Improving NEC Contract Change Management with CCM

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bettertogether

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Foreword

Having written the "Foreword" to the interim research paper on this subject back in November 2006, I was delighted to be asked to provide a few more words and thoughts for this final report.

In a world where improved performance is expected, indeed often demanded, innovation coupled with commitment to and belief in new ideas are key success factors. Contract Change Management (CCM) uses the discipline of process as a business tool for managing the knowledge and intelligence of people to enable delivery of real commercial value to project outcomes.

The innovation of using an information technology based system to bring the discipline of process to project management is now well established and has been acknowledged by the Construction Industry with its 2006 Q.S Innovation Award and the 2007 Construction Computing Award for CCM.

This report by Professor Ming Sun sets out both the tangible and intangible benefits of the CCM process support service for NEC based projects. However the generic nature of CCM is such that the process can be applied to any construction project whatever the Form of Contract. This is an important output of the study report because invariably cost (tangibles) and value (intangibles) are essential performance indicators dictating the procurement and delivery strategy for construction projects.

I particularly like the concept of the "Maturity Model" which is essentially a matrix management tool that can be used by clients, consultants and contractors alike as measures for taking their businesses beyond their current standards to better, quantifiable, financial management performance levels. The report also recognises that not all businesses are at the same level of NEC/CCM knowledge or usage and in this respect the management tool can be tailored to individual needs and objectives.

This is a comprehensive and worthwhile study directed at reducing business risk by improving the management of projects. Its findings and recommendations represent a move to improvement and "best practice"! But "best practice" requires practice so I hope those seeking to improve their construction management performance will seek guidance from this study report.

David H Williams, CEng, FICE
Founding Chairman of NEC Users' Group 1994-1997

Executive Summary

This report presents the final findings of a two-year research project on measuring the benefits of a collaborative and workflow IT business support system for NEC projects. The Contract Change Management (CCM) system was the basis of the research carried out by the University of the West of England and partially funded by the government Knowledge Transfer Partnership programme.

The New Engineering Contract (NEC), initially published in its consultative form in 1991 and now in its third edition, facilitates the implementation of sound project management principles and practice. It encourages the transition from the adversarial culture to a collaborative one in construction. "The main aspect of this transition is moving away from a reactive and hindsight based decision-making and management approach to one that is foresight based, encouraging a creative environment with pro-active and collaborative relationships." However, "the NEC contract requires project managers to be on top of things on a daily basis. This is quite an onerous responsibility on the project manager. Daily means that they must have global and updated information on contract status in order to ensure that the contract is operated with minimum delays and that costs are properly controlled."

CCM is an internet delivered collaborative system, provided by Management Process Systems Ltd (MPS), which supports the implementation of the contract change management process. It has been used on hundreds of building and engineering projects in the UK. A user survey, conducted in August 2006, showed that 84% of the CCM users consider it as a 'good' or 'excellent' system. According to the users, CCM offers a range of both tangible and intangible benefits. Detailed survey results are published in an interim research report, entitled *"Collaboration Support Realises Business Process Benefits for NEC/ECC Projects – The Internet CCM System"*, in November 2006 by the University of the West of England. It is available at:
[http://www.built-environment.uwe.ac.uk/research/cprc/publications/CCM-nov2007.pdf]

Following the survey, this research has developed methods for measuring both tangible and intangible benefits of CCM.

Tangible benefits refer to cost and time savings as a result of adopting CCM, which can be quantified in financial terms. The measurement of tangible benefits focuses on four key change management tasks that CCM supports. These are Early Warning; Compensation Event; Value Change before Instruction; and Value Change after Instruction. The process of each task is analysed for when CCM is used and when it is not used. Savings for each task are calculated through detailed process analysis of how the task is carried out with and without CCM. A spreadsheet tool is developed to allow users to assess the tangible savings of using CCM in their project by simply entering the numbers of times that these four tasks are performed. For example, for a typical project with 100 early warnings, 110 compensation events, 30 instances of value change before instruction and 80 instances of value change after instruction, a saving of over £52,000 can be gained in staff time and consumable costs.

In addition to tangible savings, CCM can also help project teams to improve process effectiveness, reduce risk of process failures and increase compliance with NEC requirements. These benefits are intangible, which cannot be easily measured in financial terms. However, they are as important as tangible benefits. In many cases, they are more important because greater certainty and predictability and less risk can potentially lead to bigger savings. This research adopted the Capability Maturity Model approach, originally proposed by the Software Engineering Institute at Carnegie Mellon University in 1991, to evaluate the intangible benefits of CCM. A Change Management Maturity Model (CM3) is developed, which provides a measurement framework for assessing a project team's capability in dealing with contract changes. The Model defines five levels of maturity – *ad hoc, informal, systematic, integrated and continuous improving*. Measurement is carried out on six key process areas – *management process, risk management, communication, management information, collaboration, and leadership/objectives*. Three case studies have been carried out. It is found that CCM, in conjunction with NEC, helps to improve project teams' maturity level in these key process areas from typical levels 1 and 2 to levels 3 and 4.

1. What is CCM?

The Contract Change Management (CCM) system is an internet delivered collaboration system which supports the contract change management process for the NEC form of contract.

NEC was endorsed by Sir Michael Latham in his 'Constructing the Team' report and by the Office of Government Commerce (OGC) in their advice for public sector construction procurement. It has been used in many prestigious projects, such as Heathrow Terminal 5, the Eden project, the Cross Channel Rail Link (CTRL), and lately the London 2012 Olympic Games projects.

NEC is not just a contractual document that defines the legal relationships between the project partners. More importantly it is also a management tool to ensure the smooth delivery of a project:

- NEC encourages proactive management of project risks. The contractor and the project manager are required to give an Early Warning (EW) as soon as they become aware of something that might cause an increase in cost, delay in completion or negative impact on performance. Contractors can be penalised for failure in raising EWs.

- NEC defines a clear procedure for tasks and responsibilities after an EW is raised, and how it feeds into the risk management procedure. It requires each party to take appropriate actions promptly. Matters cannot be left unaddressed. There are consequences for failure in compliance with the procedure.

- NEC is 'a very administrative and process based contract'. Audit trail is important. All important communications must be in writing as verbal communications have no contractual relevance.

- NEC uses the programme as the baseline for managing the project. Any alteration to the programme has to be agreed by all parties concerned. As changes are agreed during the project, there are few surprises at the completion.

Many projects found compliance with NEC procedures difficult using a paper based management system. CCM is an on-line service specifically designed to support all key NEC processes.

The success of NEC projects depends on all the parties following the operating procedures. Unfortunately, in practice many projects found compliance with these procedures difficult using a paper based management system. The CCM system is specifically designed to electronically support the NEC management process.

The system manages the life cycles of all notices issued by the Project Manager (PM) and Contractor under the NEC contract, in a collaborative environment over the Internet. These include Early Warnings (EWs), Project Manager Instructions (PMIs), Compensation Events (CEs), Notification of Compensation Events (NCEs), Quotations, Project Manager Assessments (PMAs), Implementations, and a variety of PM/Contractor Communications. All documents are user and date stamped and held in an audit trail. The impacts of CEs are monitored against the activity schedules for each work package, in order to ensure that the adjusted target price and target completion date are up to date. If necessary, escalation mechanisms are activated in order to highlight potential delays to process execution requirements.

During the last few years, the CCM system, provided by Management Process Systems Ltd (www.mpsprocess.com), has been used by a growing number of companies in the UK. Based on anecdotal evidence, many users are convinced of the benefits of the system in helping them reduce risks and save costs.

2. What Are the Benefits of CCM?

2.1 What do CCM users think?

A questionnaire survey was conducted with CCM users during August 2006. The aim was to find out their views on the benefits of the system. The questionnaire was sent to 260 randomly selected CCM users and 85 (33%) valid replies were received. The respondents included Main Contractors (40%), Client Organisations (21%), Consultant Quantity Surveyors (15%), Project Management Consultants (14%) Architect/Design/Engineering (5%), Specialist Sub Contractors (1%), and 'Others' (4%). The survey result shows that the vast majority of users (84%) regard CCM as a "Good" or "Excellent" system.

In order to find out users' views on the benefits of CCM in specific aspects, 43 potential benefits in 8 categories were identified prior to the survey. These categories were: (1) Process improvement; (2) Business improvement; (3) Risk management; (4) Communication; (5) Management information; (6) Efficiency; (7) Collaboration/Partnering; and (8) Traceability. A question was posed in the questionnaire, which read: "anecdotal evidence indicates CCM offers the following benefits. Do you agree?" Users were asked to choose one from 4 possible answers - "Strongly agree", "Agree", "Disagree" or "Strongly disagree".

The results showed that there is a high degree of consensus on the benefits of the CCM system in these key project management aspects. 41 out of 43 benefits received positive rating. Table 1 lists the top 20 benefits according to the level of support from CCM users.

A user survey revealed that CCM helps the contract change management process of NEC projects. 84% of the users consider the system as "good" or "excellent".

As previously stated, for NEC projects process is extremely important. When a compensation event occurs, the requirement of notification and acceptance by all the principal parties is clearly defined in the contract. The party who fails to take appropriate action in time will risk losing money or time. It is therefore not surprising that CCM functions related to Traceability scored very highly with "8.2 Date stamps all key operations" at number 1 and "8.1 Archives of key documents for analysis" at number 8. Similarly, Process Improvement related benefits, such as "1.2 Rigorous process support" and "1.1 Quality assured change management process" are also high on the list.

Compared with other forms of contract, NEC projects generate more written information in the form of early warnings, notifications, quotations, project manager instructions, etc. This information needs to be managed effectively. CCM users really appreciate the Communication and Information Management functions provided by the system, e.g., "4.2 Documents are not lost or mislaid", "4.7 Records communications: PMI, EW, CE, NCE", "5.1 Data can be analysed during/after the contract", "5.2 Contract progress with date stamps", "4.3 E-mail notification for important actions", and so on.

The key principle of NEC is about proactive and more effective risk management during construction projects. In addition to project risks, there is a greater risk of process failure because of the demanding compliance requirements. According to the survey, CCM can help to reduce such a risk through "3.2 Provides a documented audit trail", "3.7 Improves compliance to NEC procedures", "3.3 Provides early warning notification of risk", "3.1 Greater visibility of status of all incidents", "3.6 Proactive management of early warnings", and "7.4 Highlights next action not be ignored/forgotten".

Further details of the survey results can be found in the interim research report (source is given in the Executive Summary).

Table 1 Top 20 benefits of CCM

Ranking	Description	% of support
1	8.2 Date stamps all key operations	99%
2	7.1 Access to process operation/status by the team	98%
3	3.2 Provides a documented audit trail	97%
4	3.7 Improves compliance to NEC procedures.	93%
5	4.2 Documents are not lost or mislaid	93%
6	7.2 Assures document version control	93%
7	1.2 Rigorous process support	92%
8	8.1 Archives of key documents for analysis	91%
9	4.7 Records communications: PMI, EW, CE, NCE	91%
10	5.1 Data can be analysed during/after the contract	91%
11	5.2 Contract progress with date stamps	91%
12	4.4 Facilitates monitoring by senior management	90%
13	7.4 Highlights next action not be ignored/forgotten	90%
14	1.1 Quality assured change management process	89%
15	3.3 Provides early warning notification of risk	89%
16	3.1 Greater visibility of status of all incidents	88%
17	4.3 E-mail notification for important actions	86%
18	4.5 Instant availability of latest contract prices	84%
19	3.6 Proactive management of early warnings	83%
20	6.1 Simple, point and click operation process	83%

2.2 What do senior executives think?

In addition to the questionnaire survey, three senior managers/directors were interviewed to obtain feedback on the benefits of CCM from their perspectives. They are from three separate client, contractor and engineering consultant organisations. These senior executives, while not necessarily using CCM hands on, manage a range of projects where the system is used. Therefore, they are in a position to assess the benefits of the system beyond the scope of individual projects. The following is a summary of the results of their interviews:

■ CCM provides support for continuous business improvement. One of the common methods of business efficiency improvement is cutting waste by applying Value Stream Analysis to the existing processes. The audit trails captured in CCM are very useful in helping senior executives in carrying out the necessary analyses.

■ The project database held by CCM provides information for senior executives to perform Root Cause Analysis to identify common causes of contract changes so that they can be addressed proactively.

■ CCM is an excellent training tool for the NEC contract. The system, with its underlying NEC methodology, helps professionals who are new to the NEC contract to get up to speed with the NEC procedures quickly.

■ CCM helps to ensure that the NEC contract procedures are implemented correctly. Any delays in response are highlighted using the thermometer function.

■ It makes the project management process more transparent and puts pressure on all parties to perform well.

■ CCM is a useful tool to enforce common standard practice across multiple projects. Without such a system, different projects may adopt different management and reporting procedures, leading to difficulties in benchmarking across them.

■ The clear audit trail provided by CCM helps to resolve, even avoid unnecessary disputes.

■ CCM helps to control project risks, so that they will not escalate out of control.

■ CCM helps to settle the final account more speedily.

> When used on a series of projects, CCM can help senior executives to benchmark the performance of these projects and achieve continuous improvement.

2.3 Can these benefits be measured?

Since the 1980s with the growing use of computers to support business process operation, there has been a consistent interest in measuring the benefits of IT. Back in 1984, the UK HM Treasury (1984) published a report outlining a method for evaluating the impact of information technology in government offices. It divided the IT benefits into three categories: (1) those capable of quantification and valuable in monetary terms; (2) those generally quantifiable but difficult to value; and (3) those identifiable but not quantifiable. This work influenced many subsequent studies on measurement of IT benefits. In the construction sector, CIRIA (1996) and the Construction Industry Computing Association undertook a study on quantifying the benefits of IT in construction organisations. They carried out seven in-depth case studies. The study highlighted the complexity of conducting cost/benefit analysis for IT investment. It recommended that both tangible and intangible benefits should be considered in any analysis. A subsequent study by the Construct IT Centre (1998) produced a formal framework for measuring the benefits of IT investment. It suggested that IT benefits should be evaluated in three perspectives: efficiency; effectiveness and performance. A benefits matrix was proposed by this study to facilitate the application of this measurement framework.

> It is important to measure the benefits of CCM so that its users can see how much the system is helping in saving costs and improving contract change management processes.

Based on review of existing studies on measuring IT benefits, this research adopted a simplified benefit classification for measuring the benefits of CCM: tangible benefits and intangible benefits. Tangible benefits refer to time and cost savings that can be measured in monetary terms, while intangible benefits refer to capability improvement of a project team in dealing with contract changes.

3. Quantifying Tangible Benefits

Tangible benefits refer to cost and time savings achieved as a direct result of adopting the CCM system in a project. Measurement of tangible benefits is done through comparing the ways that key contract change management processes are handled with CCM and without it. Four such key processes are identified – Early Warning, Compensation Event, Value Change before Instruction, and Value Change after Instruction.

Detailed workflow analysis has been carried out on these four processes to identify the sequence of activities for each process in traditional practice. It further identifies the average staff time and likely consumable costs for these activities, which are potential savings using CCM. The analysis results have been validated through interviews with NEC experts and practitioners. The following is a summary for each process.

3.1 Early Warning

Early Warning (EW) is the most common procedure in NEC projects. It usually starts when one party of the project team notices a potential risk and informs the project manager. The manager needs to identify the risk under the appropriate contract clause by referencing the contract; and then issue the EW document to other parties. When these warnings are reviewed at risk reduction meetings, duplicate EW documents often need to be prepared. Following the risk review, decisions need to be recorded and circulated to the whole team. The whole process requires significant administrative support. Incoming and outgoing documents need to be registered and filed for future reference. In a paper based project, the costs for a typical early warning include the printing of multiple documents, postage costs for circulating notifications and instructions, and administrative staff costs. Furthermore, there are delays and

risk of loss when documents are sent through the post. In practice, documents are sometimes not registered or filed properly due to busy schedule in the office. When a contract falls into adjudication there is often a lack of valid audit trail or important documents might be missing, which may lead to the loss of a legal dispute.

Wastes and risks with paper based processes
- Costs of printing multiple copies of documents
- Delays in postage of documents
- Costs and delays with filing and retrieving documents
- Crucial documents missing
- Confusion caused by different versions of the same document
- Lack of reliable audit trails

Using CCM, early warnings can be issued directly by entering information to the central server. The project manager can review the warnings on the system and circulate information to all parties through CCM. This eliminates the need for printing, posting and filing documents manually.

For each EW, the estimated tangible savings, as a result of using CCM, include £1.15 consumable costs and approximately £30 administrative staff costs (1.50 hours at £20 per hour) and £137.50 managerial staff time (2.75 hours at £50 per hour).

3.2 Compensation Event

Compensation Event (CE) is one of the processes under contract change management where contract notices are issued by the PM in the event of contract changes. It provides an effective procedure for assessing and agreeing the time and cost effects of the events as they occur and in a timely manner.

Using CCM, notification and quotation are submitted on-line and recorded automatically by the server. It greatly improves the communication speed between the project partners and reduces the routine need for paper filing and copying.

In a traditional paper based system a CE document is prepared in the form of a letter, fax, or email by the project manager. The manager has to refer to the contract itself to find the appropriate clauses to refer to before making any decisions. Some CE decisions need to be approved by senior management and agreed by other project partners. CE documents represent alterations to the original contract. They need to be formally issued to all partners involved. Using a paper based communication method a CE process can take days before the manager receives the necessary information when making decisions. For every CE, the partners involved have to maintain an audit trail by logging both incoming and outgoing communications. This requires managerial, administrative staff time. It also increases the risks of making mistakes and errors.

Using CCM, all CE communications are carried out through the CCM server, which automatically provides an audit trail. The system also helps to ensure that decisions are made in a timely manner in accordance with NEC requirements.

For a typical CE, CCM can save a project £0.76 in consumable costs, £23.40 in administrative staff costs (1.17 hours at £20 per hour), and £71 in managerial staff costs (1.42 hours at £50 per hour).

3.3 Value Change before Instruction

This process reflects the valuation of a potential change (CE) before an Instruction is issued by the project manager. Although this is preferable, it is a rare occurrence in reality because the time required to carry out this process is not usually available.

In the traditional situation, the process of pre-agreed value of a proposed change is followed in a similar manner as other processes. The manager issues an Instruction seeking a quotation for a proposed change. The Contractor prepares a price known as the Contractors quotation. Most managers seek the advice of a Quantity Surveyor to check and agree the price. Here the document is prepared in similar manner as other NEC processes with associated consumable costs as well as managerial and administrative staff costs. Documents need to be sent to other parties for review and thus involving delays in post and also risks of loss in transit.

Using CCM, all the communications of this process can be handled on-line through the system. For each instance, it will result in tangible savings of £0.76 consumable costs, £28.4 administrative staff cost (1.42 hours at £20 per hour), and £75 managerial staff cost (1.50 hours at £50 per hour).

3.4 Value Change after Instruction

This is one of the most expensive processes if carried out using traditional methods. The process is initiated when the Client's representative issues a Change Instruction or PMI. The PMI document follows the notification cycle before reaching the Contractor. It is then reviewed by the Contractor who values the change and sends a Quotation to the manager for acceptance. After receiving the Quotation document the manager can either (1) reject the Quotation and carry out his own assessment; or (2) reject the Quotation and seek a new valuation; or (3) accept the change.

If the manager rejects the valuation and seeks a new Quotation, the contractor has to re-value the change and repeats the process of notification till the value is accepted by both parties. This process becomes more expensive as the number of negotiation or assessment cycles increase. Even worse, it can slip into a post project completion phase before there is an accepted agreement. The NEC contract sets out a number of response periods for these cycles but they are often ignored or extended. The traditional communication methods sometimes cause delays during this process not to mention the costs in staff time and consumables.

Using CCM, the speed of communication is greatly increased. It helps to improve the notification and negotiation process and leads to quicker agreement. In addition, it also produces tangible savings of £2.99 consumable costs, £53.4 administrative staff cost (2.67 hours at £20 per hour), and £196 managerial staff cost (3.92 hours at £50 per hour).

3.5 Spreadsheet tool

On the basis of analysis of the above four processes, a spreadsheet tool is developed, which can calculate the tangible benefits of CCM in a project (Figure 1). The calculation only requires some simple data inputs – the number of early warning generated; the number of compensation events; the numbers of value change both before and after instruction. These data are readily available to CCM users from the system log file reports. The spreadsheet tool will calculate (1) Consumables costs savings, (2) Staff costs saving, and (3) Total savings. The example in Figure 1 illustrates that Staff costs savings count for the majority of the tangible benefits of the CCM system. The spreadsheet may also be used for future projects to produce potential cost savings when using CCM.

The underlying process analysis is included in the spreadsheet tool. Users can further customise it to reflect their processes more accurately so that making the calculation more reliable for them. The variables that can be modified by the users include:

- Rates of managerial and administrative staff cost
- Unit costs for printing and postage
- Number of copies of document circulation
- Number of tasks of the four key processes
- Duration for each task of the four key processes

The spreadsheet tool calculates the amount of tangible savings for a NEC project as a result of using CCM. It also shows where the savings are made.
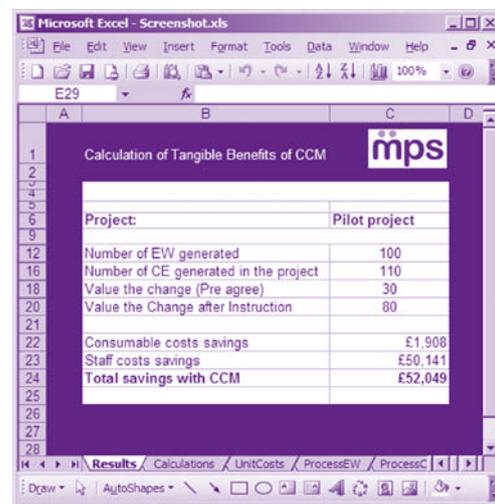
4. Measuring Intangible Benefits

By using CCM, construction projects can improve compliance with NEC procedures, minimise process failures, and increase efficiencies. As a result, project teams can deliver successful projects on a more consistent basis. Benefits of this kind are intangible and cannot be easily measured in pure financial terms. Instead, the de facto industry standard Capability Maturity Model methodology is adopted for measuring the intangible benefits of CCM.

4.1 What is a Capability Maturity Model?

The concept of Capability Maturity Model (CMM) was originally proposed by the Software Engineering Institute (SEI) at the Carnegie Mellon University in 1991 (SEI, 2002 & 2006). It provides a framework to continuously measure, evolve and improve the processes of software development. Subsequently, CMM has been adopted in other sectors, such as Structured Process Improvement for Construction Enterprises (SPICE) (SCRI, 2005), PRINCE2 Maturity Model (P2MM), Programme Management Maturity Model (PMMM), Portfolio, Programme and Project Management Maturity Model (P3M3) and Organisational Project Management Maturity Model (OPM3) (APM, 2007).

CMM was based on the widely accepted belief that "the quality of a system or product is highly influenced by the quality of the process used to develop and maintain it."

Figure 1 Screenshot of tangible benefits calculation tool

The purpose of CMM is to improve the processes of an organisation, through which products and services are delivered. It contains the essential elements of effective processes for one or more disciplines and describes an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness.

A more mature organisation's business process is more reliable. Its performance is more predictable; less risk and few surprises.

The latest version of this model is known as Capability Maturity Model Integration (CMMI). It defines 22 generic process areas, such as requirement development, project monitoring and control, risk management, measurement and analysis, etc. It also defines five process maturity levels: Level 1 – Initial; Level 2 – Repeatable; Level 3 – Defined; Level 4 – Managed; Level 5 – Optimizing. A maturity level is a thoroughly-defined pattern and characteristic of process behaviour of an organisation.

CMMI has two different representations: Staged and Continuous (Figure 2). The Staged representation defines the required Process Areas, out of the total 22, at each of those five levels of maturity. It assesses an organisation against the existence or absence of these Process Areas and produces an overall Maturity Level rating. For example, an organisation with no process improvement programme is usually at the lowest level of maturity – Level 1. As it adopts the appropriate goals and practices of processes defined at higher levels, the organisation can progress through the maturity hierarchy. At the other end of the spectrum, a Maturity Level 5 organisation is expected to have continuous improvement processes, such as Organisational Innovation and Deployment, and Causal Analysis and Resolution.

Continuous representation of CMMI has the same 22 Process Areas. However, rather than allocating Process Areas to different maturity levels, it assesses all the Process Areas against the maturity level from 0 to 5. The Maturity Level 0 is added to indicate that a particular Process Area is nonexistent. This approach allows greater granularity in the capability measurement. It recognises that some higher level Key Process Areas might be partially achieved in an overall lower level of maturity organisation. It will also allow organisations to identify their strengths as well as weaknesses. For example, an organisation can reach capability level 2 in one process area but capability level 4 in another.
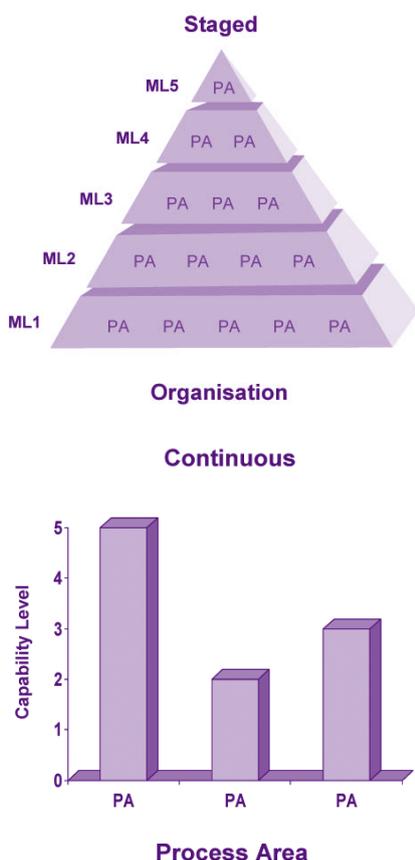
Following the principle of the CMMI Continuous representation, a Change Management Maturity Model (CM3) is developed in this study. It is a measurement framework that specifically aims at assessing a project team's capability in dealing with contract changes during construction and engineering projects. A typical project team consists of members from different organisations, such as client, contractor, and consultant. CM3 focuses on the project team rather than project partner organisations. However, the capability of the organisations will no doubt have an impact on the capability of the project team.

Figure 2 Two different representations of CMMI

4.2 What do levels of maturity mean?

CM3 defines five different levels of capability maturity with regards to contract change management. Their characteristics are summarised in Table 2.

Table 2 Maturity levels in contract change management

MATURITY LEVEL	DESCRIPTION
Level 1 Ad-hoc change management	A project team is characterised as ad-hoc or even having no change management processes in place. Few processes are defined or followed on a regular basis, and success depends on individual effort and their heroics. At this level a project team is in a 'dormant' state as far as change management is concerned.
Level 2 Informal change management	Informal change management processes are established. The necessary instruction is in place to repeat earlier successes on similar programme with similar performance levels. However, it is not enforced consistently. At this level, the project team is 'reactive' to changes.
Level 3 Systematic change management	A project team has set up systematic protocols and procedures to repeat the processes. Process is controlled and documented according to pre-agreed set procedures. The project team is 'adaptive' to managing changes.
Level 4 Integrated change management	The change management processes are integrated throughout the team. Process is integrated with other functions of project management. There is a dedicated measurement system. The project team is 'supportive' to managing changes.
Level 5 Continuous improvement in change management	The change management process is continuously improved so as to prevent any repetition of any failures. The main focus is on learning and improving continuously. The project team is 'pro active' towards change management processes

4.3 What are the Key Process Areas?

A Key process area (KPA) refers to a cluster of related activities which aim at achieving a set of goals. The CM3 framework identified six Key Process Areas (Table 3):

Table 3 Key Process Areas of CM3

KEY PROCESS AREA	DESCRIPTION
Management Process	Change Management processes help project teams to establish a standardised procedure of working and handling project changes in the event of their occurrences. The Change Management processes include all the events right from the beginning of the occurrence till the completion of the change. The purpose of assessing the maturity of project team's change management process is to evaluate the consistence and effectiveness of their change management procedures.
Risk Management	Risk Management helps to identify, analyse and avoid the negative effects related with risks during a project. It involves the use of standardised documents for managing and reducing risks. The purpose of establishing Risk Management maturity is to ascertain the existence of any risk management procedures in a project team and how effectively and efficiently these procedures are implemented.
Communication	The purpose of Communication is to establish information flow across the project team and to ensure that all the partners have the necessary tools and skills to share information and coordinate their activities efficiently. Its assessment should include both the capacity of the communication systems used and the extent that capability is utilised by the project team.
Management Information	Management Information should ensure that the project team is able to share information in the most efficient manner. The level of maturity in this aspect is determined by whether project information is managed effectively so that the right information is provided to the right people at the right time and in the right format.
Collaboration	Collaboration helps to improve trust and cooperation between the project partners in dealing with contract changes. Good collaboration promotes good teamwork. It will help to identify project risks early and avoid some unnecessary changes. When a change becomes inevitable, good collaboration will help the project team to find an optimum solution.
Leadership/Objectives	The purpose of Leadership/Objectives is to assess the involvement of the Senior Management in preparing the project team to deal with project changes. It also ascertains the objectives of the whole project team as well as of individual project partners. Senior Managers should ensure that the project team has the required skills to perform the project tasks effectively and provide necessary training.

Table 4 Change Management Maturity Model (CM3) Matrix

	Level 1 Ad-hoc Change Management	Level 2 Informal Change Management	Level 3 Systematic Change Management	Level 4 Integrated Change Management	Level 5 Continuous Improvement
Management Process	There are no consistent change management procedures or practices. Any change management process, that might exist, is not shared by the whole team. The project team is reactive to changes rather than anticipates them. There is a poor audit trail of the change management process. Changes are rarely reviewed after they occurred.	Change management processes exist, however they are not followed on a consistent basis. Many changes are handled informally without following the correct processes. The project team is still largely reactive to changes rather than anticipates them. Documentation record is poor. Changes are sometimes reviewed after they occurred.	Change management processes are followed on a consistent basis. The whole project team shares the same processes, although each team member may still operate a localised process in parallel. The project team begins to be proactive in anticipating changes. Audit trail is recorded. There is a requirement of review after a change.	Standard change management processes are adopted and followed consistently by the whole team. Processes are efficiently implemented, possibly with the support of an IT tool. Most changes are managed proactively. Change management audit trail is complete using standard documents and forms. Changes are reviewed in various contexts.	Change Management performance evaluation metrics are developed and analysed for potential improvement. The project team takes full advantage of technology support. Learning is regarded as an essential part of Change Management process.
Risk Management	Risk Management procedures are ad-hoc or not present at all. React after a problem occurs. No attempt is made to identify risks or to develop contingency plans. During a crisis, plans are abandoned and changes are made without clear understanding of their consequences. The project team is not aware of key circumstances that may impact the project budget and schedule.	Risk Management is recognised by the project team. However roles and responsibilities are not well defined. Risk reviews are conducted informally and not always effective. There is no systematic plan to deal with risks. Risks are often dealt with through individual initiatives. The project team does not adopt any tools to support the risk management process.	Risk Management is recognised by the project team. All team members are aware of their roles and responsibilities. There is a proactive risk management system in place. The project team adopts appropriate tools to support the risk management process. Decision making process can be easily audited.	Risk management strategy and system are clearly understood by the whole team. All team members are fully aware of their roles and responsibilities. All project risks are managed proactively in a coordinated fashion. The risk management process is supported by IT tools. Risk management effectiveness is regularly measured and corrective actions are taken when required.	Risk management is embedded in the culture and practice of the project team. All team members feel empowered to contribute to the risk management process. The risk management knowledge is captured and reused. Risk management focus is on continuous improvement, through regular reviews and measurement.
Communication	There is no agreed project wide communication strategy and standard protocol. Communication is on a 'need to know' basis only and uses multiple mediums, such as letter, phone, e-mails, fax etc. Key decisions are made on the basis of informal communication. There is no audit trail. Communication delay is prevalent. There is no way of knowing the communication effectiveness.	There may be an agreed project wide communication strategy, but it is not implemented effectively. Communication is done using multiple methods, such as letter, phone, e-mails, fax etc. There is no effective communication audit trail. Communication delay is still a common problem. Communication problems are identified by chance, and ad hoc solutions are adopted. The same problem might occur again.	There is a project wide communication strategy, involving agreed systems to be used. Multiple communication methods are still used for different purposes. There is no central repository. There is some kind of record system to provide an audit trail. Communication delay occurs occasionally. Communication problems are identified systematically, and appropriate solutions are developed to prevent the same problem from occurring again.	Communication strategy is agreed at the beginning of the project. Communication systems are put in place. IT based systems are used to provide a central hub for project information exchange. The communication system provides an instant audit trail. Communication delay is rare. Communication problems are anticipated before they occur.	The communication systems provide good process transparency. Good communication makes positive impact on other aspects of the project. The communication effectiveness is reviewed, measured and improvement is sought on an on-going basis.

Table 4 Change Management Maturity Model (CM3) Matrix (continued)

	Level 1 Ad-hoc Change Management	Level 2 Informal Change Management	Level 3 Systematic Change Management	Level 4 Integrated Change Management	Level 5 Continuous Improvement
Management Information	There is no clearly defined information management strategy. A variety of disparate information management systems are used. Project information is stored in different places; and difficult to retrieve. It is difficult to keep track of different versions of the same document.	There are informal agreements on project information management. However, these are not implemented effectively. Each project partner uses its own information management system. Information exchange is general done through paper. There is no single information storage. Information retrieval is time consuming. It is still difficult to keep track of different versions of the same document.	There are formal agreements on project information management, which is implemented effectively. There is a shared information management system. However, each project partner also maintains its own system. There may be a single project information repository. However, access control relies on manual methods. Project information is managed in a disciplined manner.	There is a clear information management strategy, which is implemented effectively. The team adopts the same information management system; and uses it for all project information. There is a single project information repository, with proper access control support. Update project information is available instantly.	There is a clear information management strategy fully shared by the whole team. The team use the same on-line information management system, integrated with decision making process. There is a common project information server, with proper access control support. Project information is managed as a knowledge asset.
Collaboration	The relationship between project partners is adversarial. There is no effective team working. Project risk is allocated to each partner and managed locally. When things go wrong, project partners blame each other.	The relationship between project partners is determined by contract. Team working does not happen on a consistent basis. Collaboration depends on the individuals involved. Project risk is allocated to each partner, but managed in a coordinated fashion. When things go wrong, the party at fault is always identified and blamed.	The relationship between project partners is collaborative. Team working is encouraged. However, it does not always happen because of organisational or culture barriers. The project team works together to manage project risks. When things go wrong, the whole team helps to find a solution.	A collaborative contract is adopted. Team working is expected. Project risks are shared and proactively managed by the whole team. There is a high degree of mutual interest and trust between the project partners.	The project team is a partnership supported by a collaborative contract. Team working is the norm. Knowledge is shared. High level trust is reinforced by appropriate measures, such as open book accounting.
Leadership Objectives	There is a lack of common objective in the project team. The senior managers are not closely involved in the event of change or risk occurring. Roles and responsibilities are not clearly understood. There is a weak leadership in the project team.	The common objectives are shared by part of the team. The senior managers are informally involved in the event of change and risk. There is confusion in the roles and responsibilities of team members. Leadership is not consistent.	The team shares a common objective and work towards achieving it in the best possible manner. The project teams have high levels of motivation and senior management involvement. Senior managers take an active role in overseeing the aims and objectives of the project and help to develop necessary skills.	The whole team shares a common objective. Senior Managers provide clear leadership in the event of change and risk. Roles and responsibilities are clearly understood at all levels. 'No blame' culture is promoted.	Continuous improvement is a shared objective. Necessary training at all levels is provided prior to immediate needs. Effectively managing change is the goal of the project team and senior management. Performance measurement is adopted.

4.4 How is the assessment conducted?

When choosing an assessment method, you need to consider the purpose of your assessment and the amount of resources available.

Following the widely adopted principle of CMMI, three different assessment methods (Class A, B and C) are defined for using CM3. Table 5 outlines a summary of these three methods.

Table 5 Brief description of different assessment methods

METHOD	KEY FEATURES
Class A	Fully comprehensive method Thorough model coverage Multiple corroborated evidence sources – documents and interviews Requires independent lead assessor Minimum appraisal team size of 4 Produce reliable maturity rating A relative lengthy process Resource intensive in terms of staff time Implemented as part of process improvement drive
Class B	Less comprehensive than class A Can be restricted to specific process areas Multiple evidence sources – documents and interviews Done internally by the project team Minimum appraisal team size of 2 Focus on areas needing attention Time length and resource requirements can be variable Good interim check before a Class A assessment
Class C	Quick review Can be restricted to specific process areas Single evidence source – documents or interviews Done by the project manager Minimum appraisal team size of 1 Inexpensive, little training is required Good for initial gap analysis

The simplest assessment (Class C) can be done by a single individual, most likely the project manager of a project. It does not require special training. The assessment is done easily by comparing the assessor's judgement of the project team's capability and performance against the maturity levels description in the CM3 matrix. Clearly, the result of this method is more subjective. However, it is a quick and easy way of identifying those areas where a project team might be doing well or those areas that the team is not performing as well as expected. If the result reveals causes for concern, e.g., under performance in certain process areas or big discrepancies between maturity levels of different process areas, further detailed assessment may be recommended.

Class B assessment method requires a small assessment team which normally includes the project manager and representatives from the key project partners. The assessment team still uses the CM3 matrix directly to assess the project team's levels of maturity in the key process areas. Because all key stakeholders of a project team are involved in this assessment method, its results are better than that of the Class C method in terms of accuracy and objectivity. However, the assessment still largely relies on subjective judgements rather than on documented supporting evidences. As it is a relatively simple process, which can be done as part of the usual project review meetings, it is good for team building and promoting good relationship between the project partners.

Class A method provides the most comprehensive and reliable assessment of a project team's capability in dealing with contract changes. In addition to the participation of the key project partners, an independent facilitator is required in the core assessment team. The facilitator needs to be someone who is from outside the project team and is familiar with the CM3 framework and its assessment procedures. Using this method, an assessment goes through several phases:

- Planning and Preparation phase: During this phase, a small core assessment team is set up with minimum four members, including a representative from each key project partner and an independent facilitator. The team needs to agree on the purpose and scope of the assessment. The facilitator should provide the necessary training to other members on the CM3 assessment methodology. At the end of this phase, all parties should be committed to the exercise and understand their roles and responsibility, as well as be aware of the schedule of subsequent activities.

- Data Collection phase: A questionnaire (see an Extract in Appendix A) will be used to obtain feedback from all project participants, including those who are not part of the core assessment team. The questionnaire consists of

six sections, corresponding to the six key process areas of the CM3 matrix. Each section has three questions. The project participants are required to complete the questionnaire independently.

■ Data Consolidation and Validation phase: During this phase, the core assessment team will review the questionnaire responses. Further information may be obtained through interviews and review of documentations, especially when there are discrepancies between answers given by different project participants. The aim is to ensure that questionnaire answers are supported by solid evidence where possible and information from different sources is validated and corroborated.

■ Rating phase: The assessment team will analyse the data collected through questionnaire and interviews during the previous phase and assess the maturity levels of the project team against the description of the CM3 matrix. A maturity level rating is assigned to each key process area based on collected evidence and expert judgement of the assessment team. Rating is not done automatically through a computerised algorithm. Different maturity levels may be awarded to different key process areas. For example the project team may score a maturity level 4 for Management Process and maturity level 3 for Communication. The assessment result is shown in the form of a spider diagram (Figure 3). The diagram has the 6 Key Process Areas as its axis and 5 Maturity levels on each axis. A maturity profile is formed by linking all the key process area ratings, which indicates the overall maturity of the project team in change management.

■ Review and Feedback phase: Finally, the assessment results and findings will be presented at a workshop to all project participants. This workshop provides an opportunity for everyone to review and comment on the assessment findings. It is also a forum to review existing performance and discuss potential improvement. The output of this workshop will be an implementation plan with clearly defined responsibilities.

The CM3 framework and its assessment procedures are generic. They can be applied to any construction project regardless whether or not NEC and CCM are used.

5. Case Studies

Three projects were selected as case studies during this study. The main objective is to follow the actual use of CCM on real projects and to examine the benefits it brings. These three projects are:

■ Case study 1 is a £34million refurbishment project for an office block in central London. It is carried out by a team that has not worked together previously. Most project partners are new to NEC contract and CCM system. The project is fairly standard and risk is low.

■ Case study 2 is a sub-station power plant with a budget of £6million. The project team collaborated on other projects before. Its members have mixed levels of experience with NEC and CCM.

■ Case study 3 is a £3million civil engineering refurbishment project. The project team members are all experienced with NEC and CCM. Due to the nature of the project and its site condition, this project has a high level of risk.

At the start of each project, the researcher interviewed the key members of the project team to identify which areas they expect CCM would provide support for them. During the project, data related to the usage of CCM by the three projects are captured by the system in a log file. The usage patterns were analysed and the analysis results contributed to the development of the calculation method for tangible benefits of CCM. Table 6 illustrates some basic information about these projects and the results of the calculation of tangible benefits as a result of using CCM.

Table 6 Case studies and tangible benefit calculation results

	CASE STUDY 1	CASE STUDY 2	CASE STUDY 3
Project description	£34m building refurbishment project	£6m sub station power plant project	£3m civil engineering project
Project duration	20 months	18 months	18 months
Number of Early Warning	78	53	105
Number of Compensation Event	123	79	106
Value change before instruction	13	6	9
Value change after instruction	110	73	97
Consumable cost saving	£1969	£1294	£2017
Administrative staff cost saving	£11445	£7497	£11052
Managerial staff cost saving	£41954	£27629	£41617
Total tangible saving	£55368	£36420	£54685

The size of the tangible benefit is directly linked to the numbers of EWs, CEs and Value Changes of a project. The higher the numbers are, the bigger the saving will be. For these three case studies, the tangible savings were £55368, £36420 and £54685 respectively. The majority of the savings comes from reduction in staff time. This is because CCM helps project teams improve the operation of NEC processes significantly. The result is often that key staff are able to manage more projects then they could previously. In other words, the system helps with raising the capability of construction organisations. It is particularly important in today's climate since it is difficult to recruit competent managerial staff. The saving of printing and posting documents has both economic and sustainable environmental benefits.

The assessment of the intangible benefits is done at the late stage of each case study project. This was done by partially following the Class A assessment method of the CM3 framework. The result is shown in Figure 3. It is clear that as a result of adopting NEC and CCM, these projects have achieved capability maturity levels between 3 and 5 in all key business process areas. These are well above the industry benchmark of levels 1 and 2, as suggested by other studies and our own research findings.
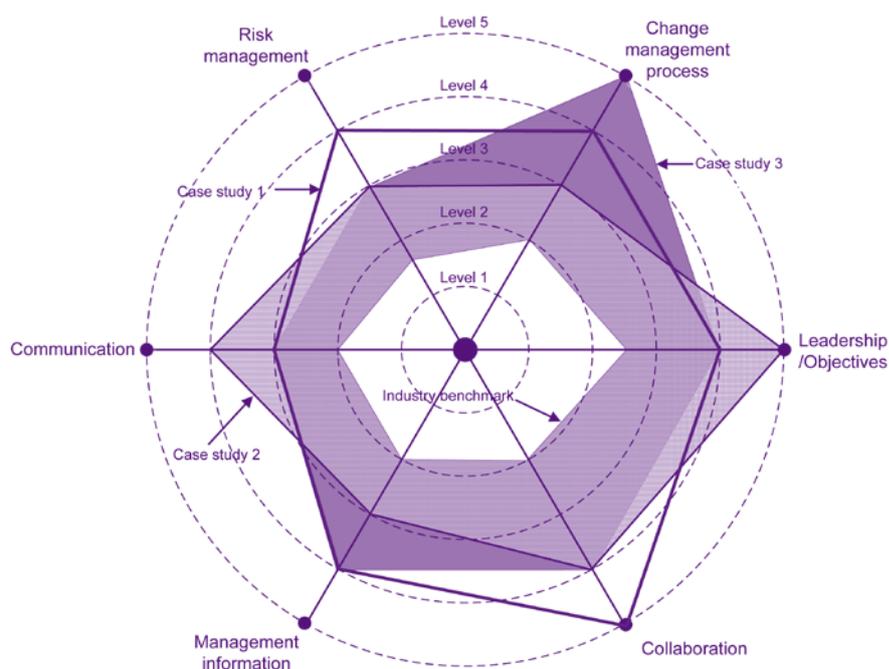

Figure 3 Case studies intangible benefits assessment

6. Summary

The report presents the main findings of a two year research project, which set out to investigate the benefits of the CCM system in supporting NEC projects. The main conclusions are summarised as follows:

■ As more and more construction projects adopt IT collaboration tools, there is a growing demand for evaluation of the benefits of these tools. First of all, users would like to see evidence that their investment in these tools is justified. Secondly, they are interested to learn how to maximise the benefits of these tools by knowing their full potential.

■ The vast majority of CCM users believe that the system is delivering real benefits, especially in improving contract change management process efficiency and compliance with NEC requirements.

■ Senior executives are particularly pleased with the aspect that CCM helps to reduce project risks and improve predictability. CCM is a useful tool, in junction with other management systems, to control and monitor multiple projects. Quick closing of final account is also highlighted.

■ The tangible benefits calculation method helps a project team to make a case for adopting an IT tool like CCM. It shows that in most cases tangible savings alone can outweigh the cost of the system.

■ The proposed CM3 framework helps to measure the intangible benefits of CCM and quantify them using the improvement of capability maturity levels. Previous studies in both construction and other sectors have already established that higher capability maturity levels will lead to better and more consistent performance.

■ Using CCM and NEC will not automatically translate into higher capability maturity levels in relation to contract change management. Nevertheless they help to raise the maximum levels that can be achieved. Without systems like these it is extremely difficult to reach maturity levels 4 and 5 in the key process areas, such as Management Process, Communication, Management Information, etc.

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Extract from Change Management Maturity Model (CM^3) Questionnaire

This document contains questions about the implementation of important Change Management practices in your project team*. The questions are organized in groups of the six change management key process areas of (1) Change Management processes, (2) Risk Management, (3) Communication, (4) Management Information, (5) Collaboration and (6) Leadership/ Objectives.

This questionnaire is aimed at assessing the level of maturity of a construction project team in dealing with Change Management. Please answer all the 18 multiple choice questions based on your knowledge and experience in your current project.

GENERAL INFORMATION

Name: _____
Organisation Name: _____
Designation: _____
Project Name: _____
Project Role: _____
Date: _____

Section 1: CHANGE MANAGEMENT PROCESSES

This section will ask you about your experience in using Change Management processes. Change Management processes help project teams to establish a standardised procedure of working and handling project changes in the event of their occurrences. The Change Management processes include all the events right from the beginning of the occurrence of change till the completion of the change. The purpose of establishing project maturity for Change Management is to evaluate how effectively and efficiently the project team is utilising the Change Management processes in managing change.

1.   Does the project team adopt any change management process?
        ☐   Yes, but the Change Management process is not clearly defined.
        ☐   Each project partner has its own Change Management process.
        ☐   The whole project team uses a common Change Management process.

2.   To what extent is the Change Management process implemented during the project?

        ☐   The Change Management process is not followed consistently. Changes are dealt with on an ad-hoc basis most of the time.
        ☐   The Change Management process is followed most of the time and for most of the changes.
        ☐   The Change Management process is rigorously followed for all changes.

3.   Does the project team carry out any reviews or learning following change events?
        ☐   There is no review at all.
        ☐   Review is done infrequently at certain stages of the project.
        ☐   Review is always done following a change event so that lessons can be learnt.

Section 2: RISK MANAGEMENT

Continue…

Acknowledgements