Turning hindsight into foresight - our search for the 'philosopher's stone' of failure

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Turning hindsight into foresight - our search for the ‘philosopher’s stone’ of failure

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Abstract

This paper tells the story of work using Systems thinking to study failure. It describes the methodological developments that have taken place in this area at the Open University and looks at how the emphasis has shifted from the examination of past failures to the prediction and prevention of future failures and the facilitation of organisational learning through the analysis of failures. It ends with an outline of some of the work on systems failures that is currently underway.

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1. INTRODUCTION

A wide range of Systems teaching and research has taken place within the Open University over the last quarter of a century. This has covered the spectrum from 'hard' to 'soft' and has encompassed a rich variety of domains including food production, co-operatives and the social economy, overseas development, industrial production and information systems. However, in terms of methodological development the area that has perhaps made the greatest contribution to systems methodologies and attracted most interest has been one which is applicable in all domains: the study of failure. This paper tells the story of the work that has been carried out in this area and describes some of the research that is currently underway.

2. CASES FOR TEACHING

When the Open University started teaching in the 1970s one of the ways in which it was profoundly different from almost all other higher education institutions was the age and career profile of its students. Across the student body was a variety and richness of experience that was unparalleled elsewhere. The consequence of this, in subjects such as Systems that are concerned with 'real-world' situations, was that students were able to draw on personal experience of the same or similar situations to those being studied. For instance, a tutorial in the East Midlands on Emery and Trist's work on longwall mining would have been very likely to have a miner as a member of the tutorial group whereas in other Universities at that time it was rare for students to have had any experience of work beyond jobs in the long vacation. The beneficial effect students' ability to draw on their experiences would have on their learning was quickly realised by academics writing Systems courses and right from the start they adopted a case study approach so as to capitalise upon it.

In adopting a case study approach one of the drawbacks encountered was the lack of availability of good source material with enough breadth and depth to allow sufficient scope for the rigorous application of systems concepts, techniques and methods. Publication of lengthy, detailed case studies was rare at that time and full-scale accounts of projects in management literature was in its infancy. However, one area where the conduct and findings of well-researched investigations were documented and placed in the public domain was disasters and accidents. For example, provisions for the investigation of civil air accidents have been in place since 1922 and its current counterpart the Air Accidents Investigation Branch (AAIB) of the Department for Transport, Local Government and the Regions (DTLR) publishes annual summaries of all reportable accidents, special bulletins after major incidents detailing the initial facts and Aircraft Accident Reports for the more major investigations. Indeed, AAIB's report of the Public Inquiry into the crash of Trident I G-ARPI near Staines on 18 June 1972 which was published in 1973 was soon to become a case study for OU Systems students.

Wider reading about disasters and accidents soon showed that there was very little academic work in the area apart from Jenkins (1969) who had used the need to avoid disasters as a major plank in his argument for the adoption of a systems approach to engineering and de Greene (1970) in his work *Systems Psychology*. Identification of this opportunity to fill a knowledge and application gap became the spur to new research, followed swiftly by the preparation of new teaching in the specific area of 'Systems Failures'.

3. EARLY METHODS

The first course in this area, TD342 Systems Performance: Human Factors and Systems Failures appeared in 1976. At the heart of the systems teaching within the course lay a series of 'questions for tackling a systems study' devised by Thomas. (See Figure 1.) These were used to examine cases such as the accident at Hixon level crossing on 6 January 1968 where an express train collided with a 120-ton transformer which was being transported along a road crossing the railway line. The crash took place at a crossing that should have been protected by an automatic half-barrier. For instance, one of the systems looked at in this situation was the 'transport safety system'. The main objective of this system was identified as the safe, quick transport of the transformer, its transporter and driver, crew and police from A to B. The constraints operating were: the traffic laws; physical constraints such as low bridges; the need to avoid damage to property and traffic infrastructure such as roads; and that the power to select the route was vested in the Ministry of Transport. The components of the system were identified as the transformer, vehicles, the driver and crew and the police. The wider system comprised Staffordshire Police Force, the haulage company and the Ministry of Transport. Other road users, railway personnel, trains, British Railways and the physical surroundings such as hills, corners, bridges, railway crossings and the like were part of the system's environment.

Figure 1 Questions for tackling a systems study (Thomas in Naughton and Peters, 1976)

The course also introduced a 'post hoc failures methodology' consisting of seven steps.

Step 0	Pre-analysis phase - an unstructured examination of the details of the situation being examined in order to determine whether a failure exists and whether it is significant.
Step 1	Development of a systems model/hypothesis of the failure situation in order to understand what happened and how it should have worked. (The systems questions set out in Figure 1 are used here to build up a picture of how the systems involved interacted to produce the failure.)
Step 2	Definition of a hypothetical system(s) and its activities which is relevant to the failure situation and which satisfies the 'necessary' set of objectives. (The 'necessary' set of objectives follows from Step 1. The objectives can be functionally determined and will probably include some of the objectives that were not met.)
Step 3	Comparison of the actual (from Step 1) and the hypothetical (from Step 2) systems to ascertain where and why the system failed.
Step 4	Selection of areas for further research and for experimentation.
Step 5	Selection, design, and implementation of feasible, desirable 'solutions'.

Step 6 Appraisal of the investigation.

A version of the methodology for looking at potential failures was also included. In this the purpose of the pre-analysis was to determine the problems intrinsically worth studying within a particular potential failure area and Step 1 looked at how the system usually worked and what could happen. The remaining steps were very similar to those in the 'post hoc' methodology except they were concerned with what might happen rather than what had happened.

The methodologies were found to be powerful and robust. They met their main teaching aim which was to provide a vehicle for the introduction and assimilation of systems concepts and techniques but they also provided students with the opportunity to gain understanding of failure situations which were important to them. The range of applications was huge, varying greatly in terms of scale, domain and type of failure. Just to cite a few examples, they included: the failure of the airship as a form of passenger transport consequent on the loss of the *Hindenburg* which exploded at a mooring mast in the US in 1937; the operation of a suburban health centre where the behaviour of the receptionists had been the subject of a large number of complaints; overhead travelling bridge crane accidents; and a study of a train derailment which occurred in Nuneaton in 1975.

Although pedagogy had driven the development of the methodologies the level of interest in them within and outside the student body showed that work to develop them further would be worthwhile. This work led to The Failures Method (Bignell and Fortune, 1984). This has subsequently been subject to revision and a more recent version will be described briefly in the next section. (A more detailed treatment can be found in Fortune and Peters (1995).)

4. THE SYSTEMS FAILURES METHOD

Fundamentally, the methodologies that appeared in TD342 and the Systems Failures Method work in the same way. They are based on conceptualisation and modelling of the problem or failure situation as a system or systems and they operate through a process of comparison. The main difference between them is that the nature of the comparisons is specified much more closely in The Systems Failures Method. They begin with a comparison between a systems representation of the situation and the Formal System Model (FSM). The FSM was developed from Checkland (1979) and was first published in 1984. (See Watson, 1984.) It is a model of a robust system that is capable of purposeful activity without failure. Subsequent comparisons, using other systems-related models concerned with control and communication and devices for looking at human aspects of the situation, are triggered through this use of the FSM. The Systems Failures Method is shown in Figure 2.

The FSM appears as Figure 3. The formal system itself comprises a decision-making subsystem, a performance-monitoring subsystem, and a set of subsystems and components that carry out the tasks of the system and thus effect its transformations by converting inputs into outputs. Other features of the model include: a continuous purpose or mission, a degree of connectivity between the components, an environment with which the system interacts, boundaries separating the system from its wider system and the wider system from the environment, resources, and some guarantee of continuity. Because of the hierarchical nature of the model, each of these subsystems can also be perceived as a formal system with its own decision-making, performance-monitoring and transformation-effecting components, and for complex situations it is often necessary to conduct analyses at these various levels.

Figure 2 The Systems Failures Method

Figure 3 The Formal Systems Model

The stages of The Systems Failures Method are:

Stage 1	Pre-analysis	Definition of the viewpoints and perspectives from which the study is being carried out and examination of the situation from the various viewpoints that have been identified as important.
Stage 2	Identification of significant problems	More precise specification of the problems in accordance with the outcomes of Stage 1 and structuring of relevant aspects of

	and/or failure(s)	the situation into a range of possible systems.
Stage 3	System selection	Selection of system(s) to be carried forward to Stage 4. (For the purposes of analysis, the problems are regarded as the outputs of the selected system(s).)
Stage 4	System modelling	Representation of the system using the Formal System Model format. (Models at different hierarchical levels may be needed.)
Stage 5	Comparison	Comparison between the output of Stage 4 and the FSM.
Stage 6	Further analysis	Further investigation of the discrepancies between the systems representation of the situation and the FSM.
Stage 7	Synthesis	Remodelling of the system at various key levels.

Figure 4 provides an example of the output from Stage 4. The analysis was undertaken to amine the failures associated with the emergency rescue system as it fought to save the passengers and extinguish the aircraft fire at Manchester International Airport on the morning of 22 August 1985. An engine had shattered as the aircraft tried to take-off, rupturing a fuel tank. Of the 136 passengers and crew on board, 48 were killed by the smoke and toxic gases from the resulting fire and six were burnt to death.

Figure 4 The emergency rescue system in the form of the FSM (Fortune and Peters, 1995, p. 114)

One of the major discrepancies revealed by comparison between the emergency rescue system and the FSM was that the initial design of the system was not formulated effectively. This led to delays in fighting the fire because there were problems with the arrangements to escort local authority fire service vehicles from the appropriate rendezvous point to the site of the crash. Comparison also revealed that the provision of resources to the system was not adequate in that the fire hydrants nearest to the crash site were all empty. In addition, performance information was not supplied to the performance monitoring system or the wider system during the event.

5. LEARNING

It is fair to say that for a long time the work described here was seen, almost entirely, as a way of looking at individual situations (for example, a particular aircrash, a specific construction project, an identified suburban health centre) or at groups of very similar activities or events (for example, overhead travelling bridge crane accidents, science teaching in primary schools, the command and control structure for policing major incidences). However, more recently emphasis has switched to the promotion of learning from failures.

Quotations asserting the value of learning from failure can be found from a long list of illustrious sources. Examples include the following.

Sir Humphrey Davy, 1778–1829	“The most important of my discoveries has been suggested to me by my failures.”
Thomas Edison, 1847–1931	“Just because something doesn’t do what you planned it to do doesn’t mean it’s useless.”
Carl Jung, 1875–1961	“The psychotherapist learns little or nothing from his successes. They mainly confirm him in his mistakes, while his failures on the other hand, are priceless experiences in that they not only open up the way to a deeper truth, but force him to change his views and methods.”
Kenneth Boulding, 1910–1993	“Nothing fails like success because we don't learn from it. We learn only from failure.”

Russell Ackoff, 1919–	"When one does something right, one only confirms what is already known: how to do it. A mistake is an indicator of a gap in one's knowledge. Learning takes place when a mistake is identified, its producers are identified and it is corrected."
Bill Gates, 1955–	"It's fine to celebrate success, but it is more important to heed the lessons of failure. How a company deals with mistakes suggests how well it will bring out the best ideas and talents of its people and how effectively it will respond to change."

The change of emphasis to learning from failure began with some work carried out for the Department of Health. The brief was to look at accounts of past attempts, mainly in the US and Canada, to introduce electronic patient record systems into acute hospitals with a view to informing a large three-year strategic research and development programme which had been set up to establish a successful system at a couple of demonstrator sites in the UK. The success of this work showed that The Systems Failures Method could be used to prevent failure in a new system by uncovering lessons from elsewhere.

At the same time parallel work on change management elsewhere had led to an investigation of the factors inhibiting risk taking. Both pieces of work emphasised the value of reflecting on previous mistakes and the need to regard failures and recovery from them as an inherent part of the normal management processes of an organisation.

It has long been accepted that the ways in which an individual learns a task is reliant upon mistakes being made and appropriate lessons being drawn from them; the breakthrough was the recognition that the same model could also be applied to organisations. Thus a "learning organisation" can be thought of as one which routinely gathers information about its failures (as well as its successes) and uses it to improve and change its structure and activities. However, even this simplistic view of learning depends for its success on the quality of the information and intelligence upon which it is based and there has been a lack of robust methods for gathering information and turning it into useful intelligence. At the very least, therefore, that The Systems Failures Method provided just such a method and so was an important tool for improving organisational learning. This was the approach taken in the Department of Health study above. A discrete attempt to learn a specific set of lessons from a particular set of previous initiatives (failures).

However the general applicability of The Failures Method permits its much wider usage in an organisational context. The next level of generality would be to use it regularly within an organisation in a variety of different contexts so that generic lessons could be learned. At present work is underway to identify a set of organisations that can trial this approach. The next phase of work will involve moving up to the next level of generality where in effect The Failures Method can be conceived as a method for an organisation to "learn to learn".

6. FURTHER DEVELOPMENTS

In addition to pursuing this work on learning from failures efforts have continued to develop The Systems Failures Method still further. Two examples of this activity will be looked at here, both of which involve the FSM. The first is being undertaken by Diana White who is developing a version of the FSM for use in the important area of project failure. She has gathered extensive information of three projects as they were being undertaken and is testing the model she has devised (see Figure 5) to determine the extent to which it explains the success or failure of each of the projects.

Figure 5 Project version of the FSM

As part of a programme of research which look at the application of systems thinking to modern policing Trevor Pearce has been looking at the best way of taking on board ethical issues and dealing with situations where there are conflict between the rights of various groups and individuals. His work to date shows that in terms of policing systems the FSM does not take sufficient account of ethical issues and though it deals well with conflict between the formal system and the environment it takes a unitary view within the formal system itself. He is investigating whether heuristics may provide a platform to enable the FSM to be developed to take better account of these issues.

7. CONCLUSION

So the work on failures continues at The Open University. This paper has described its origins and looked at the way it has progressed. But where is it going? Sadly, one thing is very true. The work is not running out of subjects to examine. Every day the media bring tales of new disasters and, if anything, the failure rate of projects and the like seems to be on the increase. Therefore, like all other areas in the systems field the failures work can continue round and round the learning cycle as attempts to use it generate new insights and opportunities to develop further.

There never will be an end to failure but perhaps if the rotations around the cycle continue and are productive enough we shall reach the end point where hindsight can be turned into foresight through the use of systems thinking.

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