Application maintenance: One shop's experience and organization

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ABSTRACT

Several years of data on software support activity at Dow Corning are analyzed to illustrate the problems of managing this function. Most software changes are small from the user's point of view, but few changes are small from the maintenance point of view. Several organizational models have been tried for the management of support. None is entirely successful.
THE COMPUTING ENVIRONMENT

Through formal logging and recording of support requests and applied personnel time since mid-1976, Dow Corning's support group is able to report various characteristics of our applications support effort—about 60 person years of effort to date.

The following facts will give an idea of the environment and context of this support history:

- Each support person has been provided with a CRT and IBM's System Productivity Facility (SPF) timesharing software.
- Access to production source code is administered through a library control function.
- Batch turnaround time for compiles is usually less than 30 minutes, and probably 30% of the time it has been less than 15 minutes.
- Virtually all programming is done in PL/I, with small amounts of report programs written in Pansophic's EASYTRIEVE language.
- Administratively, requests are documented by the responsible key analyst as they are received (or encountered).
- The individual(s) working on requests logs his/her time on a daily basis but the time sheets are collected monthly for recording.
- About 50 individuals have had some part in this support activity over a period of 6½ years. About a third was done by contract programming people.
- Table I gives some of the particulars as to the size and growth of Dow Corning's production environment.

THE MAINTENANCE LOAD

Some 60 person-years of data on support effort have been accrued over a 6½ year period. About 64% was logged to individual requests; about 16% was logged against two general application support requests; about 20% was logged to nonproject time—e.g., vacation, holidays, and sick time. The following list of specifics relates to the 64% category of individual requests; it shows the important characteristics of the scheduling and performance of these requests.

| Total number of logged support requests to date | 4,454 |
| Approximate number of open requests not completed (typically) | 250 |
| Total number of logged person-days to date | 15,200 |
| Total number of requests completed | 3,690 |
| Total number of requests canceled | 460 |
| Average size (in actual person-days) of completed requests. (See cumulative distribution curves, Figure 1) | 2.6 |
| Standard deviation of size of completed requests | 6.4 |
| Average turnover time (number of days from date request received until request was fully implemented and closed out) for all completed requests | 73.4 days |
| Average “queue” time (number of days a request waited before being assigned to a support person to implement) | 38.3 days |
| Average active time (number of elapsed days it took to complete a request once it was assigned to a support person) | 35.1 |
| Average age of current open request queue | 354 days |

Estimated backlog of work has ranged from 400 to 1300 person-days. Typically, the backlog estimate is near 600 person-days.

The average size of a request measured in effort to completion is 2.6 person-days; the average turnover time is 73.4 days.

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TABLE I—Growth of Dow Corning's production environment

<table>
<thead>
<tr>
<th>Date</th>
<th>Production Jobs</th>
<th>Total Lines of JCL Code (thousands)</th>
<th>Active Production Programs</th>
<th>Total Lines of Program Code (thousands)</th>
<th>Average Lines of Code/Program</th>
<th>Production Runs per Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/73</td>
<td>647</td>
<td>37</td>
<td>N/A</td>
<td>256</td>
<td>N/A</td>
<td>2300</td>
</tr>
<tr>
<td>9/1/73</td>
<td>739</td>
<td>49</td>
<td>N/A</td>
<td>342</td>
<td>N/A</td>
<td>3230</td>
</tr>
<tr>
<td>9/1/76</td>
<td>1114</td>
<td>N/A</td>
<td>1863</td>
<td>440</td>
<td>236</td>
<td>5489</td>
</tr>
<tr>
<td>5/1/79</td>
<td>1444</td>
<td>164</td>
<td>2343</td>
<td>571</td>
<td>244</td>
<td>5523</td>
</tr>
<tr>
<td>9/1/80</td>
<td>1576</td>
<td>N/A</td>
<td>2693</td>
<td>N/A</td>
<td>N/A</td>
<td>6952</td>
</tr>
<tr>
<td>9/1/81</td>
<td>1662</td>
<td>218</td>
<td>2895</td>
<td>876</td>
<td>302</td>
<td>7202</td>
</tr>
<tr>
<td>9/1/82</td>
<td>1707</td>
<td>245</td>
<td>3282</td>
<td>1115</td>
<td>340</td>
<td>7793</td>
</tr>
</tbody>
</table>

From the collection of the Computer History Museum (www.computerhistory.org)
days. Of the turnover time, about half is spent in the queue and the rest is spent while the request is being actively worked on. There seem to be valid reasons for this disparity between the size of the change and the duration of the change process.

First, changes in applications need to go through certain control and verification procedures before they can be considered as complete. This usually involves a designated probationary production period where the application is watched, and if unforeseen problems occur, the probationary time may be extended. Second, support people batch their effort by working on a number of requests concurrently.

**Maintenance by Category**

When requests are received or initiated, they are assessed as either *mandatory* or *discretionary* in nature. Mandatory requests require immediate attention—e.g., production application failures, executive edicts, and government requirements. Discretionary requests are all the rest, i.e., not mandatory.

Analysis of the most recent 19 person-years of support to distinguish mandatory versus discretionary effort is summarized in Table II. Individual comparisons of the last 2 years of the support group’s efforts produced very comparable results showing a rather constant relationship.

The key analyst assigns a request type of code when requests are documented. The codes were established to categorize requests as to their primary reason for occurring, e.g., user request, consequence of some type of failure/problem, or preventive maintenance. Fourteen request type codes were used as follows:

**User request types:**
- **MI.** Request for information about a system, e.g., how do I update this information?
- **MM.** Maintenance due to management decisions, e.g., department reorganization, and new marketing strategy.
- **MP.** Mass update of production files, e.g., change credit coding for a large group of customer types.

**TABLE II—Mandatory versus discretionary support**

<table>
<thead>
<tr>
<th>Request Type</th>
<th>Approximate Number</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory requests supported</td>
<td>435</td>
<td>36.6</td>
</tr>
<tr>
<td>Discretionary requests supported</td>
<td>752</td>
<td>63.4</td>
</tr>
<tr>
<td>Totals</td>
<td>1187</td>
<td>100</td>
</tr>
<tr>
<td>Person-days expended on mandatory items</td>
<td>890</td>
<td>22.9</td>
</tr>
<tr>
<td>Person-days expended on discretionary requests</td>
<td>3002</td>
<td>77.1</td>
</tr>
<tr>
<td>Totals</td>
<td>3892</td>
<td>100</td>
</tr>
</tbody>
</table>
New job development, e.g., develop some new application.

Request for discretionary modifications to existing production applications.

Stand-alone request, e.g., write a program to do a one-time analysis of sales activity.

Consequences of some failure/problem:

Maintenance due to operations' problems, e.g., ran job out of sequence.

Maintenance in support of a restart, e.g., an application failed and the restart was not a minor experience. The failure is not directly attributable to any specific problem area.

Maintenance due to systems design, e.g., a hard coded table ran out of space and caused a failure.

Maintenance due to technology changes, e.g., new printer requires changes be made to some report generating programs.

Maintenance due to user problems, e.g., user inadvertently input the same data twice.

Maintenance due to user support function, e.g., inadequate testing of a change causing problems in the production environment.

General maintenance request. Not attributable to any identified problem area, yet it is necessary in order to keep an existing application functioning—e.g., routine restart support, make small corrective changes to a program.

Preventive maintenance—e.g., expand a field size before it causes a failure; correct edit logic oversight before erroneous data get passed into the system, etc.

Table III reports on the distribution of completed requests and the associated effort, the portion of support that was logged to specific requests. This relates to 10,200 person-days of effort, 64% of the total time recorded over some 6 years of experience. The average and standard deviation columns relate to completed requests only, leaving out canceled, withdrawn, and open requests. Completed request effort makes up 95% of the total effort reported.

Organizations and approaches

Like many healthy, growing companies, Dow Corning over the past decade has seen fit to reorganize its management information service (MIS) function many times. Each new or modified structure had its own rationale and was an attempt to improve the effectiveness of the MIS function. The organizations that reflect the way maintenance effort was addressed or managed will be described.

About 11 years ago, the MIS function of Dow Corning had reached the point of a fairly respectable shop:

1. Approximately 500 production batch applications with online order entry and customer file maintenance
ter they were first approved by the supervisor of the programming and analysis group. Because the functional system supervisor was intended to be occupied with longer term and larger application activity, users in need of more immediate support of small projects were considered a detraction to the functional system supervisor. To provide for this, a small projects group was set up with a leader and a variable resource budget equivalent to a staff of one or two. This budget was reconsidered on a quarterly basis, by the Computer Action Committee. This committee consisted of a group of key user representatives from the main functional organizations of Dow Corning who approved the project plans and resource schedule proposed by the systems development manager. This basic organization continued until the time frame of the oil embargo and the corresponding economic slowdown of 1974.


As a result of the slowdown, large project activity was curtailed, the functional system supervisor positions were eliminated and the systems development manager position was vacated and an expanded small projects group was renamed User Support Group (see Figure 3 for this organization struc-
Connected with the establishment of this new group was the intent that all small projects activity (including operational maintenance support) would be done exclusively by this group of about six full-time and one part-time person. This represented about 40% of the application programming resources in the department at that time. A 30 person-day maximum was defined as the threshold for classifying a request as a small project.

The title, User Support Group, was picked to emphasize the user interface role of this group. This role included some technical consulting to aid users in learning their own systems, as well as learning elementary DP skills for creating their own reports from production files.

The user interface with the User Support Group was with the four chairmen of the functionally aligned planning groups. Requests for small projects were received by the User Support Group supervisor and he made time estimates to accomplish the tasks. There was always a backlog of work requests, and on a quarterly basis, the User Support Group supervisor met with the Systems Planning Group representatives to communicate progress and decide on priorities for all the open requests. This basic structure continued until late 1976.

**Small Projects Separated From Maintenance: 1977**

Better economic conditions allowed for a revitalization of the Systems Development Group, but the User Support Group was moved under the operations manager position (see Figure 4). Part of the reason for this move, was to enable systems development to concentrate on new systems exclusively.

Another attempt was made to have the USG staff of eight responsible for small projects only, and a separate group of four responsible for maintenance, all under the operations manager. At this time, Systems Development had a staffing level of fifteen. Maintenance was defined as any work (on a pre-existing system) necessary to keep the system functioning as it was intended at implementation. Such maintenance requests tended to average about one and one half person-days effort, whereas small project requests averaged about six person-days.

The separation of a maintenance group from the small projects group came to be viewed as being inefficient. Both groups had a supervisor who separately communicated with the functional representatives now called functional system coordinators. The nature of the communications was the same, i.e., setting priorities and communicating progress or problems. Furthermore, the nature of the work was the same and there was confusion among all parties as to what category a particular request might fall under. Was it maintenance or was it a small project? A larger number of requests were addressed under this approach, compared to the years before and after. This may have been because more resources were concentrated on this category of support maintenance that typically required less effort per request to complete than the small project request.

During this period an MIS departmental procedure was formally established that required User Support Group approval of new applications before they were considered to be in a fully supported production status. Our shop started being more sensitized to the desirability of formally documented standards for production applications.

One of the benefits of having the maintenance function under the operations side of the MIS organization was the degree of checks and balances that tended to consider the long term operations concerns of an application: Was the job conveniently restartable? Were there backup provisions identified for permanently created files? Are the reports uniquely identifiable to enable their routine distribution? Are error interrupts appropriately reported? Does the job delete all its temporary files upon completion?

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![Figure 4—Basic MIS organization 1977 and onward](From the collection of the Computer History Museum (www.computerhistory.org))
Small Projects and Maintenance Reconsolidated: 1978

A divided maintenance group was reconsolidated and the work activity was viewed as being either mandatory or discretionary after a year. The mandatory work activity would be addressed immediately in order to maintain or restore integrity to the production applications, while discretionary requests would be prioritized by the user organization. The previous practice of meeting every couple of months with the systems coordinators was continued. A joint consensus was reached at these sessions as to what was most important to the corporation, rather than deciding according to a strict functional perspective. In practice, this caused dissatisfaction among some of the systems coordinators who could not plan on any particular program because their requests were superseded by new, higher-priority needs in other functions. Some coordinators thought that their functions had had, and continued to have legitimate needs, but could not compete favorably with the more visible and always-pressing needs of other functions.

Current Approaches

This led to the approach that Dow Corning has used for the last four years. Each function is allocated a percentage allocation of available user support resources. This percentage is renegotiated on an annual basis. In addition, the functional systems managers (as the functional systems coordinators were renamed) could, on an individual basis, provide funds to augment their allocation with contract programming resources or they could negotiate with their functional counterparts to trade resource time or temporarily acquire a larger percentage allocation. It was expected that this would enable the functional systems managers to better plan their own destiny and eliminate some of the haggling of group priority-setting sessions. This was largely accomplished, but not without some other effects.

In 1977, Dow Corning management developed and formalized the current organizational structure on the user side. The Systems Management Board is made up of top level executives from Dow Corning's key operating functions. Subordinate to each of these executives is a functional systems manager. The Systems Management Board sets the broad direction for systems at Dow Corning. The functional systems manager coordinates the development and operation of information systems for his function and is the primary liaison with all MIS department managers. Each functional systems manager was charged the time expended on mandatory maintenance for their applications as they were encountered. This was somewhat predictable, based on historical averages of 20–25% of total support allocation. The annual exercise to establish new percentage allocations for the new year met with disagreement and the easy way out simply perpetuated the status quo. The interfunctional trading or surrendering of resource time has occurred only to a limited degree. This has resulted in an effective reduction of the corporate perspective in our systems maintenance. Some functional areas have what appear to be important needs waiting while other functions might simply be using their time to provide only marginal benefits to the corporation.

The User Support Group organized its activities along functional lines and the User Support Group name was exchanged for Production Systems Support. The word production was used to reflect the exclusive production emphasis of this group of resources. Support of documented and accepted production applications or support of new applications being developed for documented production status could normally be considered valid activity for Production Systems Support. The 30 person-day limit was still a limiting constraint for all requests or groups of related requests.) This meant that Production Systems Support would not provide consulting or programming services for individual users unless this criterion was met and the activity had been given priority approval by the associated functional system manager. There had not been that much non-production activity going on but with more and more user computing anticipated, it was recognized as a difficult activity to support and control centrally and still keep up with the demands for support of production applications.

The Production Systems Support Group organization (see Figure 5) identified a lead analyst role entitled key analyst. Each key analyst has primary responsibility to oversee all Production Systems Support efforts that affect his/her functions' applications, about 425 batch jobs and 2 online systems per analyst. The functional systems manager is the key analyst's user contact for purposes of receiving change requests and receiving priority assignments for requests. Mandatory priority status can be assigned by the key analyst or the systems manager.

REMAINING PROBLEMS AND POTENTIAL SOLUTIONS

Development of Production Systems Support staff in the latest technology is difficult and impractical. Ever present user demands and mandatory maintenance produce an environment that will quickly develop staff in the traditional DP technology used in existing systems, but it does not lend itself to learning the latest technology being implemented in the new systems. The movement of people between development and applications support can alleviate this, but it does not naturally happen, especially when groups are under different managers.
Personnel motivation and enthusiasm can be difficult under normal circumstances, but problems are compounded when the staff is given low priority work in the less active or over-budgeted functional areas.

The intermediate sized project (30 to 100 person-days) is very awkward to handle. Such a project is too large for the support groups' resource level and too small to disturb the progress or plans of the systems development group who are usually involved in much larger projects. The problem of lengthy elapsed times from assignment to completion of even the small requests remains an undesirable characteristic of our experience.

Consideration is now being given to a couple of changes that might serve to solve some of the past problems without introducing many new ones. One change would consolidate most of the Production Systems Support resources with the development resources, but retain the existing functional key analyst position of the support group. A small portion of the support group would stay in the operations structure to provide basic operational maintenance support for failed applications. This change would help resolve the technological development problem of support staff since rotation of support staff would be less difficult to arrange under the same manager.

The second change deals with the manner in which resources are allocated to the functions. Rather than each function having a percentage of the total support budget so that all the percentages sum to 100, a portion of the support budget would be allocated. This portion would be determined by what was considered slightly more than sufficient to handle all mandatory maintenance. The remaining portion would be applied to support Production Systems Support projects as decided by periodic priority-setting meetings of the functional systems managers. This change would make it more practical to handle the intermediate size project, since if desirable, all the discretionary resources could be applied to the task so that it could be completed in a reasonable time frame. Furthermore, all the functions would get some minimal level of resource, but a good portion of the effort (about half) would be more consistently applied to the highest-priority corporate need. Another alternative to settling the resource allocation questions would be to charge back time directly to the functional departments, thus letting the buyer decide his/her budget.

One potential weakness seen in consolidating the support resource with systems development is the organizational loss of commitment to operational concerns. Perhaps a strong operations representative on project review committees would alleviate this weakness. Another area that could introduce frustration and inefficiency is overlap of responsibilities. The operations support activity would have to be controlled and adequately distinguished from the production systems support activity. Perhaps making the operations role one of a short-term perspective (to keep applications running on schedule) would enable an adequate delineation of responsibilities to be made.

Chargeback of time could introduce difficulty in maintaining a stable staffing level—low budget years would probably translate into dramatic reductions in support purchases.

WHAT IS THE ANSWER?

Managing application support effort is fraught with dilemmas:

1. A large demand for changes coexist with demands for new systems—how is an effective balance defined and achieved?
2. Personnel development in new technology is not practical when support people are fed a diet of traditional DP demands.
3. How can support effort be distributed to effectively meet corporate needs while retaining viability with individual corporate functions?
4. Where do you put support activity and still retain operational interests along with personnel development needs?
5. How do shops reduce the “active time” of a request and still retain needed verification and control features?

Different DP organizations share these basic problems, although the size of the shop will alter the extent to which some of these areas actually cause serious concern. Are there any management models that have been developed and tested that address this business situation? Has a consensus of opinion or experience been identified?

REFERENCES
