

Dynamic Planning and Control Methodology (DPM) for Large-Scale Design and Construction Projects

What the innovation is: A robust simulation-based project planning and control framework for large-scale design and construction projects was developed, which enables understanding of the dynamics of errors and changes and provides policy guidelines to effectively manage them.

Why it is innovative: DPM takes a holistic approach in analyzing non-value adding iterative cycles caused by errors and changes (Figure 1), which are the major drivers for uncertainty and complexity in large-scale design and construction projects. It has often been hypothesized that a phase in design and construction projects is not affected by other phases and processes. However, any deviation usually resulting from errors and changes may impact other processes even if the deviation does not directly involve these processes. Furthermore, errors and changes can be hidden and reappear at a later stage of projects, which adds to project management uncertainty and complexity. To address these issues, DPM aims to understand project reality (e.g., 90% syndrome, cost overruns, schedule delays), which has not been easily explained by traditional project management approaches, and to evaluate the impact of possible control policies (e.g., overtime, overmanning, proactive schedule buffer) through the use of novel metrics which can measure errors and changes, as well as their latency and propagation (e.g., reliability, stability, latency, and sensitivity).

What it changed or replaced: DPM supplements the widely adopted CPM/PERT (Critical Path Method/ Program Evaluation and Review Technique) providing more analysis capability. DPM integrates CPM/PERT and simulation methodology and thus, the user can maintain their current CPM/PERT standard while obtaining richer information from a simulation at the strategic and operational management levels. In particular, DPM adopts System Dynamics for simulation capability at the strategic management level, which focuses on system structure as a whole for better understanding of construction. This holistic approach can ultimately change the way the construction project is planned and controlled. For example, DPM takes into account how errors and changes occur and how they generate the negative impact on project performance in advance, thereby enabling the user to create a realistic construction plan. Also, in a project control stage, when as-built information does not match as-planned, the effect different policies can have on construction performance can be observed and thus, more robust control actions can be made. Now, extensive research efforts are being taken to make DPM a comprehensive simulation environment integrating discrete event simulation in order to address the operational management levels.

Where and when it originated, has been used, and is expected to be used in the future: Initial concept of DPM was realized by the IESL (Intelligent Engineering Systems Laboratory) at MIT in 1997 using System Dynamics. Then, for enhanced capability and usability in managing large-scale construction projects, strengths of other project management approaches such as network based model, DSM (design structure matrix), and critical chain project management have been integrated in a comprehensive framework (Figure 2). For its validation, DPM has been applied to a highway bridge infrastructure project in Massachusetts and a laboratory building project in Malaysia which demonstrated its powerful strength in understanding and managing uncertain and complex projects. Also, a series of construction projects are under study to detect the current progress in a real time manner through vision-based techniques and apply the current status to DPM for real time simulation and visualization.

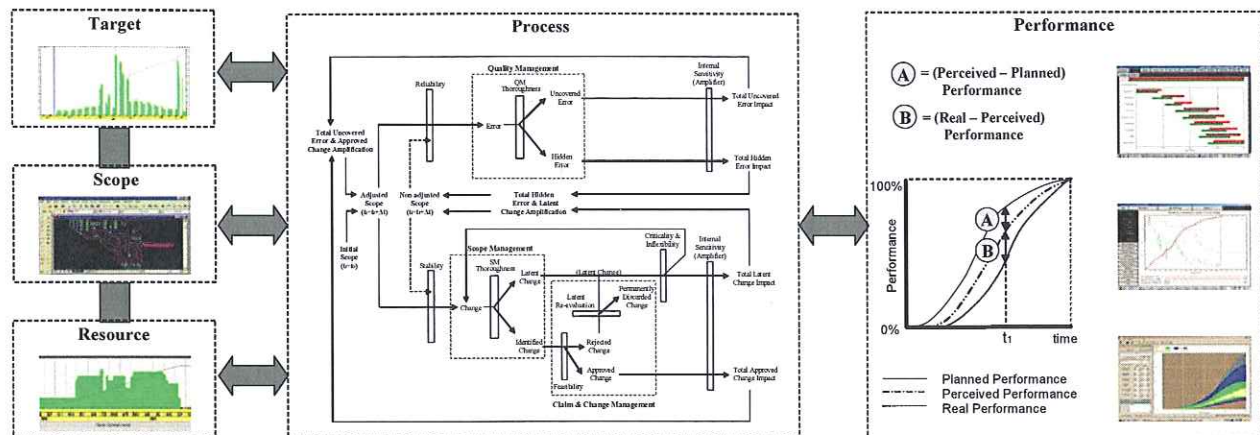


Figure 1. Understanding of Impact of Errors and Changes on Project Performance

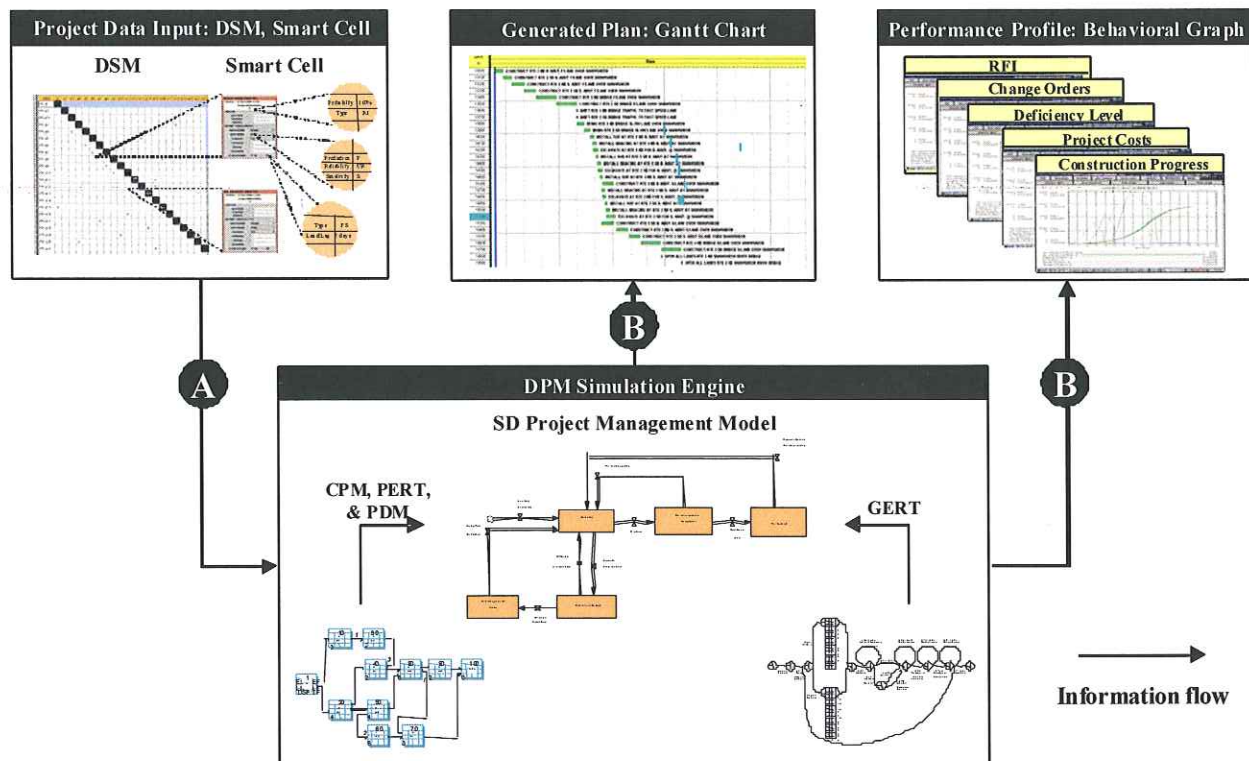


Figure 2. DPM System Overview