
OAKDENE HOLLINS

Co-ordinator's Report
on the Sustainable
Technologies Initiative

for

Department for
Business, Enterprise and
Regulatory Reform

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Dedication

This report is respectfully dedicated to the memory of Dr Steve Mosley, Chairman of the Programme Management Committee of the Sustainable Technologies Initiative 2000-2006. He contributed his expertise and enthusiasm generously to the programme. Its smooth running and its contribution to UK business sustainability were substantially influenced by his work.

Executive Summary

The Sustainable Technologies Initiative allocated £10.6m of Government funding to collaborative R&D between 2000 and 2007. The programme involved three research councils and two government departments. It was a broadly based programme, but with some guidance on preferred areas of focus.

Outputs reported by most of the larger projects within the STI estimated substantial increases in sales (c. £100m) and decreases in costs (c. £20m) after five years, an overall economic impact that exceeds comparative UK programmes. Environmental impacts were relatively modest compared to estimates for these other programmes. Scientific quality of research sponsored by EPSRC was satisfactory, albeit reflecting the more applied nature of the research.

Dissemination, in addition to that at the individual project level, was carried out according to emergent themes within the project portfolio. These themes included zero emissions, biodegradable polymers, re-inventing traditional technologies, enhancing performance through surface modification, controlling coloration and preservation, decision support tools and design management. Some of these themes have been picked up by organisations for further funding; others have not, and require consideration.

The performance of the portfolio in output terms was skewed by the excellent performance of a few projects. This is in keeping with experience of previous programmes such as WMR3 and with expectations of the success rates of R&D projects through the different phases of development. Reflections of participants on the programme (albeit from a very limited sample) were generally positive as regards outcomes and processes, even when a direct commercial outcome had not resulted. The ROAME objectives set at the start of the programme were generally met or exceeded. Awareness of the programme appeared high and a substantial oversubscription of proposals was received in all calls for proposals.

A key area to be taken forward is to create new kinds of projects that link technological innovation to necessary social change to achieve sustainability goals; and how to utilise linkages with social science research, particularly work on innovation, environmental policy and transitions to sustainability.

Other issues arising from the programme were the need for better linkages to follow-on funding for demonstration and diffusion, the use of emergent themes within programmes, and proposals on how to better measure programme performance.

Summary of Recommendations

Section	Page	Recommendation
3.1.1	10	Gathering and submission of metrics information should be a contractual obligation of the consortium members.
3.1.2	12	Estimates from researchers should be moderated, perhaps by internal peer review by funding organisations (or their appointed contractors) to avoid over-optimistic estimates in particular and to check understanding of the metrics requirements.
3.1.2	12	Estimates of the consortia should be given as ranges (maximum and minimum) with confidence levels, rather than as a single estimate.
3.3.1	15	Identification of emergent themes within programme portfolios can be a useful tool for discerning trends and issues.
3.3.1	15	Programmes should consider dissemination along emergent themes rather than simply along prescriptive lines (e.g. by sector or by technology)
3.3.1	16	Funding bodies concerned with innovation and sustainability, particularly NESTA, should consider how the theme of re-inventing traditional technologies can be incorporated into future planning.
3.3.1	17	Forums and events to promote networking, dissemination, exploitation and reflection on competition themes should be encouraged and their effectiveness measured and monitored.
3.3.1	17	EPSRC and TSB consider funding a theme of enhancing sustainability performance through surface modification, and link to initiatives in the product design area (e.g. Design Council, Materials KTN).
3.3.1	17	EPSRC and TSB consider whether such a theme should be developed further in future funding competitions.
5.4	28	A clear briefing is required from the monitoring officer on roles, reporting and dissemination.

Section	Page	Recommendation
5.4	28	Monitoring officers and funders should insist upon and enforce early production of IPR agreements.
5.4	29	Funding for demonstration projects should be made available in all collaborative research programmes.
5.4	29	A higher level of risk may have to be accepted by government in the funding of small start up organisations.
5.4	29	Sustainability projects should be reviewed by officials to see how market deployment of projects with strong potential for sustainability gains can be encouraged.
5.4	30	A clear guide to reporting requirements should be supplied in the offer letter (this is also being addressed through more comprehensive briefing of applicants in the Technology Programme).
6.1	31	The TSB, EPSRC and ESRC consider how they might create projects that bring together social change and technological innovation, particularly focusing on actions subsequent to successful R&D projects.
6.2	32	The TSB should continue to fund competitions with explicit sustainability themes, and to continue to embed sustainability criteria in collaborative R&D funding.
6.3	33	The TSB should consider 'grand challenge' and other output-orientated programmes as being more helpful in the general business sustainability area than attempting to define the most appropriate technologies.
7.1	34	The Technology Programme should consider involving social scientists in the assessment of significance of project outcomes in its thematic areas, notably those orientated towards the goal of increased sustainability.
7.2	34	Sectoral scoping studies are not the route used in collaborative R&D programmes to stimulate projects that address industry needs.
7.3	35	The outcome data of importance to the programme is explicitly forecasted at the proposal stage. This estimate is refined during the project and forms part of the project monitoring process, eventually contributing to the programme evaluation.

Section	Page	Recommendation
7.5	37	The TSB should offer adequate demonstration funds for follow on funding for R&D projects.
7.5	37	Market deployment incentives (e.g. the Enhanced Capital Allowance Scheme) should regularly be updated to take account of new technologies being developed by programmes such as STI.
7.5	37	Support and supervision from the TSB should continue beyond the completion of the project to assist with the next stage of the project's commercialisation, if it is shown to have large potential for sustainability improvement.

1 Introduction

This report is the Co-ordinator's final summary of the Sustainable Technologies Initiative. Although not an independent third party evaluation of the programme, it does summarise outputs and activities of the programme, discusses key issues raised by the programme and attempts to evaluate the programme against other collaborative R&D initiatives and in the policy context of the years in which the programme was conceived and operated. Looking forward, the report makes recommendations for the future operation of sustainable technology R&D programmes, and on the areas that should be considered for further support under this theme.

Input to the evaluation was formed from:

- Project Completion Forms completed by the project teams at the end of their projects
- meetings with the project leaders at the end of their projects
- reflections at the end of the programme by business participants
- comments from the project monitoring team at TUV-NEL
- opinions of the programme Co-ordinator
- views of the PMC.

2 Background

2.1 History

The Sustainable Technologies Initiative (STI) was conceived by Environment Directorate DTI (ENV) as a broadly based collaborative R&D programme that addressed the need to build sustainability into the earliest parts of product and process development. It formed a progression from in-process and end of life recycling, which had been the focus of an earlier programme, the Waste Minimisation through Recycling, Re-use and Recovery in Industry (WMR3) programme, which was coming to an end in 1999.

In order to investigate the programme idea, two scoping studies were commissioned in 1999 and 2000 from AEA Technology and from Oakdene Hollins. The AEA study involved desk research and two workshops. It resulted in a list of possible themes of the study and a proposal for a number of collaborative research programmes, for example on sustainable manufacturing and on sustainable design. A second scoping study by Oakdene Hollins was a series of interviews with industrial and academic researchers to determine the capacity to deliver the programme(s) and the possible early projects that the programme might fund. 36 serious possible project proposals were identified and a satisfactory level of both demand and research capacity was identified to give confidence for launching the new programme(s). Ultimately it was decided to propose a single programme integrating sustainable design and sustainable manufacture, since the integration of sustainable design thinking into other disciplines was likely to be a key message of the programme.

An outline strategy for the STI was agreed by the IPC in 1999. This was modified by the results of the scoping work, and a ROAME was successfully agreed and the programme authorised during 2000. The IPC approved £10m of DTI funding for a LINK-type programme with EPSRC, and a parallel programme of collaborative research projects that did not require an academic partner.

In comparison with other European collaborative programmes in Sustainable Technologies, the programme was of medium size, larger than programmes in Austria, Sweden and Denmark (€8.1, €2.1 and €3.2m respectively) but much smaller than the German FONA programme on sustainable development (€102m for 100 projects up to March 2006).

2.2 Programme Funding

Discussions were held with potential funding stakeholders that included ESRC, Defra, EPSRC and BBSRC. EPSRC had indicated that they were interested in co-funding the programme, and made an initial commitment of £5m over the programme lifetime.

During 2000/2001 Defra and BBSRC were coming to the end of their funding commitment to the LINK programme "Competitive Industrial Materials from Non-Food Crops" (CIMNFC). Instead of continuing this programme, they opted to become a co-funder of the STI, provided that the use of non-food crops was a theme within the programme. Defra did fund a number of STI projects. However none was considered suitable for BBSRC funding. BBSRC has subsequently funded non-food crop projects in similar programmes, so there is no indication of a systemic difficulty in funding projects in this area.

ESRC was initially very interested in participating in the programme, with the idea that social science research might be integrated with some of the physical science research projects. This would give social science researchers access to industrial company contacts, which has always been difficult historically. Ultimately ESRC decided to fund its own discrete programme, the Sustainable Technologies Programme (STP), which ran in parallel with the STI. ESRC did in addition budget co-funding projects in STI, and had a representative from the STP panel on the STI programme management committee, as well as the STP Programme Director. The issues raised by this experience are discussed in more detail in Section 7.

2.3 Structure and Themes

After consultation and consideration of the various options, ENV decided to run the programme as a twice yearly competition, with set deadlines for submission, evaluation and determination of success. The projected lifetime of the programme was five years, with a total of ten competitions. A contract for co-ordination and monitoring was let by open tender to a consortium of TUV-NEL and Oakdene Hollins Ltd.

A programme management committee (PMC) was appointed, using contacts made during the scoping exercises, from suitable individuals known to ENV and the co-ordinators and also using contacts from the WMR3 programme previously run by ENV. Other members of the PMC were representatives of the funding bodies and the Director of the ESRC Sustainable Technologies Programme. The members of the PMC are given in Appendix 1.

Although “sustainable technologies” was conceived of as a broad theme, with the onus on proposers to justify the sustainability impact of their projects, encouragement was given to proposers to submit in certain areas, or sub-themes. Twelve possible sub-themes for the programme were identified in the scoping work, from which eight were selected by ENV and the PMC for the first competition, also taking account of STP panel input to the process.

Themes identified during scoping work:

- Replacement of organic solvents (driver: VOC Directive)
- Design for disassembly and recycling
- Ownership structures and environmental management responsibility
- Minimisation of embedded (intrinsic) energy in products
- Materials for efficient performance (e.g. gas turbines)
- Elimination of toxic compounds from structural and functional materials
- Minimisation of environmental releases to air/water/land
- Minimisation of equivalent carbon dioxide releases (directly or indirectly)
- Natural product alternatives to synthetic products (what is “natural”? – beware pesticide needs etc)
- Novel environmental beneficial alternatives to high carbon dioxide equivalent products
- Measurement of sustainability/identification of key parameters
- Zero release processes (environmental/H&S).

Key themes requested in first competition:

- Developing criteria for industrial sustainability
- Sustainable use of raw materials
- Improved resource-efficient processes and equipment
- Reduction in hazardous material content of products and processes
- Contributions which enhance social inclusion via new products and processes
- Production of less waste and pollution
- New product/service concepts
- Associated socio-economic/management research.

The fit of proposals with these themes is discussed in Section 7.

2.4 *Timeline*

The timeline for the STI was as follows:

Year	Task
1999	Scoping work Initial IPC approval
2000	Continuation of scoping work Final IPC approval Inclusion of other sponsors Appointment of PMC First competition opened
2001	First two competitions run Continuation of inclusion of new sponsors
2002	Third and fourth competitions run
2003	Fifth and sixth competitions run

In 2003/4 the planning for the Technology Strategy Board (TSB) and the Technology Programme was put in place, bringing to an end future STI funding. Hence only six out of a total of ten competitions were run, although the total projected size of the programme had grown due to the inclusion of new sponsors.

Year	Task
2007	Almost all projects completed by year end

3 Key Outcomes

It would be ideal to measure the impact of the programme on government policy objectives such as improved quality of life, economic prosperity for all, and reduced environmental impact. However, measuring outcomes of the programme arising from its activities is sufficiently problematic. Introducing another level of assumptions in order to generate impact estimates generates too much potential for inaccuracy. It is therefore reasonable to restrict discussion of the programme to outcomes and to activities.

3.1 *Environmental and Business Outcomes*

3.1.1 Methodology

Project completion forms (PCFs) were sent to project leaders at the end of their projects, often followed by a visit by the Co-ordinator to go through the requirements of the PCF and to discuss the future options for exploitation, dissemination and for future research. PCFs were only required from full-scale R&D projects; small scale feasibility, scoping studies and networks were not required to return them. Some difficulty was experienced in getting PCFs back in a timely way, since completion of a PCF was not a contractual obligation of the consortium. At the time of reporting on the programme, six PCFs had not been received, compared to 29 received.

Recommendation: gathering and submission of metrics information should be a contractual obligation of the consortium members.

3.1.2 Comparison with Technology Programme

A number of competitions under the Sustainable Production and Consumption theme of the TSB's Technology Programme were funded by the Business Resource Efficiency and Waste (BREW) programme. Three of these competitions are directly comparable with STI, since they are, to an extent, follow-on programmes that use learning obtained from STI. These are:

- Design and Manufacture of Sustainable Products
- Towards the Zero Emissions Enterprise , first competition (ZEE 1)
- Waste Minimisation.

Most of these projects are at a relatively early stage, although some of the waste minimisation projects are approaching completion. A total of 32 projects within these themes have provide estimates of the outputs of the projects, the probability of success and the attribution of that success to TSB/BREW funding, as reported by the research consortium. The metrics and their explanation are given in full in Appendix 2, but the results are summarised below. The Technology Programme (TP) measures are the “base case” i.e. the impact of the project once it is successful multiplied by the probability of success as estimated at that point in the project. The STI figures are an estimate by the consortium of the expected impact of the project in five years’ time, made at the end of the project’s life. The methodologies are therefore not absolutely identical, but are roughly comparable since they address the impact of the single project some way into the commercialisation phase.

Table 1: STI and Technology Programme Outputs

Measure	Design & Mfr of Sus Products	ZEE 1	Waste Minimisation	STI
Funding commitment (£)	£6.5m	£8.9m	£7.7m	£6m (£10.6m)
Diversion from Landfill (tonnes)	190k	250k	200k	10k
Virgin raw material saved (tonnes)	160k	100k	100k	10k
Carbon savings (tonnes CO ₂ equivalent)	870k	590k	90k	2,270k
Water savings (m ³)	130k	560k	710k	Nil
Hazardous waste reduction (tonnes)	50k	20k	100k	>10k
Cost savings (£)	£10m	£31m	£7m	>£20m
New business sales (£)	£12m	£14m	£93m	£94m

Notes: tonnages rounded to nearest 10,000
 £s rounded to nearest million
 STI bracketed figures are total cost of programme, unbracketed figures relate to those projects within the project that reported metrics. Outputs cannot be proportionately scaled.
 STI carbon saving figure dependent on one large estimate from a single project (refrigeration modelling and design)

In addition to these outputs, at least five STI projects focused on hazardous material substitution that did not result in hazardous waste and therefore were under-reported by the above metrics. These projects dealt with chrome plating, organic (rather than heavy metal) wood preservatives, epoxy (rather than chrome) tanning agents, and tin replacements for both cadmium pigments and brake pad formulations.

The conclusions that can be drawn from the outputs (which are shown in full in Appendix 2) are:

- The methodology is reliant upon estimates by the researchers. In certain cases these can appear somewhat optimistic e.g. the carbon savings figure for STI is largely contributed by one project on commercial refrigerator design.
- Many projects contributed percentage savings figures when absolute numbers had been requested. This made estimating an absolute figure very difficult.
- Generally the STI showed equivalent or better economic outcomes than comparable recent programmes.
- Generally (with the exception of one project's estimated carbon savings) environmental outcomes of STI were not as large as recent programmes. This may be due to a number of factors as well as greater success of the TP projects:
 - The point at which the outcomes are estimated differs between STI and TP
 - The greater upstream emphasis in STI will tend to produce smaller impacts unless indirect as well as direct impacts are taken into account.

Recommendation: estimates from researchers should be moderated, perhaps by internal peer review by funding organisations (or their appointed contractors) to avoid over-optimistic estimates in particular and to check understanding of the metrics requirements.

Recommendation: estimates of the consortia should be given as ranges (maximum and minimum) with confidence levels, rather than as a single estimate.

3.1.3 Comparison with Other LINK Programmes

The Strategic Review of the LINK Scheme carried out in 2002^a attempted to estimate the economic benefits of all LINK programmes. The additional sales number is a net present value figure of the impact of the LINK programme to date and over the next three years, adjusted for what is likely to have happened without LINK, but also increased to allow for a multiplier effect of LINK success onto other businesses.

^a "Strategic Review of the LINK Scheme" Technopolis Ltd and SPRU, DTI Contract Ref. CBBF/P/45, September 2002

Using this methodology, the study estimated an additional cumulative turnover attributable to the WMR3 programme (the predecessor of STI) of £43m from a programme cost of £8.8m (using a sample of only three from 53 projects), compared to a year-5 turnover figure of at least £94m from a programme cost of £10.6m for STI. These figures are not directly comparable, but are the nearest available.

The CIMNFC programme was assessed to have negligible impact on turnover, using the same methodology.

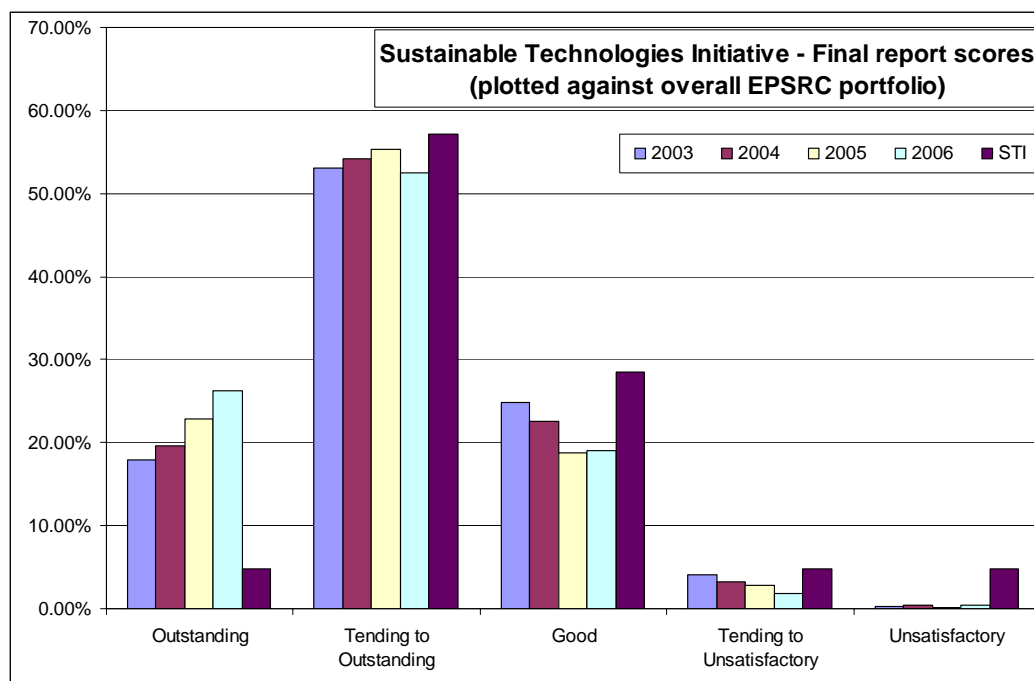
3.1.4 Comparison with the Carbon Trust

The 2006/07 annual report for the Carbon Trust's Innovations, Enterprises and Investments estimates that the annual cost effectiveness based on potential annual CO₂ emission reductions for 2010 (i.e. 3 years hence) is £66-£103/tCO₂. In comparison, STI has a cost effectiveness of c. £3/tCO₂, but this is hugely dependent on one single estimate and should therefore be used with caution. The Technology Programme competitions gave estimates of £7, £15 and £85/tCO₂.

3.2 Scientific Quality

The STI final report scores from EPSRC-funded projects are given in Figure 1. They show that the peer-reviewed scientific quality had fewer 'outstanding' gradings, and a greater number of 'good' gradings than the overall EPSRC portfolio over several years. This was likely to be due to the applied research nature of the programme, and therefore the difficulty in generating both direct industrial relevance and also scientific research that was at the absolute cutting edge.

Figure 1: Final Report Scores of STI Projects



3.3 Dissemination

In addition to the usual dissemination of project outcomes by researchers (papers and presentations), non-specialist summaries were posted on the STI web site and a dissemination strategy based on emergent themes was encouraged within the programme. Despite these activities, it was felt that more could be done on dissemination to industry (see Section 5.3).

3.3.1 Dissemination of Emergent Themes

At the suggestion of the then STP Director, Dr Frans Berkhout, the projects were allocated into groups according to the themes that were emerging within the programme:

- Biodegradable polymers
- Solvent free/zero emission processes
- Re-visiting traditional technologies
- Enhancing performance through surface modification
- Controlling coloration and preservation
- Decision support tools/design management.

After discussion and refinement the PMC then adopted a dissemination strategy based on these emergent themes. The strategy was to use STI's

dissemination budget to address underpinning issues that would help a group of STI projects, rather than just one individual project.

Some of these themes, such as biodegradable polymers, had been explicitly requested by the PMC and were mentioned in the call document. However some themes, notably that of re-inventing traditional technologies for sustainability, were unexpected and were believed to be interesting and valuable by the PMC.

Recommendation: identification of emergent themes within programme portfolios can be a useful tool for discerning trends and issues.

Recommendation: programmes should consider dissemination along emergent themes rather than simply along prescriptive lines (e.g. by sector or by technology).

Biodegradable Polymers: increasing awareness of biodegradable polymers such as starches and polylactic acid and their potential in packaging had led to a number of life cycle analysis (LCA) studies. Some of these questioned whether such biodegradable polymers would result in sustainability benefits. This was seen as a key underpinning issue to be addressed by STI to support its portfolio of projects. Therefore the following actions were undertaken:

- Dr Richard Murphy of Imperial College was commissioned to review as many comprehensive LCAs of biodegradable polymers as possible and to use these to comment on their sustainability credentials.
- The outputs of this academic study were combined with a survey undertaken by the National Non-Food Crop Centre (NNFCC) and published as a short report for the non-specialist, aimed at supermarket buyers and other relatively informed but non-specialist potential purchasers.
- The report was launched at an event organised by the NNFCC on biopolymers and sustainability, and coinciding with another dissemination event on the CIMNFC LINK programme. About 80 people attended, including a number of international companies and researchers.
- The report was also disseminated by post to key decision makers in the packaging purchasing area.

This theme is being taken forward under R&D competition themes within the Technology Programme, by promotion and dissemination from the NNFCC, and by R&D competitions run by Defra.

Re-inventing Traditional Technologies: a number of STI projects involved the revisiting, re-interpretation or improvement of technologies that had previously been in widespread use and then largely abandoned, only to be re-examined because of their sustainability credentials. Examples included mechanical spring power, natural fibres such as nettles, and lime mortars. Reasons for revisiting could be because of their low resource use in production, low environmental impact at end of life, or new applications and technologies (such as miniaturisation of electronics) that enabled a formerly discarded technology to be reconsidered.

Working hypotheses for the interest in these innovations are easily constructed, based on the high energy costs and low resource intensity of many previously abandoned technologies compared to those developed in the era of cheap and abundant oil and material resources.

A workshop on this theme was held at the Dana Centre in London involving a number of science and innovation communicators such as Trevor Bayliss and Adam Hart-Davis, as well as STI researchers and STP programme members. About 70 people attended, and the workshop was followed by a public event along the same theme in the evening at the same venue.

The area spans innovation theory, the history of technology as well as sustainability. For example, David Edgerton, Professor of History of Technology at Imperial College and author of "The Shock of the Old" also spoke at the Dana event. Although it opened up several fruitful lines of interest, these have not been followed through by traditional technology or science funding agencies. Some interest has been shown by NESTA, since there is a fit with their theme of "hidden innovation". However this has not crystallised into any action yet.

Recommendation: Funding bodies concerned with innovation and sustainability, particularly NESTA, should consider how this theme can be incorporated into future planning.

Zero Emissions Processes: several STI projects had objectives of taking an integrated approach to reducing the use of volatile organic compounds (VOCs,) or of emissions generally, by integrating a number of technical approaches. This theme was taken up by two competitions within the Technology Programme "Towards the Zero Emissions Enterprise", which have allocated c. £20m of government funding. This is a substantial expansion compared to the c. £11m for the whole of STI.

Dissemination of project outcomes and learning from STI took place at the launch event of the first of the ZEE competitions.

The “Towards Zero Emissions” and STI researchers and companies have also been given an opportunity to explore this common theme further through the funding of an experimental “Zero Emissions Forum” by the Resource Efficiency Knowledge Transfer Network (KTN), whose role is to facilitate items of common interest to the researchers and companies, be they events, speakers, case studies, international comparisons or follow-on funding.

Recommendation: forums and events to promote networking, dissemination, exploitation and reflection on competition themes should be encouraged and their effectiveness measured and monitored.

Enhancing Performance through Surface Modification: this was a small group of projects in STI, but felt to be worthy of note. The rationale behind the projects is often that new materials give difficulty in customer acceptance (including regulatory approval) and in end of life management. A better strategy may be to use well known, approved materials with established recycling or re-use routes, but to improve performance through modification of the surface properties. This theme may also link to thinking within the design community on choice of materials for products.

This theme does not appear to have been taken up elsewhere in EPSRC or TSB strategic development. The main project in the portfolio, which involved the improvement in longevity of artificial hip joints through a novel plasma surface treatment, may collaborate with the Centre for Remanufacture and Re-use on an event on improved longevity of products.

Recommendation: EPSRC and TSB consider funding a theme of enhancing sustainability performance through surface modification, and link to initiatives in the product design area (e.g. Design Council, Materials KTN).

Controlling Coloration and Preservation: this consisted of a number of projects in the textiles, wood and leather areas. Despite the offer of funding for a suitable event, none of the organisations or researchers contacted was sufficiently interested in the general theme to produce a proposal. This may indicate that sectoral approaches are too deeply ingrained to make cross-sectoral collaboration possible, or that this type of grouping is in fact inappropriate. The projects included development of new biocides for wood preservation, improvement of indoor air quality through new paint formulations, novel methods of leather preservation that eliminated the use of chromium, and better control of the cotton dyeing process.

Recommendation: EPSRC and TSB consider whether such a theme should be developed further in future funding competitions.

Decision Support Tools / Design Management: a number of projects were supported concerning tools for improving sustainable design. Since the STI also funded the Sustainable Design Network, involving a number of the same researchers, this appeared to form a natural route for project dissemination.

3.3.2 Dissemination by project teams

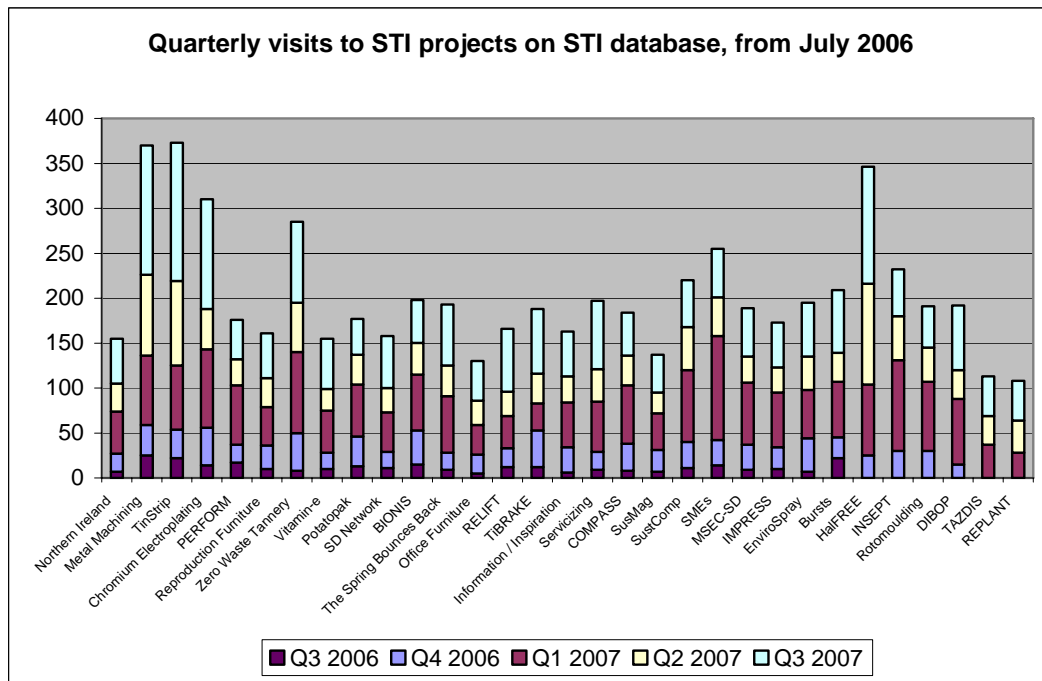
The 29 projects submitting PCFs reported an average of 5.3 presentations and 4.3 papers per project (i.e. a total of 155 presentations and 124 papers). This compares to an average of 5.4 publications in technical or peer reviewed journals reported in the LINK Strategic Review i.e. STI is around the same level as the mean, perhaps slightly below.

3.3.3 Dissemination by the Co-ordinator

A brief summary of each report for the non-specialist was written by a professional copywriter and published as a PDF on the STI web site, as well as a searchable database of projects being maintained.

Download statistics for the PDFs are shown below (Figure 2), with projects listed in the order in which they were loaded to the STI website. The download frequency can increase or decrease with time, depending on the PDF considered, with no clear pattern emerging.

Figure 2: STI Dissemination Data



Occasional enquiries were received from interested parties by the Co-ordinator and passed on to the project leader, as well as an unknown number of enquiries that went directly to the contact named on the project PDF.

3.4 Innovation and Exploitation

3.4.1 Patent Analysis

The total number of patents applied for by the sample of 29 projects within STI was 16, i.e. a ratio of 0.55 patents per project. This is almost exactly the same as the average number produced by LINK programmes assessed in the LINK Strategic Review of 2002 (0.5 patents per project), which itself was comparable with an equivalent project funded by a UK research council. The previous LINK programme, WMR3, had produced four patents applications from sixteen projects.

3.4.2 Successful Project Profiles

Projects that have either already achieved, or have a strong expectation of, very successful outcomes include:

Novel Mattress for Enhanced Sleep Comfort Incorporating Non-Food Crops: This project anticipates substantial sales of the “eco-mattress” being developed by a consortium of Yorkshire fibre, non-woven and mattress manufacturers working with Leeds University. This product combines lower cost, longer lifetime and elimination of components such as polyurethane foam, with attendant gluing and bonding processes. There are increases in recycling (c. 2,500tpa), due to availability of steel for recycling, reductions in carbon dioxide emissions (c. 17,000tpa CO₂e) due to the substitution of materials. However there will be an increase in water consumption due to the use of crop-based materials.

Envirospray: A small start-up company (Lionstar) collaborated with UMIST (now University of Manchester) to develop cost-effective spray pumps that could match current spray performance of aerosol cans. The eventual design comprised a substantial reduction in the number of components over standard pumps (hence reducing cost in assembly) with superior spray performance. A trigger has also been developed with fewer components. These have been licensed globally to a range of large FMCG product suppliers and are expected to be present in the shops soon. The ultimate environmental performance should be to eliminate around 0.1%-1.0% of anthropogenic VOC emissions in Europe.

Both the post-doctoral workers have been recruited from UMIST by Lionstar, and a further range of spray products delivering better

environmental performance is being developed, financed directly by licence income. Within five years the company is forecasting substantial increases in licence income.

Improving the Sustainability of UK Waste Water Treatment

Works: By using advances in condition monitoring developed at Cranfield University, the reliability of rotating electrical equipment such as pumps and blowers can be substantially increased. This will result in fewer catastrophic failures, with consequent reduction in pollution potential. A four- to five-fold reduction in the cost of routine maintenance is predicted, with similar improvements in downtime reductions. The main industrial partners were Severn Trent Water and a number of equipment suppliers.

SECRET - Novel Extraction Method for Titanium Dioxide: This project uses molten salt research by Professor Jha at Leeds University to improve the extraction method used by Millennium Chemicals in the preliminary stages of titanium dioxide manufacture, with substantial reductions in operating costs and in effluent discharge. Four patents have been filed to protect the process innovations.

Development of a Sustainable Metal Working Fluid

Technology: This project was notable for the fast introduction of a commercial product by the project partners, which followed on almost immediately after completion of the project. Cost and performance parameters were met or exceeded to allow for a competitive formulation to be produced. This was a product substitution project, so increased sales are not expected, although costs were reduced by around 25%. Environmentally, around 6,000tpa of mineral oil is expected to be diverted from disposal.

Plasma Thermochemical Surface Engineering of Co-Cr

Alloys: A novel environmentally benign surface treatment technology based largely on plasma surface alloying with carbon and carbon/nitrogen was developed to significantly improve the friction, corrosion and wear characteristics of Co-Cr alloys, which are largely used in hip replacement joints. This has made substantial commercial and scientific advances, in particular bearing in mind the conservative and regulation-constrained industry of in-body medical devices. Once adopted, these materials will result in significant improvements in well being (through extension of the period between hip joint operations) as well as business and environmental gains. Licenses for the technology are being arranged through a university spin out company.

NB Commercially-sensitive data is not given for individual projects, but is summarised in a separate appendix (which will be removed from the publicly available copy of this report).

3.4.3 Comments from Industrial Participants

The industrial partners (only) within the STI projects were contacted at the end of the programme, via the project leaders, to comment on their experience with STI and to reflect on the longer term impact of the project. This was to get some reflective comment to supplement the largely factual feedback of the Project Completion Forms. Relatively few replies (just 8) were received, probably due to the churn of personnel, and the non-compulsory nature of the enquiry. However, with caveats about the size of the sample, the following comments may be useful:

What difference did the STI projects make to your business?

“As it turned out, the STI project has not made a major difference to our business...the STI bioresins project was actually very successful and we came very close to investing heavily in the technology...it did alert us to other possibilities...so I suppose that the project has helped us indirectly...”

“The project had a significant impact on our business in providing a supporting basis for the technical development...all of these areas are still on-going with commercial partners...”

“A lot as it enabled us to move a long way forward”

“Neither project has had a significant impact on our business. We felt that both were extremely promising projects and were keen to be involved with both. However both failed in our opinion to fulfil their promise.”

“It was therefore opportune and has been used as a basis for initiating many other actions and studies and for providing key baseline data for the performance of the office furniture sector.”

“We always planned on a longer term strategy to introduce new flame retardants into our sector of the industry.”

Were there additional benefits of STI programme membership above purely financial?

“We didn’t benefit from associated publicity since we chose not to – we didn’t want to alert our competitors to the area of bioresins.....We made some very good contacts as a result of the project....”

“The most important benefit was certainly the financial support...However since completing the project we have had a good number of commercial enquiries in response to press releases based on the reported results of the project”

“No” (3 responses)

Any comments on programme processes?

"We have no issues with the processes of the programme apart from the dissemination of information...there have been considerable differences in opinion concerning dissemination...The 'academic' partners will wish to publish findings as soon as they can while commercial partners wish to gain commercial advantage for themselves"

"All aspects of the programme were run efficiently and transparently. Dissemination and follow up activity has been particularly strong"

"No" (2 responses)

Any other comments?

"For small companies like us, it was great"

"Both projects had excellent potential and were worthwhile concepts. While the strict objectives of the projects may have been met, the final results were not conclusive enough and would require further work to produce a commercial benefit"

"No" (2 responses)

"We learned a good deal about flame retardants during the exercise and believe that the EU will constantly push for the use of "greener" products in electronic devices...we believe that the work done was very relevant to developing the next generation of laminates for our industry"

4 Comparison with ROAME Objectives

A comparison of the achievements of STI with the original ROAME objectives is given below (Table 2). Generally the objectives were exceeded, sometimes substantially. In the non-LINK component of the programme, the original conception of collaboration with Regional Development Agencies (RDAs) in regional programmes or projects was not fulfilled. This could have been due to lack of knowledge about the opportunity from RDAs, or the lack of fit with their own interests at the time.

Table 2: Comparison of STI achievement with proposed plan of work

Overall objectives:	Objective	Achievement
Trade associations emailed	25 contacted	Have 469 on mailing list
Trade journals emailed	20 contacted	Have 175 on mailing list
STI posted on web sites	4	OHL, DTI, EPSRC +partner-finding database set up, then removed
Academic network		See current STI list of 657 HEI, down from peak numbers
Turnaround times for R&D applications	Per LINK guidelines	Achieved
Set up LINK programme with EPSRC	By mid 2000, reviewed by end 2001	Achieved

Objectives for Non-LINK:	Objective	Achievement
Support development of ST strategies in business sectors, through scoping studies	10 sectors by end 2000	2 studies commissioned pre-STI (pre-end 2000), 15 scoping studies in total
Support ST programmes or projects in business sectors	5 sectors by end 2001	14 projects in 13 sectors by end 2004
Support development of ST strategies in regions	5 regions by end 2000	1 regional study in 2001
Support ST programmes or projects in regions	3 regions by end 2001	1 regional project in 2002

Objectives for LINK:	Objective	Achievement
Annual calls	5	6 bi-annual
Type of proposals	Two-stage (outline and full)	Achieved, except for networks which were single stage
Additional support	Increase interest in RCs	EPSRC, ESRC, BBSRC, Defra brought on board
Meeting legislative targets	Assist >4 industrial sectors to meet current/imminent SD legislation	> 5 sectors (ceramics, leather, GRP composites, metal coating, machining)
Reducing costs through waste minimisation or efficiency gains	Assist >10 companies in >4 industry sectors to demonstrate 5% cost reduction	At least 14 projects out of 29 reported cost savings of at least 5%
Involvement of SMEs	>20 SMEs in R&D projects	c. 50 SMEs involved in collaborative research with universities
Support of R&D	>20 R&D projects supported	32 collaborative research projects supported with universities
Involvement of Trade Assns in dissemination	>10 trade assns promote changes in practice through technology transfer, publications, seminars	9 trade associations involved with university collaborative projects

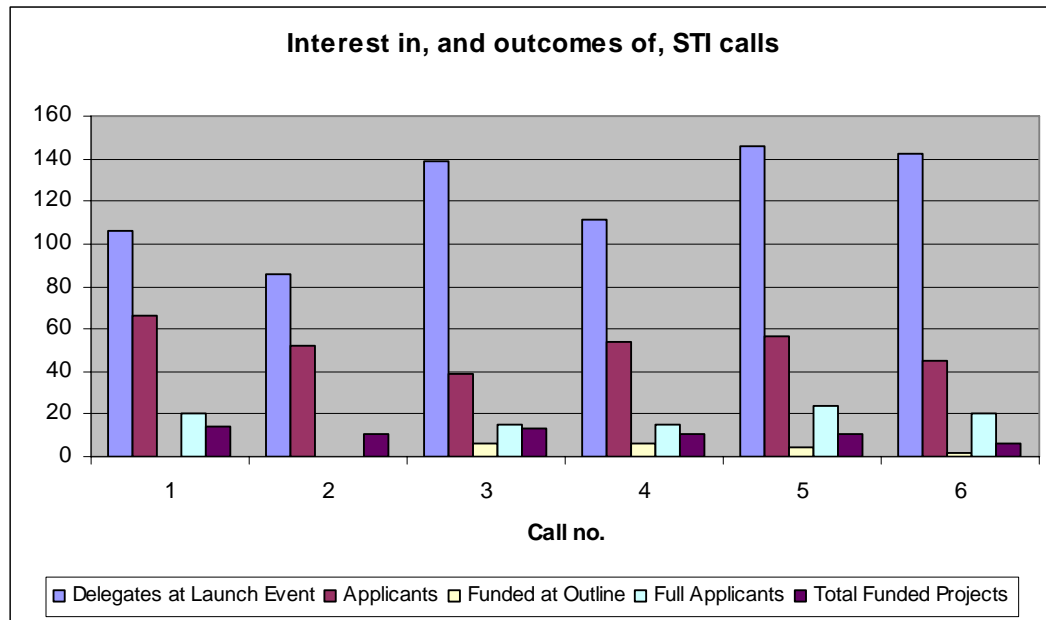
5 Management of the Programme

5.1 Publicity and Awareness

The generally high level of activity on awareness of the competition is given below. During its operation the programme was assessed, in research carried out for EPSRC among environmental technology firms, as having the second highest recognition after the SMART scheme.

Awareness and interest in the scheme increased as the programme became more established, and was maintained at a fairly steady level, as evidenced by the numbers of launch event delegates and outline applicants to the programme (see Figure 3). Launch events were held around the UK, in Cardiff, Glasgow, Melton Mowbray (East Midlands), Manchester, as well as in London, with corresponding liaison with devolved administrations and RDAs. A typical event included information on how to apply, background to the programme, project examples and a variety of networking and consortium-building activities. Typical attendance was 100-140 people, and the events were usually slightly over-subscribed, but with some drop-out on the day due to its charge-free nature.

Figure 3: Launch Event and Applicant Statistics

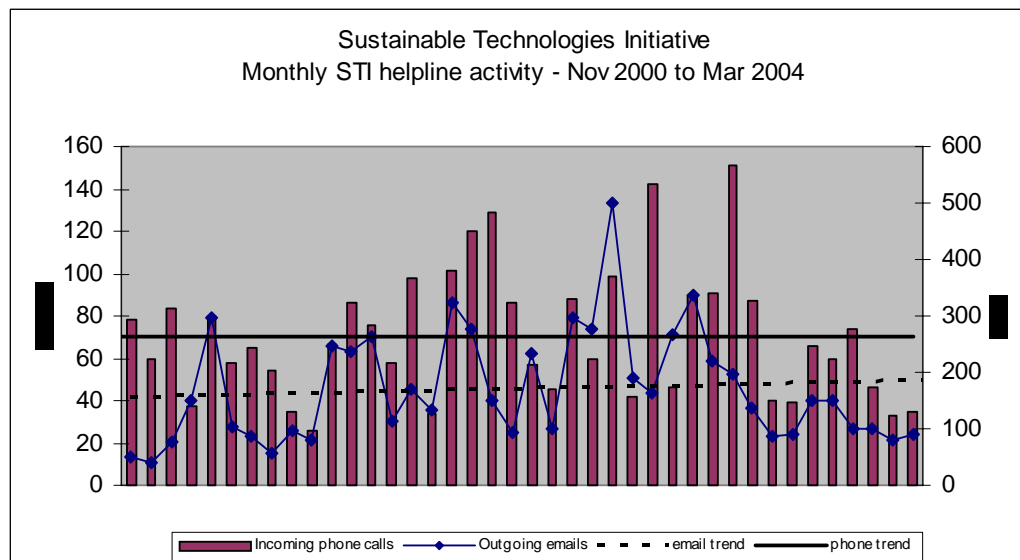


The ratio of total proposals to successful ones was around 5:1. Smaller studies (<£25,000 funding) were approved at the outline proposal stage,

with larger proposals submitting a full proposal. Once at the full proposal stage, the mean success rate over the calls was around 50%. Generally the competitiveness of the calls was felt to be about right: competitive enough to ensure good quality proposals, but not sufficiently high to discourage applicants.

The STI maintained a dedicated telephone helpline to assist applicants and also used an email enquiry system. Calls were logged and could be analysed by RDA region. The response time for replying was also recorded (see OHL contract performance for more details). In the peak year of 2003/4 around 2,200 emails and 823 telephone calls were responded to. The monthly statistics are given in Figure 4.

Figure 4: Helpline Activity (Telephone and Email)



In 2004/5 and 2005/6 the calls and emails tailed off fairly rapidly (e.g. 146 telephone calls in 2004/5), reflecting the closure of the programme to new proposals.

Over the lifetime of the programme, some 3,000 individuals registered an interest in the Sustainable Technologies Initiative and were listed on the STI database. Registrations were made by phone call to the helpline, by email or by fax. Those registered on the database were emailed information about calls for proposals, funding announcements etc: bounce-back emails were used to keep the database up to date. At the end of the programme, the balance of interest from industrial vs academic sectors was as shown in Table 3 below:

Table 3: *Individuals Registered on STI Database, by Sector*

Sector	No of individuals registered
Government body	237
Non-governmental body	61
Higher Educational Establishment	838
Other Science Base	168
Industry Body	173
Large Enterprise	315
Small/Medium Sized Enterprise	708
Not categorised	30
TOTAL	2530

5.2 *Activities of the PMC*

The PMC comprised the members given in Appendix 1, supplemented at its meetings by officials from the funding bodies and the programme Co-ordinator. In its early years the PMC was largely concerned with appraisal of outline and full proposals. Outline proposals were assessed by at least three PMC members to produce a list of projects to be invited to the next stage. Typically this list allowed for a 50% failure rate at the full proposal stage. Full proposals were assessed by external peer review organised by EPSRC. One of the key roles in appraisal was felt by the PMC to be the moderation of peer review, which was generally orientated towards the scientific rather than the industrial nature of the proposal or towards the sustainability challenge. Hence PMC members had to take serious account of peer review, but were not bound to accept its conclusions. PMC members also attended launch events and contributed to certain of the dissemination events (notably the STP Director).

After the cessation of grant-making activities the PMC received summaries of monitoring reports and feedback on completed projects. This enabled them to question the progress and outputs of projects and to contribute advice via the programme Co-ordinator to the projects.

Many members of the PMC fulfilled their role over a seven year period from 2000 to 2007, and are thus able to reflect on the whole of the process and on the results of the programme.

5.3 Costs

Compared to a budget in the ROAME statement of £10m from DTI, the actual spend was:

Sponsor	Contribution
DTI	£5.5m
EPSRC	£4.5m
Defra	£0.6m
ESRC	£0.02m
BBSRC	£0.0m
TOTAL	£10.6m

Of the 29 projects which produced a PCF, the actual spend (industrial and governmental) was £13.5m compared to the originally forecasted total of £13.3m. The actual Government spend on these projects (i.e. just those producing PCFs) was £6.54m, hence the multiplier effect of government funding bringing in business funding was 1.1

5.4 Monitoring and Co-ordination of Projects

In consultation with the technical monitors on the STI programme (TUV-NEL), the following points were noted:

It was important to be able to provide projects with guidance on reporting and the importance of dissemination, particularly when the project partners were new to publicly funded projects.

Recommendation: a clear briefing is required from the monitoring officer on roles, reporting and dissemination.

Some projects had IPR-related issues/problems, although these were sometimes the inevitable consequence of the conflict between academic and industrial interests. The greater problems generally arose from the IPR agreements being left until too late in the project, even though the project guidelines required each consortium to produce one.

Recommendation: monitoring officers and funders should insist upon and enforce early production of IPR agreements.

It was important that regular meetings took place between all of the partners in a project. Although close working arrangements may exist between partners within a project, particularly at the detailed technical level, the Project Review Meeting is often the only opportunity for all the

partners to meet and discuss general issues including IPR and commercial exploitation.

A number of consortia would have liked a clear route for support for follow-on projects. All projects were directed to the Technology Programme (TP) but initially some found it a rather intimidating process, particularly for smallish groups looking for support for commercialisation of research results.

Support for the later stages of development and the early stages of market deployment is important. The Technology Programme does support product development by providing 25% development funding and allowing potentially risky start-ups to participate (it is worth noting that some of the most exciting outputs from the STI programme came from a start-up company that eventually had to seek cross-guarantees from a partner company in order to get the DTI funding).

Recommendation: funding for demonstration projects should be made available in all collaborative research programmes.

Recommendation: a higher level of risk may have to be accepted by government in the funding of small start up organisations.

Since the programme had outputs related to an additional social good (climate change, environmental improvement) on top of the business and societal benefits of innovation per se, additional support for development and deployment from Government is justified. This support is explored in the Stern Review, but may come through market interventions such as public purchasing preferences. These conclusions are in close agreement with the PMC reflections in Section 6.

Recommendation: sustainability projects should be reviewed by officials to see how market deployment of projects with strong potential for sustainability gains can be encouraged.

Despite considerable technical success from the projects, dissemination of the results to industry, apart from case studies via Oakdene Hollins and university papers was considered poor by the monitoring team. Possible improvements include seminar-type dissemination events covering the sustainability theme on an annual basis, providing networking opportunities and cross-fertilisation of ideas from the variety of projects. *This re-inforces earlier recommendations made in Section 3.3.1.*

The output from many of the projects was prototype equipment: in many cases who actually owned it was not clear which in some cases led to disputes. In a couple of projects this meant that equipment was left unused, further development was hindered leaving the equipment to 'rust away', or

the equipment was left with a small company which did not have maintenance facilities if something went wrong with the machine or when it could have been developed further.

Many projects were not clear on reporting requirements at the end of the project i.e. how much was actually required to be submitted in terms of final reports and to whom. A clear guide in the offer letters would have been useful.

Recommendation: a clear guide to reporting requirements should be supplied in the offer letter (this is also being addressed through more comprehensive briefing of applicants in the Technology Programme).

6 Recommendations of the PMC

This section includes reflections of the PMC upon the programme itself and includes key areas where improvement can be made in collaborative funding of programmes of this type.

6.1 *Sustainable Innovation and Social Change*

The meeting of radical government targets in the sustainability area (e.g. carbon reduction targets) will require projects that go beyond those of the type in STI, since it is apparent from the timescale and impact that these will not be translated to environmental impacts sufficiently quickly. The STI attempted to experiment in the area of mixing social change with technological innovation (see Section 7.1 below). An important output of the STI was the belief held by the PMC that new types of project were required that embraced this idea. Such projects should be characterised by:

- Selecting successful R&D projects from the earlier stage funding, and allowing unsuccessful projects to die.
- A strong user-orientated approach, gathering groups of end-users keen to develop and adopt the technology.
- Access to subsequent funding, which may be demonstration grants, deployment incentives, or a loans system similar to that operated in the USA.
- Public investment in creating and facilitating partnerships for the development of the project.

Such a programme of “innovation for a sustainable society” is strongly recommended.

Recommendation: the TSB, EPSRC and ESRC consider how they might create projects that bring together social change and technological innovation, particularly focusing on actions subsequent to successful R&D projects.

6.2 *Explicit Themes versus Embedded Criteria*

Sustainability is increasingly becoming embedded within Government policy-making, for example in energy and innovation. Within collaborative R&D it has been encouraging to see how life cycle impact concerns are starting to be included into various Technology Programme competitions. However it is felt that making the sustainability challenge explicit in a themed programme such as STI is helpful in raising the profile of the issue to business and in helping to more deeply embed this thinking into business processes and priorities. There may be a time when such explicit themes are no longer needed. However that position has not yet been reached.

Recommendation: the TSB should continue to fund competitions with explicit sustainability themes, and to continue to embed sustainability criteria in collaborative R&D funding.

6.3 *Outcomes versus Technology Orientation*

The STI was largely an outcome-orientated programme. That is, it defined the sort of results it wished to achieve (the greater sustainability of UK business) but did not prescribe a particular technological approach or business area. The PMC and external experts assessed which of the proposed approaches were likely to give maximum delivery of this output, along with other concerns such as level of innovation, robustness of consortium and cost. Thus novel and unexpected themes were able to emerge, such as the “re-invention of traditional technologies”. These are much less likely to emerge in programmes that are specific about the kinds of technology that are required.

Recommendation: the TSB should consider ‘grand challenge’ and other output-orientated programmes as being more helpful in the general business sustainability area than attempting to define the most appropriate technologies.

7 Further Issues for Action

7.1 *Collaboration with the Social Sciences*

The STI was originally conceived as integrating social and physical science research within projects, supported by core funding from social science funders, notably the ESRC. This was a recognition that improvements in the sustainability of products or processes may require changes in purchasing and consumption behaviour, and in the social context or system within which the innovation takes place and is adopted. However such integrated projects did not emerge from the programme. Rather, a separate programme was established (the Sustainable Technologies Programme, STP), with the option to support STI projects on a case-by-case basis. The STP disbursed £3m in grants to social science projects whereas just one STI project was part-supported, with funding of less than £0.1m.

The reasons for this appear to be:

Governance: because of ESRC internal rules, it was not possible for it to devolve authority to a PMC consisting largely of non-ESRC appointees. Therefore any STI project with ESRC funding would have to obtain a second approval from an ESRC-appointed panel. With integrated projects this therefore raised the possibility of parts of the project receiving funding whilst others did not, and a time lag between these decisions also complicating these matters.

Project requirements: even though the STI themes included “associated social and management research”, little interest was shown by researchers in submitting integrated proposals. Virtually all proposals were physical science or technology-orientated with no recognition or input from social science researchers. Reasons for this mentioned to the Co-ordinator during the programme included:

- The difficulty in social science researchers getting sufficient industrial interest to meet the “50% in-kind support” required to leverage STI funding.
- Lack of interest from the technologists driving the project proposals in the wider issues of adoption and consumption, although at a higher level within the organisation these issues were sometimes recognised. This was sometimes linked to a difficulty in understanding what specific outcomes social science research could offer to the success of an individual project.

The social science input into the direction and management of STI, consisted of a number of STI PMC members, ESRC representative and the STP Programme Director. Social scientists therefore carried out a substantial proportion of the proposal assessments (perhaps 10-20%). The input of the STP Programme Director was also very significant in determining the dissemination strategy based around emergent themes. This latter area of communication, dissemination and allocation of significance to the results of a technology-orientated programme has been a valuable contribution to STI and could be emulated by other programmes.

Recommendation: the Technology Programme should consider involving social scientists in the assessment of significance of project outcomes in its thematic areas, notably those orientated towards the goal of increased sustainability.

7.2 Use of Scoping and Feasibility Studies

STI funded 10 sectoral scoping studies, whose original purpose was to scope the sustainability issues within a business sector, and to set out some possible ways to address them, some of which would form the basis of further full STI applications.

The first scoping study funded in this way was by the Printed Circuit Industries Federation (now Intellect). It generated a number of STI proposals, two of which were funded, including a "Zero Emissions" project, "TAZDIS". However subsequent scoping studies, some by trade associations and some by sectorally-orientated RTOs such as FIRA and Pera, resulted the generation of very few STI proposals. This may have been because the original scoping studies were revenue- rather than needs-driven and therefore lacked the champions within the industry associations to bring forward STI applications. The alternative explanations (that these industries lacked problems that could be addressed by STI, or that the organisations involved were not appropriate to carry out the studies) seem less plausible.

Recommendation: sectoral scoping studies are not the route used by collaborative R&D programmes to stimulate projects that address industry needs.

It is interesting that the ZEE theme of the Technology Programme is using feasibility studies to test the viability of a specific idea before allowing a full proposal for significant funding to address the problem. This allows the testing of an approach before funding the full proposal, hopefully ensuring better value for money from the proposal.

7.3 Programme Metrics

The metrics of the original ROAME statement were based on activities of the programme, although there were some outcome measures, notably concerning the cost reduction hopefully achievable through more eco-efficient products and processes. Outcome measures are to be preferred to activities, since they relate more directly to the objectives of the programme. Activity or 'busy-ness' within the programme does not guarantee that this is directed towards the correct objectives or is being effective. However the STI programme did not have embedded within its structure a method that obliged successful applicants to provide output data from their projects. Hence it has proved difficult to obtain output data from projects, since the consortium members are not obligated to provide it and, being asked for this data in some cases retrospectively, the consortium members may not have gathered the information.

The BREW-funded themes within the Technology Programme are required to provide a suite of seven metrics in order to measure the effectiveness of BREW. After a number of developments through the various BREW-funded competitions, applicants are now required to give estimates of their project outcomes at the proposal stage, and then continuously to refine these.

Recommendation: the outcome data of importance to the programme are explicitly forecasted at the proposal stage. This estimate is refined during the project and forms part of the project monitoring process, eventually contributing to the programme evaluation.

7.4 Emergent Themes and Supporting Actions

The identification of emergent themes, their use in identifying supporting actions and in the formation of new themes and insight, using the input and reflection of social science researchers, has been one of the distinguishing features of STI and has been recommended for emulation by other programmes. Science and technology development programmes are focused on exploitation by individual companies rather than on the dissemination of information to a broader audience. However the use of emergent themes can identify underpinning or generic actions, research or policy support that can assist the faster adoption and exploitation of sustainable technologies.

STI has had some success in the areas of biodegradable polymers and in the Zero Emissions Enterprise. However three areas have been identified where no actions, either by industry bodies or by government funded organisations, seem to be evident:

Re-inventing traditional technologies for sustainable innovation. This theme covers a number of possible approaches:

- the re-invention of craft industries with new technology
- the revisiting of forgotten or abandoned research and technology from businesses or universities
- the upgrading of older industrial processes that appear now to have significant sustainability advantages over the processes that displaced them.

The theme runs counter to accepted wisdom that valuable science and technology development should be radically new and innovative; to an extent it mirrors the revisionist view of the history of technology put forward by researchers such as David Edgerton at Imperial College and individual commentators such as Adam Hart Davis. The sustainability rationale lies largely in the use of technologies that were originally developed when energy and the extraction of resources were much more expensive and when solutions tended to be based on readily available materials using low energy processes. Processes and products could also be revisited when what had displaced them had become relatively more expensive due to increased costs of energy or of pollution control.

The use of surface modification to enable increased durability of materials also appears to be a fruitful theme for further investigation. The rationale is that the bulk material remains unchanged, therefore existing end of life management techniques and existing regulatory approvals may be used, rather than establishing new ones. Its attraction can be compared to the use of composite materials to improve performance, where end of life recycling can become a problem. In some cases this has led industrial design consultancies concerned with sustainability issues to focus product development on materials such as polypropylene, where bulk material recycling is theoretically quite straightforward.

In the medical field (where one of the STI projects was successful) the fact that the bulk material was unchanged meant that existing regulatory approvals could be used, and the time to market radically reduced. One can foresee this approach being attractive when REACH, and other similar directives governing the environmental and human risk of new materials, becomes established.

The sustainable preservation and coloration theme reflects the need of producers to offer processes in these industries, which historically have shown poor percentage utilisation of material resources, and where a number of materials are used which have been shown to be detrimental to human health and the environment.

7.5 *Subsequent Development of the Projects*

In common with many collaborative R&D programmes, the issue of follow-on funding to take projects to a demonstration and adoption phase has been raised by the Co-ordinator, the monitoring organisation and the PMC. In the context of sustainability and climate change, the issue is also raised in the Stern Review, which also raises the issues of deployment support for low carbon technologies when they have moved beyond the demonstration phase. Some assistance was given in STI by the Co-ordinator and monitors as regards introductions to venture capital organisations and follow-on funding opportunities such as the Technology Programme and FP7.

In the case of the ZEE projects funded by the Technology Programme, a kind of support organisation has been established for the projects, which may involve introductions to or assistance with further funding through additional visibility of the projects. However it has been suggested that more active support should be offered for incorporating these ideas into products, perhaps along the lines of the US support offered for new businesses via government contracts. Certainly successful projects require greater active promotion and follow-through to subsequent phases.

Recommendation: the TSB should offer adequate demonstration funds for follow on funding for R&D projects.

Recommendation: market deployment incentives (e.g. the Enhanced Capital Allowance Scheme) should regularly be updated to take account of new technologies being developed by programmes such as STI.

Recommendation: support and supervision from the TSB should continue beyond the completion of the project to assist with the next stage of the project's commercialisation, if it is shown to have large potential for sustainability improvement. (See also recommendations in Section 6)

Glossary

BBSRC	Biotechnology & Biological Sciences Research Council
BERR	(Dept for) Business, Enterprise and Regulatory Reform
BREW	Business Resource Efficiency and Waste Programme
CIMNFC	Competitive Industrial Materials from Non-Food Crops LINK programme
Defra	Department for Environment, Food and Rural Affairs
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
FIRA	Furniture Industry Research Association
IPC	Innovation Programme Committee
IPR	Intellectual Property Rights
KTN	Knowledge Transfer Network
LCA	Life Cycle Assessment
NESTA	National Endowment for Science, Technology and the Arts
NNFCC	National Non-Food Crop Centre
PMC	Programme Management Committee
PDF	Portable Document Format
RDA	Regional Development Agency
REACH	Registration, Evaluation, Authorisation and restriction of CHEMical substances
ROAME	Rationale, Objectives, Appraisal, Monitoring and Evaluation
RTO	Research and Technology Organisation
SMART scheme	R&D support scheme for small businesses
STI	Sustainable Technologies Initiative
TSB	Technology Strategy Board
VOC	Volatile Organic Compound
WMR3	Waste Minimisation through Recycling, Re-use and Recovery programme
ZEE	Zero Emissions Enterprise