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The Benfield Column Repair Project

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At 12:30 P.M. on Tuesday, March 8, 1994, a fire broke out in the carbonate regeneration column in the Benfield Unit of the Gas Circuit at Sasol Three, one of the factories of Sasol, a leading South African coal, chemical, and crude-oil company. The column, which was open for repairs and maintenance during the annual factory shutdown, is used to process hydrogen. It is one crucial component in a long chain of equipment that converts coal to oil and chemicals. Without it, a large section of the factory could not function, resulting in a considerable loss of income.

A damage investigation revealed that buckling in the shell of the column had caused it to bend in the middle to such an extent that the top of the steam chimney was 500 mm (20 inches) off-center, making the 70 m (231 feet) column resemble the Leaning Tower of Pisa.

Decision analysis revealed that, to get the plant safely back online in the shortest possible time, the damaged portion of the shell would have to be cut out and replaced. The main component of the project, therefore, was to strip out the original shell,

fabricate a new section, reinstall the column, and recommission the unit.

GROUND RULES

- The project will be schedule driven, not cost driven.
- There is NO float on this project.
- Plan to reduce scheduled times, not be governed by them.
- The project will be a team effort with Sastech and Sasol Operations as partners, assisted by Sasdiens and CBI.
- Safety will not be compromised at any stage during the project.
- Quality will not be compromised at any stage during the project.
- Technical decisions will be authorized by Mr. J.D. Bosch and Dr. J.H. Snyders.
- Process decisions will be authorized by Mr. A.S. du Toit and Dr. J.H. Snyders.
- Resources will not be considered as a limitation.
- Commitments will be adhered to.
- Communication will be continuous at all levels.
- Sasol Mechanical Maintenance and Production will be notified of all work before it takes place in the unit.

And all this was to be accomplished in forty-seven days.

The project team. Sastech, a subsidiary of the Sasol Group of Companies, was requested to undertake the repair at 8:00 A.M. on Thursday, March 10. The Sastech project team consisted of a project manager, a senior project engineer, a cost engineer, and a planner. The total team, however, had twenty-seven members: four process engineers, six mechanical engineers, a pressure vessel specialist, a metallurgist, a welding engineer, a pipe stress engineer, a piping draftsman, a mechanical draftsman, a structural engineer, a structural draftsman, three quality assurance inspectors, a commercial contract officer, and a commercial procurement officer. Members were drawn from Sastech, Sasol Three, Sasdiens, Chicago Bridge and Iron Works (the original fabricators of the column), and from suppliers of the equipment and material.

CBI was contracted to remove, fabricate, and replace the vessel, with Sasdiens providing the rigging, piping, electrical, and associated work. Some of the CBI engineers involved when Sasol Three was built fourteen years ago now worked on the repair. The cutting up and removal of the damaged sections of the column was a combined effort between CBI and Sasdiens.

Within fifteen minutes of receiving the contract, CBI had contacted employees from six sites in the United States, Saudi Arabia, Turkey, and South Africa and were faxing drawings from their head office, placing provisional orders for material, completing the rigging study, and arranging delivery of the massive spreader beam to be used to lift off and replace the damaged and new sections. This speed of response set the standard for

everyone involved.

The column was handed back to production on Sunday, April 3, at 12:30 P.M., certified as "ready for commissioning." The project completion certificate was signed on Friday, April 8, at 4:30 P.M.—fifteen days ahead of schedule.

Special management methods. Conventional project management techniques were not sufficient to ensure that the work was carried out in the shortest possible time. Two areas were identified as requiring special attention: innovation and creativity, and enthusiasm and commitment. Because the time frame was short, any time saved on individual tasks would have a direct effect on the overall project duration.

PROJECT STATISTICS

Disabling injuries 0
Welding rods burned 3,500 kg
X-rays shot Over 1,000
Packing rings loaded 157 tonnes
Bottles of cola consumed 15,000
Companies supplying material/equipment 12
Budget R23.3 mil ($85.3 million)
Amount under budget R5.9 mil ($21.6 million)
Hamburgers eaten 12,000
Contractors employed 12
Activities in the schedule 450
People involved 700
Project duration 25 days
Days cut from the schedule 15

But because the majority of the workforce had been involved in the maintenance shutdown when the fire started, they were locked into a mindset that the schedule governs the duration of each task and a successful task is perceived as one that is completed "on time." On the first day of the repair project, two people were overheard saying that they had "plenty of time" to finish a particular task. It was explained to them that, for this project, they would be given credit for work finished ahead of schedule rather than on schedule.

This story was recounted at the next meeting, and supervisors were asked to pass the message on to their teams. The result was incredible. People came up with ideas for saving even five minutes—unheard of under normal circumstances. Such was the enthusiasm created in the workforce that this became the dominant culture. On the third day, when a new supervisor joining the team said that he would start first thing in the morning, there was an immediate uproar, with everyone in the meeting shouting that he should begin immediately!

It was agreed at the beginning of the project that to get the commitment of everyone involved, they had to know what was going on at all times. This was achieved in a number of ways.

A list of ground rules, developed in conjunction with the client's senior management team, was distributed to everyone on the project. Any decision, even if unconventional, could be accepted if it complied with these rules. For example, the welding foreman hired welders from a rival company rather than delay completion of a task because the ground rule stated that resources could not be considered as a limitation.

A board was put up outside the command center caravan and updated twice daily. When people performed well, their names were posted there. This was a real morale booster. The project team was located on-site and was present before the night shift finished in the morning and after it started at night. Visits were frequently made during the night, removing the feeling of isolation normally associated with this shift. The project team also made a commitment to visit every crew at least twice a day to give feedback and encouragement. Frequent visits were also made to off-site supervisors. Each member of the project team had a pager and the crews were encouraged to make contact at any time of the day or night, which helped to speed up the decision-making process.

From the first meeting, we encouraged innovation and creativity. Even silly ideas were examined in case they produced a worthwhile solution. This continuous push for innovative ideas produced numerous timesaving solutions.

Each person was encouraged to work for the benefit of the project as a whole and not for his or her own interest. The person responsible for a critical path activity would get help voluntarily from all other members in the team because he or she understood that to shorten the critical path would also shorten the total project. This concept was so successful that at one stage a fistfight nearly broke out because three different artisans wanted to work on one particular section of scaffold at the same time, such was their enthusiasm for the job.

A policy of "Accept It … Or Change It … But Never Complain About It" kept meetings positive. In addition to the shift change meetings, communication sessions were convened twice a day when the activities of the next two days were discussed in minute detail.

This positive spirit created a dedicated project team that had many successes leading up to the overall success. Over one million Rands ($3.6 million) worth of material and equipment was ordered and not one single item was late. Each piece of piping fitted correctly the first time—and there were many hundreds of meters installed. The managing director of one company opened up his factory over the Easter weekend to

supply urgently required material. The production department, swept up in the spirit of the project, applied the same principles to re-commissioning activities and slashed the previous record for bringing the plant safely back online. The human factor was what made the project a success.

SCOPE MANAGEMENT

The objective of the project was clear from the beginning: Bring the plant back online in the shortest possible time. The first step was to determine the exact scope of the repair. We had to determine if it was an option to simply do nothing. A communication link was set up between CBI and the Sastech process engineers, which involved working very long hours because of the ten-hour time difference between South Africa and the United States. Their decision analysis revealed that the optimum solution was to remove the damaged shell sections.

While they were deliberating, other scope functions were already running in parallel. A meeting was convened to identify that work which could be performed irrespective of the type of repair selected. Items that fell into this category included removing the damaged packing material, insulation, and cladding, which would have to be changed even if the decision was to do nothing. Tasks that could not wait for a formal decision before starting without affecting their overall duration, and therefore the duration of the project, also had to be identified.

Scope statement. The brief scope statement issued initially simply stated that part of the Benfield Unit was offline due to fire damage and that it must be repaired as soon as possible. Development of the scope statement from this single sentence to the final format was carried out in conjunction with the development of the work breakdown structure. In fact, the work breakdown structure formed the basis of the scope, quality, schedule, and cost control documents.

To reduce bureaucracy, only two aspects required management approval: technical and process decisions used to determine whether to repair the column or leave it in its damaged condition. The baseline plan therefore lay in the hands of the project team. There were no fundamental changes to the baseline plan throughout the project life-cycle apart from the fact that durations were reduced and the project was completed ahead of schedule.

Project plan and control system. Once the optimum course of action was decided upon, planning started in earnest. The first step was to develop a work breakdown structure. This was completed at open meetings with representatives from each interested party present. A brainstorming process was used, with each topic identified on a Post-it note and attached to a huge white board. Delegates were encouraged to shout out tasks as they came to mind. The meeting was adjourned once the ideas dried up. A second meeting was convened to fine-tune and accept the WBS. The WBS determined what had to be done and when it had to take place, as well as the logic associated with each task.

Everyone was aware from the start that a higher premium would be placed on team performance than on individual performance. That this concept was clearly understood was demonstrated during feedback sessions. As soon as a task was reported as being in trouble or not being completed ahead of schedule, the rest of those present immediately offered to help. This removed the fear of reporting negative feedback and raised the morale of the whole team.

On completion of the project, a series of post-project analysis meetings were convened with the major players. Although we thought we had fast-tracked this project to the last second, there were a number of problems which, if recognized, would have saved time on the critical path. For instance, we failed to consider religious faith when we drew up the schedule. A number of the welders and boilermakers employed on the fabrication of the new shell sections were Muslims whose religious festival of Ramadan fell right in the middle of the most critical portion of their work. By the time we realized the problem, it was too late to employ welders with the same track record of zero defects from other ethnic groups. We updated the planning checklist to include this topic in case the same situation arises in the future.

QUALITY MANAGEMENT

Quality was one of the ground rules of the project. Everyone employed on the project had previously worked within the Sasol quality system and was familiar with Sasol's forms and procedures. One aspect that emphasized how far team building had come was the cooperation between QC personnel and the artisans. Not once did the foreman or supervisor have to call out the QC people to do their work; they were ready and waiting for the artisan to finish each task. The artisans didn't rush off to the tea hut the minute their work was complete; they stayed behind and helped the inspectors by preparing and cleaning the material to be inspected. This was reciprocated by the inspectors who dropped their "That's failed … fix it!" attitude and worked together with the artisan to identify problems and rectify them.

From a managerial point of view, normal quality-related steps were followed for each aspect of the project. The complete quality dossier for the project was signed off and filed before the close-out certificate was signed.

TIME MANAGEMENT

From the beginning it was clear that the project would be schedule-driven. There would be no constraints as far as resources were concerned and no "float" would be published. Tasks identified during the development of the WBS were given to the teams responsible for carrying out the work and they were asked to attach durations to them. This gave the teams ownership of the schedule; and who better to develop accurate durations than the people with the relevant experience?

In the initial stages a two-day look-ahead window was used, which allowed immediate

tasks to continue while future tasks were being developed. Meetings were held twice a day in the initial stages as detail was developed and input into the program. Because of its user-friendliness, Microsoft Project for Windows was used as the scheduling tool at the beginning of the project.

The schedule was also used to identify resources with the potential to affect critical task durations. Resource utilization was continuously examined to make sure that the labor and equipment to perform each task in the shortest possible time was available. If a task had work for ten welders but only eight welding machines were available, two additional welding machines would be located, plus a standby. The standby philosophy also applied to labor.

COST MANAGEMENT

Project cost management principles employed on this job paid a handsome dividend. The initial budget was R23,300,000 ($85,278,000) and the final job cost was R17,414,945 ($63,738,698): a massive savings of 25.26 percent of the total project cost.

A cost control base was developed based on the existing Sastech system and established estimating and forecasting methods. Regular feedback was given to each cost center. A one-page cost report was developed and presented to management on a regular basis.

Costs were also reduced by using techniques like value analysis. One example of cost reduction due to value analysis was the saving of hundreds of meters of scaffolding required to weld the connecting piping to the column. The regulations state that you can either put men or equipment into a man-rider basket hung from a crane; you cannot have both. This regulation was challenged and a man-rider was developed specifically to carry men and equipment. Drawings were taken to the responsible government minister in Pretoria, who accepted the proposal. A prototype was fabricated on-site. It passed the required tests with flying colors and was immediately put into service. From conception of the idea to the approved piece of equipment being used on-site took only four days.

RISK MANAGEMENT

Risk management ranged from ad hoc discussions to formal Potential Deviation Analysis (PDA) studies. Some of the results of these studies included arranging to receive weather reports from two different weather stations twice daily, extending every scaffold to make it possible to drape tarpaulins over the tower in the event of rain, the extensive use of standby equipment and materials, extensive servicing of equipment in the early stages of the project, canceling Easter holidays for key personnel (not a single person objected to this measure), and having crane maintenance personnel permanently on-site during lifting operations. Formal PDA sessions were convened for operations such as the removal and replacement of the shell sections. These sessions

were attended by representatives from the fire brigade, insurance companies, production, maintenance, loss control, projects, design, Sasol management, and everyone involved in the operation.

In order to minimize risk associated with design, all design information was verified by actual site measurement before being finalized. The small increase in time paid dividends in the fact that all designs fitted the first time, reducing rework to zero.

TEAM DEVELOPMENT AND HUMAN RESOURCES MANAGEMENT

For a team to function at its peak, each member must devote all his or her energy to the task at hand. If they are worried about things like working conditions and transport arrangements, they will not be able to devote all their efforts to the project. Thus, a simple plan, centered around communication and considering the "soft" issues of each team member, maximized the motivation of the workforce.

The huge hierarchical gap between team members at some of the meetings had to be recognized. On some occasions, participants ranged from the factory manager to site laborers, and lower-level team members tended not to contribute in such senior company, which stifled valuable input. Therefore, meeting attendees were very carefully selected.

One member of the project team was appointed to give feedback to management and one member of the management team was appointed to receive it. This reduced the risk of confusing or misleading information being propagated up the management ladder. Secondary information was always cleared with the contact person before it was accepted, eliminating rumors and exaggerations.

The "soft" issues of hourly-paid team members involved ensuring that transport was provided, that contractors' accommodations were acceptable, that lunch packs were provided for the entire project team every day, and that overtime hours were strictly controlled. This policy of "looking after the people and letting the people look after the job" really worked. One example: A welder flown in from the United States was accommodated in a well-appointed apartment. Expecting him to be more than satisfied, we were amazed to discover that he was not happy with his situation. He was on night shift and the apartment block was also home to a large number of noisy small children. The welder got virtually no sleep. He was moved to the more Spartan but quieter Sasol single quarters and his productivity shot up the next day.

PROCUREMENT MANAGEMENT

Only two main contracts were entered into, one for the repair of the pressure envelope of the column and the second for all the other ancillary work such as removing and replacing piping, painting, scaffolding, rigging, and cranage. Therefore, Sastech would have to trust contractors to work on a verbal instruction to proceed, followed in due course by a conventional written contract. There simply was not enough time to work

any other way. All the steps used in conventional procurement and contract management were followed, but on an informal basis and in a very short time frame.

CBI, the fabricator and installer of the original column, was asked to provide a target price within three days and to follow this up within a further ten days with a fixed price. Sasdiens was selected for the remainder of the work because it was on-site, knew the Sasol systems, and was part of the Sasol organization. Its contract was on a rates basis with a governing target price.

In addition, ten smaller contractors were involved. We were honest with all of them, explaining the situation and asking them to proceed without official paperwork in cases where it could not be generated timely. Though risky, this paid off. The level of trust in Sastech was such that we were invited to attend the internal meetings of some of the contractors.

On the procurement side, one buyer was selected to handle all purchase orders. By using one person rather than a department we had accurate feedback when and where we needed it. The risk associated was that if anything happened to the buyer, we would lose continuity. We reduced this risk by asking the buyer to keep a handwritten diary of events on his desk at all times.

The approach adopted with suppliers was to go in aggressively to ensure that we were not taken advantage of in our vulnerable situation. Once we came to an agreement, we dropped the adversarial attitude. By including suppliers in the team, we reaped tremendous benefits. A number of suppliers worked at night, during weekends, and even during holidays.

COMMUNICATIONS MANAGEMENT

Most of the communications management techniques employed on this project are described elsewhere in this article—which is as it should be, since communication is at the heart of successful management of risk, scope, cost, and so on. Communications management, the golden thread that ran through the project, was the one aspect that received the greatest attention; yet, it was also the one where most improvements were identified during the post-project evaluation.

A number of important people were left out of the communications list altogether at the beginning. One example was the quality inspector from the supply depot. When the first consignment of material was requested, we discovered that the inspector had gone home without clearing the goods we urgently required. We phoned him and apologized for not keeping him informed about the repair and he was onsite within ten minutes, eager to do his part. This incident prompted a critical look at the communication list, which revealed a surprisingly high number of "missing" people. A checklist was developed to ensure that the problem will not reoccur on future projects.

The communication channels covered contractors and vendors, subordinates, peers, and management, with frequency and type of communication structured to suit each recipient. At its request, feedback to management was mostly verbal and restricted to once per day so that we were not burdened with unnecessary paperwork. The only written reports given to management were the cost report and the schedule. One senior manager passed on progress information to interested parties outside the Sasol organization and to the head office. This ensured that there was only one "horse's mouth."

Meeting notes that required follow-up were typed into a computer program designed specifically for expediting action items. Each person with follow-up actions informed the meeting secretary on completion of the task so that the program could be updated. This meant that meetings could be restricted to exception items, which saved precious minutes each day. At meetings a PC screen was projected on the wall of the conference room for everyone to read. Minutes were printed at the end of each meeting. Since no one wanted his or her name to be on the follow-up list after the specified completion date, a great deal of effort was expended to ensure that action items were worked off quickly.

The only other information covered at every meeting was safety. Safety representatives were encouraged to give feedback and recommendations, and it was made clear to everyone that safety was not negotiable and that safety-related threats must be resolved on-site as soon as they were identified.

The project team spent a minimum of fourteen hours per day on-site. Talking to the workforce was an excellent way to pass on and receive information. As the level of familiarity increased, the quantity of information flow increased proportionally, confirming the maxim that the simplest solutions are the best.

CONCLUSION

The November 1993 issue of Chemical Processing contained an article entitled "'Fast Track' Approach Replaces Tower in Record Time." The column in question was 6 feet (1.83 m) in diameter and 140 feet (42.6 m) high. This compares to our column, which was 5.8 m (19 feet) in diameter and 70 m (231 feet) high. Their work was completed in ten weeks, a new record, according to the article. Our work was completed in only twenty-five days! This was the only other project of its kind that we could find to use as a benchmark; but it gives a good indication of what was achieved. The project is over, but it lives on in the form of accumulated knowledge and lessons learned to be used on all future projects.