Implementing the Defect Prevention Process in the MVS Interactive programming organization

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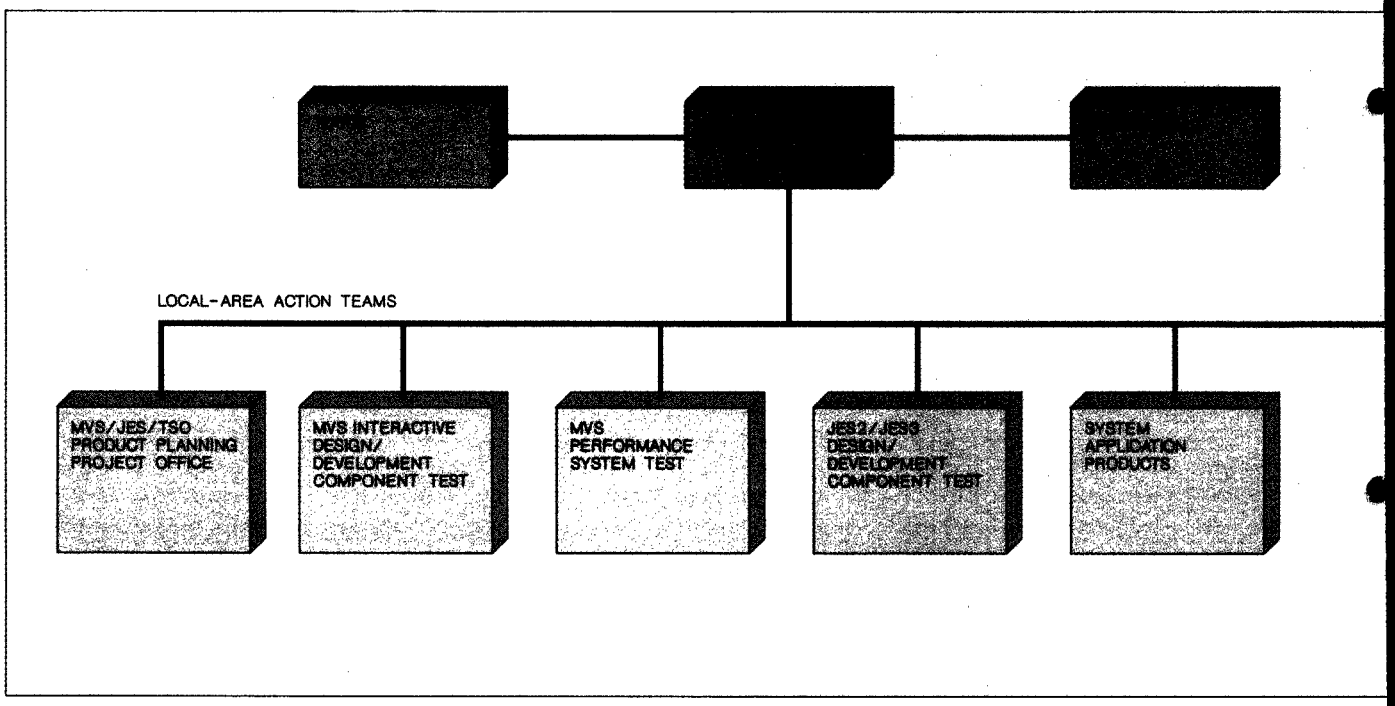
A process for preventing defects has been gaining momentum in the IBM Corporation as a way to improve quality and increase productivity. The Communications Programming Laboratory in Research Triangle Park, North Carolina (near Raleigh), has been implementing the process for the past six years and has realized a 54 percent reduction in errors. This paper documents experiences at the IBM Myers Corners Laboratory MVS Interactive programming area in putting the Defect Prevention Process theories into practice. This paper begins with the proposal to adopt the Defect Prevention Process at the Myers Corners Laboratory in Poughkeepsie, New York, and our experiences thus far. It is our belief that other organizations can benefit from our experiences by understanding how the Defect Prevention Process can be adapted to best meet the needs of any organization.

The software development business is becoming more and more competitive daily. The IBM Corporation, for example, is developing more function in shorter time. Increasing productivity is critical in the software development field. Rework and testing call upon a significant amount of resources. To reduce the development cycle time, IBM program developers have been studying ways to reduce error injection rates.

The Defect Prevention Process is a key result of these studies and involves a three-step process—kickoff meetings, causal analysis, and action team meetings—to ensure that defects do not recur.[1,2] Kickoff meetings are held at the beginning of each work phase to review and prepare for the upcoming phase. Process changes, common errors, techniques, and tools are all highlighted at this meeting. Causal analysis meetings are held to analyze defects and their underlying causes, and to create action items that will prevent those types of errors in the future. Action teams evaluate, prioritize, and implement the suggested actions.

Implementation of the Defect Prevention Process is expected to reduce the number of defects that are injected into a product, until all defects are prevented. The ability to eliminate defects is increased as more activities are automated. Implementing a process involves more than a mere understanding of the philosophies of that process. It requires an understanding of how to incorporate those philosophies into the everyday work environment. This paper illustrates how the Defect Prevention Process can be adapted and modified to suit organizations other than our own.

Figure 1 Action team structure



Productivity Task Force

During the spring of 1988, a group known as the Productivity Task Force was organized and given the objective to increase productivity at the Myers Corners Laboratory by 100 percent over the next two to three years. This objective was later refined to that of completing the same function with equal or better quality in half the time with the same number of people.

Speakers representing organizations throughout the laboratory as well as other areas were invited by the task force to tell of their experiences in topic areas that might help the task force fulfill its objective. The topics discussed included:

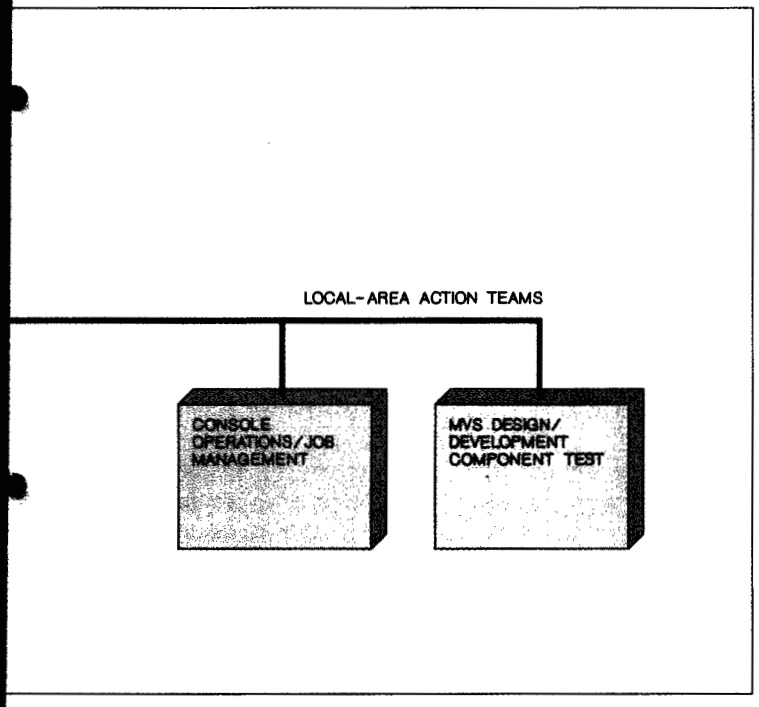
- Use of tools to improve productivity
- Team ownership of products
- Software reuse
- Defect Prevention Process

The teams comprised members from all areas involved in the development process—design, development, test, information development, project office, and management. The initial findings of the task force showed that productivity enhancements were being implemented in pockets, meaning that there was minimal sharing of ideas and tools among the different organizations in the laboratory. The Defect Prevention Process was one of the promising items for more comprehensive productivity improvements. The Defect Prevention Process was just starting to be used in other organizations, and a pilot project was selected for implementation at our laboratory.

A parallel work group composed of representatives from various organizations at the Myers Corners Laboratory was working to identify the actions necessary to implement the Defect Prevention Process in the laboratory. The Productivity Task Force selected the MVS Interactive programming organization as the pilot project and allowed the Defect Prevention Process work group to determine the implementation details.

Defect Prevention Process work group proposal

The Defect Prevention Process work group outlined the purpose, organization, and follow-on work for



each phase of the process—causal analysis, action teams, and kickoff meetings.

Causal analysis. The purpose of causal analysis is to learn from the errors made by analyzing the root cause of the error and generating action items to prevent those errors in the future. These action items most commonly involve process changes, communication enhancements, enhancements to existing tools and languages, education requirements, changes to the products themselves, requests for new tools, and creation or improvement of documentation. These meetings are held on a team basis as necessary and organized by the team leader.

One of the objectives of the Defect Prevention Process education is to train people to lead causal analysis meetings. The leader of a causal analysis meeting should remain objective and involve all participants in the discussion without becoming involved in the content directly. The leader's sole responsibility is to make the meeting run smoothly and effectively, so that all ideas are heard. Although some people had already been through the formal Defect Prevention Process training, most of those in the laboratory still needed to be educated. The instructors were brought in to educate the people in those areas that had agreed to use the Defect Prevention Process. The formal training has the added benefit of generating enthusiasm among those who take the class.

A database was needed to record suggested actions in an easy and efficient manner. A database system known as the Defect Prevention System (DPS) was developed in Raleigh for this purpose. This system has proved itself to be an excellent vehicle for the entry, tracking, and resolution of suggested actions.

Action teams. Action teams act on the items suggested at causal analysis. A hierarchy of action teams as created for the Myers Corners Laboratory is shown in Figure 1. This structure was defined to best represent the needs of the laboratory. The bottom of the chart represents the local-area action teams. Each local action team represents people who work together to build a specific product and thus face common problems. Although each of the local areas in the laboratory follows the same development process philosophies, each area interprets these philosophies in a slightly different manner to best meet the needs of the product being developed. Local action teams are responsible for analyzing all suggested actions that are generated from the areas they represent. The teams take those actions that can be wholly contained within each area.

Many of the suggested actions cannot be handled at the local action team level because they involve the commitment of resources outside a given area. These actions are forwarded to higher-level action teams, which are themselves members of the Myers Corners Laboratory Action Team Council. The responsibilities of the higher-level teams are again to evaluate and implement actions forwarded to them, and to facilitate communication among the local action teams.

This structure ensures that action items are implemented encompassing the proper scope. The local-area teams are free to evaluate and prioritize actions that affect their area in a timely fashion and the higher-level team reflects committed resources to handle actions of a more general nature. All action team assignees were taken from a pool of volunteers who allocated 10 percent of their time toward action team duties.

Kickoff meetings and kickoff packages. Kickoff meetings are held on a team basis and allow the

team leaders to prepare their teams for upcoming work phases. Kickoff packages are used at kickoff meetings to document the philosophies and methodologies of each work phase. This ensures that the team achieves maximum readiness for the work ahead and is aware of process changes that have been incorporated. Each local-area action team is responsible for creating and maintaining the kickoff packages its organization needs.

Management's commitment to the Defect Prevention Process is key to success.

Starting the Defect Prevention Process in MVS Interactive

The MVS Interactive programming area represents nine first-line departments, consisting of approximately one hundred programmers, and is represented by one action team. This area is responsible for the development and test of several IBM products. These varied responsibilities are dispersed across all the first-line departments. Some of the products developed in MVS Interactive follow strict software engineering principles and well-defined software reuse techniques, whereas other products do not. The entire organization, however, has agreed to implement the Defect Prevention Process. Our experience shows that the Defect Prevention Process can be applied to an area that does not follow a common software development process. The communication that has resulted from the Defect Prevention Process is helping the area converge on an improved software development process.

The first step toward implementing the Defect Prevention Process in one area was to identify a manager who was interested in making the Defect Prevention Process a success. Management's commitment to the Defect Prevention Process is key to success. In our laboratory, management has fully supported the activities in the Defect Prevention Process. Managers have participated in causal analysis meetings when appropriate, while allowing employees the time necessary to be a member of an action team. Management has funded the activities of the action teams and has provided funding for enhancements to tools or for the development of new ones. They have also funded education, newsletters, and other related activities. Management has been key in endorsing the Defect Prevention Process and ensuring that it becomes an integral part of the MVS Interactive organization's development process. It is widely recognized that by reducing the number of errors injected into software during the development life cycle, the quality of the product is improved and productivity increased.

The management representative proceeded to solicit volunteers for participation in the MVS Interactive organization action team. Several employees in the organization had attended the Defect Prevention Process class and either volunteered for participation or encouraged others to do so. The next step was to hold regularly scheduled action team meetings and implement actions to communicate and incorporate the methodologies of the Defect Prevention Process into the development process.

Causal analysis. Members of the action team facilitated many of the early causal analysis sessions. As people in the area become more experienced with the process, however, this participation has declined. A proposal to include causal analysis sessions and kickoff meetings as a part of the development process was presented to and approved by management. When developers see their suggested actions being implemented, they are more enthusiastic about holding these meetings.

Kickoff packages and meetings. The action team decided that a component-level design kickoff package should be developed first, because that was the phase that most of the organization was entering. The primary objective of component level design is to put into place and document a formalized design. This design defines the structure and behavior of a single component, focusing on the definition of functions and state data. Interfaces between functions are also defined. The component-level design is based on the overall product design, as defined in the product-level design. Whereas the product-level design emphasized the function and interfaces of components for the entire product, the component-level design emphasizes the functions and interfaces of a subset of the product design at a greater level of

detail. The IBM Raleigh laboratory's component-level design kickoff package was used as a base that was modified to reflect the MVS Interactive process. As more kickoff packages were created, a standard was defined that has been accepted by other local action teams. The implementation of these action items helped to make the Defect Prevention Process an integral part of the MVS Interactive development process by using kickoff packages as the source of information for all stages in the development process.

Structure and implementation

Causal analysis. MVS Interactive has found it useful to hold causal analysis sessions both as part of the development process and to address specific problems. MVS Interactive management has endorsed the incorporation of causal analysis and kickoff meetings into the development schedules so that time may be allocated to perform these functions. Causal analysis meetings must be held at a minimum of once during a development phase. However, they may be held as often as necessary. These meetings are coordinated by team leaders and are held at a team level. Each team decides how they want to implement their causal analysis sessions to meet their specific needs. Participation by team members is voluntary.

A causal analysis meeting can address anything that is making it more difficult for people to work.

Causal analysis meetings are also scheduled to address specific problems. One such problem is that to reduce the product cycle time, defects in the subprocesses must be eliminated. Other causal analysis sessions have been held on the reuse process, specification process, Authorized Program Analysis Report (APAR) certification process, and many other subprocesses. A causal analysis meeting can be held to address anything that is making it more difficult for people to do their work. Causal analysis sessions on specific problems are often coordinated by the action team, which assures adequate representation from all affected areas, and the team often leads the meeting.

Although managers are not usually involved in causal analysis sessions that are part of the normal development process, they often participate in the causal analysis sessions on specific problems. Causal analysis sessions involve all persons involved with a given problem, including both managers and developers. The team approach gives managers and developers a forum for working together to improve the development process at all levels.

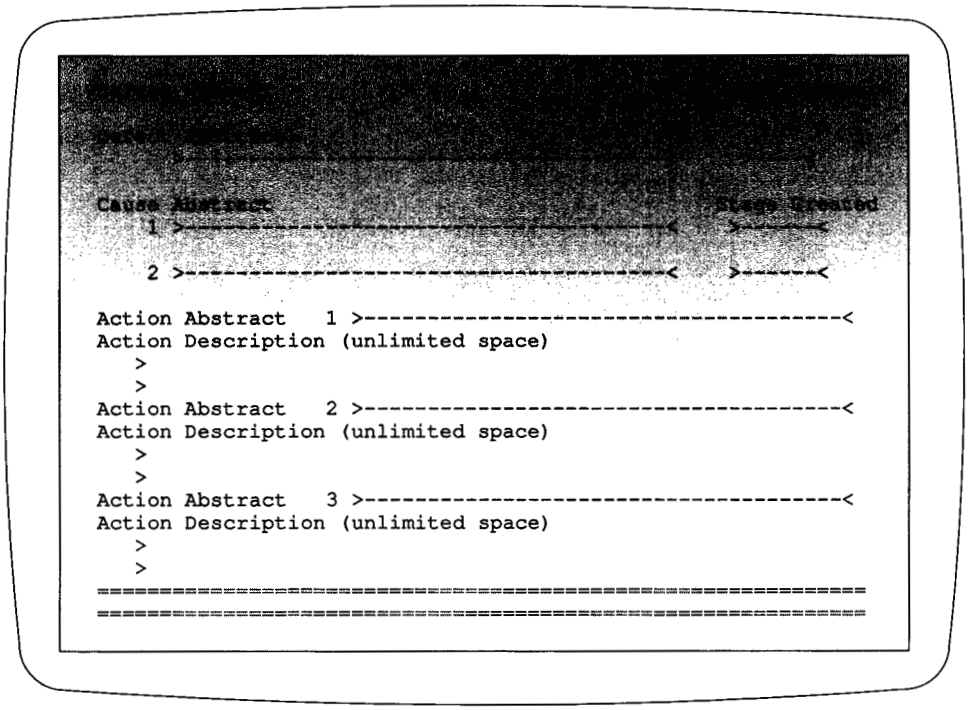
Causal analysis sessions are no more than two hours long. The first hour-and-a-half period is used to discuss defects, their root causes, and actions to take to prevent them. The last half hour is used to discuss general trends. It is often useful to ask the question "What went right?" to ensure that the positive aspects of the process are maintained.

As an aid in recording the proceedings of a causal analysis meeting, a template has been created for use with a personal computer (PC) functioning as an editor. The organization owns several PC convertibles that are used at these meetings. Figure 2 shows a template that the coordinator of the meeting uses to send minutes of the meeting to all participants easily and quickly. The Defect Prevention System is being enhanced to automatically upload this file, thereby saving considerable time and effort.

Actions may also be submitted to the action team in the form of miscellaneous actions and need not be associated with a causal analysis session. Developers often talk over lunch about how such and such might have been prevented if such and such had happened. In the past, these ideas were lost because there was no formal vehicle through which these ideas might be considered. Now the developer can submit ideas as miscellaneous actions for the action team's attention. During the early implementation of the Defect Prevention Process, most of the actions have been of this type. As more causal analysis meetings are held, this trend will change.

MVS Interactive area action team. The MVS Interactive action team has representatives from development, test, management, performance, information development, vendor management, and process. The composition of the action team has changed

Figure 2 Causal analysis personal computer template



significantly since the team began operations. Its membership now offers the best representation of the organization and will keep changing to meet that objective. The team started with only two developers, and more developers have joined as actions relating to design and code increased. If the scope of the actions should change significantly, so will the team. Two management representatives are on the team to ensure management participation at all times.

Because the MVS Interactive developers work with vendors, representation from vendor management is required. Many actions dealing with the vendor process have been implemented.

Although there are two process representatives on the team, they serve very different functions. The MVS Interactive organization has a process representative who is responsible for tracking all process-related activities in the area. The Defect Prevention Process is a large part of those activities. The other process representative is a member of the Programming Methodology Department. This department participates on the action team to help improve the software development process and is an active member of the team. The Programming Methodology Department has been instrumental in implementing the Defect Prevention Process throughout the laboratory by coordinating education, installing tools, and implementing actions that affect the entire laboratory.

All team members have equal voice, equal decision-making power, and freedom to make recommendations. The resolutions are made by consensus. Actions are assigned on a volunteer basis. Members of the team have areas of expertise, but the volunteer system ensures that actions are implemented quickly. People often volunteer for actions that eliminate defects they find personally irritating. Although there is little pressure on team members to have the actions completed, progress is tracked and actions are often reassigned when a particular member's workload increases. No distinction is made between management and nonmanagement members. The team is truly a team.

The MVS Interactive process representative typically schedules and leads the meetings. Action team meetings are scheduled bimonthly, at a time that does not interfere with the members' primary responsibilities.

A typical agenda for an action team meeting begins with the evaluation, prioritization, and assignment of the new action items. Next, actions that are ready to be closed are discussed to ensure that the implementation will indeed prevent the defect and ensure that the development process continues to improve. All implemented actions are considered for cost effectiveness suggestions. Finally, the status of the assigned actions is given. The most important aspect of the action team is that it is free to modify itself as necessary to meet the needs of the organization.

Kickoff packages and meetings. All products developed in the MVS Interactive area follow a similar process. For each phase of this process, a kickoff package has been developed. The packages provide an interpretation of the standard IBM programming process[3] as it pertains to MVS Interactive.

Section 1 of the kickoff package contains the change activity of the document. Many different teams use the kickoff packages, so it is important to highlight all the changes that were made. These can be highlighted at kickoff meetings. A kickoff package is one vehicle in which the action team can communicate the process changes that have occurred. The change activity is kept in a table that tells the date the change was made, has an abstract of the change, and references the action that prompted the change. This provides an easy way to understand the justification for all process changes.

Section 2 of the kickoff package contains process information intended to explain the philosophies of that particular work phase. The philosophy includes the purpose of the work stage, the entry and exit criteria, checkpoints, task descriptions, and validation methods. Section 3 provides details specific to the way in which the philosophies documented in section 2 are implemented. It is expected that this section will change with each iteration of the product cycle as we continually learn to do things better. Finally, section 4 contains reference information to assist in the completion of these tasks. These materials include tools, common error lists for that work phase, checklists, and related documents. The kickoff packages are used as part of the development process and are considered living documents that are changed often. This encourages the developers to view development as a living and dynamic process that is being constantly improved.

The MVS Interactive action team owns the kickoff packages and is responsible for maintaining the accuracy of the packages. The packages are on line and are available to everyone in the laboratory. Packages for the major work phases, product-level design, component-level design, module-level design, code, unit test, variation identification, test-case development, and test-case execution have already been developed or are currently under development.

The rationale behind rejecting an action is saved as part of the history of the action.

Kickoff packages are also being written for the specification process, project leadership, and APAR certification subprocesses, as well as others as needed.

Tools. The Defect Prevention System is a tool that was brought to the Myers Corners Laboratory from the Raleigh laboratory and is supported by the Programming Methodology Department. The MVS Interactive area was assigned a product ID and given access to the tool. This tool is used to document the description and status of each action.

An action item is created by entering it into the system, either associated with a causal analysis session or as a miscellaneous action. Initial information includes the description of the action and the suggester's name, node, and ID. The action is automatically assigned a status of NEW, and all action team members receive notification that a new action has been written.

After the action has been discussed by the action team and assigned to a member, this member is responsible for keeping the status and all related information up to date in the system. Any member of the organization can use the Defect Prevention System to see the status of any action item.

When an action is updated, modified, or closed, a notification is sent to the suggester and to all action team members.

The rationale behind rejecting an action is saved as part of the history of the action. This information

can be used at a later date if the action has to be reopened. For example, when an action is rejected because of its cost, it can be reopened if the defect is pervasive and other measures have not been successful in preventing it. In other words, the tool can be used to build business cases for implementing expensive actions.

When an action is implemented, information about the effectiveness to prevent the defect and the cost of implementation are input directly into the Defect Prevention System. This information can be used to generate reports on the benefits and costs of the process improvement.

The kickoff packages document many of the process changes.

Communication. The MVS Interactive action team is responsible for communicating all Defect Prevention Process activities to the organization. An action is not considered closed until the implementation of that action has been communicated to all affected parties. The kickoff packages document many of the process changes, and a monthly newsletter is published to highlight both Defect Prevention Process news and general information. Anyone is free to submit an article for publication that is felt to be of general interest to the community.

Other action teams. When the MVS Interactive action team analyzes an action that is beyond the scope of the action team to implement, that action is forwarded to the appropriate action team. The Myers Corners Laboratory Action Council and Tools Action Team are commonly the receivers of those actions. MVS Interactive has a representative on each of these action teams. Actions may also be transferred from one action team to another. The Defect Prevention System is being enhanced to allow action items to be automatically transferred across different products.

Myers Corners Laboratory Action Council. The Myers Corners Laboratory Action Council is the highest level action team at the laboratory. It is responsible for those actions that are beneficial to everyone who works at Myers Corners. These actions typically involve education and laboratory-wide process changes. The action council is also responsible for communicating the activities of the various local teams throughout the laboratory. The action council has representation from each local area, management, the tools group, education, and the Programming Methodology Department. This ensures that all discussion during the action council meetings truly reflect the needs of the entire laboratory. Each member of the council has a backup to ensure representation at all meetings.

The local-area representatives are responsible for explaining the actions that were forwarded from their respective action teams. In addition, the local-area representatives are involved in evaluating and prioritizing actions not from their area. The pervasiveness and importance of action items can be determined during the council meetings. Often one area has faced a similar problem and has implemented an action to prevent that problem.

The managers on the council represent the laboratory director and are instrumental in giving direction and obtaining resources to implement suggested actions. Participation in the action council helps provide management with a first-hand appreciation of the problems that are being faced by the general community at Myers Corners Laboratory. Management actively participates in developing solutions to problems. Active participation provides highly visible participation by management as part of the team, helping to eliminate us-and-them perceptions.

The process, tools, and education representatives gain deeper insight into the problems of the user community. Participation on the action team gives them added perspective with which to perform their duties.

All members of the action council are responsible for implementing those actions assigned to them and communicating action council activities to their organizations.

Communication is a vital responsibility, and the council has several vehicles for promoting information throughout the laboratory. First, the meetings themselves are opportunities for representatives from different organizations to meet and talk to one an-

other. An incredible amount of information is shared during the meetings. Problems that one area is experiencing have often been solved in another; people can now contact one another directly.

The council also has more formal ways of communicating. Myers Corners Laboratory publishes a quarterly newsletter titled *Technical Vitality*. One member of the council is responsible for writing an article for this newsletter every quarter. These articles highlight work being done in the laboratory that relates to the Defect Prevention Process. In addition, a Defect Prevention Process bulletin board has been created. Each month a different action team is responsible for posting on this board information about what their action team is doing.

The action council also maintains three on-line conferencing files, called forums, for Defect Prevention Process information. These conferencing files can be updated by anyone in the laboratory and items can be searched, viewed, or printed. Any Myers Corners Laboratory employee can subscribe to a forum to ensure that all updates are sent to that person's mail. Action team members can subscribe to the ATEAM forum for hints and tips on running action team meetings, creating kickoff packages, and so forth. The Defect Prevention System forum contains information about the Defect Prevention System and answers questions new users might be having. Finally, DEFECTP contains information that has surfaced through the Defect Prevention Process that might be interesting to anyone in the laboratory. Other action teams can put their common errors lists and similar items on this forum. The Raleigh laboratory maintains a company-wide forum to discuss Defect Prevention Process information that is common to all laboratories implementing the process. The action council is continuously working on ways to improve communication in the laboratory and reduce the amount of rework done by the various organizations.

Local-area representatives are responsible for the justification and requirements for a tool request.

Myers Corners Laboratory Tools Action Team. An aim of the causal analysis sessions is to determine those action items that will automatically eliminate a defect from ever reoccurring. Automatic elimination is the most effective action item that can be generated. Because of this focus, many tool enhancements and new tool requirements have been generated. The Myers Corners Laboratory has a laboratory-level tools group responsible for the development and maintenance of all tools. A tool-requirement action team was formed to meet the growing number of tool-related action items. This action team has representation similar to that of the action council. This team evaluates and prioritizes all tool requirements for Myers Corners Laboratory, not just those generated by the Defect Prevention Process. This ensures that the prioritization of the requirements takes all factors into consideration.

Local-area representatives are responsible for the justification and specific requirements for a tool request. Tool area representatives are responsible for implementing most of the actions. Again, management lends direction, helps obtain resources, and actively participates in resolution of problems. Tools, process, and education are most often handled at the laboratory level, but the local-area teams implement actions in these areas that are specific to their areas. The action council and Tools Action Team represent committed resources to implement actions far-ranging in scope. They give the Myers Corners community a place to have their suggestions implemented.

Benefits

The MVS Interactive organization has already realized many benefits from the Defect Prevention Process. It is very difficult to quantitatively measure the benefits of the process because of the short time it has been in effect. We expect to see, as the Raleigh laboratory has seen, a reduction in errors across the whole development process. We have, however, seen many qualitative improvements already.

The MVS Interactive action team has implemented actions ranging from the development of a guide, to vending a software product, to standardizing document tags so that all documents can be easily printed. An expert review process was established to ensure

that all specifications are thoroughly reviewed by appropriate areas. Focal points have been established to ensure that activities are carried out in a coordinated fashion. Projects have established file naming conventions, so that information is easily accessible.

By understanding the defect a process change is intended to eliminate, the developer becomes more aware of quality considerations.

Each action that is implemented allows the organization to learn from its mistakes and ensure that those mistakes will not be made in the future. The action team has filled the void of having committed resources focused on prevention instead of detection.

All development areas are required to document their process, and often this is in the form of a process notebook. These process notebooks are large and hard to use. The ownership is vague, the notebook is infrequently reviewed, and the information quickly becomes inaccurate. Once the notebook is out of date, the users no longer trust the information contained in it, and the process becomes undocumented. The result of this is that the process itself becomes vague and hard to change. When the process becomes undefined, productivity declines, because the benefits of having a clearly defined process are lost. Responsibilities are no longer clearly defined and communication can break down. The Defect Prevention Process kickoff packages help keep this information up to date.

The Defect Prevention Process itself continually changes to best meet the needs of the laboratory. Many action items have been written to improve the way the process is implemented, including requirements against the Defect Prevention System and actions to improve communication of Defect Prevention Process throughout the laboratory. The dynamic characteristics of the Defect Prevention Process have been transferred to the development process by means of the kickoff packages.

The kickoff packages are small documents created to provide information on a specific task. They define the philosophies and methodologies of the task giving the user of the package both the knowledge needed to perform the specific task and the reason for doing it. Responsibilities are defined so that the user knows just what to do. The reference sections provide information that facilitates those tasks. Reviews of these packages are a necessary part of the development process; hence, the packages (and the processes themselves) are continually updated to remain both accurate and effective. The user of the package can easily identify the process changes and the justification for those changes. By understanding the defect a process change is intended to eliminate, the developer becomes more aware of quality considerations.

Users of the kickoff packages are now both the author and audience of the packages. The MVS Interactive action team has received updates to kickoff packages while those packages were being developed. Accuracy is maintained, and the process stays clearly defined.

The causal analysis meetings have been effective in both increasing quality awareness and encouraging people to consider how to improve their everyday work environment. The management support of the Defect Prevention Process has turned the focus away from finding errors to preventing those errors. This is the best way to shorten the product cycle.

Conclusion

This paper shows how the MVS Interactive area used the Defect Prevention Process to change the focus of the software development process to quality awareness. Because our responsibilities are to develop a software product, the paper emphasizes defect prevention in software development. The Defect Prevention Process can be applied to tasks ranging from information development, to the requirements process, to any task done in a cyclical fashion. The dynamic nature of the process allows it to be adapted to a wide range of situations.

The flexibility of the Defect Prevention Process enhances its effectiveness. It has the ability to change the mindset of the people performing and managing the work, which is the most important aspect of the work environment to change. This is done by making people more conscious of the defects made and harnessing their creative nature to prevent them.

Who can better understand how to eliminate defects than those making the mistakes? And who can better find process improvements needed to make this possible than the process owners themselves?

The MVS Interactive organization strongly believes that we are only now realizing the potential of the Defect Prevention Process. As the process becomes more ingrained at the Myers Corners Laboratory, we expect to see a reduction of defects and improved communication leading to higher quality products and increased productivity.

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