SWP 10/97 THE APPLICATION OF FORESIGHT IN UK RESEARCH AND DEVELOPMENT

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THE APPLICATION OF FORESIGHT IN UK R&D

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THE APPLICATION OF FORESIGHT IN UK R&D

ABSTRACT

A study has been made of participants' experiences of the recent Technology Foresight exercise which was conducted on a national scale by the UK government.

Open-ended interviews were conducted with a sample of participants, and interviewees' statements were categorised as to whether they expressed a positive, negative or neutral view of their experiences. Overall there were twice as many negative statements as positive ones, which raises cause for concern about the exercise.

Content analysis was used to group the statements into 19 different areas of concern. Some areas were viewed positively and others were viewed negatively. The largest number of negative statements were made when interviewees described the way in which three of the main operational elements of the Technology Foresight exercise were conducted.

The authors hypothesise that, regardless of whether the methods used in HMG TF were well chosen, the question of how well they were applied is also important.

Further work to investigate this hypothesis is nearing completion and will be reported later.

THE APPLICATION OF FORESIGHT IN UK R&D

1. INTRODUCTION

1.1 Motivation for this Research

At the time of commencing the research, one of the authors was employed in a regional office of the Department of Trade & Industry and had responsibility for devising and managing a series of activities to disseminate and implement the findings of the United Kingdom (UK) national Technology Foresight exercise (HMG TF) in that region. An interest in and a wish to carry out a study of the origins, processes and applicability of HMG TF developed as a result. In order to carry out the research the author concerned registered for a higher degree at the R&D Management Centre in the School of Mechanical Engineering at Cranfield University. The other author is head of the Centre.

1.2 Definition and Brief Description of Technology Foresight

Technology Foresight may be generically defined as a structured process for identifying emerging technological and economic trends, their likely effect on economic performance and quality of life, and the science, engineering and technological capability needed to respond positively to them. Typically the process involves seeking the views of researchers and industrialists on emerging possibilities and hardening trends, on topics relevant to a particular commercial area. One purpose of the process is to agree on likely developments while another is to network people with insights into different aspects of these developments. The range of the forward look involved in such a process may vary between five and 25 years.

Typical forms of participation in a Technology Foresight process may include:

- membership of an expert panel;
- facilitation of an expert panel;
- provision of specialist evidence for consideration by an expert panel;
- participation in consultation through postal questionnaires or attendance at events;
- taking an interest in and/or implementing the results.

2. LITERATURE REVIEW

2.1 Foresight Activities Reviewed

From the literature we were able to build up a picture of the way in which Foresight exercises are carried out at different levels, examples of which include:

National HMG TF

A national scale exercise covering 15 broad industrial and commercial sectors begun in 1993 following the publication of a Science, Engineering and Technology White Paper (Office of Public Service and Science 1993).

The conduct of the exercise was co-ordinated by the Office of Science and Technology (OST). In HMG TF the inputs of thousands of academics, industrialists and researchers were sought and collated through a framework of sectoral panels of experts which presented their views of likely developments over a 10 to 20 year period. These findings were reported in 1995 with the intention that they be used to inform the policies and spending decisions of both Government and other interested parties. A dissemination and implementation phase followed the publication of the reports.

Sectoral Ceramics

CERAM Research's Technology Foresight Study (CERAM Research 1996) conducted by the industry research and technology organisation in 1995/6 among ceramic industry companies. This technical exercise was complemented by the Tableware Strategy Group's commercially-orientated study of 1995/6 (Tableware Strategy Group 1995, 1996).

Company BP

The concept of Technology Foresight by Roadmaps (Barker & Smith 1994) was developed and used within BP as a visual tool to assist the derivation and presentation of an R&D strategy which meets the needs of the company's business activities.

Medical Research PRISM

A study of the cardiovascular research field (Anderson 1994, Anderson & Williams 1995), carried out co-operatively among medical researchers, funders and practitioners in 1993-5 at the initiative of the funding agencies supporting research in this specific field.

2.2 The Foresight Framework

In studying the literature on the foresight activities listed above we identified a common framework for conducting foresight exercises which consisted of three phases:

- origination and preparation;
- a survey;
- follow-up activities.

When it is intended that multiple programmes will be carried out over an extended period of time, for example in the case of national programmes which are repeated over a five year cycle, there may additionally be an element of review linking the repeating exercises.

Within each of the three phases listed above a number of stages were identified as follows:

Origination and Preparation

- the **decision** is taken to carry out an exercise;
- the exercise is **announced**;
- **preparations** are made to carry out the main body of the exercise.

Survey

- views on expected developments are **canvassed** through a variety of methods including workshops, one-to-one interviews and postal surveys;
- these are then **considered**, a process which may go through a number of iterations such as that of a Delphi survey;
- before the **publication** of reports typically containing the findings of the exercise and recommendations for action.

Follow-Up Activities

- **dissemination** activities such as seminars are held;
- **responses** to the reports are issued by interested parties;
- **action** to implement the recommendations set out in the reports takes place.

While all exercises studied appear to contain all these phases and stages, the degree of emphasis placed upon particular stages was found to vary considerably between exercises.

2.3 Literature on HMG TF

We built up a picture of the extent of available information on HMG TF. We discovered that the literature on HMG TF fell into five main categories:

- general and technical press coverage of the exercise;
- "glossy" brochures produced by OST to publicise various aspects of the exercise;
- the official reports containing the findings of the exercise;
- customised versions of and commentaries on the official reports produced by interested parties such as trade associations and professional institutions, for example the Institute of Physics' interpretation specifically aimed at small and medium sized enterprises (SMEs) (Institute of Physics, 1996) and that for the mechanical and electrical engineering sector produced by Segal Quince Wicksteed under contract to the DTI (Segal Quince Wicksteed, 1996);

- reviews of aspects of the exercise process, for example those on the use of co-nomination to identify participants (Georghiou et al, 1994) and the sector specific regional workshops (OST, Scientific Generics Ltd & W S Atkins, 1995).

2.4 Academic Publications on Foresight

We discovered that there were relatively few publications in the academic literature on the subject of Foresight. Those that exist fall into two categories:

- those which report the development and use of Foresight techniques in industry (Barker & Smith, 1995) or in specific research fields such as medical research (Anderson & Williams, 1995);
- those which report the development of Foresight techniques and their application at a governmental level outside the UK (Irvine & Martin, 1984), (Martin & Irvine, 1989) and (Martin, 1992).

3. OUR RESEARCH ON PARTICIPANTS' EXPERIENCES OF HMG TF

3.1 HMG TF in Context

HMG TF was the largest such exercise ever carried out and was completed very quickly after first being proposed in the 1993 Science, Engineering and Technology White Paper. The exercise gained a high reputation in various quarters. One American author wrote: "I consider this to be unquestionably the finest Delphi of any field published in the English language" (Coates 1997). We decided to investigate the exercise with an open mind and to start by asking people who had been involved in it for their views on the experience, in order to identify any issues that needed attention.

3.2 Selecting Interviewees

Open interviews were carried out with 12 individuals who had been involved with HMG TF in various capacities. The interviews took place between December 1995 and May 1996. The interviewees had been involved with HMG TF at different times from the start of the exercise in Autumn 1993 to the appearance of the reports in the Spring of 1995. Interviewees were selected to represent a broad range of types of involvement in order to try and ensure that all issues were identified. The rationale for these interviews followed that of the practitioner research approach used in the R&D Management Centre; that in order to help define the detailed research topics to be explored one must identify those issues which concern those who are active participants in the particular field being studied.

3.3 Interview Method

Questioning was kept to a minimum, since the purpose was to identify issues of concern to participants. Participants were invited to talk about their personal experiences of HMG TF, and also wider Technology Foresight issues, from their own perspective. It was generally the case that, having been advised in advance that the researcher was interested in their involvement in HMG TF, the interviewees were keen to talk without the need for formal questioning. However, where necessary use was made of trigger comments such as "I understand that you were on the xyz Panel" or "I understand that you gave a paper on abc recently", to stimulate conversation. Direct questions such as "What is your opinion of the Delphi survey" were not asked. The interviews lasted between twenty minutes and one hour. Table 1 describes the interviewees in order by interview date and indicates their positions and involvement in the TF process.

Table 1: Brief descriptions of interviewees involved in exploratory open interviews.

	Position	Involvement in HMG TF
1	University Head of Department	"Interested Bystander" - Interested in the findings but did not participate in consultative process stages.
2	Independent Consultant	Advisor to OST
3	University Head of Department	Panel Member, EPSRC College Member
4	University Pro Vice-Chancellor	Panel Member
5	Head of a Research & Technology Organisation (RTO)	"Independent Player" - RTO conducted own Foresight exercise.
6	University Senior Research Officer	Delphi Participant, Foresight Challenge Bidder
7	Independent Consultant	"Independent Player" - Commentator on HMG TF.
8	Managing Director of an SME	Panel Member
9	University Head of Department	Delphi Participant, Expert Advisor to Panel
10	Head of R&D of a PLC	Panel Member
11	OST HMG TF Panel Secretary	Panel Secretary
12	Head of R&D of a PLC	Delphi Participant, EPSRC College Member

3.4 Interview Results and Analysis

Interviewees generally had a great deal which they wished to say concerning their experience of HMG TF, and little prompting was required.

The interviews yielded 214 individual statements to which content analysis was applied. All statements were combined into one list and were then grouped by inspection into 19 topic areas. For example, the three statements reproduced below, plus other similar ones, were grouped into a topic area which we named "Application of the Delphi process".

> *"The wealth creation questions on the Delphi questionnaires were on occasions a thinly disguised market survey."*
>
> *"The Delphi process involved high effort and high cost for a small contribution to the overall output."*
>
> *"Some of the information gathered was not used, but wasted."*

We refer to the topic areas identified in this way as *concerns* as they represent the concerns expressed by the interviewees. Table 2 lists the concerns and their definitions. The names and definitions of concerns in Table 2 were assigned by ourselves, having regard to the statements grouped under each concern.

The number and frequency of mention of concerns by interviewees are given in Table 3.

3.5 Completeness of the List of Concerns

From the bottom row in Table 3, it can be seen that after the eighth interview no new concerns were found. We therefore consider it very unlikely that a concern has been missed, and thus that 12 interviews was sufficient for the purposes of identifying the concerns of participants in HMG TF. This claim remains valid even if the interviews were rearranged in a "worst case" order, i.e. with the least-identified factor (which was identified by only two interviewees) occurring in the eleventh and twelfth interviews, so that all 19 factors would have been identified by the end of the eleventh interview.

Furthermore it is suggested that a plot of the number of new concerns raised in each interview (with the interviews in chronological order) may be presented in the form of a gamma distribution (Milton & Arnold, 1990). On this basis eight interviews could be expected to give 98.2% completeness while twelve would give 99.7%.

As an additional check intended to reinforce the claim of completeness, a second series of interviews was conducted with the original interviewees. This time the interviews were semi-structured, with each interviewee being asked a common series of questions based on the 19 concerns and invited to suggest any further concerns beyond the 19.

For example, the questions applicable to the concern "Application of the Delphi Process" were:

- Do you believe that the Delphi questionnaires were of value within TF? (Yes or No)
- Do you have any comments on the manner in which the TF Delphi exercise was conducted?

No new concerns were suggested. This was taken as another confirmation of the completeness of the list of concerns. The answers to the questions were recorded and retained for further use later in the research.

3.6 Evidence of Dissatisfaction with HMG TF

We categorised every statement made according to whether a positive, negative or neutral feeling about the interviewee's experience of HMG TF was expressed. We defined positive, negative and neutral statements as follows:

Positive:	Statements expressing approval, enthusiasm, agreement etc.
Negative:	Statements expressing criticism, lack of enthusiasm, disagreement etc.
Neutral:	Statements which are not either obviously positive or negative, or statements containing both positive and negative aspects which "cancel out".

The categorisation was carried out independently by both authors and by a third individual. Each assessor's total "score" of positive, negative and neutral categorisations appears in Table 4.

Averaging the three scores reported in Table 4 gives 42 positive statements and 99 negative, so it could be suggested that twice as much dissatisfaction was expressed as satisfaction.

Of the 214 statements, all three assessors agreed on 111, two out of three agreed on 97, and in only six cases did each assessor categorise the statements differently. The following examples are drawn from the 111 statements in which there was unanimity of marking:

Positive:	*"Technology Foresight is a bridge between industry and academia"*
	"Networking is a benefit of Technology Foresight"
Negative:	*"Many people in industry don't know about Technology Foresight"*
	"The Technology Foresight process was under-resourced"
Neutral:	*"I participated in two Panels' Delphi exercises"*
	"There is a need to side-step the international competition"

Table 2: The 19 Factors or Concerns identified from the exploratory open interviews.

Concern		Definition (where required)
E	Conduct of the Panel process	Role and operation of the Panels within the HMG TF exercise.
D	Selection of the participants	Composition of the HMG TF Panels and involvement of other players throughout the exercise.
G	Application of the Delphi process	
J	Form and content of the Panel reports	
P	Follow-up activities	Follow-up activities staged or planned following the publication of the HMG TF Panel reports.
N	Impact of HMG TF on policy	Impact of HMG TF on HMG SET policy issues.
A	Definitions of Technology Foresight	Different understandings of HMG TF and its scope.
L	Impact of HMG TF on industry and commerce	
H	Political influences	Political influences on HMG TF.
U	Foresight Challenge Competition	
B	Awareness of HMG TF	Interviewees' experience of the awareness of HMG TF among those they are in professional contact with.
C	Timespan of the forward look	Timespan of the forward look taken within HMG TF.
Q	Internal foresight exercises	Links between HMG TF and in-house foresighting activities carried out by businesses, trade associations, research organisations and other bodies.
R	Networking through HMG TF	Networks established as a result of the HMG TF exercise.
S	International comparisons	Comparisons drawn between HMG TF and similar exercises conducted by other nations.
K	Involvement of SMEs in HMG TF	SME involvement in the HMG TF and its impact on SMEs.
M	Impact of HMG TF on R&D funding	Impact of HMG TF on existing funding regimes and potential influence on future funding.
T	Frequency of HMG TF	Opinions on the frequency with which HMG TF should be conducted and the issue of whether or not HMG TF should be a rolling programme.
F	Operation of the consultative workshops	Role and operation of the consultative workshop phase of HMG TF.

Table 3: Number and frequency of mention of Concerns by interviewees in open interviews. (NB : Multiple statements on a concern made by an interviewee are not identified in the main body of the table but are counted in the right-hand column. In the main body of the table "1" indicates that the concern was mentioned by an interviewee and "0" indicates that the concern was not mentioned.)

CONCERN	INTERVIEWEE												NUMBER OF INTERVIEWEES MENTIONING CONCERN	NUMBER OF STATEMENTS MADE ON CONCERN
	1	2	3	4	5	6	7	8	9	10	11	12		
E	0	0	1	1	0	1	0	0	1	1	1	1	7	29
D	0	1	1	0	0	1	0	1	1	1	1	0	7	22
G	0	1	1	1	0	1	0	0	1	0	1	1	7	20
J	1	0	1	0	1	1	0	1	1	0	1	1	8	17
P	0	0	0	1	1	0	0	1	1	1	1	0	6	19
N	0	0	1	1	0	1	1	0	0	1	1	1	7	12
A	0	0	1	1	1	1	1	0	0	1	0	1	7	12
L	0	0	0	0	0	1	1	1	0	1	1	1	6	9
H	0	0	1	1	0	1	1	1	0	0	0	0	5	10
U	0	0	0	0	0	1	0	0	0	1	0	1	3	11
B	0	1	0	1	0	0	0	1	0	1	0	0	4	8
C	0	0	1	0	0	0	0	1	1	1	0	0	4	8
Q	0	1	0	0	1	0	0	1	0	0	0	0	3	9
R	0	0	1	1	0	0	1	1	0	1	0	0	5	5
S	0	0	1	0	0	0	1	0	1	1	0	0	4	6
K	0	0	0	0	0	0	0	1	0	0	1	1	3	6
M	0	1	0	1	0	1	1	0	0	0	0	0	4	4
T	1	0	0	1	0	0	0	1	0	0	0	0	3	4
F	0	0	0	0	1	0	0	0	0	0	0	1	2	3
No. CONCERNS MENTIONED	2	5	10	10	5	10	7	11	7	11	8	9	95	214
NEW CONCERNS RAISED	2	5	7	1	1	2	0	1	0	0	0	0		
CUMULATIVE RAISING OF CONCERNS	2	7	14	15	16	18	18	19	19	19	19	19		

Table 4: Assignment of open interview statements by three assessors.
(Assessors rated each of 214 statements about HMG TF as being either positive, negative or neutral.)

	AUTHOR	AUTHOR	INDEPENDENT	AVERAGE
POSITIVE	28	43	56	42
NEUTRAL	102	54	61	72
NEGATIVE	84	117	97	99

3.7 Identification of the Most Significant Concerns.

Table 3 shows that one third of all statements made were on just three concerns:

- E Conduct of the Panel process
- D Selection of the participants
- G Application of the Delphi process

In Table 5 more detail is given of the categorisation by the assessors of the statements which contribute to each concern. It can be seen that for the three most popular concerns, the statements were categorised as predominantly negative.

Table 5: Details of assignment of exploratory open interview statements by three assessors. (NB: "+" indicates positive, "0" indicates neutral and "-" indicates negative assignment. Fore example, "++0" indicates those statements that were regarded as positive by two assessors and neutral by the third.)

CONCERN	NUMBER OF INTERVIEWEES MENTIONING CONCERN	NUMBER OF STATEMENTS MADE ON CONCERN	Categorisation of Statements by Three Assessors							
			+++	++0	+00	000	00-	0–	—	Other
E	7	29	2	1	0	0	3	13	10	0
D	7	22	1	1	1	1	3	2	13	0
G	7	20	2	0	1	3	4	1	9	0
J	8	17	3	1	2	1	2	1	6	1
P	6	19	0	1	3	5	2	4	3	1
N	7	12	1	2	0	1	4	1	2	1
A	7	12	6	0	2	0	0	2	2	0
L	6	9	0	3	2	1	1	1	1	0
H	5	10	0	0	1	0	3	0	6	0
U	3	11	0	0	0	1	1	2	7	0
B	4	8	0	0	1	1	1	2	3	0
C	4	8	1	1	1	1	2	0	0	2
Q	3	9	4	2	1	2	0	0	0	0
R	5	5	4	1	0	0	0	0	0	0
S	4	6	0	0	2	2	1	1	0	0
K	3	6	0	0	0	3	1	1	1	0
M	4	4	0	0	3	0	0	1	0	0
T	3	4	0	0	3	0	1	0	0	0
F	2	3	0	0	0	0	0	0	2	1
	95	214	24	13	23	22	29	32	65	6

4. IDENTIFICATION OF A RESEARCH TOPIC

4.1 Common Theme of the Three Most Popular Concerns

These three most popular concerns each cover a different stage in the process of carrying out the HMG TF exercise. We now propose that these concerns may be grouped as a topic which we shall name "Skill in Application of Methods" and that the dissatisfaction of the interviewees arose from the manner in which the methods applicable to those stages of HMG TF were applied in practice.

4.2 "Skill in Application of Methods" as a Research Topic

We propose that, regardless of questions such as whether the methods used in HMG TF were well chosen, the question of how well they were applied in practice was directly relevant to our interviewees' personal experience of HMG TF. Most participants in HMG TF had given their time voluntarily to what they considered a worthwhile exercise but the statements made by our interviewees suggest that they felt that on occasions their time was wasted because of the way in the way the process was carried out.

This is borne out in statements like:

> *"The Technology Foresight process was under-resourced"*
>
> *"The way it has been done is a shambles"*
>
> *"Lack of support compromised the credibility of the exercise"*

We suggest that some of the methods used in HMG TF, such as questionnaires and Delphi consultation, are almost indistinguishable from methods that are well known in management research. In the field of management research it is recognised that researchers need firstly to be taught the methods and then to gain skill in their use through practice. To illustrate this point, the student author of this paper had to learn how to conduct interviews, carry out content analysis and compile questionnaires in order to carry out this research effectively, and this took time.

We suggest that in carrying out HMG TF it had not been fully recognised that skills would need to be acquired and experience gained before the plans could be carried out to best effect. We therefore propose that our subsequent research will be centred around concerns D, E and G and will concentrate on the topic of skill in the application of research methods in HMG TF.

There is a practical dimension to this choice, in that it limits the work to the non-political topic of methodology and confines it to processes of which we have some experience.

5. DISCUSSION

5.1 Mobilisation versus Operation

It is clear that the "mobilisation" aspect of HMG TF was fairly successful. Officials and consultants were appointed to carry out the organisational work, the voluntary efforts of a large number of participants were secured, the Panels did their work and reports appeared. However, it appears from the work described above that the "operation" aspect was less successful, at least as perceived by those involved.

5.2 A Procedural Model

We propose that once the methods for operating HMG TF had been chosen the following procedure could in principle have been followed in setting up and operating the exercise:

1. Take instruction in the use of methods;
2. Practice using the methods in order to gain skill;
3. Carry out the exercise.

It appears from the findings described above that steps 1 and 2 may have been weak. A future report will describe our further investigations of this hypothesis.

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