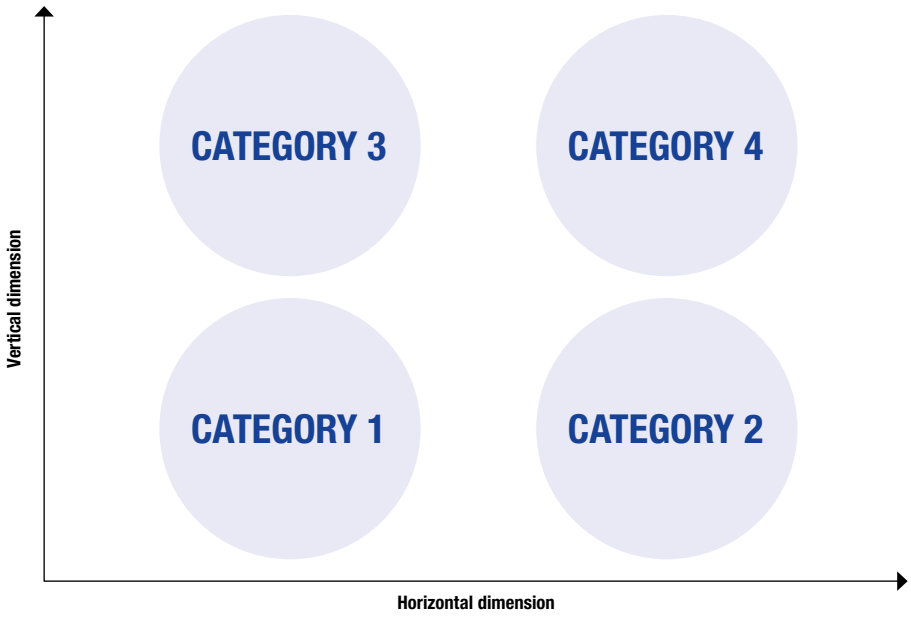
([25]) An example includes the work around transition to more sustainable and low-carbon energy production and use in Europe (*Energy roadmap 2050*) and a number of major European countries.

([26]) It is not unknown for senior decision-makers who are wrapping up workshops to request that participants tell them what they consider to be the one outstanding action point to emerge from the workshop.

to place options in the appropriate cell of the 2x2 matrix based on two criteria. The vertical dimension was for ease of implementation of the idea (lower=easy, upper=difficult), and the horizontal dimension for originality (left=quite normal, right=original). This produced four categories:

(a) Category 1 – ideas to be discarded as both unoriginal and unfeasible;
(b) Category 2 – ideas for the future, dreams, challenges, stimulation for the brain;
(c) Category 3 – ideas that are easy to implement, low risk, high acceptability, done before;
(d) Category 4 – ideas that are innovative, breakthrough, exciting, can be implemented ([27]).

Figure 3. **Choice matrix**



Source: Cedefop.

([27]) Inspired by 27 creativity and innovation tools in one-pagers, p. 24.

Box 10. **Higher education example using a choice matrix**

In a foresight exercise dealing with new challenges and new courses in a higher education context, some of the activities classified in different categories included:
Category 2: training of ambassadors among graduates; strategic development of partnerships and pilot programmes; and investment in facilities that adequately reflect the determination and quality of the organisation.
Category 3: examining experience in overseas institutions facing this challenge; provision and targeting of scholarships; and reduction of internal barriers to multidisciplinary work.
Category 4: bringing in high-profile individuals to give lectures and lead events; enhancing student support to increase retention; organising institution-wide foresight events addressing the topics, ensuring participation of senior leadership.

Source: Unpublished 2015 study, conducted for a UK university.

Another way to use such a matrix in policy and business contexts is for the horizontal dimension to represent impact (usually in terms of economic benefits, but it is also possible to use 'share of the workforce affected' as impact criterion) and the vertical dimension feasibility or cost of the activity.

In this case the four categories can be characterised as follows:

(a) Category 1 - ideas here are less attractive, with low potential to achieve them, and low impacts. However, these may be areas to monitor: for instance, technologies might improve and applications proliferate, they might become easier to use or more worthy of skill development investments;
(b) Category 2 - ideas here are of high interest and may be regarded as 'low-hanging fruit', where obvious benefits may result relatively rapidly. Implementation could begin immediately;
(c) Category 3 - ideas here are fairly low-risk and could have benefits in specific areas, even if overall impacts may appear limited;
(d) Category 4 - these are areas where most effort may be needed to achieve wide and long-term impacts; they will typically require considerable investment and planning.

Such a matrix approximates the prioritisation criteria typically employed in critical technologies approaches, and it is possible to build assessments of different dimensions of feasibility/cost and impact/benefits into a multiple

criteria analysis framework (Section 5.3.5). Examples of such application to various topics, including those concerned with training, education and skills, are numerous and useful for inspiring new foresight initiatives ([28]).

5.3.5. **Multiple criteria analysis**

Multiple criteria analysis (MCA) is a more elaborate way of considering alternative ideas. It looks at fewer ideas but in much more detail and using more criteria to inform decision-making. Like many other judgemental techniques, MCA can be used with individual stakeholders or be part of Delphi or other survey studies. It can also be embedded in workshops, particularly where there are not too many issues or criteria to be employed, and when groups can share the work. The face-to-face discussions in workshops ease insight into what underpins judgements, which can help clarify what is being appraised or assess the evidence on which opinions are based. The technique is simple and involves assessing a set of actions or development paths in terms of set criteria.

The criteria are often outcomes of interest, such as creation/reduction of employment, in particular occupations or industries, increased/decreased demand for particular skills or any other policy- or business-relevant topic. Typically, the options are assessed in using rating scales for the criteria. The different criteria may be weighted, so that overall scores can be obtained, and particular options prioritised based on, for instance, economic or environmental or social welfare benefits/costs.

Apart from the simpler approach of simply averaging responses collected in workshops, it is also possible to ask groups to decide how to reflect different outcomes and the weights of different criteria. Findings based on responses of larger expert groups, obtained via surveys and interviews, may be more convincing for audiences than those based on few responses gathered in small group discussions. This does not mean such discussions are not valuable in a broader sense. Small group discussion, using the systematic approach MCA offers, stimulates profound learning and reflection.

([28]) Examples at:
(a) https://hbr.org/2017/09/a-2x2-matrix-to-help-you-prioritize-the-skills-to-learn-right-now
(b) https://www.bu.edu/tech/about/service/incident-management/managing-tickets/priority-matrix/

Box 11. **Multiple criteria analysis in the FISTERA project**

MCA was used to build a priority matrix in a scenario workshop undertaken in the context of the FISTERA project. Participants assessed feasibility in terms of what was dubbed the PREST framework (political feasibility, resources (economic feasibility), ethical constraints and values, sustainability and technological feasibility). The impacts examined were sustainability/environmental quality, social cohesion, job creation, economic growth/wealth creation; competitiveness and innovativeness, employer-employee relations and work-life balance ([29]). Small break-out groups provided their ratings using an IT platform.

Among actions rated high in terms of feasibility and positive outcomes were (Green et al., 2005):

- EU to sponsor education of end users in security policies for user empowerment (to control the process) at EU level to balance security and privacy, and to educate users about regulations, and to generate competence in the communities' public debate, awareness raising, ethical curriculum to educate young people.
- Training for information society technologies at all levels in society, including SME development, with educational programmes at all levels including universities. This includes lifelong learning for pleasure and for the workforce.

These were among the least well-formulated proposals. Most others (for instance, use of information technologies in the public sector and the push for various standards) were more concisely formulated. These examples illustrate a limitation of prioritisation approaches. Although all proposals were the product of lively discussions and concrete ideas, activities proposed may well vary considerably in terms of their breadth. Broad activity may attract a great deal of support, while something more specific attracts little. While feasibility assessments should moderate this effect, it may be difficult to assess feasibility of broad formulations because they are imprecise. Therefore, it is good practice to remain critical and aware of methodological limitations when presented with a priority list.

Source: Green et al., 2005.

([29]) The same goals had been used to contrast different scenarios and Lisbon agenda goals (job creation, wealth creation, competitiveness, social cohesion, environmental quality, and social inclusion) in a Delphi survey concerning impacts of various applications of ICT (Popper and Miles, 2005).

5.4. Putting foresight findings in practice

5.4.1. Consensus building

After crafting an action plan or policy roadmap, a final and crucial stage of the foresight process is reaching consensus among key stakeholders on the best way to proceed with implementation. The success of consensus building critically depends on a range of factors and conditions (Table 10).

Table 10. **Success factors in consensus building exercises**

Establishing a common goal	It is vital to begin the process by stating what the goal is for each participant and try jointly to define the common goal.
Commitment to reaching consensus	Reaching consensus is a time- and energy-consuming process and requires commitment. Participants must be honest about their positions and actively listen to the opinions of others. They should be open to slightly shifting their positions if needed and expect others to do the same.
Trust and openness	Participants need to trust each other and know they are working towards a common goal. No participant should try to manipulate the process for own gains. This requires openness so that all participants have an honest and holistic understanding of their respective wants and needs.
Sufficient time	Participants should allocate enough time for taking part. This avoids having to revisit decisions made in earlier stages later in the process.
Clarity about process and methodology	It is important that all participants understand the process and the methodology used.
Active participation	All participants should listen to others, participate actively in the discussion and voice their concerns and thoughts whenever relevant.
Good facilitation	Where there is a large group, a facilitator should be appointed to guide the process and make sure its goals are met.

Source: Cedefop

In small groups (up to 15-20 people), consensus can be achieved with all members coming together and discussing different opinions and viewpoints. When people cannot meet physically, or cannot complete the discussion because of time restrictions, a Delphi-type consensus building method incorporating feedback loops in several sequential rounds may be used ([30]) (Section 3.2.2). The typical steps involved are illustrated in Figure 4.

([30]) Hsu and Sandford (2007) generally suggest that a minimum of 45 days will be needed. Moreover, they recommend giving subjects around two weeks to answer the questionnaires.

5.4.2. Communicating foresight findings with impact

Communicating foresight findings effectively goes far beyond simply presenting information. It also involves awareness raising among stakeholders and wider audiences: participants should transmit the main messages of the activities to their own constituencies and organisations. Efficient dissemination of results can take the form of releasing publications via conventional publication outlets or online media.

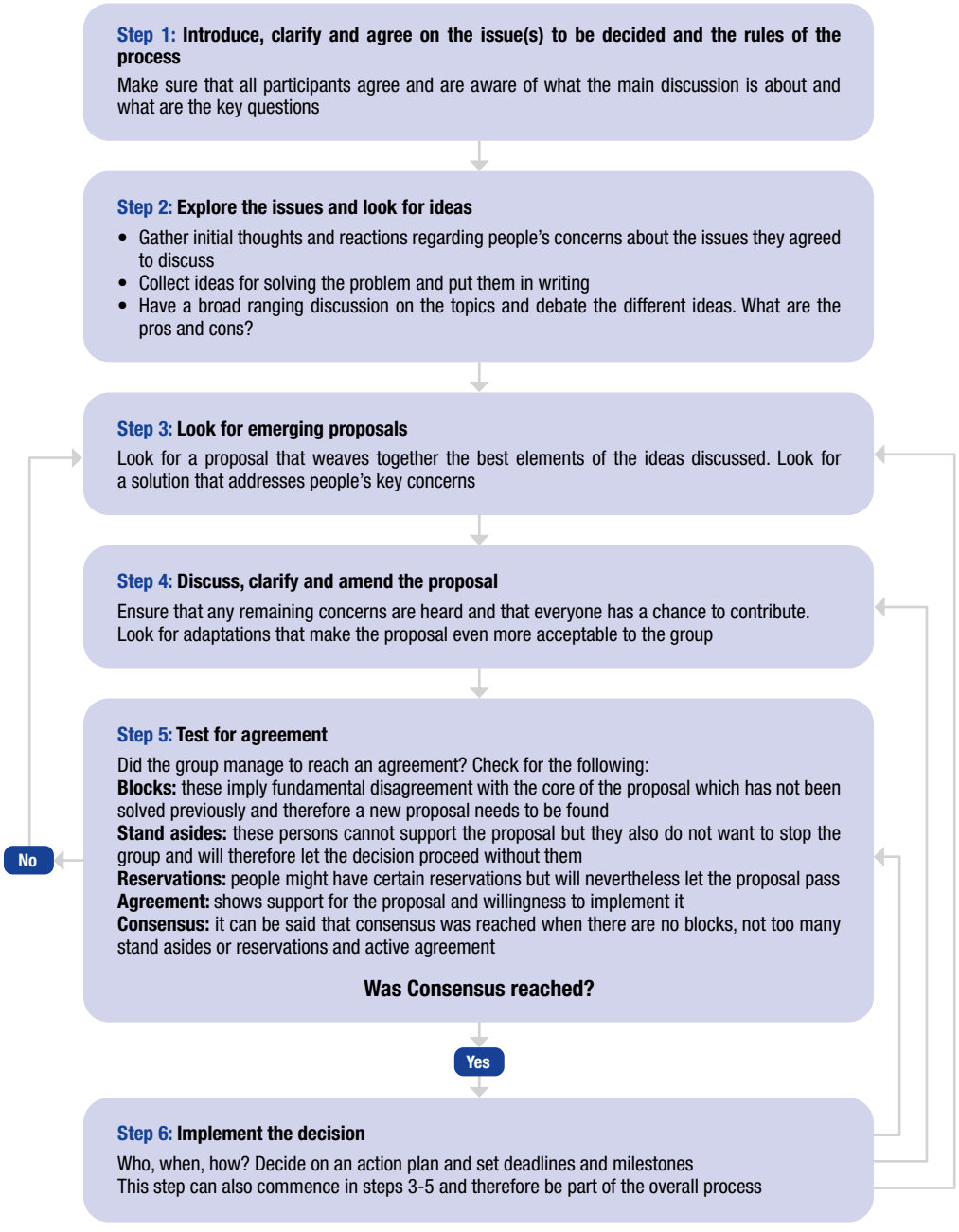
To promote or disseminate findings further, foresight participants can be encouraged to take part in, or even organise, public meetings and/or more specialised workshops and conferences. Foresight may also engage a wider set of intermediaries, such as trade unions, industry associations, education specialists and opinion shapers to help promote key messages. Although such wider outreach may happen spontaneously later during a foresight exercise, it is better to plan it at an early stage.

Quality of presentation, lucidity, accuracy of accounts and conciseness of texts drive the effectiveness of foresight documentation. Knowledge of target audiences is also critical. Offering opportunities for feedback, valuing it and using it whenever possible builds trust and contributes to creating a positive image of the exercise. Cooperating with professional publication/marketing professionals is beneficial.

Packaging several actions into a coherent set – a demonstrator – is one way of avoiding a lengthy list of actions and helps organisations and decision-makers move forward. Demonstrators also support evaluation of the proposed actions and can be a basis to pilot or stepwise implement them.

From a wider perspective, evaluating foresight exercises is important for understanding organisational or economic impacts. It is good practice to draw on participants and end users' feedback, especially in terms of what they have learned from the process, and how it contributed to establishing new networks and relationships. The insights on altered perceptions and practices they offer, and their continued support after foresight has been completed (for example monitoring the take-up or implementation of actions plans), are valuable. An important achievement of every well-conducted foresight exercise is its contribution to fostering a foresight culture. A context where communities and decision-makers are aware of the benefits of foresight will help ensure it is used whenever economies or societies can benefit from the insight it offers.

Figure 4. **Consensus building process**



CHAPTER 6.

Choosing a method

This third Cedefop guide on methods for identifying technological change and its impact on skill requirements has looked at the value of technology and skills foresight approaches. Four important points need to be borne in mind when considering foresight analysis in the wider context of skills anticipation methods.

First, while skills foresight integrates purely quantitative approaches to skills anticipation, it is fundamentally different from them. A long-term labour market forecast can be conducted by an expert group with little recourse to participatory methods. In contrast, it is rare to engage in participatory foresight without some use of information stemming from non-participatory skills anticipation methods. Anyone engaging in future analysis will implicitly draw upon earlier studies, materials and discussions.

Second, a wide spectrum of tools and techniques can be used in either participatory or non-participatory settings. At one extreme are exercises with low levels of participatory engagement, such as those relying on a small stakeholder or expert group. At the other extreme, skills anticipation approaches involve large numbers of people representing a wide range of stakeholders.

Third, foresight is a process, and different steps in the process may be organised in more or less participatory ways. In the entire process, and at the level of the steps it includes, the purpose determines which particular techniques can be successfully applied. Sometimes a foresight exercise includes components that are best shaped using non-participatory methods; it is important to share these with foresight participants.

It is important to be aware of the fact that many assumptions that are routinely made in standard non-participatory quantitative approaches are not appropriate where it comes to dealing with technological change and social innovation. Such phenomena disrupt (supposed) equilibria, introduce new variables and are usually only reflected by crude proxies in standard analyses. Reliance on just one type of expertise runs the risk of unjustly reflecting the narrow assumptions of that expertise into the entire process. This is a key argument for encouraging broader participation and multidisciplinary work.

Fourth, the question of who participates in foresight is a central one. One major reason for relying on participatory methods is to access knowledge from a broad range of expertise and to shed light on the motivations and capabilities of various stakeholders. These experts and stakeholders may be important actors for disseminating the results of foresight exercises. In many cases, they can also help implement the recommendations in their own organisations or communities of practice.

When considering foresight analysis, the checklist presented in Table 11 can be used.

Conventional skills forecasts and surveys (see first Cedefop guide, 2021a) and big data and artificial intelligence analysis (see second Cedefop guide, 2021b) are a rich source of information on technological changes and skill demands in labour markets. Information developed, based on these skills anticipation techniques, complements technology and skills foresight methods, which tend to address policy-relevant questions with a longer-term horizon. By engaging with key stakeholders, the process of technology foresight offers opportunities to reflect critically on findings based on non-participatory approaches. There is potential to arrive at novel insights about how the future will unfold and how policies and actions need to develop to build on positive features, while addressing unwanted negative effects. Such methods give those with a responsibility for skills governance or intelligence the tools that help them match future skills supply and demand in ways that benefit society.

Qualitative participatory and quantitative non-participatory methods are not mutually exclusive. Ideally, they should support one another so that they can potentially shape an iterative process whereby stakeholder engagement can ease data collection and analyses in the non-participatory stages (and vice versa). Such interaction makes it possible to develop views on how the future will unfold and in what direction skills policies and actions need to develop. In many respects the challenge is to make effective use of the wide variety of data and information available.

Table 12 provides a summary to guide policy-makers and analysts in understanding when to use the approaches covered by Cedefop's skills anticipation practical guides. To learn more about conventional labour market and skills anticipation approaches (skills surveys, skills forecasting) and big data and AI-based methods, readers are referred to the other two Cedefop 'how-to' guides.

Table 11. **Issues to consider before undertaking technology/skills foresight analysis: a checklist**

Checklist	Issues and questions to be considered
Initial check	• Determine why a participatory foresight type approach is required. Is there a lack of consensus on the impact of technologies on skills, or a high unknown factor that needs to bring together various groups?
Types of question that can be addressed regarding technologies	• What dominant technologies are likely to emerge in the medium term, either in the economy or in a particular sector or locality?
Types of question that can be addressed about skills	• What are the skill needs that are likely to be linked to the various technologies of interest? • Does this involve skills transversally required in many jobs/ occupations/sectors or skills required in niches which are critically important? • What skills may no longer be needed to the same extent in the future? • What needs to be in place for skills supply to keep up with demand?
Requirements	• Background information that can be used to inform the foresight process • Willingness of groups to work together to find solutions
Foresight steps	• Deciding on participation: who should be involved and why • Initiation: scoping exercise, determining main foci, intended uses and users • Intelligence: literature review, horizon scanning, trend analysis • Imagination: establishing understanding of linkages between issues and using creativity to explore implications • Integration: development and appraisal of possible futures • Interpretation: identification of strategies and prioritisation of actions • Intervention: discussion of proposed strategies, priorities, and next steps with key actors. Establishing roadmaps and implementation plans • Impact: evaluation of impact of foresight, identification of follow-up activities
Selected further information	• ETF; Cedefop; ILO. *Developing skills foresights, scenarios and forecasts. Guide to anticipating and matching skills and jobs: volume 2*. Luxembourg: Publications Office. • Miles, I. (2010), The development of technology foresight: a review. *Technological Forecasting and Social Change*, Vol. 77, No 9, pp. 1448-56. • Miles, I., Keenan, M.; Kaivo-Oja, J. (2003). *Handbook of knowledge society foresight.* Dublin: European Foundation. • Miles, I.; Saritas, O.; Sokolov, A. (2017). *Foresight for science, technology and innovation*. Berlin: Springer.

Source: Cedefop.

Table 12. **A menu of skills assessment and anticipation choices**

Type of approach	When to use	Capacity to predict the future	Timeliness
Quantitative, non-participatory approaches			
Surveys and other primary data collections	When there is a relatively well-developed understanding of the technologies and associated skills of interest. Surveys will tend to provide information on the extent of use of skills and technologies, extent to which skills are available, efforts taken to fulfil skill needs, etc.	Tend to be good at collecting information about recent past and impending changes. Not well suited to anticipating future technological changes and future skill needs.	Can be time-consuming to undertake – design of questionnaires, conducting fieldwork, cleaning data, producing findings.
Skills forecasting	Where time series data are available on skill needs (based on qualification and occupation), and where there is an underlying macroeconomic model that can provide robust estimates of future employment demand by sector, skills forecasts can provide a robust means of providing quantitative projections of future skill demand (circa 10 years ahead).	Skills forecasting models tend to provide a projection of future demand, based on an extrapolation of past trends and/or current policy. The assumption is that the future is based on a continuation of things as they are currently. Scenarios provide some basis for varying this to some extent, to account for continual technological change.	If the model already exists, analysis can be undertaken over a relatively short space of time. But setting up the initial model and ensuring regular updates of the results can be time-consuming and resource-intensive.
Big data analysis	Particularly useful where views about the future may not be well developed: where there is uncertainty about either the types of technology that are likely to become dominant or commonplace, and/or the skills associated with those technologies. Can also provide the detailed level of analysis that forecasting and surveys struggle to provide.	Can provide relatively real-time information on technological change and skill needs. By identifying those technologies that are at the point of take-off, there is scope to gauge likely future skill needs. There are uncertainties about how representative data are of a given population and about how much 'noise' can be removed from any analysis or their inability to provide standardised information on skills complexity.	Can be time-consuming to develop initial search algorithms but, once established, can be undertaken in a relatively fast manner. It needs to be borne in mind that coding/classifying of technology and skills data can be time-consuming. Maintenance and operational costs are also non-trivial.

Type of approach	When to use	Capacity to predict the future	Timeliness
Participatory approaches			
Technology foresight	Where there is a large amount of information that needs synthesising to develop actions to ensure that skills needs associated with particular technologies can be met. Where there is limited data and information and where expert groups can address the lack of information.	Can provide a view of the future and, importantly, an indication of how the future might be shaped for the benefit of society as a whole. Is dependent upon the availability of expert groups who can provide key input and a process in place to develop a degree of consensus about the future direction of change.	Depends upon the scale of the exercise. Full-scale foresight involving a large number of participants is likely to prove time-consuming. But it is possible, and at times advisable, to conduct foresight with smaller groups over a relatively short-time span.

Source: Cedefop.

Acronyms

AI	artificial intelligence
Cedefop	European Centre for the Development of Vocational Training
CEPIS	Council of European Professional Informatics Societies
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EU	European Union
FGB	Fondazione Giacomo Brodolini
ICT	information and communications technology
IT	information technology
LMSI	labour market and skills intelligence
MCA	multiple criteria analysis
Q&A	questions and answers
R&D	research and development
SBS	Straighten basic skills
SME	small and medium-sized enterprise
STEEPV	social, technological, economic, environmental, political and values
STEM	science, technology, engineering, mathematics
STI	science, technology and innovation
SWOT	strengths, weaknesses, opportunities and threats
VET	vocational education and training

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EN

Understanding technological change and skill needs

Technology and skills foresight

The world of work is being impacted by a fourth industrial revolution, transformed by artificial intelligence and other emerging technologies. With forecasts suggesting large shares of workers, displaced by automation, in need of upskilling/reskilling, the design of active skills policies is necessary.

Conventional methods used to anticipate technological change and changing skill needs, such as skill surveys and forecasting, have limited scope to provide insights into emerging trends. With the increasing use of big data and AI methods, analysts have new real-time tools at their disposal. Skill foresight techniques are also increasingly used to gauge in-depth stakeholder information about future technologies and skill needs.

A series of Cedefop guides aims to inform analysts and policy-makers about available skills anticipation methods used to navigate through the uncertainty of changing technologies and skill demands. This third practical guide focuses on technology and skill foresight methods.

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