

THE ORIGINS OF MODERN PROJECT MANAGEMENT

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See also: *'A Brief History of Scheduling - Back to the Future'*
www.mosaicprojects.com.au/Resources_Papers_042.html

'Trends In Modern Project Management - Past Present & Future'
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The Origins of Modern Project Management

Introduction

Projects in one form or another have been undertaken for millennia:

- the ancient Egyptians constructed the pyramids some 4500 years ago;
- Sun Tzu wrote about planning and strategy 2500 years ago (every battle is a project to be first won; then fought¹);
- numerous transcontinental railways were constructed during the 19th century and
- buildings of different sizes and complexity have been erected for as long as mankind has occupied permanent settlements.

However, it was only in the latter half of the 20th century people started to talk about 'project management'; earlier endeavours were seen as acts of worship, engineering, nation building, etc. And the people controlling the endeavours called themselves priests, engineers, architects, etc. Whilst the Manhattan Project to build the atomic bomb in the 1940s is generally considered the first 'program', its managers primarily saw their roles either as military officers or scientists.

For the purposes of this paper, there is an important distinction to be drawn between projects: 'a temporary endeavour undertaken to create a unique product, service or result²' and project management or at least the profession and practice of 'modern project management' as it is embodied in the various project management associations around the world. In this context, 'modern project management' is a phrase used by the author and others³ to describe the management of projects in the way described by organisations such as the APMⁱ (UK) and PMIⁱⁱ in their respective 'bodies of knowledge' (BoKs) - both current and former.

This paper will discuss three themes. Firstly a brief look at the evolving processes of schedule analysis (CPMⁱⁱⁱ) and other project management tools - the technology. Second, the evolution of management science through to the 20th Century that laid the foundations for the development of modern project management as a distinct branch of general management and finally the 'serendipity' that brought these two factors together to create a new profession.

Developing the Technology

The invention of the Critical Path Method (CPM) and Scheduling^{iv}

Starting with the industrial revolution, management science evolved through the 19th and 20th centuries (discussed in the next section), and various processes, tools and techniques were developed to help identify and control business functions. Some of these tools directly related to project management included:

- The Barchart, which can trace its origin to 1765. The originator of the 'bar chart' appears to be Joseph Priestley (England, 1733-1804) in his '*Chart of Biography*'. Henry L. Gantt, popularised the concept in the USA some 150 years later in his book, *Work, Wages, and Profits*, published in 1916.
- Flow-Line scheduling in the 1930s. Among other projects, Flow-Line was used to schedule the construction of the Empire State Building in record time⁴,

ⁱ Association for Project Management

ⁱⁱ Project Management Institute Inc.

ⁱⁱⁱ Critical Path Method

^{iv} See also: *A Brief History of Scheduling* - www.mosaicprojects.com.au/Resources_Papers_042.html

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- the LOB (Line of Balance) technique developed by the Goodyear Company in the early 1940s and adopted by the U.S. Navy in the early 1950s for the programming and control of both repetitive and non-repetitive projects, and
- Milestone Charts in the 1940s.

The first 'project' to add science to the process of time control was undertaken by Kelley and Walker for E.I. du Pont de Nemours. The meeting that approved the funding for this project was held in Newark, Delaware, USA on the 7th May 1957 and as they say, the rest is history⁵. In 1956 Kelly and Walker had started developing the algorithms that became the 'Activity-on-Arrow' or ADM method of critical path scheduling after approval of funding for the development project. The computer program they developed was trialled on plant shutdowns in 1957 and the first paper discussing the critical path method (CPM) of scheduling was published in March 1959⁶.

These developments were closely followed by the development of the PERT system. The US Air Force translated PERT into PEP (Program Evaluation Procedure) and a host of similar systems appeared over the next few years. Whilst CPM and PERT use the same basic approach, including the Activity-on-Arrow network diagram, PERT focused on time as the key variable (what varied was the probability of hitting a milestone or completion date) where CPM 'fixed' time and the cost of achieving the target time varied. The cost variable component of CPM quickly faded from use. The time variable PERT approach lasted longer and was eventually replaced by the more accurate Monte Carlo analysis. Modern tools based on the Monte Carlo approach such as Pertmaster^v are capable of calculating time and cost variables at the same time.

In Europe, the Operational Research Section of the UK Central Electricity Generating Board (CEGB) was also working on similar ideas to Kelley and Walker in the period 1955 to 1958. They developed the term the 'longest irreducible sequence of events' and applied their system to the shutdown and maintenance of Keadby Power Station, Leicestershire in 1957. The use of CEGB - CPM achieving a saving of 42% compared to the previous overall average time for similar shutdowns⁷. However, whilst some of the CEGB work may pre-date 7th May 1957 (as did some of Kelley and Walkers), I have been unable to find any data to substantiate a significant milestone when work on the CEGB - CPM 'started'. Consequently, as the CEGB-CPM developments remained largely within the CEGB and the first major use of the methodology grew out of the work at du Pont in 1957, I have selected the documented start of the du Pont project as the most clearly defined beginning date for 'critical path scheduling' as we know it.

The Precedence (PDM) methodology was developed by Dr. John Fondahl as a 'non-computer approach to scheduling' and the results published in 1961 (the initial contract for this work was issued to Stanford University on 1st July 1958⁸). PDM was developed into a computerised tool by H.B. Zachry Co of Texas and then commercialised by IBM as its 'Project Control System' software⁹. The initial 'publicity' surrounding scheduling focused on PERT, this was fairly quickly overtaken in the commercial world by CPM (Activity-on-Arrow networking) founded on the work of Kelley and Walker and by the end of the 60s PERT and CPM had merged into a general 'Activity-on-Arrow' networking approach to scheduling. However by the mid 1970's the trend towards Precedence networking was gaining momentum and by the 1990's Precedence had become the dominant method of scheduling.

The development of scheduling is discussed in depth in *A Brief History of Scheduling - Back to the Future* (see: www.mosaicprojects.com.au/Resources_Papers_042.html). However, the US Government quickly realised schedule control was only part of the answer. The US Military and

^v See www.mosaicprojects.com.au/Tools.html#Pertmaster

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NASA developed a range of new tools (or refined the use of existing tools) including among many, the WBS (Work Breakdown Structure), PERT/Cost, PERT-RAMPS (Resource Allocation & Multi-Project Scheduling), etc. leading to the Cost/Schedule Control Systems Criteria (C/SCSC or C/SC²) developed during the 1960s¹⁰. This proliferation of systems was opposed by the major US contractors and refinements and simplification occurred, however, the importance of these developments in underpinning the processes of project management were critical and many elements such as the WBS and Earned Value^{vi} which grew out of this period are now core project management processes and others developed at the same time such as Configuration Management and Value Engineering are gaining in importance. Arguably, with the exception of Risk Management no new principles of cost, design, or schedule control have been developed since Earned Value, Configuration Management, Value Engineering, Precedence Scheduling and Resource allocation in the mid 1960s¹¹.

Some of the more recent developments in this area that post-date the 1994 Morris book used as a reference for much of this section, include Critical Chain, Earned Schedule and portfolio management tools. Whether these constitute 'new principles' or are merely improvements on existing processes remains to be seen.

If the central hypothesis defined in this paper is proved, the 7th May 2007 was not only the 50th anniversary of the development of 'critical path scheduling', but also the 50th anniversary of the start of 'modern project management' as we know and practice it.

The invention of the 'Iron Triangle' – Time, Cost and Output

Dr Martin Barnes (UK) first described the 'iron triangle' of time, cost and output (the correct scope at the correct quality) in a course he developed in 1969 called 'Time and Money in Contract Control'^{vii}; interestingly, even then the course was not entitled 'project control'¹².

Whilst all three elements have always been important, the evolution of scope and cost control into relatively precise processes occurred with the industrial revolution in the 18th Century. Whilst time control was important, and many projects such as the Crystal Palace^{viii} were built in remarkably short times, 'scheduling' lacked science and recognition until very much later.

This situation continued, despite advances in process/production controls and the development of various 'Gantt Charts' (including the 'modern barchart') by Henry Gantt in the early 1900s^{ix}. In

^{vi} The modern 'Earned Value' standards in the USA, Australia, etc have developed from the C/SCSC systems promulgated by the US Military. Similarly, some of the earliest 'standards' for WBS were US 'MIL Standards'.

^{vii} In 1968, Dr. Barnes went on to develop a Fortran mainframe computer program that integrated cost, time and resources and could show the effect of decisions about the work and how it affected both cost and time simultaneously. He commercialised this in 1971 with John Gillespie as a COBOL version; the program was called the Project Cost Model (PCM), it treated a project as a plan which produced both the cost and time forecasts, broken down into (or built up from?) plans for doing each activity which led to a budget and a programme. Dr. Barnes said "You could do 'what ifs' and all the other clever things but it was quite difficult as the input was all on punched cards and the only output was voluminous line printer output. Nevertheless we sold it to some quite big project outfits such as the CEGB and Costain in the UK and Anglo-American in South Africa - at a huge price. We are talking early 1970s".

^{viii} The Crystal Palace, a building the size of a modern shopping mall: 1848 feet [563.3 meters] long, 408 feet [124.4 meters] wide and 108 feet [32.9 meters] high, was built in eight and a half months starting on 15 July 1850, opening on 1st May 1851.

^{ix} For more discussion on the links between early industrial 'production control' systems and scheduling see: *A Brief History of Scheduling* - www.mosaicprojects.com.au/Resources_Papers_042.html

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fact, there was no general recognition of scheduling as a special ‘project management process’ until the marketing of CPM by Mauchly and Associates brought this third element of the ‘iron triangle’ to the public attention in the early 1960s and Dr. Barnes did the connecting a few years later.

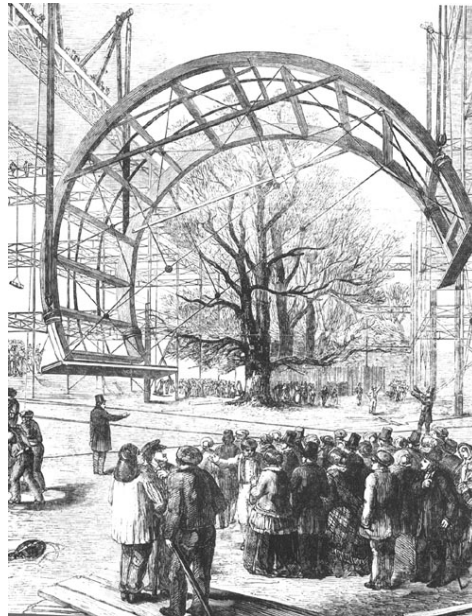


Figure 1 - Raising a main roof truss, Crystal Palace 1851

Project Management ‘Scope Creep’

The understanding of what is involved in project management is continuing to evolve, expand and segregate. There are now recognised disciplines of Program and Portfolio management in addition to ‘project management’. And whilst the integration and control of time, cost and scope is still the essence of ‘modern project management’, other elements such as quality, risk, technology, stakeholder management and communications, have been added over the years with supporting tools, techniques and processes.

The evolution of project management seems to have mirrored the evolution in general management (discussed in the next section); starting with a focus on ‘scientific’ (or hard) processes in the early years, moving to a softer skills focus in the 21st century. This trend is clearly demonstrated by analysis of papers published in the International Journal of Project Management¹³ which shows a drop from 49% to 12% for task focused papers (scheduling, etc), offset by increases in papers on ‘soft’ subjects such as leadership and stakeholder management. Similarly many of the new ‘tools’ entering the market in the 21st century are directed towards collaboration, communication and stakeholder management including the innovative *Stakeholder Circle* system from Stakeholder Management Pty Ltd^x.

^x See: www.stakeholder-management.com

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Project Management Methodologies

As the ‘scope’ of project management expanded, various methodologies were developed to formalise the way organisations managed their projects. The popularity of ‘methodologies’ grew rapidly from the beginning of the 1970s into the 1980s. However, since the turn of the century, the focus seems to have shifted from organisations buying expensive ‘methodologies’ from commercial vendors towards adopting the use of maturity models such as P3M3 and OPM3^{xi}.

The core of any methodology is its process descriptions; these processes are typically implemented by the consistent use of templates, forms and software, and the overall methodology is supported and developed by some form of PMO^{xii}. Most methodologies were (and still are) internal to their organisations; they describe ‘how we do business here’. Others that were commercialised and marketed have had varying degrees of success (and generally fairly short lives closely coupled to their supporting software systems); a notable exception is the PRINCE2 methodology. The forerunner of PRINCE, PROMPT (Project, Resource, Organisation, Management and Planning Technique) was originally developed by a British company called Simpact Systems Ltd in 1975. PROMPTII was adopted by the UK’s CCTA (Central Computer and Telecommunications Agency) in 1979, as the default methodology for all UK government information systems projects. In 1989, PRINCE was created from PROMPTII and was made ‘public domain’. PRINCE replaced PROMPTII as the default methodology in the UK and started to spread internationally. In 1996, PRINCE2 was published by the CCTA’s replacement, the Office for Government Commerce (OGC^{xiii}) following extensive consultation with users. Today the PRINCE2 methodology is undergoing a ‘refresh’ (due for completion in 2009), and is widely used in government throughout Europe and Australia and is being increasingly adopted by commercial organisations.

Technology Conclusion

An effective methodology (either developed as a ‘mature’ internal system or based on a standardised approach such as PRINCE2) is the ultimate ‘tool’ to help organisations consistently deliver successful projects, programs and portfolios. However, whilst every profession has its special tools and techniques, the possession of these artefacts alone is insufficient to create a profession. A knowledge framework and an organisational framework are needed as well.

Management History^{xiv}

The Role of ‘Project Manager’

The appointment of people as ‘project managers’ only started to emerge in the 20th century. In earlier times, the leadership of the project endeavour moved from a generalist role held by the coordinating architects such as Wren (15th to 17th C), responsible for all aspects of design and delivery including cost control and time management; to more specialist roles and responsibilities

^{xi} For more on OPM3 (from PMI) and P3M3 (from OGC) see: <http://www.mosaicprojects.com.au/OPM3.html>

^{xii} PMO = Project Management Office, for a range of papers focused on PMOs see: http://www.mosaicprojects.com.au/Resources_Papers.html#Proj_Off

^{xiii} OGC and PRINCE2 see: <http://www.ogc.gov.uk>

^{xiv} For a more expansive history see: http://telecollege.dcccd.edu/mgmt1374/book_contents/1overview/management_history/mgmt_history.htm

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assigned by contract in the 18th and 19th centuries to ‘program’ and then ‘project’ management in the 20th century.

Sophisticated contractual arrangements for the execution of major building works were in use 2500 years ago. The Long Walls in Athens were managed by the Architect Callicrates with the work let to ten contractors. A few centuries later the Colosseum was built by four contractors. These contracts contained detailed specifications of the work and requirements for guarantees, methods of payment and completion time were usually important considerations. Much of this sophistication was lost with the collapse of the Roman Empire in the 5th century and only started to re-emerge in Europe during the Renaissance.

These trends continued into the 17th and 18th centuries with contractual transactions forming an important part of the realisation of most projects. By the 18th century the professions of (design) Engineer and Architect had evolved into professional societies and those who built the projects were contractually and organisationally separate from the designers¹⁴. One of the earliest business management roles that could be defined as ‘project management’ was the role of Proctor and Gamble’s ‘brand managers’ in the mid to late 1920’s. These managers were responsible for the overall marketing, planning and control of a product and *the integration of those functions influencing the success of the venture*. By the 1930’s the US Air Force was starting to use ‘project offices’ to monitor the progress of aircraft developments and process engineering companies such as Exxon had begun to develop the ‘Project Engineer’ function to follow a project as it progressed through various functional departments¹⁵. These developments are definitely a pre-cursor to the shift from functional organisation structures to matrix management, and are close to project management, but lack the emphasis on implementation and the processes found in project management. These techniques grew out of the development of general management theory.

In the construction industries, Bechtel first used the term ‘project manager’ in the 1950s and the ‘Trans Mountain Oil Pipeline’ in Canada (1951-53) was the first project on which the company functioned as the project manager. However, the idea of having a project manager responsible for the whole project from design through construction to commissioning was still meeting resistance in Bechtel in the early 1960s. In Australia, Civil & Civic Pty Ltd had adopted the ideas of ‘project management’ by the mid 1950s and was marketing its capability to clients by 1958. By the end of the 1950s the idea of appointing a ‘project manager’ either as an individual or as an organisation to take full and undivided responsibility for achieving the project objectives had arrived and was starting to spread^{xv}.

General Management Theories

Management science evolved through the 19th and 20th centuries in response to ‘waves’ of innovation in business and society (see Figure 2). Modern project management uses many of the ideas and techniques developed from these evolving general management concepts and experiences.

The Industrial Revolution brought about the emergence of large-scale businesses with an intrinsic need for professional managers; early military and church organizations provided the leadership models adopted to control these enterprises. From these beginnings, the foundations of modern management were progressively developed around the world. However, it was the developments

^{xv} See ‘A short history of project management: part one: the 1950s and 60s,’ The Australian Project Manager 14 (1): 36-37 by Alan Stretton (1994) for more details. Download from: <http://www.pmfforum.org/library/second-edition/2007/PDFs/Stretton-10-07.pdf>

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in American management theories that particularly underpinned the beginnings of modern project management.

In 1975, Raymond E. Miles wrote *Theories of Management: Implications for Organizational Behaviour*¹⁶. In this book, he popularised a useful model of the evolution of management theory in the United States. His model includes the ‘classical’, ‘human relations’, and ‘human resources’ management phases summarised below.

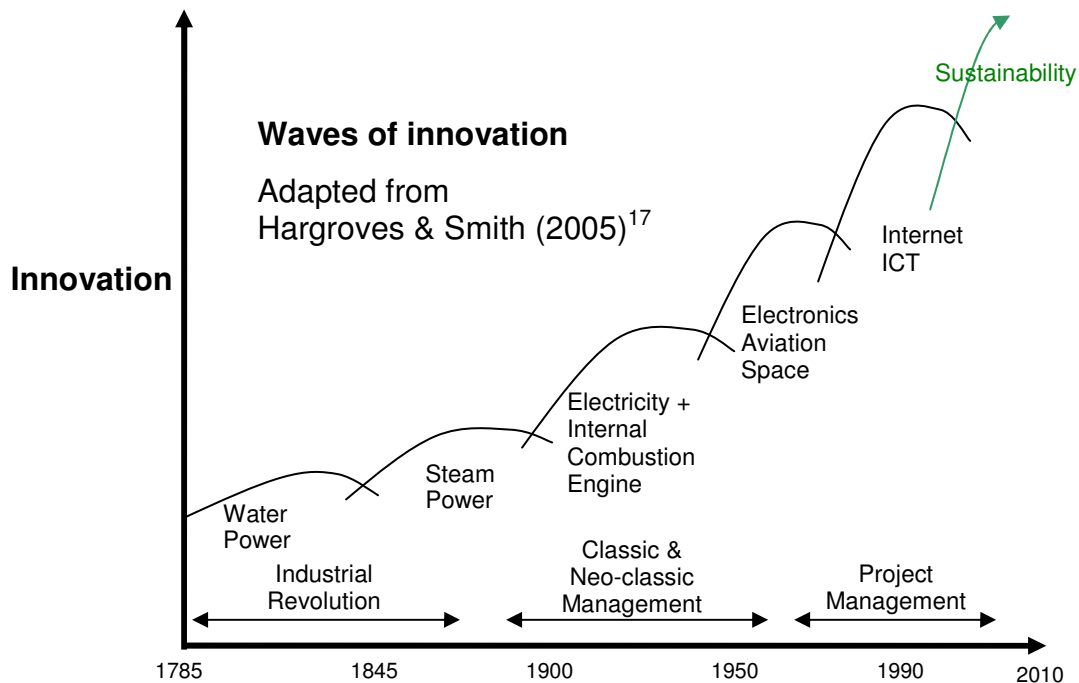


Figure 2¹⁷

Pre-Classical Developments¹⁸

The genesis of the ideas that led to the development of modern project management can arguably be traced back to the protestant reformation of the 15th century. The Protestants and later the Puritans introduced a number of ideas including ‘reductionism’^{xvi}, ‘individualism’^{xvii} and the ‘protestant work ethic’ (PWE)^{xviii} that resonate strongly in the spirit of modern project management. From the perspective of the evolution of modern project management, these ideas were then incorporated into two key philosophies, Liberalism and Newtonianism (see Figure 3).

Liberalism included the ideas of capitalism (Adam Smith), the division of labour, and that an industrious lifestyle would lead to wealthy societies. In the *Wealth of Nations* Smith advocated breaking the production of goods into tiny tasks that can be undertaken by people following

^{xvi} Reductionism = Removing unnecessary elements of a process or ‘ceremony’ and then breaking the process down into its smallest task or unit to ‘understand’ how it works.

^{xvii} Individualism = we are active, independent agents who can manage risks. These ideas are made into ‘real things’ by social actions contingent upon the availability of a language to describe them.

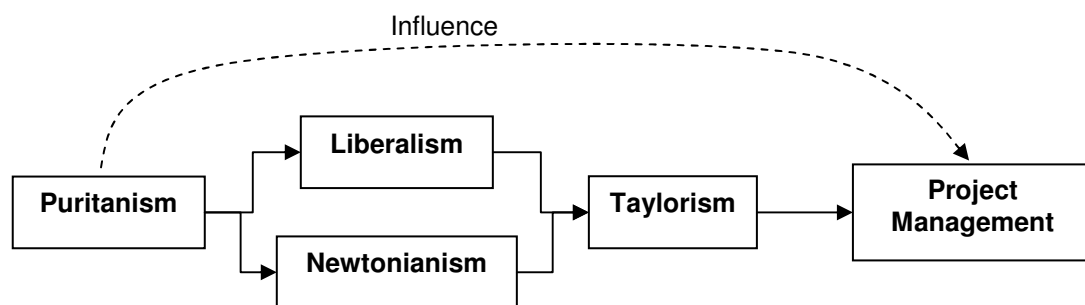
^{xviii} PWE = Prior to the protestant reformation most people saw work as a necessary evil (or at least as only a means to an end). For Protestants, serving God included participating in, and working hard at, worldly activities as this was part of God’s design and purpose for each individual.

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simple instructions. *‘Why hire a talented pin maker when ten factory workers using machines and working together can produce a thousand times more pins than the artisan working alone?’* An overall benefit for all was assumed, based on the concept that doing good and sympathy for others created happiness whilst rejecting them created misery. Therefore the ‘self interest’ of the factory owner was synonymous with benevolence, and as a consequence, directs his ‘selfish interest’ to the benefit of society as a whole.

Newtonianism marks the era of scientific enquiry. Newton saw the world as a harmonious mechanism controlled by a universal law. Applying scientific observations to parts of the whole would allow understanding and insights to occur^{xix} and eventually a complete understanding of the ‘clockwork universe’.

Robert Owen (1771-1858) and Charles Babbage (1792-1871) were two of the early management thinkers. Owen recognised people should not be considered as if they were simple machinery and introduced improved working conditions into his Scottish cotton mill. Babbage was interested in work specialisation and motivation; as well as being an eminent mathematician credited with developing the forerunner of the modern computer.



For a full discussion of this diagram see ‘The impact of Puritan ideology on aspects of project management’. International Journal of Project Management 25 (2007) 10-20¹⁸

Figure 3

All of these philosophies influenced the scientific management theories of Taylor. Taylor was undoubtedly influenced by his Quaker roots (Protestantism), worked in an intensely capitalistic society (Liberalism) and used the scientific approach of Newtonianism in his work developing the ‘Classical School’ of scientific management.

Classical School

The Classical school of thought began around 1900 and continued into the 1920s. It focuses on efficiency and includes scientific, bureaucratic and administrative management. Scientific management focuses on the "one best way" to do a job. Bureaucratic management relies on a rational set of structuring guidelines, such as rules and procedures, hierarchy, and a clear division of labour. Administrative management emphasizes the flow of information in the operation of the organisation. All of these traits are important to ‘modern project management’.

^{xix} But as Douglas Adams pointed out in his famous speech to BIOTA 2 in 1998, *‘If you try and take a cat apart to see how it works, the first thing you have in your hands is a non-working cat.*
<http://www.biota.org/people/douglasadams>

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Scientific Management

Scientific management focuses on worker and machine relationships and assumes productivity can be increased by increasing the efficiency of production processes. In 1911, Frederick Taylor, known as the Father of Scientific Management, published *Principles of Scientific Management* in which he proposed work methods designed to increase worker productivity. One of his famous experiments had to do with increasing the output of a worker loading pig iron to a rail car. Taylor broke the job down into its smallest constituent movements and timed each movement with a stopwatch. The job was redesigned with a reduced number of motions as well as reduced effort and a reduced risk of error. The Taylor model gave rise to dramatic productivity increases.

This 'reductionist' approach to complex endeavours, supported by the division of labour is central scientific management as well as to many modern project management processes such as developing the 'Work Breakdown Structure' (WBS) and scheduling.

The Gilbreths built on Turner's work; they also believed that there was one best way to perform an operation. However, this "one best way" could be replaced when a better way was discovered. The Gilbreths defined motion study as dividing work into the most fundamental elements possible, studying those elements separately and in relation to one another; and from these studied elements, when timed, building methods of least waste. They defined 'time and motion' study as a searching scientific analysis of methods and equipment used (or planned to be used) in doing a piece of work; using the information gained to develop in practical detail the best way of doing it, and a determination of the time required.

Henry Gantt (1861-1919) also belonged to this school. He developed a range of charts including the now ubiquitous Gantt chart (bar chart), which was used for scheduling multiple overlapping tasks over a time period (but without any computational capabilities). He also developed motivational schemes, emphasising the greater effectiveness of rewards for good work over penalties for poor work. Gantt developed a pay incentive system with a guaranteed minimum wage and bonus systems; he also focused on the importance of the qualities of leadership and management skills in building effective industrial organizations.

Bureaucracy

Bureaucracies are founded on legal or rational authority. Efficiency in bureaucracies comes from:

- clearly defined and specialized functions,
- use of legal authority,
- hierarchical form,
- written rules and procedures,
- technically trained bureaucrats,
- appointment to positions based on technical expertise,
- promotions based on competence, and
- clearly defined career paths (a bit like a well developed PMO).

Administrative Management

Administrative management emphasises the manager and the functions of management. Henri Fayol (1841-1925), known as the Father of Modern Management, wrote *General and Industrial Management*. His five functions of managers were plan, organize, command, coordinate, and control. His fourteen principles of management included division of work, authority and

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responsibility, discipline, unity of command, unity of direction, subordination of individual interests to general interests, remuneration of personnel, centralization, scalar chain, order, equity, stability of tenure of personnel, initiative, and esprit de corps (union is strength). All of these elements resonate strongly in the core elements of the project management body of knowledge.

Human Relations School

Behavioural or human relations management emerged in the 1920s and dealt with the human aspects of organizations. It has been referred to as the neoclassical school because it was initially a reaction to the shortcomings of the classical approaches to management. The human relations movement began with the Hawthorne Studies which were conducted from 1924 to 1933. The illumination experiments tried to determine whether better lighting would lead to increased productivity. Surprisingly, both the control group and the experimental group produced more whether the lights were turned up or down. It was discovered that this increased productivity was a result of the attention received by the group (known as the Hawthorne Effect). The Hawthorne Studies are significant because they demonstrated the important influence of human factors on worker productivity.

Chester Barnard developed the concepts of strategic planning and the acceptance theory of authority. Strategic planning is the formulation of major plans or strategies, which guide the organization in pursuit of major objectives. Barnard taught that the three top functions of the executive were to:

- establish and maintain an effective communication system,
- hire and retain effective personnel, and
- motivate those personnel.

His Acceptance Theory of Authority states that managers only have as much authority as employees allow them to have. The acceptance of authority depends on four conditions:

- employees must understand what the manager wants them to do,
- employees must be able to comply with their directive,
- employees must think that the directive is in keeping with organizational objectives and
- employees must think that the directive is not contrary to their personal goals.

Barnard believed that each person has a zone of indifference or a range within which he or she would willingly accept orders without consciously questioning authority. It was up to the organization to provide sufficient inducements to broaden each employee's zone of indifference so that the manager's orders would be obeyed.

Human Resources School

Beginning in the early 1950s, the human resources school represented a substantial progression from human relations. The behavioural approach did not always increase productivity. Thus, motivation and leadership techniques became a topic of great interest. The human resources school understands that employees are very creative and competent, and that much of their talent is largely untapped by their employers. Employees want meaningful work; they want to contribute; they want to participate in decision making and leadership functions^{xx}.

^{xx} Some of the theories include; McGregor's Theory 'X' and Theory 'Y', Theory Z (Ouchi), Contingency Theory (Morse & Lorsch), Goal-Setting Theory (Latham & Locke) and Expectancy Theory (Vroom).

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Systems Theory & Contingency View

Systems theory and a contingency view helped integrate the theories of management in the 1960s.

Systems Theory

During the 1940s and World War II, systems analysis emerged. This viewpoint uses systems concepts and quantitative approaches from mathematics, statistics, engineering, and other related fields to solve problems.

From a management perspective, a system is an interrelated and interdependent set of elements functioning as a whole. It is composed of inputs from the environment (material or human resources), transformation processes of inputs to finished goods (technological and managerial processes), outputs of those finished goods into the environment (products or services), and feedback (reactions from the environment). Systems develop synergy; this is a condition in which the combined and coordinated actions of the parts of a system achieve more than all the parts could have achieved acting independently. Project management is concerned with managing a complex 'system' with multiple inputs, outputs and complex, interrelated processes and consequently benefits from analysis using the systems approach^{xxi}.

Contingency View

In the mid-1960s, the contingency view of management emerged and provides a framework for integrating the full spectrum of management knowledge and thought. This view emphasizes optimising the fit between organization processes and the characteristics of each particular situation. It is based on the assumption that different situations and conditions require the application of different management techniques and proposes adjusting the structure of the organization to manage various possible or chance events.

The contingency approach assumes that managerial behaviour is dependent on a wide variety of elements and questions the use of universal management practices; instead, it advocates using selected and appropriate traditional, behavioural, and systems viewpoints independently or in combination to deal with various circumstances as they arise.

Operations Research

Whilst not strictly a 'management theory', Operations Research supports management decision making and has a critical part in the story of 'modern project management'. Operations Research (OR) is an interdisciplinary science which deploys methods such as mathematical modelling, statistics, and algorithms to decision making in complex real-world problems concerned with the coordination and execution of the operations within an organisation. It is distinguished by its ability to look at and improve an entire system, rather than concentrating only on specific elements (though this is often done as well) which was the focus of Taylor's 'scientific management'. The growth of OR is to a large extent the result of the increasing power and widespread availability of computers. Most (though not all) OR involves carrying out large numbers of calculations which would be a practical impossibility without computers. Some of the specific techniques used include linear programming, statistics, optimisation, stochastics, queuing theory, game theory, graph theory, and simulation^{xxii}.

^{xxi} For more on system thinking see: http://www.mosaicprojects.com.au/WhitePapers/WP1044_Systems_Thinking.pdf

^{xxii} See http://en.wikipedia.org/wiki/Operations_research

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Americans refer to ‘operations research’, British/Europeans to ‘operational research’; fortunately both are shortened to just OR¹⁹. Other terms used for this field (or closely allied fields) include ‘management science’ (MS), which can be combined to OR/MS or ORMS, ‘industrial engineering’ (IE) and ‘decision science’ (DS).

OR started in the late 1930s and has grown and expanded tremendously. In July 1938, with the prospect of war imminent, the British Air Ministry conducted a major air-defence exercise using its new radar stations. This exercise revealed a new and serious problem had arisen, the need to coordinate and correlate multiple, and often conflicting, streams of information received from various sources. A new approach was needed.

Accordingly, on the termination of the exercise, the Superintendent of Bawdsey Research Station, A.P. Rowe, proposed that a crash program of research into the operational - as opposed to the technical - aspects of the air-defence system should begin immediately. The term ‘operational research’ [RESEARCH into (military) OPERATIONS] was coined as a suitable description of this new branch of applied science. The first team was selected from amongst the scientists of the radar research group the same day.

Although scientists had been involved in the hardware side of warfare for decades (if not centuries) scientific analysis of the operational use of military resources had never taken place in a systematic fashion before the Second World War. What the OR people brought to their work were ‘scientifically trained’ minds, used to querying assumptions, logic, exploring hypotheses, devising experiments, collecting data, analysing numbers, etc. By the end of the war OR was well established in the armed services both in the UK and in the USA.

Following the end of the war OR took a different course in the UK as opposed to in the USA. In the UK many of the distinguished OR workers returned to their original peacetime disciplines. As such OR did not spread particularly well, whereas in the USA OR spread to the universities so that systematic training in OR for future workers began.

OR appears to be the catalyst that triggered the start of CPM scheduling. The Operational Research Section in the UK CEGB were significant early adopters of CPM^{xxiii} and the purchase of a book on ‘Operation Research’ in 1958 triggered the ground breaking work by H.B. Zachry Company (Texas) that led to IBM developing its ‘Project Control System’ software^{xxiv}. Critically, OR was also an area of interest to Jim Kelley. Kelley was scheduled to give a paper to the Case Institute operations research conference in January 1957 when he was seconded to the du Pont team being assembled by Morgan Walker that led to the development of CPM (see Kelley and Walker above). Kelley’s paper to the OR conference went ahead with the inclusion of a ‘simple linear program formulation’ of the construction scheduling problem²⁰. There would appear to be a strong link between the work at the Case Institute^{xxv} and the development of CPM at the H.B. Zachry Co²¹.

^{xxiii} Discussed in more detail in ‘A brief History of Scheduling’
http://www.mosaicprojects.com.au/Resources_Papers_042.html

^{xxiv} Discussed in more detail in ‘A brief History of Scheduling’
http://www.mosaicprojects.com.au/Resources_Papers_042.html

^{xxv} The Case Institute of Technology was a university that merged with Western Reserve University to form Case Western Reserve University, Ohio, USA.

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Emerging Management Positions

Since the 1960s, new management viewpoints have emerged.

- **Quality management** emphasizes achieving customer satisfaction by providing the right quality goods and services that are fit for their intended purpose.
- **Reengineering** the organization redesigns the processes that are crucial to customer satisfaction.
- **Chaos theory**^{xxvi} models the corporation as a complex adaptive system that interacts and evolves with its surroundings. Many seemingly random movements in nature exhibit structured patterns. Living systems operate at their most robust and efficient level in the narrow space between stability and disorder - poised at "the edge of chaos."
- **Project / program and portfolio management (PPP).**
Project management describes the tools, techniques, process and structures suited to accomplishing the objectives of a defined project. This branch of PPP is currently the best developed although arguably 'program management' evolved first^{xxvii}. The use of 'project management' did not gain wide acceptance until the 1960s and it is likely the first book with project management in its title was 'Project Management' by John Stanley Baumgartner, published by R.D. Erwin in 1963²². Certainly the first 'BoKs' published in the 1990s focused almost exclusively on projects.

Program management describes the coordinated management of a number of related projects to achieve a specified outcome or benefit. The 'Manhattan Project' to create the atomic bomb occurred in the 1940s was arguably the first 'program'^{xxviii} and the US military were describing numerous other 'programs' (eg, the 'Atlas Program') from the early 1950s. Defence industry adapted to align with their military clients; in the early 1950s the McDonnell Aircraft Company started to move from a 'functional' structure to a matrix organisation with the appointment of 20 'company wide program managers'²³. By 1958, a 'general manager' of program managers had been appointed and a true matrix structure developed with functional disciplines interacting with numerous aircraft programs, with each program typically reporting to a single client in the military.

Portfolio management is the newest branch of PPP. Portfolio management focuses on the selection of the 'right' projects and programs to best meet an organisation's strategic objectives within its capacity and capability limits.

^{xxvi} See also 'A Simple View of Complexity in Project Management':
www.mosaicprojects.com.au/Resources_Papers_070.html

^{xxvii} The USAF was establishing 'joint project offices' from 1951. The first for the B47 bomber was set up in Feb. 1951; these offices focused on coordination between engineering and production with a focus on systems management. By 1954 the practice was extended to 'Weapons system Project Offices (WSPOs)'. During the 1950's project and program management was very closely aligned with 'systems management' in the US military. The Navy 'Special Projects Office' (SPO) for the Fleet Ballistic Missile program (Polaris) was created on Nov. 17th 1955, this organisation developed PERT (Program Evaluation and Review Technique) in 1957/58.

^{xxviii} The project was led by General Groves (his leadership is seen as vital). Groves identified five elements leading to its success: there was a clear objective, the 'project' was divided into 'tasks' that together would achieve the objective, there was clear direction of the project at all levels, authority was delegated with appropriate authority, existing resources were used where ever possible, there was full backing from the government. The words used are Groves, modern usage would describe a program of works decomposed into projects – all of the other factors including the full support of the sponsor are still essential for successful project and program delivery.

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Management Theories Conclusion

The development of general management theory in the USA through to the 1960s was a critical underpinning for the creation of 'modern project management'. Its roots can arguably be traced back to the Protestant reformation of the 15th Century and most of the ideas implicit in the early days of our profession (from the 1960s to 1980s) are firmly rooted in the ideas of Scientific Management. By the 1970s the focus of 'project management' was spreading from its roots in scheduling and its 'home' in the defence and construction industries to embrace 'all industries' and the emerging recognition of the distinctive nature of project management as a specialist management discipline if not a profession was recognised by a number of leading writers. However, neither the tools described above nor the general management theory outlined in this section, either on their own or in combination, would have been sufficient to create the emerging profession of 'modern project management'. The creation of our profession is described below.

Creating the Profession of 'Modern Project Management'

Definition of a 'Profession'

The various attributed or traits generally considered necessary for a discipline to be considered a profession are:

- practitioners are required to meet formal educational and entry requirements,
- autonomy over the terms and conditions of practice,
- a code of ethics,
- a commitment to service ideals,
- a monopoly over a discrete body of knowledge and related skills²⁴.

Within this context, project management is best described as an 'emerging profession' whilst there is a defined 'body of knowledge' different associations around the world have somewhat divergent views on their content. Only some bodies require formal educational and entry requirements (eg, AIPM^{xxix}) others have none (eg PMI^{xxx}). Formal certifications exist (eg PMI's PMP credential) but certification is not a prerequisite to practice. Whilst most associations have a commitment to service ideals, only a very small proportion of project management partitioners belong to an association. Similarly, whilst there is a 'project management body of knowledge' and project management research taking place, the support of academia for the concept of project management as a separate academic school is at best limited despite the emergence of research conferences and refereed journals over the last 15 years. And the debate over the existence of a 'theory of project management' is only just beginning²⁵.

The premise underlying this paper is that if project management is not already a profession, it will definitely emerge as one over the next few years; and this profession is the creation of the project management associations that have progressively worked to refine and define the essence of 'modern project management'.

^{xxix} AIPM = Australian Institute of Project Management.

^{xxx} PMI = Project Management Institute (USA)

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The Profession of 'Modern Project Management'

Projects have existed for as long as people have set out to accomplish a specific objective with limited resources. However, until relatively recently, these 'objectives' were not seen as projects; they were seen as acts of worship, engineering, nation building, war, etc., and the people controlling the endeavours called themselves priests, engineers, architects, generals, etc. The use of the terms 'project' and 'project management' have only become common within the last 50 years and largely align with the growth of 'project management associations'. Despite the abundance of projects in earlier times, no one talked about 'project management' until the 1950s; and the spread of discussions around and about project management seems to have closely followed the spread of scheduling in the 1960s. Certainly, the advent of scheduling as a discipline completed the iron triangle of time, cost and scope; as defined by Dr. Martin Barnes in 1969.

Given the embodiment of 'modern project management' is the major 'project management associations' such as IPMA^{xxxi} and PMI, the forces that created these associations also created 'modern project management' and as this paper will demonstrate, these bodies were essentially founded by schedulers.

Based on these observations, it would appear that:

1. The catalyst for the spread of discussions on project management was the formation of the 'project management associations'; and
2. the formation of these associations was triggered by the spread of scheduling (or more importantly professional schedulers) in the early 1960s, therefore
3. the genesis of modern project management was the schedulers need to create forums to discuss and develop their new discipline.

Well over 50% of the people in each of the groups that founded PMI in the USA, INTERNET in Europe (now IPMA) and the UK branch of INTERNET (now APM) were schedulers and a large proportion of the remainder cost engineers. Recollections of early conferences and the early publications from these bodies suggest that their focus was almost exclusively on project controls and in particular 'critical path scheduling'. It is therefore, reasonable to argue that the spread of scheduling linked to the need to make effective use of the data generated by the schedulers as they calculated their critical paths, was the catalyst that created modern project management.

The two key distinguishing features of the early project management associations were a focus on techniques (initially scheduling and cost control) rather than outcomes (eg engineering structures) and the cross industry nature of the early membership which led to the creation of 'modern project management' as a profession in its own right rather than as a branch of engineering, building or some other industry.

Therefore, assuming the central hypothesis in this paper holds true, that *'the spread of scheduling was the genesis of modern project management'*; then the 50th anniversary of the start of the project that created 'modern project management' was the 7th May 2007.

^{xxxi} IPMA = International Project Management Association

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The role of the Associations in creating ‘modern project management’

Once founded, it was (and still is) the various project management associations that led the development of a defined and documented ‘project management body of knowledge’. Only after the body of knowledge was formulated, did it become possible to define project management competencies, formally examine project management knowledge and start the process of creating a true profession of project management.

Over the last 30 to 40 years, initially supported by practitioners and more lately by most of academia, the project management associations have:

- developed a generally consistent view of the processes involved in ‘project management’,
- encoded these views into ‘Bodies of Knowledge’ (BoKs),
- described competent behaviours and are now certifying knowledgeable and/or competent ‘Project Managers’,
- conducted both academic and practitioner focused conferences around the world,
- sponsored research into various aspects of project management and
- worked to create a global community of ‘project managers’.

Academia has supported this process with the development of research programs, refereed journals, research conferences (often in partnership with the associations), the publication of learned articles and the development of various undergraduate and post graduate qualifications in project management.

The central theme running through the various BoKs is that project management is an integrative process that focuses on the project lifecycle from initiation (or concept) through to the transfer of the ‘product’ created by the project to the client and closure of the project. It has at its core the balancing of the ‘iron triangle’ of time, cost and output (scope / quality), and the objective of project management is the completion of the project, as efficiently as possible, to the satisfaction of the project’s stakeholders.

The first endeavour to develop a BoK was approved by the PMI Board in 1981, was published in August 1983^{xxxii} and PMI’s first certifications were awarded in 1984. The next version of the PMBOK appeared in August 1986 and an updated version was published August 1987 initially in a PMI Journal and then as the first standalone publication^{xxxiii}. The PMBOK has been under review on a regular basis since this time^{xxxiv} and in the last couple of decades similar documents have been created by Associations in the UK (APM BoK), Japan, etc.

Despite the steady expansion of knowledge areas covered by the BoKs to include the integration and management elements such as risk, quality and communications, as they apply to the project, and the development of allied standards such as program and portfolio management, the

^{xxxii} This project was known as the ‘Ethics, Standards and Accreditation (ESA) project. The project developed a Code of Ethics, the BoK with 6 knowledge areas (scope, cost, time, quality, human resources and communications) and guidelines for the accreditation of courses offered by academic institutions and the certification of individuals.

^{xxxiii} The 1986 - 87 version of the PMBOK added the concept of a project framework and added risk and procurement management as separate knowledge areas to the document. ‘*The project Management Body of Knowledge*’ was published in August 1987.

^{xxxiv} The next update was initiated in 1991 and published in 1996. The title was changed to ‘*A Guide to the Project Management Body of Knowledge (PMBOK Guide ®)*’. This was followed by the 2000 update and then the ‘*Third Edition*’ in 2004. The next edition of the *PMBOK Guide®* will be published in 2008.

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foundation techniques for modern project management remain the integration and control of time, cost and 'output'. All three facets must be present within a defined life cycle for a management process to be considered project management.

The Associations:

The Project Management Institute (PMI), the International Project Management Association (IPMA) and its constituent national associations such as the Association for Project Management (APM) in the UK together with independent national associations such as the Australian Institute of Project Management (AIPM) and the Engineering Advancement Association of Japan (ENAA) are the current flag bearers for the profession of modern project management. This section will briefly describe the start of three of these associations.

INTERNET / IPMA

INTERNET was formed in 1965, originally as a forum for European network planning practitioners to exchange knowledge and experience. Recollections of early conferences and publications suggest that in the early years INTERNET's focus was almost exclusively on project controls and 'scheduling'. What is now the Association for Project Management (APM) started out as the UK branch of INTERNET. The emergence of a totally different 'internet' and a shifting focus prompted the name changes to IPMA and APM respectively. Dr Martin Barnes (APM member #10) recalls: "I went to the INTERNET congress in Stockholm [1972] and can confirm at that time and at that congress everybody was talking about network analysis, nothing else, and the phrase 'project management' was just not in use. Very soon after the Stockholm congress we set up INTERNET (UK). For some years it concerned itself with little other than network analysis.²⁶" IPMA is now primarily an umbrella organisation for some 40+ national associations from around the world.

PMI

PMI was founded in 1969. Of the ten people involved in the organising group, a significant majority including Jim Snyder, J. Gordon Davies and Eric Jenett were 'schedulers'. Whilst the PMI founding group and the early PMI Board took pains to avoid limiting the PMI concept to the CPM and to the construction industry^{xxxv}, at the second PMI congress in 1970 more than half the papers were CPM schedule oriented²⁷. In addition to the people mentioned above, Russ Archibald (PMI member #6) published one of the early books on scheduling and he, together with Stu Ockman, former President of the PMI College of Scheduling were at the first PMI congress in 1969²⁸. Hugh Woodward, former editor of PMForum recalls: "My understanding is that PMI formed around a common interest in scheduling. In fact there was some thought the organisation would be called the project scheduling association²⁹." PMI has grown into a multi-national member based organisation with more than 1/4 million members and Chapters in virtually every major country around the world.

^{xxxv} From an interview with Russ Archibald, PMI Founder: *Initially, the discussion was primarily focused on PERT, CPM, and related planning and scheduling methods and systems. In fact the January 29 1968 letter from Ned Engman ... says "we are discussing forming a National CPM Society." At our later meetings in New Orleans we had long discussions on the scope and name of the association and gradually the group moved toward a consensus that we should be targeting the broader subject of project management.* Published in PM World Today – October 2008 (Vol X, Issue X)

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Project Management Forum / AIPM^{xxxvi}

The Australian Institute of Project Management was founded as the Project Management Forum in 1976. This association was probably the first to formally focus on 'project management' from the beginning (rather than CPM), although again, the majority of the 19 people who started the 'forum' were project schedulers and cost engineers³⁰. The change in focus can be attributed to the later date this association was formed, and the shift in knowledge and thinking that was occurring around the world from 'pure CPM' to the wider view of 'project management'.

Conclusions

Based on the research outlined in this paper, it is entirely reasonable to argue that the evolution of modern project management is a direct consequence of the need of professional schedulers for a forum to discuss and develop their new discipline, combined with the need to make effective use of the data generated by schedulers in an attempt to identify, manage and control their 'critical paths' (not to mention the expectations a schedule generates in the minds of senior managers). These needs and requirements led directly to the formation of the early associations that evolved into today's 'project management associations', and then to the development of a defined and documented 'project management body of knowledge' by these associations.

After the body of knowledge was formulated, it became possible for the associations to define project management competencies, formally examine project management knowledge and start the process of creating a true profession of project management.

Project management has evolved in its specialist area along very similar lines to general management theory. In the early days, project management closely mirrored the 'classical school' of management with a focus on 'scientific' processes (scope, time and cost). More recently the emphasis has shifted towards the 'soft skills' more closely aligned with the 'human relations' and 'human resources' schools of management theory including more focus on stakeholders, communications and leadership. One wonders if the next phase will mirror the chaos theory (or have we already arrived?).

Finally, I believe this paper has identified the reason for the 'sudden' development of 'CMP' like tools at the CEGB in the UK, the Polaris SPO and du Pont in the period 1956 to 1961. These developments can be directly linked to their roots in Operations Research (OR) and the development of computers. In particular books and conferences focusing on OR would have provided the conduit for the spread of the ideas underpinning CPM.

Therefore, in conclusion I believe this paper has clearly demonstrated that the spread of CPM and the arrival of professional schedulers was the genesis of 'modern project management', and the 50th anniversary of its beginning will be the 7th May 2007 when du Pont committed funds to the project to develop its CPM software and methodology.

Concluding Comments

One major drawback in the origins of project management outlined in this paper was the focus on tools and systems that lasted from the 1960s through into the 1990s. Only in the 21st century has the people side of project management started to move into prominence despite the fact it is

^{xxxvi} Note: AIPM joined the IPMA as the Australian national association in 2010

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people who create, design manage and execute the project for another group of people, the 'customers'. This emphasis on people does not change the need for project management tools such as schedules, rather changes the focus of their use from a 'command and control' approach to a collaborative, consensus-leadership role¹. The definition of 'success' also requires expanding beyond the 'iron triangle' of time cost and output to include stakeholder satisfaction². The third paper in this series, *Trends in Modern Project Management, Past, Present & Future*³ considers these issues and the future direction of our profession.

The other 'missing link' that has now been addressed is the strategic issues associated with program and portfolio management⁴. The publication of standards for Portfolio and Program management by PMI and work by others in the UK has started to effectively position projects and project management within the overall spectrum of corporate governance.

¹ For more on this see: *A Simple View of 'Complexity' in Project Management* - www.mosaicprojects.com.au/Resources_Papers_070.html

² For more on this see: *Avoiding the Successful Failure!* - www.mosaicprojects.com.au/Resources_Papers_046.html

³ For more on this see: *Trends in Modern Project Management, Past, Present & Future* - www.mosaicprojects.com.au/Resources_Papers_061.html

⁴ For more on this see: *Understanding Programs and Projects - Oh, there's a difference* - www.mosaicprojects.com.au/Resources_Papers_078.html

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* An email based discussion including, among others, Russell Archibald, Eric Jenett, Stuart Ockman, James (Jim) O'Brien, Hugh Woodward, Jon Wickwire, J. Gordon Davies and Fran M Webster, ran through November 2005. The quotes included in this paper were part of this discussion. There were no dissenting comments from any of the group regarding the formation of PMI primarily by 'schedulers'.

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