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# FOUR WAYS OF THINKING ABOUT R&D MANAGEMENT

We have found that managers of research subscribe to four different forms of reasoning about the R&D process, which we call Schools of Thought, and we propose that this explains some of the problems that occur in practice. We have also found that publications on R&D management can be classified according to the same four forms of reasoning; however, publications favor one school of thought while managers favor a different one.

We came to this idea after seeking an explanation for the apparently illogical decisions that often occur in R&D management. We had been conducting a real-time case study of the continuing development of a particular technology in one company, and it seemed to one participant-observer that both small and large decisions within the company often did not appear logical. (Small decisions concerned project approvals and terminations, whereas a typical large decision was to purchase a technology from outside when it already existed within the company.)

Although current management theory holds that many problems arise because of lack of communication, we have observed that in many situations all parties have the same information in front of them yet after in-depth discussion still differ completely on how to proceed. We conjectured that different players might simply think in

different ways; i.e., perhaps the difference lies not in the R&D situation but in the way it is perceived.

### Classifying Publications

We read 655 papers relevant to a topic 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 who 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.

The papers appeared to be based upon four models of R&D activity, which we called *schools of thought* and named them:

- Biological
- Chaotic
- Deterministic
- Empirical

To be able to classify the papers in this way, we developed definitions as follows.

1. *Biological*.—The situation changes over time and consequently a management approach is needed that can evolve. Building an organization capable of adapting is more important than the tactics for a particular project. The main concern is how to create an organization that is robust and adaptable enough to cope with change as it occurs.

2. *Chaotic*.—This word is used in the mathematical sense of referring to situations that are acknowledged to be ultimately susceptible to logic, but which are too unstable or complex for logic to be useful in practice. The pattern of the chaos can be described, but a given case cannot be meaningfully 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.

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Table 1.—Question Concerning Author's School of Thought

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: .....

Table 2.—Comparing Allocation of Papers

		Falkingham/Reeves Classifications			
		Biological	Chaotic	Deterministic	Empirical
Author's classifications	Biological	22	0	0	5
	Chaotic	0	8	1	2
	Deterministic	0	1	35	5
	Empirical	0	0	3	30

Table 3.—School of Thought and Researcher Type

School of Thought	Journalist	Academic	Consultant	Corporate	Practitioner	Total
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>Total</b>	52	320	77	149	57	655

Table 4.—School of Thought Assigned to R&D Management Process by Practitioners

	Academic	Journalist	Consultant	Corporate	Practitioner	Other	Total
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
<b>Total</b>	9	0	5	30	17	12	73

3. *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. It derives from traditional production management.

4. *Empirical.*—A series of rules or guidelines is derived by empirical analysis of a large number of 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 classic example (1).

These definitions were developed after reading 50 papers. Because subsequent classification of 600 addi-

tional papers did not suggest the need for any further categories, we concluded that these four forms of reasoning alone define our field.

**Confirmation by Authors**

Our hypothesis relied on the opinion of one person who read all the papers. Consequently, 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 above definitions were reduced to one line and authors were asked to indicate the school of thought that most closely

described the conceptual framework in which their paper was set. Table 1 reproduces the relevant question. The questionnaire also asked about the authors' backgrounds.

The questionnaire was sent to 296 of the most recent authors. Of 121 responses, 112 answered this question. Table 2 shows that there was good agreement between our classifications and the authors' classifications. In the language of the social sciences, the Four Schools is a robust construct. The correlation in Table 2 is amazingly strong for this type of study—in fact, almost perfect.

In Table 2, Empirical is the category where agreement was least strong. In fact, the original questionnaire called this school of thought “cookbook.” After the questionnaire returns showed that a few authors seemed not to understand what was meant by this term, we replaced it with “empirical.”

### Schools of Thought and Author Type

Having noticed relationships between the backgrounds of the authors and a paper's school of thought, we allocated an author background to each paper and compared it with its school of thought. 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).

Table 3 shows a clear relationship between author type and school of thought. It is taken from a separate publication in which we reported results of a wider study of various aspects of the papers, including the methodology used and the type of output of the paper, using a method we call context analysis (2). A  $\chi^2$  test showed that the different pattern of output type for each type of author is statistically significant at better than 99 percent in each case.

We interpret the results of Table 3 as follows: The Empirical approach requires research or collation of experience, and therefore will be favored by academics and consultants, who need to base their contributions on some substantial work. The Deterministic approach requires no substantial amount of work, because only reasoning ability is required. Corporate managers presumably see it as their job to apply reasoning, and therefore strongly favor this approach. It is less clear why journalists might favor the cookbook approach, since presumably they do not undertake the substantial 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 this is why it is not favored much by any group.

The most notable finding from Table 3 is that practitioners subscribe much more uniformly to all four schools, but are strongest on the Biological, which is least favored

**Non-publishing practitioners are even more strongly Biological than their colleagues who publish.**

by the other author types. Only 9 percent of authors were practitioners but they wrote nearly half of the Biological papers. This raises a question about the match between the mindsets 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 favor a school of thought which is different from that of the majority of R&D practitioners? To investigate this, we needed to find out which school of thought non-publishing practitioners belong to.

### Practitioner Schools of Thought

We next presented a questionnaire to people attending courses and conferences on R&D management, which asked for people's backgrounds and the school of thought they believed most closely described the process of managing R&D. Most attendees were R&D practitioners and managers, and only a few had published. The results from four events are shown in Table 4.

Comparing the totals given for the four schools of thought in Tables 3 and 4, it can be seen that the proportions present for each school are reversed in the two cases. Table 3 refers to the schools of papers whereas Table 4 refers to the schools ascribed to the R&D process by non-authors. Note that 50 percent of papers were Empirical, but only 4 percent of event attendees believe that “empirical” describes the R&D process.

The sample is 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 favor the Biological and Chaotic schools, 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 research approaches.

Finally, in case course attendees are a biased sample, we presented the questionnaire to 27 non-publishing, practicing R&D managers from one European multinational. The majority had over 10 years of experience in R&D management. Supplementary questions to this group showed that they had read very little about R&D management and few had attended courses on this subject. This group had an even higher preference for the Biological school—59 percent vs. the 47 percent (8 out of 17) in Table 4.

### Applying the Findings

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 as both were answered without difficulty, we argue that the schools of thought concept has validity both in the literature and in practice. We now propose that it may also be applied to describing different ways people think. All four forms of reasoning may be valid in different circumstances, but we suggest that different people have unconscious biases toward different schools and that this dominates the way they 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 organization is aware of this, it may be possible to manage the R&D process more effectively. First, it should be recognized that the different forms of reasoning exist, and then that individuals tend to be predisposed toward one of them. In any given situation, however, there may be one approach that is the most fruitful. In a situation which, for example, is by its nature chaotic, it would be inappropriate to appoint a deterministic person to manage it; a chaotic person, on the other hand, would be both comfortable and more effective. Our experience is that we can form an opinion of which schools of thought drive different people, and we can act accordingly.

Consider the following example of a group of engineering managers that was trying to agree on uniform practice for bolting together high-current copper conductors. The industry standard specified that a layer of silver should be applied between the two copper parts. It was found that half of the production units were silver-plating

both conductors, and half were silver-plating only one conductor. In a two-hour debate, a consensus view could not be reached on which practice to adopt as standard. The single-platers argued that they had always done it that way and there had never been any problems. The double-platers argued that if you plate one conductor, obviously you should plate the other, as the point of silver plating is to prevent oxidation.

In an attempt to break the impasse, it was proposed that further studies be carried out. The single-platers offered to recheck all their records and see how strongly experience actually did support their viewpoint. The double-platers said that this was not the way forward, and offered to commission studies of the metallurgical mechanisms to find out what was actually going on. After another extended debate, the two parties again failed to agree on the way forward.

This example involved both empirical and deterministic people. Having failed to agree, they proceeded to adhere to the same schools of thought when considering the new issue of a way forward, and once again failed to agree. It was not that people were necessarily defending initial positions. Some single-platers changed sides when they heard the arguments right at the beginning, and so did some double-platers. The fruitless debate could have been curtailed by recognizing that the two views would never be reconciled. Some problems are clearly deterministic and some clearly empirical, but this one fell on the boundary. Both arguments had merit. Stopping the debate and imposing one of the two solutions would have prevented further waste of time and effort.

This is an extreme example of the observation made at the beginning of this article that apparently illogical decisions are often made. We now see how decisions can be illogical to one party, but not to the other.

### Next Steps

We suggest that the four schools of thought may apply to all types of management, and indeed to all types of reasoning. We would like to be able to ask a person, “Which school of thought do you unconsciously subscribe to?” In practice, we believe 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

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