Canadian refiner uses improvement program to increase refining profits

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In 2002, Petro-Canada issued a challenge to its refining and supply organization to add $150 million (Can.) of profits, and do it in 9 months with little or no capital. They referred to this task the Q1 Project.

Petro-Canada accomplished this goal by adopting “pacesetter” work practices with the help of the pacesetter performance process (PPP) that Solomon Associates Inc. developed.

Petro-Canada was able to add $150 million (Can.) of profits from the three refineries included in the project. The company decreased energy use, lowered maintenance and operating costs, and reduced staffing (Table 1).

Background
Petro-Canada operates three fuels refineries and one lube refinery in Canada with a combined nominal crude capacity of 313,200 b/cd. Petro-Canada has products sales of about 56.8 million cu m/day representing 17% of the Canadian market. Each refinery occupies a distinct position in the marketplace:

- Montreal. This refinery imports crude from Western Canada and international sources.
- Oakville. Located just outside Toronto, the refinery is the smallest and least sophisticated of the three fuels refineries.
- Edmonton. This refinery processes synthetic crude produced from Canadian tar sands.
- Mississauga. This lube facility is just outside Toronto. The Mississauga plant is one of the few lube oil facilities producing food-grade oils.

The lube refinery was not a full participant in the Q1 Project. In addition, Petro-Canada has announced its intent to close the Oakville refinery (OGJ, Sept. 15, 2003, p. 9). The Q1 Project would provide management a clear picture of the full potential of each refinery, which was considered in the decision to shut down the Oakville refinery.

Pacesetter process
The PPP started more than a year before the challenge was issued. The target was based in part on the results of the first two phases of the PPP (see Pacesetter performance box).

During 2001, Solomon completed Phases 1 and 2 and developed a detailed performance-gap analysis by benchmarking performance against specialized peer groups. Benchmarking with a single peer group is seldom a deep enough analysis to tell the entire story. A perfect example was the analysis done to establish staffing targets for the Montreal refinery (see Montreal box) where staffing targets were built from the ground up by a multidimensional benchmarking exercise.

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At the end of Phases 1 and 2, Petro-Canada had a clear understanding of the potential of each refinery and an outline of an implementation plan. While the strengths and weaknesses varied for each refinery, three major initiatives formed the core of the implementation plan:

- Operator-driven reliability. This was used to involve operating personnel in maintenance activities and get maintenance and operations to work together as a team.
- Operator effectiveness. Petro-Canada was not fully using the refinery supervisor, which diminished the role of process engineers.
- Planning and optimization (P&O). Petro-Canada had focused on supplying refined products to the retail marketing division at the lowest possible cost instead of trying to maximize overall profits. This philosophy was so ingrained that the refinery planning linear program (LP) models were set to minimize cost as an objective function. The P&O initiative focused on creating a maximum profit mindset.

Petro-Canada adopted the best-practice team (BPT) approach. The Montreal and Edmonton refineries took the lead in operator effectiveness and operator-driven reliability, respectively. Pilot programs for operator effectiveness and operator-driven reliability were developed and tested; national BPTs were formed to transfer this knowledge to other refineries.

A national team with representatives from all four refineries and head office was designed to implement the recommendations from Phases 1 and 2.

The challenge

By February 2001, Petro-Canada was ready to implement the changes. A meeting of the top 30-40 managers in the refining and supply organization helped to develop buy-in to the process.

The meeting established a sense of urgency for the project and had a huge positive effect.

Subsequently, the employees did not question the value of the program; rather, they began to question whether it was achievable. They questioned the timeline.

Management provided resources and priorities to the BPTs so that it could focus on the Q1 Project. Solomon ensured that the BPTs did not waste time “reinventing the wheel” and that the process focused on creating sustained improvements.

The project

The Q1 Project involved more than
Montreal refinery staffing analysis

Petro-Canada’s Montreal refinery is complex for a relatively small plant. The 105,000-b/cd refinery is configured with parallel processing units. The design and complexity of this refinery significantly complicates the task of setting staffing targets.

The Solomon analysis team knew it would need to justify to senior Petro-Canada management any target that was less than first quartile. In addition, to make any sustainable change in refinery staffing, Solomon would need to convince the refinery operating staff and labor union officials that targets were both reasonable and safe.

Solomon began the staffing analysis by separating the staffing numbers into two components: posts/shift and equivalent personnel/post (see table above).

Benchmarking revealed that the Montreal refinery had nearly the same number of people/process unit operating position (post) as the peer groups but had significantly more posts/shift. The number of posts in the refinery determined the staffing figures. The team suspected that the refinery configuration established this staffing level and began to examine the effect of the refinery’s parallel configuration.

Solomon used its database to review “economies of scale” for individual process unit staffing for atmospheric crude distillation and FCC process units (Figs. 1 and 2).

Fig. 1 shows a significant economy-of-scale effect in atmospheric distillation staffing. An atmospheric distillation unit of size 1 has 1.4 posts/shift, and an atmospheric distillation unit of size 3 has 2.2 posts/shift. If a refinery were to have three size-1 units equaling the capacity of one size-3 unit, staffing would be three times 1.4 or 4.2 posts/shift.

Fig. 2 shows a similar correlation for FCCU staffing. All conversion units have a higher baseload staffing than atmospheric distillation. The same example of three small units totaling the same capacity of one large unit results in three times 3.1 or 9.3 posts/shift vs. 4.9 for the single larger FCCU.

### Montreal refinery staffing

<table>
<thead>
<tr>
<th>Posts/shift, %</th>
<th>Equivalent personnel/post, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montreal refinery</td>
<td>Canada average</td>
</tr>
<tr>
<td>Posts/shift</td>
<td>150</td>
</tr>
<tr>
<td>Equivalent personnel/post</td>
<td>110</td>
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</tbody>
</table>

### ATMOSPHERIC DISTILLATION STAFFING

Fig. 1

![Atmospheric distillation staffing graph](Image)

### FCCU STAFFING

Fig. 2

![FCCU staffing graph](Image)

50 initiatives and everyone in the refining and supply organization. A major initiative was the max profit mindset initiative created by the P&O BPT.

This article focuses on the max profit mindset program, although the other initiatives in the Q1 Project were equally important.

As previously mentioned, Petro-Canada had focused on supplying products to marketing at a minimum cost and did not focus on maximizing corporate profits. The first step in changing this mindset was a best-practice audit of the P&O process.

The best-practice audit accomplished two primary objectives—to provide Petro-Canada a complete understanding of best practices and to provide a third-party assessment of how their current practices “stacked up” relative to the best practices of other companies in the industry.

The best-practice audit identified two primary weaknesses in Petro-Canada’s P&O department:

- The refinery LP models were not accepted as accurate. The LP model must be “universally recognized” as accurate. The P&O team should not be
Two major issues were keeping the process already in place from being a true discovery process—the mindset of minimizing cost vs. maximizing profit and the existence of a few “sacred cows” that the process was reluctant to address. These issues were addressed with these initiatives:

- Responsibility for the planning process was clearly defined with the creation of two coordinator positions. The coordinators, although they did not create the plans, were responsible for the plans being acceptable. The coordinators also served as a clearinghouse for information, which put them in the best position to recognize opportunities or to see problems developing. Pacesetters do this effectively and often beat the competition to profit opportunities.
- The organization learned to talk in terms of dollars and cents. They started to express opportunities and problems in profit terms.
- A more open environment was created at planning meetings, which was helped by having a Solomon representative present. After several meetings, the planning teams learned that management encouraged the new, more-open thinking and Solomon’s presence was no longer needed.
- A process was begun to identify the three most significant bottlenecks in each process unit in each refinery. This results in more creative and profitable operating plans.

### Four phases of change

- **Avoidance behavior**
  - “Is this really a problem?”
  - “What’s all the fuss?”
  - “Everything is okay.”

- **Confusion-chaos**
  - “Can’t we do this faster?”
  - “I’ve got another idea.”
  - “Let’s try this idea.”

- **Subconscious sabotage**
  - “This will never work.”
  - “We tried this before and...”
  - “Management will never approve this.”

- **Problem solving**
  - “Let’s find the root cause.”
  - “We can do even better.”
  - “Let’s look to the future.”

- **Denial**
  - “Is this really a problem?”
  - “What’s all the fuss?”
  - “Everything is okay.”

- **Resistance**
  - “This will never work.”
  - “We tried this before and...”
  - “Management will never approve this.”

- **Exploration**
  - “Can’t we do this faster?”
  - “I’ve got another idea.”
  - “Let’s try this idea.”

- **Commitment**
  - “Let’s find the root cause.”
  - “We can do even better.”
  - “Let’s look to the future.”
Critical success factors

Petro-Canada identified several factors that led to the project’s success:

- Senior management support. Any effort of this magnitude must have the active and continuous support of senior management.
- Follow a proven process. Although many different approaches exist to improve performance, it is vital that a company choose a process that has been proven successful for its situation.
- Benchmark. Benchmarking current performance is effective in moving people beyond denial. Individuals and organizations tend to move through four phases of change: denial, resistance, exploration, and commitment (Fig. 2).

In the beginning of a project, employees will deny that change is needed. Benchmarking against valid industry data identifies performance gaps and also proves that a similar refinery has achieved superior performance.

Benchmarking can eliminate the need to talk to or visit better performers. This accelerates the change process.
- Apply best practices. Work practices create the results shown in the

Nelson-Farrar cost indexes

Refinery construction (1946 Basis)

(Explained on p. 145 of the Dec. 30, 1985, issue)

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Pumps, compressors, etc.</td>
<td>222.5</td>
<td>777.3</td>
<td>1,487.0</td>
<td>1,522.0</td>
<td>1,540.2</td>
<td>1,546.9</td>
<td>1,599.9</td>
<td>1,613.1</td>
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<tr>
<td>Electrical machinery</td>
<td>189.5</td>
<td>394.7</td>
<td>532.6</td>
<td>529.3</td>
<td>522.0</td>
<td>518.7</td>
<td>516.4</td>
<td>515.5</td>
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<td>Internal comb. engines</td>
<td>183.4</td>
<td>512.6</td>
<td>907.3</td>
<td>911.2</td>
<td>911.7</td>
<td>915.3</td>
<td>918.4</td>
<td>920.3</td>
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<tr>
<td>Instruments</td>
<td>214.8</td>
<td>587.3</td>
<td>1,042.9</td>
<td>1,061.4</td>
<td>1,076.8</td>
<td>1,073.9</td>
<td>1,094.7</td>
<td>1,101.7</td>
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<tr>
<td>Heat exchangers</td>
<td>183.6</td>
<td>618.7</td>
<td>726.9</td>
<td>732.7</td>
<td>732.7</td>
<td>732.7</td>
<td>995.9</td>
<td>995.9</td>
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<tr>
<td>Misc. equip. average</td>
<td>198.8</td>
<td>578.1</td>
<td>939.3</td>
<td>951.3</td>
<td>956.7</td>
<td>957.5</td>
<td>1,025.1</td>
<td>1,029.3</td>
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<tr>
<td>Materials component</td>
<td>205.9</td>
<td>629.2</td>
<td>877.7</td>
<td>899.7</td>
<td>933.8</td>
<td>948.7</td>
<td>1,192.7</td>
<td>1,207.0</td>
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<td>Labor component</td>
<td>258.8</td>
<td>951.9</td>
<td>2,047.7</td>
<td>2,137.2</td>
<td>2,228.1</td>
<td>2,261.0</td>
<td>2,351.7</td>
<td>2,354.2</td>
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<td>Refinery (Inflation Index)</td>
<td>237.6</td>
<td>822.8</td>
<td>1,579.7</td>
<td>1,642.2</td>
<td>1,710.4</td>
<td>1,736.1</td>
<td>1,888.1</td>
<td>1,895.3</td>
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</tbody>
</table>

Refinery operating (1956 Basis)

(Explained on p. 145 of the Dec. 30, 1985, issue)

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<tbody>
<tr>
<td>Fuel cost</td>
<td>100.9</td>
<td>810.5</td>
<td>704.0</td>
<td>667.0</td>
<td>934.8</td>
<td>920.9</td>
<td>1,052.5</td>
<td>1,109.3</td>
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<tr>
<td>Labor cost</td>
<td>93.9</td>
<td>200.5</td>
<td>221.1</td>
<td>211.2</td>
<td>200.8</td>
<td>197.0</td>
<td>194.7</td>
<td>192.9</td>
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<tr>
<td>Wages</td>
<td>123.9</td>
<td>439.9</td>
<td>1,006.7</td>
<td>967.7</td>
<td>971.8</td>
<td>1,013.1</td>
<td>970.0</td>
<td>1,021.6</td>
</tr>
<tr>
<td>Productivity</td>
<td>131.8</td>
<td>226.3</td>
<td>455.7</td>
<td>458.9</td>
<td>485.4</td>
<td>514.2</td>
<td>498.2</td>
<td>529.6</td>
</tr>
<tr>
<td>Invest., maint., etc.</td>
<td>121.7</td>
<td>324.8</td>
<td>593.9</td>
<td>619.7</td>
<td>643.0</td>
<td>652.7</td>
<td>707.2</td>
<td>709.9</td>
</tr>
<tr>
<td>Chemical costs</td>
<td>96.7</td>
<td>229.2</td>
<td>224.4</td>
<td>220.7</td>
<td>237.7</td>
<td>237.2</td>
<td>286.2</td>
<td>290.8</td>
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<tr>
<td>Operating indexes</td>
<td>Refinery</td>
<td>103.7</td>
<td>312.7</td>
<td>428.7</td>
<td>432.8</td>
<td>464.7</td>
<td>466.2</td>
<td>505.6</td>
</tr>
<tr>
<td>Process units*</td>
<td>103.6</td>
<td>457.5</td>
<td>520.6</td>
<td>513.7</td>
<td>612.5</td>
<td>609.9</td>
<td>674.3</td>
<td>694.6</td>
</tr>
</tbody>
</table>

*Add separate indexes for chemicals, if any are used. See current Quarterly Costimating, first issue, months of January, April, July, and October.

Project results

Table 1

<table>
<thead>
<tr>
<th>Aggregate results for all three refineries</th>
<th>2000-02, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy intensity index</td>
<td>3.3</td>
</tr>
<tr>
<td>Equivalent personnel/100,000 EDC</td>
<td>7.3</td>
</tr>
<tr>
<td>Maintenance index, $/EDC</td>
<td>16.6</td>
</tr>
<tr>
<td>Nonenergy operating cost, US ¢/EDC</td>
<td>8.4</td>
</tr>
<tr>
<td>Profit added in 2002, $ million (Can.)</td>
<td>150</td>
</tr>
</tbody>
</table>

Petro-Canada financials

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Income, $ million</td>
<td>893</td>
<td>1,669</td>
</tr>
<tr>
<td>Earnings/share, $ (Can.)</td>
<td>3.28</td>
<td>6.30</td>
</tr>
</tbody>
</table>

benchmarking analysis. Practices and behavior should change if a company is going to improve benchmarking results.

- Set clear objectives and priorities. Petro-Canada’s management removed all the hurdles for the Q1 Project. When it prepared a strategic plan, the organization agreed to live with a pro-forma update to the previous year’s effort instead of a new ground-up plan.

When Petro-Canada created a system to track the value of the initiatives, it applied the 80/20 rule. It realized that it was important to develop a reasonable estimate of the initiatives and not to create a document that would stand up against an independent audit.

- Set clear expectations. Expectations are different from objectives. Expectations go directly to the day-to-day behavior of employees. Petro-Canada clearly let every employee know that change was expected and that it was safe to behave differently.

- Create a sense of urgency. Everyone is busy; nobody has enough time. But pacesetters find time to do the important things. They go about their business with a sense of urgency.

- Collaborate. Few problems in today’s business world are solved by one person and seldom by one department—collaboration is necessary. Collaboration is not just making an effort to hear all sides of an issue, but making the effort to understand all sides of the issue.

- Transfer learning. Every organization has strengths. It is likely that significant performance improvements can result if the bottom performers were
elevated to the level of the average performer.

• Use an outside force. Change is difficult; it often only happens when an outside force intervenes. An outside force can focus 100% on making positive changes and improving performance.

**Project results**

Table 1 summarizes the results of the Q1 Project.

Before the Q1 Project, Petro-Canada typically focused on inventory levels, the need to balance octane production with marketing demands, and whether the LP model was correct. After the Q1 Project, the company focuses on topics like the sales margin of high-octane components into the US refining markets, whether the refinery should run a new type of crude oil, and a long list of “what if” LP model cases.

**Acknowledgments**

Petro-Canada acknowledges the special contribution of Nathalie Aubrey, Doug Kingdon, Normand Lariviere, Caroline Montplaisir, Paul Po, Paul Sacco, and Christine Yorke in making this project a success.

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