The Virtual Design Team and Checkitt™:

Comparison of Project Organization Models

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Abstract

The paper compares two models of industrial project plans. One model is Virtual Design Team (VDT), a computational emulator of organization design (Jin, 1996) based on information-processing view of organizations. In VDT model, characteristics of tasks, resources and communication tools are EXTERNAL parameters defining task and milestone probabilities. Another model is Checkitt™ (Fishman, Hoglund, Volchegursky, 2005), where project tasks are described by wavefunctions, and probabilities of project milestones are calculated based on two INTERNAL parameters (Milestone Uncertainty Date and Recovery Period) defined from the project schedule. The application areas of two models depend on how much information is available beyond the project schedule.

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The paper compares two models of industrial project plans. In any project, at least three types of agents interact: task implementers (workers doing project tasks), managers (responsible for work coordination and actual worker activity), and external stakeholders (executives, marketeers, customers, consultants, policy makers etc).

One model is Virtual Design Team (VDT), a computational emulator of organization design (Jin, 1996) based on information-processing view of organizations. In VDT model, characteristics of tasks, resources and communication tools are EXTERNAL parameters defining task and milestone probabilities. Another model is Checkitt™ (Fishman, Hoglund, Volchegursky, 2005), where project tasks are described by wavefunctions, and probabilities of project milestones are calculated based on two INTERNAL parameters defined from the project schedule. The application areas of two models depend on how much information is available beyond the project schedule.

Virtual Design Team Model

The VDT model simulates information-processing activity of an organization through company-specific communication system. Both production (for example, design) and coordination work (i.e., communication and decision-making) can be viewed as information processing, with the processors ("actors ") sending and receiving messages (e.g., memos, voice mail, meetings) with transmission lags and persistence durations., so that the total amount of information being processed models the work volume. To simulate a real engineering project in VDT and relate the simulation results to the project performance, a link between these task properties and real project data is developed that maps project information into a VDT model. This can be done using judgment, or more formally through structured Quality Function Deployment (Hauser and Klausing, HBR, 1988) and Design Structure Matrix (Smith & Eppinger, 1977) techniques.

To model "hidden" work consisting of supervision in the spirit of (Galbraith, 1977) and various forms of coordination and communication VDT utilizes a Monte Carlo simulation, with an input of direct work taken from a precedence diagram. Communication messages acquire attributes of sender and receiver, priority, synchronicity, cost, recordability etc., communication channel is characterized by capacity and bandwidth. For example, voice mail is partially synchronous, low cost, recordable, close proximity, high capacity for concurrent transmission, and high bandwidth for spoken voice, but low bandwidth for text, schematics or geometry. Telephone is similar except that it is synchronous, not recordable, and has low capacity for concurrent transmission.

VDT modeling also addresses a control structure defined by Supervise/Report-To relationships among actors as either flat or multiple level hierarchies. For example, in a highly centralized project organization structure, most decisions are made by the project manager, through the chain of subteam member - sub-team leader - project manager. In a more decentralized organization, decisions are made by the sub-team leaders or even by the engineers themselves; therefore, fewer communications are sent to high-level managers, generally saving time and cost but maybe decreasing process quality. VDT replicates this common organizational phenomenon through attention allocation and information processing in actor micro-behavior models. In particular, it can predict when centralized decision-making may lead to lower quality because of delays in handling exceptions caused by an overloaded project manager. The level of formalization of the organization defines how frequently the actors send informal communications to each other, instead of communicating through formally scheduled meetings. A more formalized organization relies on scheduled meetings for coordination, and reduces the frequency of informal inter-actor communications, and conversely.

All communication and coordination processes are thus characterized by parameters not presented in the project plan (external parameters); these parameters have to be determined in the information exchange between the model designer and the project actors.

Checkitt™ model

Checkitt™ analyzes the project structural integrity at the most general level. The key idea is that human task duration tolerances cannot be defined accurately, and some kind of uncertainty principle manages uncertainties of task duration and human productivity. Hence, the project tasks and milestones are modeled by appropriate wavefunctions (probability amplitudes). Each task is described by its own wavefunction ψ_i, milestone wavefunction Ψ is calculated as a superposition of task wavefunctions $\Psi = \psi_1+\psi_2+\psi_3+.....$, and the milestone probability is calculated as $P=/\Psi/^2$. If the milestone is not perturbed (tasks are finished without delay), the probability amplitudes of individual tasks interfere at the milestone coherently creating a maximum intensity in the interference pattern.

If the task is delayed its phase slips, coherent interference of all wavefunctions is partially destroyed, and the milestone probability drops. The model accounts for bigger probability drops (larger phase shifts) associated with tasks that have dependencies to other tasks. Tasks scheduled to be completed just before milestones have higher impact on milestone probability than similar tasks performed long before milestones. In chains of mutually dependent tasks, perturbation of the first task causes perturbation of the whole chain increasing the delay risk for the milestone. For large and remote milestones, the probability drop is smaller than for immediate ones, etc.

Analyzing the project plan, Checkitt™ model calculates two parameters, Milestone Date Uncertainty (MDU) and Recovery Period (RP). These parameters define temporal units for task duration tolerances and for project recovery capability; they depend only on the task structure (no external information is required). If externall information characterizing project “climate” is available, MDU and RP are scaled to larger or smaller values describing less or more risk in different aspects of the project execution.

Model Comparison and Convergence

VDT was specifically developed to diagnose organizational risks for fast-track, highly concurrent projects. VDT diagnoses organizational risks (including delays in task completion and milestone achievement, cost overruns and process quality risks) resulting from information overload for particular actors in the structure at particular times during the project, given a specific configuration of tasks, actors and organization structure. Based on this EXTERNAL information describing the project environment VDT creates a network where information exchange between the key actors is included, and the managers can intervene pro-actively to change the product (by reducing its scope), the process (by reducing the degree of task overlap and extending the schedule), or the organization (by adding staff, increasing the skill levels in particular positions, etc.) to mitigate the risks. Like the way in which analysis tools support engineers doing structural or mechanical design, the process of diagnosis, synthesis and reevaluation using VDT for the analysis step can be iterated multiple times in the computer to reach an acceptable solution.

To the contrary, Checkitt™ deals with plans that have incomplete or even inadequate information, and applies power of quantum mechanical modeling to improve project structure. Without further communication with the project owners, Checkitt™ calculates two INTERNAL parameters (MDU and RP) providing reference time units for task delay and milestone recovery time affecting the milestone probability. Thus, expected probabilities of any two milestones may be formally compared on the same basis.

Both models present a project as a communication network where information is propagated and processed. VDT models communication between actors. The formalized items for simulation are specific communication tools (e.g., voice mail), the degree of reciprocal information interdependency between certain activities, the skill level of an actor, etc. Thus, VDT is flexible – changing and/or increasing respective informational items is a natural procedure with a relatively straightforward common sense validity check. Inherently, VDT is scalable meaning it could deal with as much information as could be provided by the external sources. However, receiving this information from the project owner may be increasingly difficult with the growth of the project size: if the number of actors grows as N, the informational flow grows as N^2.

For Checkitt™, the project structure itself is a network, with milestones being network nodes. The model manipulates such parameters as wavefunction frequency, amplitude and phase, task delay, task mutual coherence, etc. To incorporate budget, resources, organizational structure etc. features into Checkitt™, these features have to be "projected" onto the model parameters (MDU and RP). The model is naturally and readily scalable to many thousand tasks or actors N, with complexity growing linearly with N.

Both models start with the notion that a Gantt chart (precedence diagram) does not fully characterize the project. In VDT, it is the concept of hidden work that has to be "exposed" by careful analysis of task extensions and delays. In Checkitt™, wavefunction interference and loss of mutual coherence describes the same phenomenon of hidden work in a more abstract and general way– indicating a possible need for project clarification and re-planning. Thus, both models target and address quantitative means for planning improvement.

Model Coexistence/Convergence

It can be expected that though VDT and Checkitt™ analyse projects from different perspectives they both emphasize the project fragments having low probability of success, such as long task chains and congestions of parallel tasks. The following is an example illustrating improvement of an industrial project using both Checkitt™ and VDT software. Figure 1 is a summary of a reasonably large construction project with only summary tasks and major milestones shown. Green diamonds represent initially planned major project milestones. Each milestone aggregates many tasks, suggesting durations of direct work shown in Fig. 1. One of the major milestones (GMP Accepted) is initaially planned for the end of October. As analyzed by Checkitt™ (see respective temporal diagram in Fig. 1), probability of this date is low. Using VDT formalism, re-work, coordination and decision times are added to each direct work item, VDT analysis suggests delaying the milestone until mid-January (black diamond). For a new milestone date, Checkitt™ analysis is repeated (see respective temporal diagram) confirming much higher probability of the new milestone date.

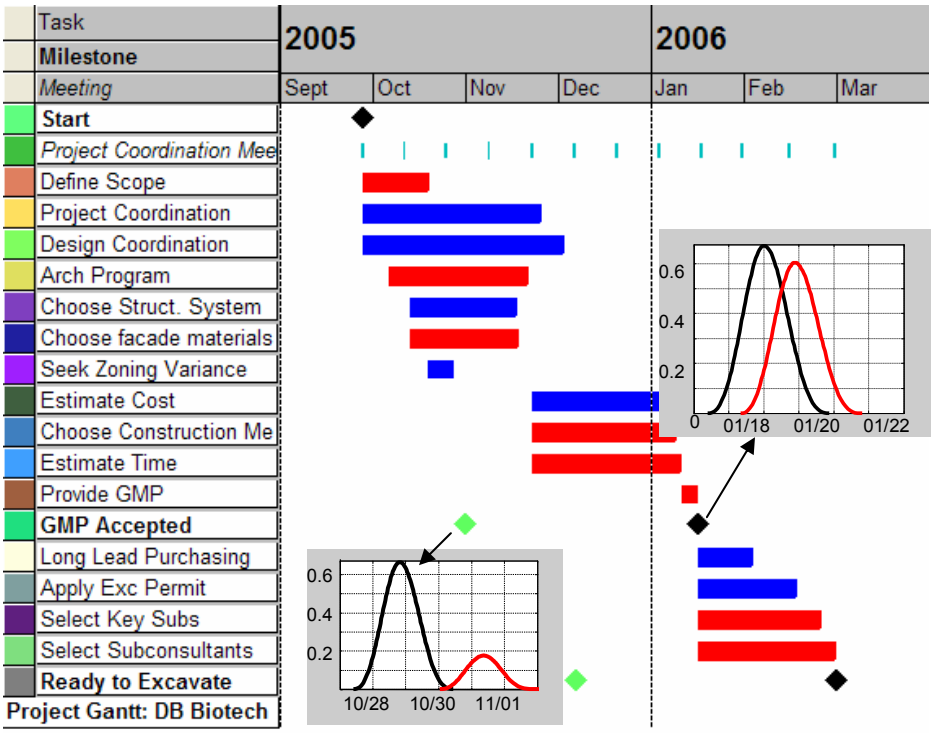

Figure 1. VDT and Checkitt™ analysis of major milestones (Green diamonds show desired milestone completion dates, black diamonds show expected milestone dates predicted by VDT simulation. Temporal diagrams show increased milestone probability for later date).

This combined approach is productive if the information required for VDT analysis is available. Today, the major problem with commercial projects is a lack of planning data. Conventional projects are often poorly created and poorly maintained; for example, even for a large scale construction projects where the project plan is vital, it is almost impossible to have subcontractors

assign resources to the tasks, not to mention task budget and/or task duration tolerances. Very often, the plan structure is extremely poorly defined: tasks do not report to milestones, milestone hierarchy is not established. Given this, the Checkitt™ approach may be applied first to correct errors, define first-order milestone probability and rank all project tasks in terms of their risk to the milestone no matter what is the project size and industry vertical.

For more mature projects (in fact, for more mature organizations with PMOs and established planning culture), tasks described by Checkitt™ may acquire features of better defined tolerances, specific metrics for milestone probability, ranking enterprise corporate structure etc. This first step, though not accurately presenting the project details, identifies risky milestones and establishes suspicious tasks responsible for high risk. At this point, a VDT model can be applied to high risk segments of the project rather than to the project as a whole.

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