Part III.

Operating System Evolution

Operating systems are expected to have long life spans. They evolve during their life spans because operating system programs are, after all, representations of real life procedures and artifacts. They are subjected to changes, enhancements and modifications, continually performed by developers and maintainers. This program evolution is one of the most challenging aspects of software engineering and must be coped with a powerful method. The first paper by L. A. Belady describes an ongoing project which is the application of data abstraction for redesigning an existing operating system component. It developed, among others, tools to facilitate the work with existing systems and to design new systems. The second paper by M. Maekawa proposes an operating system structuring concept "resource module" to help design an easily modifiable operating system. The concept is a formalization of the view that an operating system is a collection of resources, as has been recognized by industrial programmers, and is similar to data abstraction.
Modifiability of Large Software Systems
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June 1980

ABSTRACT: The problem of software modifiability is two-fold: that of modifying existing systems and of designing new systems which are easier to modify.

An ongoing project is described which is the application of data abstraction for redesigning an existing operating system component. The results of this project are tools to facilitate the work with existing systems (a graphic program notation called GREENPRINT and an automatic clustering program to regroup modules and control blocks of an operating system) and to design new systems (a new language called XPLI to enforce data abstraction, and the associated External Structure expressing intermodule connectivity, for the computer aided design of large systems out of components).

1 Introduction

Modifiability of procedures and artifacts is an increasing problem in modern civilizations. On one hand, social progress brings about an increase in freedom of choice and action. This would mean that, as individuals or members of communities, we are free to change that part of the world over which we have legitimate control. Yet, as we all know, it has become increasingly difficult to exercise this right, for many of the changes have unpredictable or predictably unpleasant side-effects.

Changes are often results of choices made of alternatives. The availability of alternatives is of course made possible by the recent massive increase in productivity, due to social cooperation in modern societies. But this is unfortunately coupled with a growing interdependence of all participants - producers and consumers. It is this interdependence which makes choices risky and the often unavoidable changes painfully expensive. Let us look at a few examples.

The woman scientist with a heavy publication record gets married, and if she chooses to change her family name to that of her husband's, she may lose, at least for a while, the continuity of her professional reputation. (We don't even mention problems of mailing address, driver's license, bank accounts, etc., which almost all marrying women must face). This problem is that of "information investment" in the minds of fellow scientists.

Or take the architect of the beautiful medieval cities, for example the ones which surround the Mediterranean. The streets are too narrow for automobile traffic - whom can we blame for not having foreseen the 20th century? Modification of the streets would be difficult because we want to preserve, not destroy and replace them just to accommodate a new function for which the original setting was not designed.

The last example is the current changeover to the metric system in the U.S. In this case the consequences are predictable but, as most of us know quite well, the cost of replacing the many tools and instruments of one of the most advanced industries in the world is horrendous, not to mention the inertia in people's mind, which acts against the development of a new "feel" for guessing, comparable to the one within the old system.

Investment, preservation, cost - these are some of the issues which must be considered whenever we contemplate modification. The main question is then how to reduce the impact on the different issues of a change. Clearly, the smaller the domain and the shorter the expected time of the impact the better we are off. Locality, in space and time, of the impact of modification seems to be the central concept. The narrower the field and the shorter lived