

- *Loose interpretation of the requirements.* Where the plans had the requirements “just like the existing house”, the Builders used, in some cases, very loose interpretations of likeness. Generally the nod was in favor of whatever was easiest as long as it came fairly close. Sometimes it was not close enough.
- *Arbitrary substitutions.* In several cases, substitutions were made for specified components. In one case, the specification was in fact incorrect and the substituted component was what was intended. In another, the proffered substitutions were not satisfactory (and, fortunately, not installed)
- *Misreadings of the plans.* I have already alluded to some ambiguities in the plans. There were also pitfalls in the way the plans were drawn that led to several misreadings of them. In one case, recovery was easy: the window opening was moved. In another case, the misreading was literally cast in concrete and the entire structure erected before it was discovered: the addition is shifted five inches to the side of where it was supposed to be. Fortunately the negative results were not all that serious: we have an extra five inches space in the master closet.
- *Communication and Coordination.* Not surprisingly, there were numerous problems in coordinating the various work crews and communicating the current state of the (dynamically) modified plans. Most were not major, but the additivity of all of them together, I think, was important.
- *Over schedule.* Additions always take longer than planned. Some of this is due to the weather, some of it due to coordination problems, and some to underestimating the magnitude of the project. We are not finished yet, but hope to be soon.

Moral. On the one hand, it is tempting to conclude that we are not doing so badly after all in building software systems. Relative to the process of evolving my house, evolving a software system seems heir to the same pitfalls and problems. I think that my biggest disappointment was finding out that architectural plans, for all their multiple views, were mostly English prose and not all that different from what we have in specifying software systems.

On the other hand, we as software developers have a much larger degree of control over our environment, tools and materials in building and evolving software systems than carpenters, electricians and plumbers have in building and modifying houses. We do have to contend with existing structures and troublesome adaptations. We do not have to contend with weather, poor quality material, and limited tools (well, at least we can build better tools). Therefore, we should not be content merely with doing no worse than other forms of product building and evolution.

various sorts and to specific architectural objects and are targeted primarily for the professionals. Because we as the customers did not understand those parts of the design aimed at the professional, we encountered some surprises that were the logical consequences of those professional-oriented parts of the design.

- *Inconsistency with requirements.* Our overriding requirement is that the addition is to have the design features that already exist in the house. In one sense, that requirement is in the design specification — at least in the textual part. However, in the vertical cross section, the plans show the baseboard and the window trim correctly, but omit the crown molding.
- *Inconsistency among the various architectural views.* It turns out that the textual and measurement views are binding whereas the visual view is not necessarily binding. A potentially serious problem was averted when we noticed that the visual depiction of the kitchen layout was correct (that is, it was drawn to scale) but the measurements were incorrect (and subsequently corrected). The measurement was what would have been used, not the picture (though I understand that the pictorial relationships are used informally).
- *Incompleteness of the specifications.* While we had thought a great deal about certain aspects of the addition and had, according to our Builder, plans that are far more detailed than usually found, some important details were missing from the specifications.
- *Omissions in the design.* It is the business of both the Architect and the Builder to know what is likely to be entailed in the particular kind of venture being undertaken and to plan for them or at least issue warnings that there may be problem areas. We had one major surprise of this sort: we have approximately twice as many circuits in the addition as in the entire rest of the house; our current electrical service is inadequate for that additional electrical demand and we need a new circuit box that was neither included in the plans nor in the estimate nor indicated as a possible expense.

Implementation. Problems with the requirements and plans aside, the proof of the pudding is in the building. There is one ameliorating factor that must be considered in determining the weight of these implementation problems: our house is 80 years old, generally out of plumb, and built with material that is generally no longer available or where it is available does not exactly match the 80 year old material. The transition from the new to the old has been done very well. Still, this is the stage where the design is realized and the following problems were encountered.

- *Dynamic adaptation of the design.* This problem came in two flavors: adjusting the design where it was ambiguous and recovering from the design where it was unbuildable. Because of the approximateness of the architectural renderings and measurements of the existing structures, some of the plans had to be adjusted to merge well with the existing building. This was the case for both the pitch and the overhang of the roof in the new addition. Particularly frustrating, however, was the back stairs design which, because of approximate measuring interacting with only a rough approximation of the slope of the land, turned out to be unusable. The stairs would have ended up too far into the driveway.

LETTER FROM THE EXECUTIVE COMMITTEE

Evolving a House — A Parable

Dewayne E. Perry

We are currently in the process of building an addition to our house to add a new kitchen and eating area on the first floor and a master bedroom and bath on the second. Throughout the course of this adventure, we have encountered a number of situations that are disturbingly similar to our experience in building software systems.

First, let me say that, in general, we are making very good progress, the workcrews are congenial and pleasant, and the standard of workmanship is quite high. When we are done, we will have an addition that will look as if it had been there as long as the house (except for the fact that it looks somewhat less weathered and aged) with a number of modern updates.

Requirements. In working with the Architect and the Builder there were several interesting problems that arose:

- *Specific requirements were ignored in creating the design.* We had thought long and hard about what we wanted in our new kitchen. Taking into account that we both cook and that we favor certain kinds of cooking styles we had detailed plans about what we wanted in our kitchen and how we wanted to lay it out. The Architect had taken our requirements as suggestions, not detailed design specifications.
- *The Architect's esthetics conflicted with our requirements.* As always, there are conflicting goals. In this case, the conflict was between the placement of the preparation sink and the placement of the windows — that is, between the interior esthetic of having the sink centered on the window at a certain position in the counter and the relationship between the windows from the external perspective. Negotiation finally produced a solution where the sink is where we want it and window placement at the end of the addition satisfied the Architect's visual esthetic desires.

Design. The design of the addition is expressed in three different forms: text, drawings and measurements. The text defines the standards that are to be adhered to, the various requirements about the quality and quantity of the material to be used, and some of the details of construction. The drawings provide elevation and floor views and define some of the construction details. Measurements are contained in both the text and the drawings and define the relationships between the various pieces of the design. The following are some of the problems that we encountered with the design of the addition.

- *Understandability of the Design by the Customer.* Only part of the architectural plans are understandable by the general customer. A substantial part of the plans refer to standards of