Chapter XXX
An Evolutionary Algorithm for Decisional Assistance to Project Management

Samuel Rochet
LESIA, INSA, France

Claude Baron
LESIA, INSA, France

ABSTRACT

Manufacturers must always develop products faster and better to satisfy their client's requirements. To help them, we have developed and experimented with a methodology to improve the management process by connecting it with the design process. An issue for the project manager is to select an organization from among the possible ones to schedule the project tasks in order to reach the targets in terms of costs, duration, quality, and so forth. This constitutes a tricky operation, because many options defined during the design can be associated to each task of the project. Choosing and optimizing the schedules is a combinatorial problem which can be solved by heuristic. This document explores the use of evolutionary algorithms to help the decision maker. It introduces the industrial context and presents our methodology to connect the design and project management processes, expressing the problem as a multi-objective optimization one. We detail the scenarios selection process and demonstrate which performances are obtained.

INTRODUCTION: THE INDUSTRIAL CONTEXT AND OUR RESEARCH OBJECTIVES

The globalization of markets and an intensive competition deeply modified the companies' organization. Manufacturers must have a great ability to react in order to satisfy the customers' requirements with shorter times to market and higher product quality. The durations of the innovation cycle were thus notably reduced in all industrial sectors: transportation, telecom-

munication, and so forth. To obtain such results, manufacturers had to considerably modify their working methods. Generally speaking, they need to keep the costs reduced to best evaluate the risks, to capitalize the knowledge and know-how, and to avoid reproducing previous errors. Therefore, today, designing innovative systems is essentially based on the mastery and the fast integration of several technologies, methods, tools, and know-how, both on the technical and on the organizational plans. A strong level of complexity, on the technical plan, characterizes the process design due to the variety and the interdependence of the design choices, but also on the organizational plan, because of the distributed feature of project management.[1] Furthermore, worried about best satisfying their customers' requirements, manufacturers have to specifically customize their products.

For a very long time, development was organized into two phases. A phase of design came first during which the system functional and organic architectures were determined in order to respect the functional requirements. Then, a project management phase intervened to schedule a list of activities deducted from the design and verifying the satisfaction of the non-functional requirements (mainly risks, quality, delays, and costs). However, this organization presents two major drawbacks:

- *A minor design decision can have major repercussions on the organization of activities leading to obtain the product.* For example, moving a structural element on an aircraft will induce technical changes with repercussions on various project activities.
- *Reciprocally, management decisions can also have consequences on the way of designing the system* (giving up a too expensive or too much risked technology, subcontracting parts of the system, etc.).

This mode of organization is not satisfactory: a close collaboration between teams turns out to be necessary. It is thus essential to build and to formalize the design at the same time as the project management. The time to market, as well as the risks of incoherence due to the lack of interactions between design and organization, would indeed be considerably reduced if the technical, administrative, and financial decisions leaned on a unique data model that would be shared by all the partners and based on the previous experiences (failures and successes). This model should be able to contain all project information to reuse them, but it should also be able to favor the traceability of design and management choices.

Such a model is not currently available, and tools integrating design and management aspects, notably by pointing out the consequences of a design decision on the organization (and reciprocally), are today still lacking. Now, it becomes essential for a decision maker to have methods and tools to organize his project according to the design choices. Indeed, design engenders numerous scenarios due to the existence of options in the choice of technologies, architectures, material, or software allocations of the functions. The representation and the management of such scenarios are complex, strongly combinatorial, and are not generally available in project management tools, which are classically based on static models. However, when trouble occurs during the project, or when a major deviation occurs from the initially envisaged organization of activities, it seems important to us that the choice of a new working plan be guided by its coherence from a technical point of view with regard to the design options already taken, but also from a project point of view with regard to the management choices made before. In this context, project manager has to first identify a set of possible scenarios to lead the project. Then, among