SAFETY STRATEGIES WHICH ALSO IMPROVE OPERATIONAL PERFORMANCE

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Research has demonstrated that workers in aviation maintenance operations often perceive that safety and operational goals are in conflict. Investigators at Purdue University have worked with numerous aviation companies over the past eleven years to improve safety and control maintenance human errors. During that time, it has become apparent that safety goals, strategies and programs are differentially supported depending on the operational and economic pressures experienced by an organization. Purdue researchers have often traced operational and performance stressors back to poorly structured processes and other factors that result in artificially induced perceptions for the need to sacrifice safety for performance. Several strategies used or developed by Purdue researchers have demonstrated that safety and productivity gains can be simultaneously achieved through the use of process mapping and identifying areas in need of improvement.

Conflicting Goals

Studies by Purdue researchers at numerous aviation maintenance organizations have demonstrated that maintenance workers often feel that safety is compromised by work pressures and mixed messages from management. This phenomenon, commonly referred to as "conflicting goals" (Reason, 1997), is recognized by human factors researchers as a common cause for the erosion of operational safety levels and the diversion of worker focus from safety to productivity goals. In the maintenance organizations studied, there was strong support by management for safety in all facets of the operation and a stated mission of "safety first". How, then, does one explain the fact that the maintenance workers studied often felt that it was necessary to neglect safety procedures or shortcut safety steps in order to attain operational or productivity goals?

Purdue researchers found that in each of the organizations studied work related metrics for performance were one-sided. That is, they focused on the exclusive reporting of operational or productivity performance and failed to capture or report the level of safety of the operation (Eiff & Stanley, 2003). In short, work related performance metrics were providing feedback for productivity performance and not safety performance thus narrowing the perception of workers to a myopic view of what was important in work related outcomes.

Exasperating the impact of this imbalanced reporting of safety and productivity performance was the frequent occurrence of operational or productivity exigencies. Poor work plan development, process control and other operational factors often resulted in work related pressures which forced workers to feel they had to chose between doing the job safely and meeting operational or productivity goals. The subliminal message imparted to workers, as expressed to researchers by maintenance personnel, was that "safety is Number One unless it impacts operational performance or productivity".

In all of the organizations studied by Purdue researchers, overriding operational or productivity performance problems which led to this perceived pressure to sacrifice safety for other work goals were most often the result of poor process design and control, work coordination, and the failed understanding of how one's work performance impacted the overall productivity or operational performance of the organization.

Process Mapping Assessment Tool

Purdue researchers have repeatedly found that they have had to help organizations better understand how to analyze and improve their operational processes in order to improve workplace and operational safety and productivity. The strategy which has proven most effective at identifying, analyzing, and resolving operational problems has been the process mapping assessment approach.

When working with airline partner companies to identify and analyze operational problems, Purdue researchers generally begin by forming a group of company representatives to work together with the researchers on the project. These representatives are generally workers from each of the career fields affected by the problem. The initial phases of the project include providing training in process mapping and other techniques to be used in isolating and analyzing the problem. Once the whole project team is trained in the process analysis and improvement

strategies to be employed, the team begins to define the operational process map by reviewing the airline's career field operation manuals to determine what the company's policies and procedures define as the company's approved way to perform the requisite tasks. This first draft of the process map normally results in the identification of policy and procedural inadequacies and the identification of many conflicts between the ways different operational manuals stipulate that identical processes should be performed. As a result, the team must begin its analysis process by resolving these procedural conflicts and revising the manuals to reflect one standard of operational performance.

Once this has been done, the team scrutinizes the map for unnecessary or redundant steps or processes. When the team has refined the map to the best of its ability, the map is then compared to how the process is actually done. Generally, the team finds that the process defined by the map is not the same as that being performed in the workplace. From this point on in the improvement cycle, the map is used to define operational process flow and feedback concerning the effectiveness of the defined process is used to improve the map and, eventually, the carrier operations manuals.

A Graphic View. Researchers have found that the highly graphic nature of the map makes it easily understood and usable by any worker. This causes the map to be the focal point of discussions between process improvement team members and workers or managers as they explore ways to streamline operational processes. The map has the additional advantage of providing workers at all levels of the operation a better understanding of operational work goals and the role they play in meeting those goals. It also provides them with an understanding of how they or their work group's tasks impact the overall operation. By utilizing the process map and following the process depicted, not only do the individual workgroups understand what is expected of them, but also the impact that their actions can have on members of other workgroups.

Task Coordination. One of the greatest contributors to the problems experienced by partnering aviation organizations was the coordination of workgroups' tasks and task integrations. Coordination of work tasks is made clear in the process maps through the alignment of the different task step lines for each workgroup along a common timeline. Therefore, if tasks are found to be occurring in parallel vertically, they are being carried out concurrently. Those that occur prior are located to the left, while those waiting yet to be completed are found to the right. In this way, individuals can look at the map to find out what should have already been completed both within their own group and by their peers in other groups to help them assess if the process is proceeding normally or if they should prepare their workers for likely deviations. In resolving study partner problems, researchers often guided the improvement team to a more effective process for workgroup coordination. This was often accomplished through the reduction of steps needed to accomplish the operational goal. By being able to assess the progress being made through the process, individuals can better plan how they will meet the needs of their own functions within the workflow in real-time.

The process map also provides graphic indication of important conjoining phases among work groups. Points within the operation which require the articulation or "hand-off" of tasks or completed processes between workgroups requires effective coordination and communication in order to insure undisrupted work flow. The process map makes the identification and analysis of both the timeliness and effectiveness of this coordination easier than with other methods.

Task Integration. Task integration is also portrayed well through the use of the process mapping technique. There is the perception among many workers that after they complete their parts of the operational process, they are no longer accountable for the success or failure of the process overall. However, as stated before, no one workgroup is able to complete their functions fully without both impacting and being impacted upon by the other workgroups involved. Therefore, the ability to interact in a professional and productive manner with members of different workgroups is a necessary part of any workflow. In the operational work environment of a station, very few tasks are accomplished exclusively by a single workgroup.

The process map expresses this notion by showing how the processes, as they are aligned, also require different steps to occur in sequences among workgroups. Using the maps as a tool, organizational members have the ability to follow the product through the process as it is moved along through the tasks of all the workgroups. Furthermore, the map can provide insights into locations within the map where integration and coordination are lacking so that the process can be improved and the map amended to reflect the new steps. Task integration was clearly demonstrated as a powerful result of the process mapping technique in the vast majority of industry

problems addressed by the researchers. After developing and studying the operational process maps, the improvement teams found that rather than needing additional manpower and other resources, they were able to accomplish their goal by improving communication and coordination through the use of cell phones or by otherwise communicating with each other with key information at the predetermined critical junctures in the process. Through such usages of the workflow process mapping technique and strategic application of the communication-related insights gleaned from this tool, great successes in process improvement have been demonstrated in actual aviation operational settings.

Roles & Responsibilities. A major strength of the process mapping strategy is that it provides clarity of workgroup roles and responsibilities in a diagrammatically depicted representation of the progressive work process steps. This easy to understand perspective provides not only a "big picture" view of how the process strategically insures meeting organizational and operational goals but also provides adequate specificity to become a framework for tactical problem solving. Structured to map the flow of the product(s) through the organization's operational processes, this highly visual format aids in identifying and defining the process' critical path and subordinate critical chains. The process' critical path is the shortest series of necessary sequential steps required to meet the operational or productivity goals of the process. Critical chains are parallel work processes that must be integrated into the critical path at specific times during the process (Goldratt, 1997). The timeliness of the integration of critical chain products into the critical path is paramount to the successful completion of the operational objectives. After viewing the process map, workers from various workgroups clearly understand the role they play in meeting the organization's operational goals.

How Process Mapping Reduces "Risk"

Process mapping clearly assisted in the identification of roles and responsibilities, the reduction of operational process flow problems, and the coordination and integration of tasks in an operational setting but can it also be helpful in identifying "risk" in maintenance settings? As mentioned in the beginning of the article, the research literature suggests that workers engage in at-risk behaviors when work pressures make them feel that they must sacrifice safety for productivity and operational goals (Reason, 1997). The process mapping strategy provides for an easy assessment of impediments to effective and efficient workflow that cause work disruption or pressures that result in worker at-risk behaviors. Purdue researchers have found positive correlations between the use of process mapping and the identification of work practices that may include unsafe operating practices or unauthorized work practices that may improve efficiency in the short run but are clearly in the high risk category of application. It also helps identify incorrect or inadequate policies, procedures, or work habits. These facets of the work process are crucial to establishing worker behaviors as they serve as the antecedents for worker behavior (Braksick, 2000). Correct worker antecedents are a pivotal step in correcting unwanted behaviors that impact safety and productivity.

The process map also identifies where, when, and between what work groups critical task coordination or integration occurs. These conjoining points most often represent interfaces between "critical chain" and "critical path" processes. It is precisely at these points that many operational problems and workflow delays occur and that increased safety exposure is generated (Eiff & Lopp, 2001). By focusing on more effective communication and work coordination at these points, researchers have been able to improve workflow and, at the same time, reduce risks which have previously resulted in accidents or safety incidents.

Improved Use of Resources

Another factor which exacerbated problems, especially at conjoining points, was the lack of adequate resources to perform the tasks of the process. At all of the organizations studied, Purdue researchers found that at critical work "turn-over" points in the process, problems often were generated or compounded by the lack of necessary resources for the effective completion of tasks (Eiff & Lopp, 2001). Resource deficits often include fewer than required workers to perform the task effectively, inadequate equipment resources, or missing supervision. Building on the foundation of process map analysis technique, Purdue researchers used the operational maps to develop a resource assessment and utilization strategy which provided organizations with insight into adequate staffing and resource levels which allowed for optimization of resources. This assessment strategy has been utilized to develop manpower and equipment resource planning guides to aid managers in allocating appropriate resources to accomplish tasks effectively and efficiently. The tool also provides managers with insight into changing resource needs in the constantly changing operational

environments normally associated with airline operations.

Systems Thinking

The highly understandable process mapping strategy also helped researchers explain to managers and workers in the studied organizations the need to address work group isolationism. It is common among aviation organizations for the workforce to become "soiled" in their own professional work groups or environments. When this occurs, workers often fail to see how their work performance or safety focus can impact other work groups or the organization as a whole. Effective safety and performance gains can be realized if the organization management and workers can take a more global or systems view of their operation. Thus, moving the organization toward "systems thinking" can have a dramatic impact on both safety and operational performance.

Systems' thinking was an additional methodology used by researchers to assist in understanding the holistic perspective within organizational settings and the perceived conflicts between operational and safety goals. Principles of system thinking include:

- Think of the "big Picture"
- Balance shot-term and long-term perspectives
- Recognize the dynamic, complex, and interdependent nature of systems
- Take into account both measurable and non-measurable factors
- Interrelatedness of systems

(Anderson & Johnson, 1997)

Process mapping allows researchers to better visualize and inform others of the work flow and identify limitations with a view toward reducing the scope of the work involved to the simplest and smallest steps. System thinking expands the vision to include multiple systems and how the dynamics involved may have unanticipated outcomes by virtue of the interrelatedness of all the subsystems and, while they can be analyzed in isolation, they cannot be solved without taking into consideration emergent effects in other areas of the organization.

Three Solution Categories; Personnel, System, Documentation

The use of these various tools in unison represents a more balanced approach to resolving troublesome workflow and, therefore, safety and productivity problems. Once the tools identify operational risks and performance impediments, three categories of need must be considered when revising operating practices. The first is personnel issues. Are there enough personnel to perform the tasks with optimal performance? Do personnel have sufficient knowledge, skills and abilities to complete the tasks as assigned in a manner consistent with the new information or should they be trained? Is the operation function in accordance with a systems approach to operational goals? Or, do job tasks need to be redesigned to insure systems compatibility? Is the process resourced adequately throughout the workflow, is the tooling available as required, is there an adequate support system for employees to receive appropriate timely feedback. Another area of concern is that of workflow and task documentation. Documentation on work process flow which specifically addresses the tasks and performance criteria for the operation provides the important antecedents for correct worker performance. These well defined antecedents are the precursors to better productivity and safety performance. It is also true that good audit trails rely on adequate documentation and are a critical component of internal and external checks and balances. A sound risk management program relies on good documentation and accurate data collection systems.

Summary

The highly intuitive nature of the process mapping technique has many advantages. It is easy for workers, managers, and researchers to use in the identification, analysis, and improvement of operational and process problems which often drive safety concerns. It has been demonstrated that the process mapping technique is also highly effective at providing insight into critical points in the process where safety problems arise and for determining the root causes for those problems. Spin-off techniques such as task coordination and integration, resource utilization, and system structure and thinking analysis and improvement strategies have proven to be dramatic enhancements to the fundamental technique of process mapping. Together, these strategies have demonstrated a highly effective way to improve both safety and operational productivity simultaneously. In today's troubled industry, such tools could prove pivotal for organizations with bleak economic outlooks.

References

Armentrout-Brazee, C. & Eiff, G. (2002, March 3-5). Communication in process: improving communication through the analysis of airline

operational processes (pp. 1-8), *Aviation Communication Conference*, Phoenix, AZ.

Braksick, L. W. (2000). *Unlock behavior, Unleash profits*. New York: McGraw-Hill.

Eiff, G. & Lopp, D. (2001, May 14-16). Measuring and correcting workers at-risk behaviors. *Proceedings of the Canadian Aviation Safety Symposium* (pp. 1-17), Transport Canada, Vancouver, British Columbia, Canada.

Eiff, G., & Stanley, D. (2003, July 21 &22). The problem with measuring operational safety, Aviation Management Education and Research Conference (Group 2 (2), pp. 1-17). Montreal, Quebec, Canada.

Goldratt, E. M. (1997). *Critical chain*. Great Barrington, MA: The North River Press.

Reason, J. (1990). *Human Error*. Cambridge, England: Cambridge University Press.

Reason, J. (1997). *Managing the risks of organizational accidents*. Brookfield, Vermont: Ashgate Publishing Co.

Anderson, V. & Johnson, J. (1997). *Systems Thinking Basics: From Concepts to Casual Loops.* Williston, Vermont: Pegasus Communications, Inc.