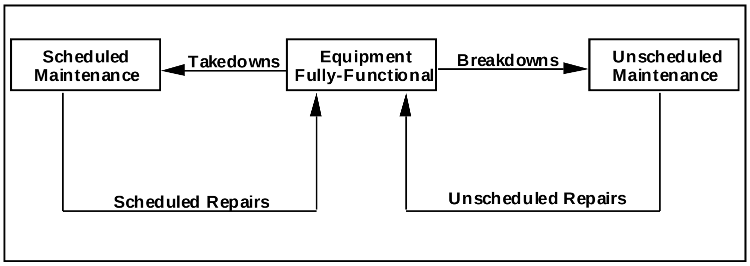
Achieving Synergy in a Production System

In the early 1990's DuPont conducted a worldwide benchmark to learn how maintenance could be improved and costs lowered. To better understand the data from the benchmark a computer model was developed representing a chemical plant with a replacement value of $444 million employing 91 mechanics and completing 500 work orders per week. This fictitious facility operated at 83.5% of capacity but could sell more product if the plant ran better. The model was organized around the flow of the equipment as shown in the figure below.



The model led us to conclude that there are five major sources of defects that needed to be addressed. They are defects from equipment design, operations, maintenance, spare parts, and failure events. To remove the randomness out of maintenance work it was necessary to deal with all of the defect sources in a systematic way. Past experience with trying to implement planning and scheduling alone showed us that operations' needs were not met and caused a lot of conflicts between maintenance and operations.

We looked at the results of the computer simulations and compared each of the scenarios to the reactive maintenance strategy used in the base case.

Planning–The number of planners was increased and a library of plans was added. The library increased the productivity of the job planners and made it unnecessary to create a new plan for every job. More planning increased mechanic productivity. As it was in maintenance at the plant sites, the result of additional planning in the model was disappointing. Uptime increased by only 0.5%.

Scheduling–We implemented a more efficient scheduling system expecting better scheduling to increase the efficiency of planned maintenance and lead to fewer breakdowns. Uptime increased by only 0.8%. The scheduling program failed because the plant was doing very little scheduled maintenance. Unscheduled maintenance is by definition unpredictable because of the randomness in failure events.

Predictive & Preventive Maintenance–We increased the frequency of equipment inspections. In the base case, the frequency of inspections was one every twenty weeks. In the predictive and preventive program, the frequency was increased to one every two weeks. The predictive and preventive program was counterproductive as uptime fell by 2.4%. This surprising result was caused by increased inspections that drew manpower away from repair work. The man-hours spent on inspections were wasted for the lack of a good scheduling system. Some of the inspections did result in repairs but without a planning system, the repairs were done inefficiently. This increased the time to repair which decreased uptime.

Synergy between Policies–The first three scenarios suggest that there is strong synergy between the maintenance policies. Model simulations revealed this to be the case. The combination of all four policies increased uptime by 5.1%. Clearly, it was the combination of the four policies that generated the gains that were expected from proactive maintenance.

The analysis of the model could be distilled down to two basic conclusions: 1) a structural analysis of the maintenance system demonstrated that it is unlikely that maintenance programs can be successful if they are implemented separately and 2) there is a great deal of synergy between the policies.

In the process of exploring the synergy in maintenance best practices, we discovered an even better strategy. By eliminating the sources of defects that cause the maintenance work in the first place, we implemented the programs as one initiative where all of the pieces fit together in a systematic manner, and we were able to spread that understanding by creating a microworld, The Manufacturing Game®, that helped people form their own mental model of what was in fact necessary.

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