Evidence on separately organizing for software maintenance

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ABSTRACT

Software maintenance activities can be organizationally combined with or separated from software development. Proponents have argued advantages for each mode, but factual evidence on the respective results and conditions has been missing. This paper reports evidence gathered from sites organized in the two ways and contrasts their characteristics. Significant differences appear that give a better factual basis for selecting an appropriate organizational position for application software maintenance.
INTRODUCTION

Our purpose in doing and reporting this work is to clear the air on the consequences and conditions associated with two alternative organizational modes. One mode is to keep application software maintenance activities organizationally combined with software development. The other mode is to keep a clear separation organizationally between application software maintenance and development.

A survey reported in 1980 revealed that only about one-sixth of organizations kept those two activities separate. No survey reported since has profiled the characteristics and results associated with each organizational mode. Publications that could reasonably be expected to have covered these matters have neglected or passed over them. For example, the Proceedings of the four Software Maintenance Conferences have not addressed this matter. The Proceedings of the CSM-85 and of the Software Maintenance Workshop of 1983 gave this matter no explicit attention. Software Maintenance News has largely passed over this matter. The National Computer Conference has not addressed this matter in its Proceedings even though software maintenance is given some attention.

Which mode to adopt and the pros and cons about each mode have received passing mention in several articles and papers. For example, Canning offers a summary of pros and cons. Reynolds can be interpreted as saying that organizational separations also build walls affecting communication with users, and hence are bad. On the grounds that maintenance is a specialized task, Parikh favors a separate organizational status. Bronstein and Okamoto argue that a separate organizational position reduces conflicts in priorities. Marks and Strowbridge advocate specializing the staff, but stop short of advocating a separate organizational status.

What little has been reported on this matter has not had a strong or broad factual base. We did the study reported here because our discussions with management at computer sites detected a warm interest in evaluating the applicability of these two alternative modes. Some managers seem to seek reassurance that the mode they have chosen is a good selection given their circumstances; other managers wonder if that other pasture is indeed as green as it looks and is touted to be. Opinions abound, but reliable facts are in short supply. We therefore decided to gather facts and report the evidence found.

In the gathering and reporting process, we used a four-part definition of software application maintenance presented by Chapin since it matches the current reality of software maintenance work better than some earlier definitions. In brief, the four parts can be termed enhanceive, corrective, adaptive, and consultative maintenance. Application software mainte-
nance itself is any servicing done to, on, or about existing application software. That servicing may result in: 1) modifying the application software (usually to extend, alter, or to correct its functionality), 2) adapting the software to perform in a changed data processing environment, or 3) consulting with (e.g., by interpreting, guiding, or training) the user personnel in securing the desired results from the use of the existing software. Packaged software in this definition is not distinguished from in-house developed software. Work related to system software is conventionally excluded by the definition of software maintenance.

DATA GATHERED

We solicited data by means of a written questionnaire from persons with managerial roles in data processing sites sprinkled all across the United States. We solicited information from sites with a data processing (DP) staff believed to number more than nine. We did a vigorous follow-up to get the questionnaires back, although some were returned only partially completed. As expected, we found the common organizational position for software maintenance is that it is combined with software development. Since our sampling process was not designed to determine the current proportion of the various organizational modes for placing software maintenance, we report neither data nor conclusions on the relative frequency of the modes.

For statistical confidence, we sought a sample of at least sixty organizations in each of the two modes, but attempted to draw a larger sample than that, anticipating some unusable returns. We attempted to secure responses from more than one person at each organization since different people in an organization often view the organization differently. After discarding clearly questionable or seriously incomplete responses, we had 232 responses spread over 130 organizations, and 684 statements of problems recognized by the responders. The modal number of responses was one per organization and the average number of responses per organization was two.

In checking our data gathering, we found that one question on the questionnaire was interpreted variously by different responders. That question asked about the years of backlog of maintenance work. Some responders framed their responses for the full size (staffing) of the organization they represented, whereas others framed their responses in terms of years of backlog per person primarily doing maintenance work. This makes the total or overall magnitude of the gathered backlog data meaningless. Also, a few large responses pulled up the averages. The medians for the backlog are 4.0 years for the separate mode of organization, and 2.5 years for the com-
bined mode. However, we found only random differences in
the varied responder interpretation with respect to the mode
of organization. Hence, on a contrast basis, any comparison
or difference can still be meaningful even though the absolute
levels reported are not meaningful for this item.

ANALYSIS
After making validation checks, we applied ordinary statisti­
cal analysis techniques to the distributions of the data. Then
we applied tests of statistical significance. Table I summarizes
our analysis.

CONFIGURATION
The analysis points to distinctive configurations for the two
modes of organization of application software maintenance.
In the following paragraphs, we summarize the statistically
significant aspects first and then some aspects showing no
significant differences.
Organizations that organizationally combine software
maintenance with software development display the following
configuration of characteristics compared to the other mode:
1) The respondents see their organizations as smaller. 2) They
believe their organizations do more enhancement and less
new development. 3) They see the maintenance backlog as
smaller but have a more negative attitude toward software
maintenance. 4) They believe they have more management
problems in maintaining software and that they have software
that is generally harder to maintain, although old software is
not seen as being as much of a problem.

Organizations that organizationally separate software
maintenance from software development display the following
configuration of characteristics compared to the other mode:
1) The respondents see their organizations as larger. 2) They
believe their organizations do more new development but less
enhancement. 3) They see the maintenance backlog as larger
but have a more positive attitude toward software mainte­
nance. 4) They believe that the age of the software makes
software maintenance difficult. 5) They believe their software
maintenance work suffers from fewer management problems.

In a number of important ways, both organizational modes
are alike. The experience level of the personnel doing the
software maintenance is about the same for both groups. Per­
sonnel turnover is seen about equally by both groups as a
problem area, as is, to a lesser extent, a shortage of qualified
staff. The groups show no significant difference in the extent
to which they see documentation as a problem, and they do
about equal proportions of corrective maintenance. The
groups show no significant differences on such personnel­
related matters as staff availability, motivation, morale, and
turnover. Both groups regard maintaining good commu­
nication with users and others as a problem area and regard user
relationships as about equally difficult to keep satisfactory.

| TABLE I—Analysis of data gathered on software maintenance for
different levels of significance by mode of organization for software
maintenance |
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<tr>
<td><strong>ATTRIBUTES</strong></td>
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<tr>
<td>Significant at one per cent level</td>
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<tr>
<td>Separate--55.8 persons; Combined--80.7 persons</td>
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<tr>
<td>Significant at two per cent level</td>
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<tr>
<td>Significant at five per cent level</td>
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<tr>
<td>Separate--37.3%; Combined--27.2%</td>
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<tr>
<td><strong>ATTITUDES</strong></td>
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<tr>
<td>Significant at one per cent level</td>
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<tr>
<td>Separate--18.1%; Combined--31.9%</td>
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<tr>
<td>Significant at two per cent level</td>
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<tr>
<td>Separate--15.5%; Combined--7.8%</td>
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<tr>
<td>Significant at five per cent level</td>
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<tr>
<td><strong>PROBLEMS RECOGNIZED</strong> as proportion mentioned in categories</td>
</tr>
<tr>
<td>Significant at one per cent level</td>
</tr>
<tr>
<td>Separate--6.7%; Combined--13.3%</td>
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<tr>
<td>Significant at two per cent level</td>
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<tr>
<td>Separate--9.4%; Combined--9.6%</td>
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<tr>
<td>Significant at five per cent level</td>
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<td>None</td>
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DISCUSSION
Statistical analysis does not tell what are the causes and what
are the effects. Management personnel in organizations may
be seeking some particular effect, such as "How to free some
time for increasing effort on new development projects." They
want to know likely causes. Also, the data presented here may be more representative and descriptive as a constel­
lation or configuration of characteristics than are the charac­
teristics individually.

A perception of a difference in the size of the organization
is noted in the configuration. The averages are far above the
median sizes of 52 persons for the separate mode and 25
persons for the combined mode. Many respondents in each
group did not report the size of the entire data processing
organization; rather, they reported the size of their own unit.
Hence, size is rarely overstated but often reflects a esprit de
corps view of personal identification—an attitude cultivated
by some managements. The smaller size reported by the
combined-organized group could reflect a measure of more
success in such attitude cultivation. We verbally explored this
possibility informally with personnel in a few organizations,
and believe it contributed little to the size difference noted
here. Generally, larger organizations are more likely to use a
separate organizational mode for software maintenance than
are smaller organizations, but the separate mode is still a
minority for all sizes of organizations. This evidence is consis­
tent with what has been reported elsewhere.

The differences in the proportion of effort on enhance­
ments and on new development are probably untrustworthy.
We found no organizations other than software houses that systematically and consistently recognized and recorded consultative maintenance as a distinct entity, even though all respondents recognized the existence of the activity in their organizations and most indicated it was an increasing drain on personnel time. To a lesser extent, and not concentrated in software houses, the same observation applies to adaptive maintenance. In the data gathered, respondents spread effort in both categories over the categories of corrective and enhance maintenance, increasing both, with no detected differences by organizational mode.

A more serious complication is the variability used in practice in defining what effort is corrective maintenance, what is enhance maintenance, and what is new development. Where maintenance is separately organized, these distinctions have more often been given some explicit attention than where the combined organization mode is used. Nonetheless, variation is rampant for both modes. A fairly common criterion is a set level of effort that “distinguishes” new development from maintenance. Such a criterion might be: Any application software work estimated at more than six person-months is classified as new development, irrespective of its other characteristics. Such criteria are pragmatically useful and not uncommon, since socially or politically unpopular (negative attitude) maintenance work can be made to disappear and new development appear at the stroke of a pen. For example, one could define any application software work of more than two person-months duration as new development, any work of more than one person-day (but less than two person-months) as enhancement (maintenance), and anything smaller as corrective (maintenance). It is our assessment that the differences noted above in enhancement and new development effort primarily reflect differences in definition, not differences in the amounts, character, or nature of the work being done.

If the work is equivalent, then the real differences in the organizational modes are the differences seen in the management area. Segregating the personnel doing the maintenance work into a separate organization unit weakens the lines of communication to those (few) personnel still around who did the development work on the software. With less of that knowledge to call upon, any impenetrability in the software looms larger. Concern with documentation is not significantly different between the two modes. Recognition of these factors appears to be an effect of selecting the separate-organized mode, but does not appear to be a cause of the mode selection.

When a separate organization is put in place for any function, securing enough qualified personnel to staff it is a common management concern, along with securing other needed resources. Yet no significant differences appear between the two modes. In the absence of such a separate organization, development personnel get assigned to do the software maintenance. This provides a staff (which may be qualified) but documentation deficiencies are still the number one complaint in both modes. In this regard, it must be remembered that no significant differences are seen by the respondents in the turnover, motivation, morale, qualifications, and experience level of the personnel between the two organizational modes.

Attitudes are seen as significantly different too. Negative attitudes are associated with the respondents’ greater frequency of mentions of management problems, and are significant for the combined-organized group. Positive attitudes are associated with the respondents’ lesser frequency of mentions of management problems, and are significant for the separately-organized group. This relationship is not surprising given the respondents’ management responsibilities. It also points to what appears to be an effect of selecting the separate organization mode—a more positive attitude by those managing the software maintenance. The significance of this has been noted before. The specific causes of this attitude difference are not seen in the work reported here.

The differences between the two organizational modes with the greatest statistical significance are the differences in the proportion of enhancement effort (see prior qualification), in management problems, in groupings of software attributes, and in the size of the organizations (see prior qualification). One of the two main groups of significant software attributes consists of the fewer problems reported by the combined-mode respondents for old software, interactions among software, and poor implementations. The other consists of the fewer problems reported by the separate-mode respondents for source-code unstructuredness, difficult-to-work with source code, and large program and system size. From the evidence reported here, the causes and effects for these characteristics are not seen directly for most of them.

CONCLUSIONS

Given the qualifications presented in the discussion about the configuration of characteristics described here, some conclusions emerge. One is that we detected no differences in the nature or characteristics of the demand for or performance of the software maintenance work between the two organizational modes. Hence, any motivation to adopt one or the other of the modes apparently arises from other sources. A hope to reduce the burden (cost or total amount) of software maintenance work in order to get more personnel time for new development appears to be a tempting motivation, but the achievement appears to be more a matter of definition rather than of any actual change in the work getting done.

What those organizations adopting a separate organizational place for software maintenance have achieved is fewer management problems and a more positive attitude toward software maintenance by those managing it. What adopting the separate organizational mode has required is an explicit definition and recognition of what is to be encompassed as software maintenance. This sharper definition may contribute to the larger backlog recognized in the organizations that organize separately for software maintenance.

Larger organizations are more receptive to a separate organizational place for software maintenance. Maintenance management personnel in the separately-organized mode report fewer problems with maintaining poorly structured and poorly implemented source code but more problems with old programs and systems. It is not known whether a recognition of these is a predisposition to or a consequence of adopting the separate-organized mode.
In summary, management's use of a separate organizational position for application software maintenance appears to have little effect upon the maintenance work, its cost, and its quantity. It does appear to reduce management-oriented problems with getting software maintenance done and to improve attitudes. From this survey, the evidence appears to us that an old management dictum—if you want something managed better, then make the managing of it be someone's prime responsibility—also applies to managing application software maintenance.

REFERENCES