

Roadmapping Congestion?

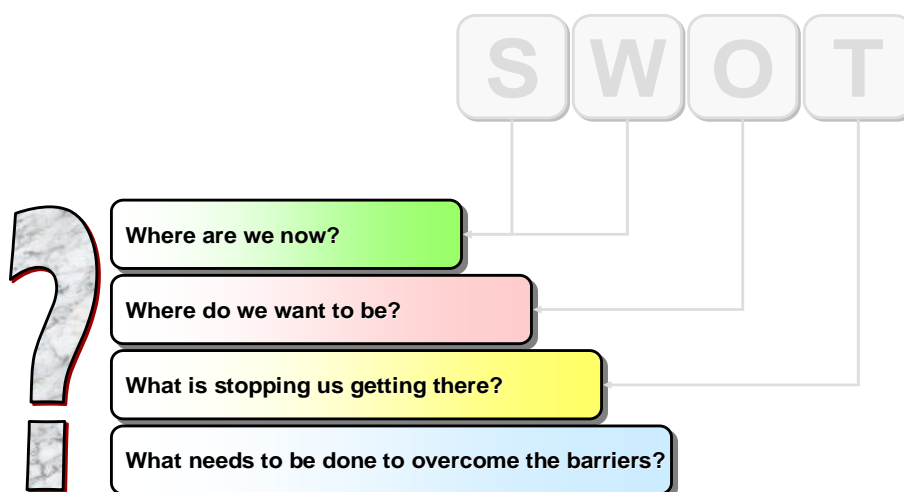
Hardly a month goes by without another materials technology roadmap being issued, but few materials scientists are even aware that they exist, despite them being freely available.

For those who have not come across technology roadmapping, it is a step further on from a Foresight exercise. The Foresight process gave a vision of what was needed in the future, generally up to 20 years ahead, but it did not provide a clear route of how to get there. Roadmapping is aimed at filling that gap. In essence, it is similar to a business plan that a company or university might draw up and adopt.

Some roadmaps have used a Delphi approach with questionnaires being sent out to experts in the particular field, but a better approach has been found by getting the experts together in the same room. The experts need to be taken from all parts of the company, research and development, marketing, production, and of course it helps to have the CEO's endorsement. In addition, an academic input is essential nowadays to any company's technology roadmap. The roadmapping process can also be useful for academic departments to help them focus on where future funding is likely to be placed.

The pressures on industrialists and academics means that their time is precious, and they want something that is relatively fast and effective. You only have to look at 'time-to-market' for new products to realise that product life times have been cut dramatically in the last decade. Therefore a roadmap should not be too time consuming for the participants and should have its actions progressed as quickly as possible.

It has been found that the best way to obtain a roadmap is to have a group of around 20 to 30 experts together for a day and take them through the roadmapping procedure, using the following steps:



The first step is to have a view of *'Where are we now?'*. A starting point for this step is to review what might already be available in other roadmaps or strategy documents, or have a couple of the experts speak about their perception of the situation. The experts are then separated into groups and are asked to give their thoughts on, for example, the following points:

- Who are our present customers?
- What are the current trends?
- What are the main drivers?
- What is the competition up to?
- What is the UK really good at? – what are our niche areas?
- Who are present leaders in the field?
- Do we have the right skills?
- Is capital investment sufficient?

Each point is captured on a large hexagon 'Post-it', which is colour coded for each step. These are then clustered by the facilitator into honeycombs of comments and ideas, often under the topics given above. For those familiar with SWOT analyses (Strengths, Weaknesses, Opportunities, and Threats) as a business tool, this stage can provide a table of strengths and weaknesses.

The second step is then to have the groups suggest *'Where do we want to be?'* which is similar to a Foresight exercise. Typical questions posed are:

- What is our vision for the future?
- What should we be doing to maximise benefit for the UK?
- Are we doing something now that we should put more effort into?
- Are we doing something currently that we should drop?
- What technologies are going to make a real impact on our activities?
- What new areas should we be working in?
- Are there opportunities for creating spin-out companies?

Again the facilitator clusters each of the thoughts. This stage gives the 'Opportunities' of a SWOT analysis. To obtain a consensus of views, each participant is given a number of sticky dots to place on the hexagons that they see as being a priority for them. It soon becomes clear what the main issues are.

The third step is *'What is stopping us getting there?'* and the expert groups are asked to look at the barriers to progress. Prompts for this stage might be:

- Do we have the skilled people we need?
- What are the gaps in our technology?
- Is funding likely to be adequate?
- Do we have the necessary infrastructure?

There might be a particular problem that is holding up a particular technology that needs solving before progress can be made. Again 'priority dots' are used to arrive at a consensus. There is little new in business practices – this is the 'Threats' part of a SWOT analysis!

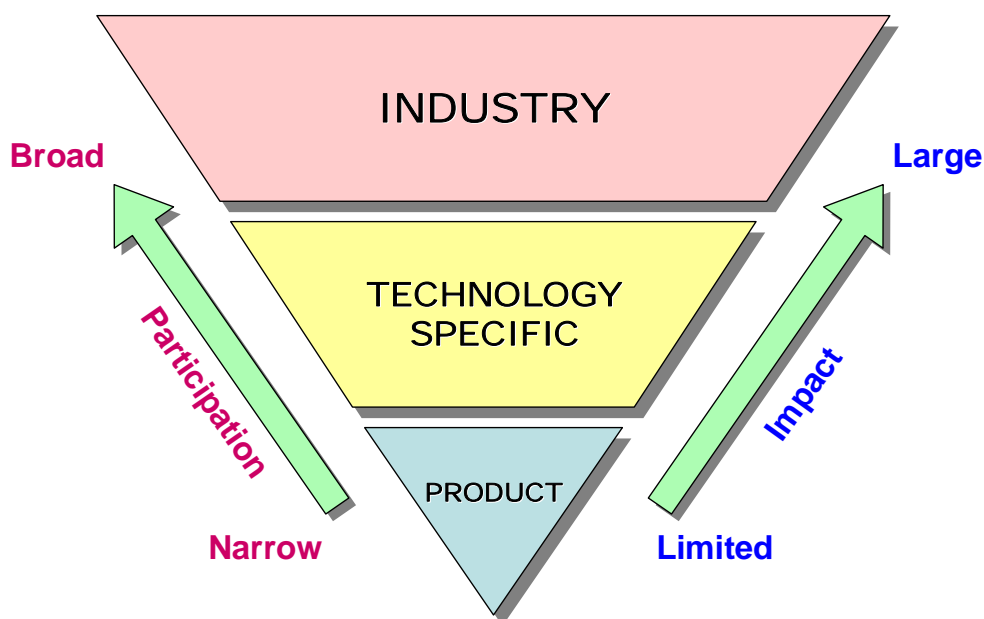
The final step of *'What needs to be done to overcome the barriers?'* lists and puts priorities on the actions forthcoming from the exercise. It has been a waste of time if the actions are not progressed and once the roadmap is written up it is essential that it is exposed to a wider audience, via the web, to have their views and comments. This is really only the first phase since a roadmap should be a living document that is regularly updated, because of the rapidly changing technical and market situation at present.

In 2003 the Foresight Materials Panel identified about 20 roadmaps in chemistry and materials, but today there are over 70 that are freely available in different areas of materials. These are tabled under the following headings:

- General
- Industry / market specific
- Materials specific
- Nanotechnology specific
- Miscellaneous.

There tends to be three different sorts of roadmap, the broad industry ones which involve a large number of people; technology specific ones which are more focused and involve fewer people; and finally those specific for a particular product. The product roadmaps are usually for a particular company, and could be for a new underarm deodorant or a new breakfast cereal. They are usually not given away free, as the others are, since they are proprietary to the company.

TYPES OF ROADMAPS



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April 2007



As might be expected there is an increasing number of roadmaps in different aspects of nanotechnology. The UK ones are led by the MNT Network which has been established by the Department of Trade and Industry to co-ordinate the varied UK activities in nanotechnology. A good example of the roadmapping process is the one for micro and nanotechnology in metrology. The above procedure was used to provide a draft roadmap which was refined by posting it on the web. The MNT Network set up a Focus Group, now known as the MNT Measurement Club, which is run by the National Physical Laboratory. The launch of the Focus Group was attended by 150 interested parties and since then they have carried out many of the actions of the roadmap by holding well attended conferences. This has provided an excellent model for roadmaps in other fields, where the aim is to fill the gaps in the UK's knowledge base.

Another advantage is that it draws together large companies and SMEs with common interests and should enable them, especially the SMEs, to access future funding more easily. The European Framework Programme, FP7 starts in the autumn 2006, with strong emphasis on general innovation, and specifically on nanotechnology and materials.

Reports on societal and ethical issues of nanotechnology

Date	Title (source)	Reference
2003	Future technologies, today's choice – nanotechnology, artificial intelligence and robotics. (Greenpeace Environmental Trust)	http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/5886.pdf
2004	Nanoscience & nanotechnologies: opportunities & uncertainties (Royal Society & Royal Academy Of Engineering)	http://www.nanotec.org.uk/finalReport.htm
2004	Nanotechnology – small matter, many unknowns (Swiss Re)	http://www.swissre.com/INTERNET/pwsfilpr.nsf/vwFilebyIDKEYLu/ULUR-5YNGET/\$FILE/Publ04_Nanotech_en.pdf
2005	Nanotechnology: “small size – large impact” (Swiss Re)	http://www.swissre.com/Internet/pwswpspr.nsf/fmBookMarkFrameSet?ReadForm&BM=../vwAllbyIDKeyLu/mbui-6e7gdn?OpenDocument
2005	Response to Royal Society & Royal Academy Of Engineering (HM Government)	http://www.dti.gov.uk/files/file14873.pdf
2005	Informed perceptions of nanotechnology & trust in government (Woodrow Wilson International Centre For Scholars)	http://www.wilsoncenter.org/events/docs/macoubriereport.pdf
2005	Managing the effects of nanotechnology (Woodrow Wilson International Centre For Scholars)	http://www.pewtrusts.org/pdf/Effects_Nanotech_011106.pdf
2005	Opportunities & risks of nanotechnologies (OECD/Allianz)	http://www.oecd.org/dataoecd/4/38/35081968.pdf
2005	Charging into the valley of death? (O Cheema and S Kaushal, criticalEYE.net)	Available through https://www.criticaleye.net/review/january06B.phtml?login=688fb97e1b85daa6b9e848d75e265573
2006	Nanotechnology: a research strategy for addressing risk (Woodrow Wilson International Centre For Scholars)	http://www.pewtrusts.org/pdf/nanotech_071906.pdf
2006	The ethics & politics of nanotechnology (UNESCO)	http://unesdoc.unesco.org/images/0014/001459/145951e.pdf
2006	Results of the informal collection of inputs for nanotechnology R&D in the field of (eco)toxicology (European Commission, Research DG)	ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/inputs_nanoecotox.pdf
2006	Nanotechnology: health & environmental risks in nanoparticles (Federal Environment Agency/BAuA/Bfr, Germany)	http://www.baua.de/nn_47716/sid_B0AA05CB8FF8141A55EAC94DDDFCC809/nsc_true/de/Themen-von-A-Z/Gefahrstoffe/Nanotechnologie/pdf/draft-research-strategy.pdf
2006	Nanotechnology in agriculture and food production – anticipated applications (Woodrow Wilson International Centre For Scholars)	http://www.pewtrusts.com/pdf/Nanotech_agfood_090406.pdf
2006	Regulating the products of nanotechnology: does the FDA have the tools it needs? (Woodrow Wilson International Centre For Scholars)	Downloadable from http://www.nanotechproject.org/83

2006	Characterising the potential risks posed by engineered nanoparticles (HM Government)	http://www.nanoforum.org/dateien/temp/Characterising%20the%20potential%20risks%20posed%20by%20engineerednanoparticles%20-%20Government%20research%20report.pdf?05122005182041
2006	Review of safety practices in the nanotechnology industry (International Council On Nanotechnology, ICON)	http://cohesion.rice.edu/CentersAndInst/ICON/emplibary/Phase%20I%20Report_UCSB_ICON%20Final.pdf
2006	Report on nanosciences & nanotechnologies: an action plan for Europe 2005-2009 (European Parliament)	http://www.europarl.europa.eu/sides/getDoc.do?language=EN&pubRef=-//EP//NONSGML+REPORT+A6-2006-0216+0+DOC+PDF+V0//EN

Reports on the benefits of nanotechnology

Date	Title (source)	Reference
2005	Nanotechnology and the poor – opportunities and risks (Meridian Institute)	http://www.meridian-nano.org/gdnp/NanoandPoor.pdf
2005	Nanotechnology and the developing world (PLoS Medicine)	http://medicine.plosjournals.org/archive/1549-1676/2/5/pdf/10.1371_journal.pmed.0020097-L.pdf
2005	Big picture on nanoscience (for schools) (Wellcome Trust)	http://www.wellcome.ac.uk/assets/wtd015798.pdf
2006	Nanotechnology – does it have a sporting chance? (IUPAC, Chemistry International)	http://www.iupac.org/publications/ci/2006/2801/2_smith.html
2006	Nanotechnology, water and development (Meridian Institute)	http://www.merid.org/nano/waterpaper/NanoWaterPaperFinal.pdf
2006	Nanotech – the way forward for clean water? (Filtration & Separation, Elsevier, October 2006)	Available on subscription through http://www.filtsep.com
2006	Water nano-based treatment technologies (Meridian Institute)	http://www.merid.org/nano/watertechpaper/watertechpaper.pdf
2006	Nanotechnology – lessons from Mother Nature (IUPAC, Chemistry International)	http://www.iupac.org/publications/ci/2006/2806/2806-pp10-11.pdf

General strategies and reports on nanotechnology

Date	Title (source)	Reference
1999	Opportunities for industry in the application of nanotechnology (Foresight Exercise, UK)	http://www.foresight.gov.uk/Previous_Rounds/Foresight_1999_2002/Materials/Reports
2003	Nanoscale science & engineering for agriculture and food systems (US Department Of Agriculture)	http://www.csrees.usda.gov/nea/technology/pdfs/nanoscale_10-30-03.pdf
2003	Socio-economic report on nanotechnology and smart materials for medical devices (nanoforum.org, European Nanotechnology Gateway, EU)	Available through http://www.nanoforum.org
2004	Towards a European strategy for nanotechnology (European Commission)	Available through http://www.cordis.lu/nanotechnology/actionplan.htm
2004	Outcome of the open consultation on the European strategy for nanotechnology (nanoforum.org, European Nanotechnology Gateway, EU)	Available through http://www.nanoforum.org
2004	Cancer nanotechnology plan (US Department Of Health & Human Services)	http://nano.cancer.gov/about_alliance/cancer_nanotechnology_plan.asp
2004	Germany's nanotechnology strategy (British Embassy, Berlin)	http://www.britischebotschaft.de/en/embassy/r&t/notes/rt-note04.1011_nanotechnology_strategy.htm
2004	Nanoelectronics at the centre of change (European Commission)	http://europa.eu.int/comm/research/industrial_technologies/pdf/nanoelectronics_june2004_en.pdf
2004	Towards a European strategy for nanotechnology (European Commission)	http://ec.europa.eu/research/industrial_technologies/pdf/nanotechnology_communication_en.pdf
2004	Microsystems & nanotechnology in healthcare & life sciences - market sector report (Technology For Industry Ltd)	http://www.tfi-ltd.co.uk/reports/index.htm
2005	Nanosciences & nanotechnologies: an action plan for Europe 2005-2009 (European Commission, EU)	http://ec.europa.eu/research/industrial_technologies/pdf/nano_action_plan_en.pdf
2005	Nanotechnologies for car interiors (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm
2005	Nanotechnologies for the oil and energy industry (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm
2005	Nanotechnologies for composites, surface coatings and sensors (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm
2005	Nanotechnologies for novel optical effects (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm

2005	Nanotechnologies for perfume encapsulation (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm
2005	New processes and applications in nanochemistry (Institute of Nanotechnology, UK)	Available through http://www.nano.org.uk/reports.htm
2005	Micro & nanotechnology in healthcare & life sciences market sector report (Technology For Industry Ltd)	May be purchased through http://www.tfi-ltd.co.uk
2005	A strategy for European standardization for nanotechnologies (CEN/BT/WG 166, EU)	Submitted to CEN/BT for approval
2006	Nanomedicine – nanotechnology for health (European Commission)	ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nanomedicine_bat_en.pdf

Nanotechnology roadmaps

Date	Title (source)	Reference
2003	Chemical industry R&D roadmap for nanomaterials by design (Chemical Industry Vision 2020 Technology Partnership, US)	http://www.chemicalvision2020.org/pdfs/nano_roadmap.pdf
2004	Senscope - strategic scoping study on the convergence of enabling technologies: microsystems, nanotechnology & sensors (Intersect Faraday Partnership)	Available through http://www.google.com/search?hl=en&ie=ISO-8859-1&q=senscope&btnG=Google+Search
2004	MNT Network roadmap in metrology (MNT Network, UK)	Access through http://www.mntforum.com
2004	MNT Network roadmap in integration (MNT Network, UK)	Access through http://www.mntforum.com
2004	MNT Network roadmap in silicon (MNT Network, UK)	Access through http://www.mntforum.com
2005	International MEMS/MST and nano roadmap (MANCEF)	Available through MANCEF at http://www.mancef.org/roadmap.htm
2005	Roadmap reports: materials - nanoporous materials; nanoparticles/nanocomposites; dendrimers; thin films & coating (NRM, FP6 Nanoroadmap project, EU)	http://www.nanoroadmap.it
2005	Roadmap reports: health and medical systems (NRM, FP6 Nanoroadmap project, EU)	http://www.nanoroadmap.it
2005	Roadmap reports: energy (NRM, FP6 Nanoroadmap project, EU)	http://www.nanoroadmap.it
2005	Nanocomposites technology roadmap (Faraday Plastics and Hybridnet, UK)	http://www.faraday-plastics.com/freedIs/NanocompositesTRM170805.pdf?id=NanoTRM.doc
2005	MNT Network roadmap in design, simulation & modelling (MNT Network, UK)	Access through http://www.mntforum.com
2005	MNT Network roadmap in diagnostics (MNT Network, UK)	Access through http://www.mntforum.com
2005	MNT Network roadmap in gas sensors (MNT Network, UK)	Access through http://www.mntforum.com
2005	MNT Network roadmap in polymer manufacturing (MNT Network, UK)	Access through http://www.mntforum.com
2005	MNT Network roadmap in nanoparticle manufacture (MNT Network, UK)	Access through http://www.mntforum.com