

Complexity: The Fifth Dimension of Project Management

Robert C. McCue, P.E.
Consulting Engineer

MDCSystems® has been providing Forensic Project Management (FPM®) services for over forty years for industrial, transportation and institutional capital projects. Using this extensive knowledge base, **MDC®**, develops and conducts seminars for the public and private sectors on many topics including the topics of Complexity and Systems Thinking, Sustainability, CPM scheduling, Claims Avoidance and Green Buildings.

Over the past Twenty Years, Project and Construction Management Art and Science has been impacted significantly by new tools. Drawing techniques have progressed from 2-D hand drawn velum and blueprints to 3-D CADD allowing for more precision, faster revisions and concept developments and more realistic working models of the project. Integrating object intelligence¹ and specifications data with the models provides a more useful tool to contractors and owners for the construction and operation of the finished project. The addition of the “Time” dimension by linking the CPM scheduling features of new software to the elements of the completed design seems to have provided the highest degree of control over the construction process and logically should result in more precision in the planning and completion of the construction. Laser scanning and the associated precision that can be input into the design model make the production of as-built drawings and the as-built model a veritable work of art. Taken altogether these tools make for a brave new world for design and construction professionals and provide a false sense of control and management insight.

How then are we to understand and accept that the perceived failure rate of modern capital projects has not changed significantly for the better! Our understanding can best be expressed as follows: The added precision in definition and description of the most intense modern 4-D CADD managed project collides with the ability of humans to grasp and model the added interactions that are formed and occurring in the overall model and physical project. In other words, adding precision increases the difficulty in successfully achieving integration at the interfaces of the elements of the work. This old, restated, Systems Thinking Concept² reminds us that our grasp cannot exceed our reach. Fundamentally different processes take place in design and construction. Estimating, Bid Packaging and Subcontracting proceed along different paths than design efforts. Construction Scheduling is more Art than Science and assumes and simplifies the actual construction events to logical groupings of activities given a precise time duration and sequence inside the assumed overall construction timeframe. Scheduling assumptions are rarely explicit and attempts by non-schedulers to make sense of the typical CPM schedule result in frustration and grudging acceptance, (If you say so!) if acceptance at all.

¹ Also know as BIM – Building Information Management System

² Systems Thinking – Perfecting parts of the system can degrade the overall function and efficiency of the system.

If we maximize the power of 4-D CADD, and couple it with typical CPM techniques we find immensely detailed activity itemizations which are of no use in effectively scheduling the project. This also creates the daunting task of developing the logical relationships between the activities. A typical modern project that would be properly scheduled with 2000 activities and 6000 relationships would easily balloon to 200,000 individual activities and over a million relationships, an unworkable outcome for any project team. This extreme granularity in scheduling would detract from the ability to manage and forecast the actual work by overwhelming the project team in details that are normally relegated to the custom and practice of the subcontractors and trades.

If we allow, as is typical on modern projects, the relationships to change over time the scheduling task can never be achieved and will not result in the project team understanding progress or status any more than a casual walk around the work site³.

This extreme example allows for an understanding of how Complexity (The Fifth Dimension of Project Management) imposes itself on the project just when it appears that computing power will allow the project team to craft and implement the “perfect” detailed schedule. What about the typical modern project without the added detail?

Multiple layers of Complexity can overlay the work when unstated assumptions concerning site conditions, process requirements, parallel operations, off-site conditions, weather issues, supplier controlled changes, commodity prices and availability, labor availability and work rules, environmental requirements and public acceptance impose themselves on the work. Because it is unlikely that any of these concerns are explicitly linked into the overall project plan and schedule, subtle but constant movement and new but unrecognized relationships between and among activities can wreak havoc with the plans and schemes of the best project teams.

Project Executives, Project Managers and all team members need to be aware of the devastating effect that emerging Complexity can have on their project and be alert to the following tell tale indicators of emerging Complexity:

- Resistance to corrective measures by the Team
- Second and Third order activity relationships prevent progress
- Established project measurement metrics cease to be reliable indicators of completion
- Increasing levels of manpower resources do not equate to additional completion gains
- “Small” events trigger large impacts on multiple work activities(disproportionality)

³ During a project review with the Captain in charge of a multi-year multi-ship refurbishment project, he revealed that the scheduling requirement resulted in a fully detailed master schedule for all twenty ships over four years of work and that his team had never finished the first schedule review, before the next months schedule was delivered. We were in his main conference room surrounded by large stacks of computer print-outs of monthly schedules all satisfying the contract scheduling requirement but providing no useful information on the project that was hopelessly delayed and had already doubled in cost. This and other similar incidents are common in our practice.

- Relationships change among activities inside the transactional space of the project and outside in the larger environment
- Traditional management tools and metrics give confusing signals and conflicting direction
- CPM schedules show increasing numbers of “Critical” activities
- CPM schedule updates are overshadowed by events and outdated before issued
- CPM schedules of remaining activities place over 50% on the “Critical Path”
- Project team frustration develops at their lack of influence over events

These and other subjective signs foretell the arrival of Complexity to the project and the project leadership team must react with reflective, insightful leadership to shepherd a path for the project to completion or succumb to the impending Chaotic and uncontrollable deteriorating project situation. Project Managers must implement trial and error approaches to allow emergent solutions to arise and instill by encouraging team members to adopt exploratory approaches to discern and test likely solutions to overcome the impediments posed by Complexity.

In his book entitled “The Black Swan,”⁴ Nassim Nicholas Taleb recounts in detail the “modern” statistical approach to determining the likelihood of events occurring. As he points out, we simply discount the rare and infrequent events because they may not happen in a normal lifetime. However, when they do occur, they disrupt the business environment in such a way that all of the underlying assumptions used to develop the project plan and execution strategy are revised and the reactions to and/or effects of the event are disproportionate and transient. Normalcy may not be quickly recovered and the resulting secondary interactions of the event/events further confuse the situation.

If you are interested in discussing how these new understandings of Complexity can be applied to Engineering and Construction projects do not hesitate to contact us at **MDC**[®]. **MDC**[®] develops and presents seminars on this and other relevant Architecture, Engineering and Construction Management topics and these can be viewed on our website at www.MDCSystems.com.

**For more information on Complexity, read Complexity – A Transient Condition Precedent to Project Failure found in the August 2010 MDC Advisor[®].*

⁴ “A Black Swan is a highly improbable event with three principal characteristics: It is unpredictable; it carries a massive impact; and, after the fact, we concoct an explanation that makes it appear less random, and more predictable, than it was.” - Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable*, (New York: Random House Publishing Group, 2007).