

**SWP 14/97 THE FOUR SCHOOLS OF THOUGHT IN  
RESEARCH AND DEVELOPMENT  
MANAGEMENT AND THE RELATIONSHIP OF  
THE LITERATURE TO PRACTITIONERS' NEEDS**

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ISBN 1 85905 102 2

## Introduction

In this paper we propose that there are four types of reasoning that can apply to the management of R&D and we present evidence that research on the topic of R&D management tends to assume that one type of reasoning is applicable to this activity whereas practitioners of R&D management tend to believe that a different type of reasoning is applicable. We have called these types of reasoning the four schools of thought.

We came to this idea as a result of looking out for an explanation of apparently illogical decisions that often occur in R&D management. We have been conducting a real-time case study of the continuing development of a particular technology within GEC ALSTHOM in recent years. It appeared to a participant observer that both small and large decisions within the company often did not appear logical. Small decisions concerned project approvals and terminations. A typical large decision was to purchase a technology from outside when it already existed within the company.

It is a current management theory that many problems arise because of lack of communication, but we have observed that in many situations all parties had the same information in front of them but after in-depth discussion they still differed completely on how to proceed. We conjectured that different players might simply think in different ways. Perhaps the difference is not the R&D situation but the way it is being perceived.

We found in our case study that over a five year period there were many occasions when unexpected events rendered current strategy irrelevant. When we have seen mention of such things in the literature they have always been seen as one-offs, not as a normal part of the R&D management environment. It therefore seemed to us that the literature did not address the problems being faced in a practical R&D situation. The literature appeared to describe a more deterministic environment than that being experienced.

### **Classifying publications on R&D management by their school of thought**

We read 655 papers relevant to a topic which we defined as "management concerns of the R&D section". This topic was chosen simply because one of us is a section level R&D manager, and he hoped to use knowledge gained from the literature to improve his understanding of his task. The papers ranged from slightly relevant to this particular topic to directly relevant.

While reading the papers it emerged that they appeared to be based upon four models of R&D activity. We called these **schools of thought** and named them

- **Biological**
- **Chaotic**
- **Deterministic**
- **Empirical**

To help with the classification of papers we developed definitions as follows;

**Biological** - the situation will change over time and what is needed is a management approach which can evolve. The building of an organisation capable of adapting is more important than the tactics for a particular project. The main concern is how to provide an organisation which is robust and adaptable enough to cope with events and changes as they occur.

**Chaotic** - this word is used in the mathematical sense of referring to situations which are acknowledged to be ultimately susceptible to logic, but which are too unstable or complex for logic in practice to be useful. The pattern of the chaos can be described, but a given case cannot meaningfully be worked out. You do not plan in detail, because things will change. Each case is individual, and it is a waste to put a lot of effort into trying to manage it.

**Deterministic** - in order to manage it is necessary to measure what is happening and apply logic. This approach concentrates on methods of measuring R&D outputs, for example by counting patent productivity or calculating return on R&D expenditure. This approach derives from the traditional production management approach

**Empirical** - a series of rules or guidelines is derived by empirical analysis of a large number of previous R&D projects. This “cookbook” approach assumes that universally applicable success factors can be derived from past experience without needing any theoretical justification for their importance. Project SAPPHO is a classical example of the popular success factor approach (1).

These definitions were developed in the light of reading the papers. Once fifty papers had been read, the definitions had stabilised. Subsequent classification of six hundred more papers did not give rise to the need for any further categories. We therefore concluded that these four forms of reasoning exist in our field, and that there are no others.

### **Confirmation by authors' opinions**

This hypothesis relies on the opinion of one person reading all the papers. We decided it would be a useful check to ask authors to classify their own papers into schools of thought, reasoning that if they gave the same allocations as we did, then the concept of schools of thought would be shown to have general validity.

We composed a questionnaire in which the definitions above were reduced to one line and we asked authors simply to tick which school of thought most closely described the conceptual framework in which their paper was set. The questionnaire is reproduced as Appendix A. (The questionnaire also asked other questions, which will be explained in a later section.)

The questionnaire was sent to 296 of the most recent authors. To date 121 responses have been received. 112 answered this question. Figure 1 shows that there was very strong agreement between our classifications and the authors' classifications.

		Our classifications			
		Biological	Chaotic	Deterministic	Empirical
Authors' classifications	Biological	22	0	0	5
	Chaotic	0	8	1	2
	Deterministic	0	1	35	5
	Empirical	0	0	3	30

Figure 1. Comparison of authors' allocation of their papers to a school of thought with our allocation of their papers.

The questionnaire allowed for authors to make a comment after answering this question. There were no significant comments, and no one offered a new category.

### *A change of terminology*

In figure 1 the category where agreement was least strong is Empirical. In fact in the questionnaire we called this school of thought "cookbook". The questionnaire returns showed that a few authors did not quite understand what was meant by this term and this was investigated by speaking to some of these authors. We decided to adopt the term "empirical" instead, which was felt to describe this school more accurately. In the version of the questionnaire shown in this paper the word "cookbook" has been moved into the definition, which is otherwise unchanged.

### **Schools of thought and author type**

While reading the papers it was noticed that there appeared to be a relationships between the backgrounds of the authors and various aspects of the papers, including the methodology used, the type of output of the paper, and the paper's school of thought. We investigated this by allocating attributes of methodology, author type and so on to the papers and examining relationships between these different attributes. We called this process **context analysis**. This technique and results obtained are the subject of a separate publication (2). Most of the questions in the questionnaire shown in appendix A relate to this.

Author backgrounds were **academic, consultant, corporate, practitioner** and **journalist**. Corporate means a hands-off corporate level manager. Practitioner means someone with hands-on involvement in R&D or its management. In figure 2, which is taken from reference (2), we see clear relationships between author type and school of thought.

<b>School of Thought</b>	Journalist	Academic	Consultant	Corporate	Practitioner	TOTALS
Biological	5	10	3	7	21	46
Chaotic	7	26	8	2	13	56
Deterministic	9	89	11	93	12	214
Empirical	30	189	55	46	11	331
None	1	6	0	1	0	8
<b>TOTALS</b>	<b>52</b>	<b>320</b>	<b>77</b>	<b>149</b>	<b>57</b>	<b>655</b>

Figure 2. **School of thought and researcher type.** A  $\chi^2$  test showed that the different pattern of output type for each type of author is statistically significant at better than 99% in each case.

### *Speculation on motives of author types*

We tentatively interpret these results as follows. The empirical approach requires research or collation of experience, and therefore will be favoured by academics and consultants, who need to base their contributions on some substantial work. The deterministic approach requires no substantial amount of work, since only reasoning ability is required. Corporate managers presumably see it as their function to apply reasoning, and therefore strongly favour this approach. It is less clear why journalists might favour the cookbook approach, since presumably they do not undertake the substantial amounts of work that academics and consultants put in. Perhaps journalists report what the others do, and so reflect their approaches. The chaotic school appears to leave little to be researched or acted upon, so perhaps that is why it is not favoured much by any group.

### *Researchers and practitioners*

The most notable finding from figure 2 is that practitioners subscribe much more uniformly to all four schools, but are strongest on the biological, which is least favoured by the other author types. Only 9 per cent of authors were practitioners but they wrote nearly half the biological papers. This raises a question about the match between the mind sets of those who supply research papers and those who presumably would be expected to benefit from them.

A further question arises. The large majority of practitioners must be non-publishers. What schools might non-publishing practitioners belong to? Does the literature favour a school of thought which is different from that of the majority of R&D practitioners? To investigate this we needed to find what school of thought non-publishing practitioners belong to.

### **Practitioners' schools of thought**

We presented a questionnaire to people attending a number of courses and conferences on R&D management, which asked for people's backgrounds and the school of thought which they believed most closely described the process of managing R&D. Most attendees were R&D practitioners and managers, and few had published. The questionnaire is presented in front of this paper. The totalled results from four events are shown in figure 3, below.

	Academic	Journalist	Consultant	Corporate	Practitioner	Other	TOTALS
Biological	1	0	2	15	8	7	33
Chaotic	4	0	2	11	5	3	25
Deterministic	4	0	1	3	2	2	12
Empirical	0	0	0	1	2	0	3
TOTALS	9	0	5	30	17	12	73

Figure 3. Schools of thought assigned to the R&D management process by non-publishing event attenders of different backgrounds. In figure 2 the category "other" does not occur because all authors were assignable to the first five categories.

Comparing the totals given for the four schools of thought in figures 2 and 3, it can be seen that the proportions present are reversed in the two cases. Figure 2 refers to the schools of papers whereas figure 3 refers to the schools ascribed to the R&D process by non-authors.

The sample is quite small but it can be seen that the non-publishing practitioners are even more strongly biological than their publishing colleagues. The non-publishing corporate people also favour biological and chaotic, which is not the case for their publishing colleagues. It might be argued that it is more difficult to conduct research and publish results that are useful in chaotic and biological situations than in the case of empirical and deterministic situations, which lend themselves to well known approaches.

## Discussion

The questionnaire to authors asked

"Which of the following most closely describes the conceptual framework in which your paper is set?"

The questionnaire to R&D people attending events asked

"Which of the following, in your experience, most closely describes the process of managing R&D?"

These questions are of necessity somewhat different, but since both questions were answered without difficulty, we argue that the schools of thought concept has validity both in the literature and in the practical situation. We now propose that it may also be applied to describe different ways people can think: all four forms of reasoning may be valid in different circumstances. We further suggest that different people have unconscious biases towards different schools and that this dominates the way individuals think and act.

The problem we started off with was "why do people sometimes appear to act illogically and why do people often fail to be of like minds about a problem". The four schools of thought theory provides a possible explanation, and if an organisation is aware of this, it may be possible to manage the R&D process more effectively.

Coming back to the factory, do we find that this now helps? We believe that this theory helps to explain some of the things which have happened in the case study and has proved valuable

in practical management. Our experience is that we can form an opinion of which schools of thought different people are driven by, and can act accordingly.

Finally we suggest that it may be that the four schools of thought apply to all types of management, and indeed to all types of reasoning.

### **Further work**

We are in the process of applying a questionnaire to a larger number of R&D managers within an organisation who are not only non-publishers but are not necessarily R&D management course or conference attenders either, in order to provide better data for figure 3.

We would like to be able to ask the question

“Which school of thought do you unconsciously subscribe to?”

In practice we think some sort of test needs to be applied. So far we have not devised one, and we would welcome suggestions as to how people could be brought to reveal whether they have an unconscious school of thought.

### **References**

(1) Science Policy Research Unit. *Success and failure in industrial innovation*. University of Sussex, report on project SAPPHO, 1972.

(2) Context Analysis - a technique for analysing research in a field. L. T. Falkingham and R. Reeves, Cranfield Working Paper SWP 1197, 1997.

**Appendix A      The questionnaire sent to authors**

Title of Paper; «TITLE»

Author(s); «AUTHOR» «Others»

Publication; «PUBLICATION» «REFERENCE» «DATE»

Respondent's Name; .....

Affiliation of Author; .....

**1. Degree of relevance of this paper to R&D Management;**

*Please Tick one.*

<i>Specific to R&amp;D</i>	1	2	3	4	5	<i>Not relevant to R&amp;D</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Comment; .....

**2. The background of the Author(s)**

	Main Contributor	Any second Contributor	Any third Contributor
<i>Academic</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Journalist</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Consultant</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>R&amp;D manager</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>R&amp;D practitioner</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comment; .....

**3. The main subject area of the paper.**

*Tick one*

	<i>Strategy</i>	<i>Tactics</i>
<i>Organisational structure or behaviour.</i>	<input type="checkbox"/>	<input type="checkbox"/>
<i>General management..</i>	<input type="checkbox"/>	<input type="checkbox"/>
<i>R&amp;D management.</i>	<input type="checkbox"/>	<input type="checkbox"/>

Comment; .....

**4. The methods used in the paper.**

	<i>Primary</i>	<i>Secondary</i>	<i>Tertiary</i>
<i>Drawing from experience.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Case Study.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Interview.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Theoretical discussion.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Review of literature.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Analysis of statistical or database information.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comment; .....



**5. Contribution of the paper to theory**

	<i>yes</i>	<i>no</i>
<i>Does it describe a theory?</i>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Does it test a theory?</i>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Not relevant to theory</i>	<input type="checkbox"/>	<input type="checkbox"/>

*Comment;* .....

**6. What does the paper give the reader?**

*Please Tick one.*

- A Measurement Technique.*
- A Recipe or set of rules.*
- Data or Information.*
- A theory or model,*
- Strategic concepts,*
- Operational concepts,*

*Comment;* .....

**7. Which of the following most closely describes the conceptual framework in which your paper is set?**

*please tick only one box.*

- Deterministic; R&D can be managed by logic and reason.*
- Cookbook; Empirical rules can be found that apply most of the time.*
- Biological; R&D management must adapt continuously to change*
- Chaotic; R&D is complex and variable, and there are limits to manageability*

*Comment;* .....

**8. Which papers of yours which are relevant to the management of R&D have we missed?;**

1) .....

2) .....

*Please append a list if necessary.*

**9. Which do you consider to be the three most significant papers relevant to the management of R&D by authors other than yourself?;**

1) .....

2) .....

3) .....

Thank you for your assistance. Please return the questionnaire in the envelope provided.

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## **Abstract**

We have found that publications in the literature on R&D management can be classified according to four different forms of reasoning about the R&D process, which we call schools of thought. We have also found that managers of research subscribe to the same four forms of reasoning. The fact that managers unconsciously think in one of four different ways about R&D management explains some of the problems that occur in practice. A preponderance of publications favour one school of thought, whereas a preponderance of practical managers favour a different one. This raises a doubt about the degree to which the published papers meet practitioners' perceived needs.