

Chapter 1 The ‘systems crisis’

1.1 Systems spark a scientific revolution

The world is changing at an increasing rate. The technological advances of recent decades have enabled us to build powerful general purpose systems that can be adapted for a seemingly boundless variety of uses, and can be interlinked across the globe. The potential of the new technologies appears to be almost limitless, allowing complicated problems to be tackled and solutions of unprecedented complexity attempted.

Not all ambitious projects succeed. One by one, prestigious high-profile projects report embarrassing delays, many are subject to severe budget overruns, lead to disappointment, or even humiliating failure. Some of these projects affect more than their client and supplier: their impact extends to the whole community, including the taxpayer at a remote part of the country who may have had to contribute towards them from his/her taxes. Since technology appears to pose no obstacle, the fate of these projects is determined by the intellectual prowess and managerial acumen of the problem solver. Apparently, technological advance has outstripped our capability to understand its implications and manage its uses!

Management must always shoulder the blame, but lack of success often stems from the inherent complexity of the problem itself, and from the dearth of suitable methods of solution.

- Most of today’s important problems are deeply embedded in their environment. When important projects fail, the inevitable post-mortems reveal that some projects were undertaken without proper appreciation of the task on hand, without isolating the problem and defining its boundaries, without identifying the key characteristics of the problem and specifying the desired solution, without drawing up an appropriate project plan.
- Even if project teams included all the right experts, communication within the team may not have been effective. Consequently cooperation suffered, designs became sketchy, deadlines slipped, costs escalated.
- When a complex system is finally built as a solution, often it proves to be capricious, unwieldy and all but unmanageable. When powerful but unpredictable systems are put into service, the manager is like the sorcerer’s apprentice: in charge of powerful devices over which he/she has no control. Therefore, industrial plants, public utilities, essential services and major organizations are in potential jeopardy, and whole sectors of society are placed at unacceptable risk. Some project failures lead to major loss of resources, and some even to loss of life.

In recent decades it became customary to blame the ubiquitous computer. The ‘software crisis’ caused trepidation among computer users, and the alarm soon

spread to the community. A few years ago the headline in a quality paper read: “Computer disasters have cost billions” [1]. More recently the software crisis has given way to a ‘systems crisis’: cause for even more general concern. Last year, a whole television series was devoted to major disasters in complex systems, and by no means were all attributable to the computer. The source of the trouble is a phenomenon identified in the famous book of T.S. Kuhn [2] as ‘scientific crisis’. A scientific crisis exists when even the best professional practices persistently prove inadequate for solving some intrinsically important problems.

Kuhn shows that the way out of a scientific crisis is ‘scientific revolution’: a fundamentally new approach, calling for the definition of new concepts, and for the development of new methods and tools. In Kuhn’s sense, such a comprehensive conceptual and methodological framework constitutes a ‘*paradigm*’ [3]. At the heart of a paradigm is an overall concept accepted by most people in a community because of its effectiveness in solving important problems and explaining ideas or observations. A new scientific paradigm:

- provides scientific foundations for tackling problems that previously defied solution,
- is progressive: it provides a new, more powerful platform for problem solving, while also preserving accumulated knowledge and experience, and harnessing existing scientific disciplines.

The numerous and varied unsuccessful projects and unsolved problems have some important characteristics in common. They involve complicated adverse situations whose resolution calls for the coordinated effort of experts from different fields. The situations are multifaceted, and the solutions are made up of many intricately interrelated parts. The generic term for such an assembly is ‘system’. The current day scientific crisis calls for a *systems paradigm*.

1.2 A ‘systems paradigm’

As all scientific paradigms, a systems paradigm is not just a single concept but a comprehensive collection of mutually complementary ideas, some already well established, others still under development. One may list the key features:

- A systems paradigm must build on the *established disciplines* of science, computing, engineering and management.
- A systems paradigm must be widely *accessible*: comprehensible by any interested person, including members of the Board of the organizations involved with the project, senior management and technical staff, subcontractors and specialist experts, personnel, customers, the public, local politicians and members of Government. For this, the concepts of the paradigm must be clearly defined, the *definitions* must be consistent, and must form a coherent structure. It is helpful if the paradigm incorporates some kind of formal *notation* to aid comprehension and avoid ambiguity.
- The systems paradigm must utilize the advanced principles of *quality*. According to these, a project must not only satisfy the client – the paying