

Benchmarking Art or science?

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Benchmarking is one of today's hot topics. Governments encourage companies to be benchmarked, consultants sell the service and universities offer courses on the subject. But what exactly is benchmarking? Why do companies use it and what are the benefits? How does the benchmarking process look and how are conclusions drawn?

There can be very few managers who are not interested in comparing their business performance with that of other companies. One way to do it is through benchmarking, in which the performance of leading organizations worldwide is used as the reference point for the comparison. Doing this has other advantages, too: benchmarking identifies potential for improvement and shows where opportunities lie.

What are the benefits?

The whole purpose of benchmarking is to obtain information which can be used to improve the company. ABB's experience is that these improvements normally return benefits worth five to ten times the money invested. A typical example would be a benchmarking assignment of \$20k leading to an improvement assignment of \$800k which, in turn, delivered customer-verified benefits of \$4.5m. These benefits arise from more effective ways of working, higher plant output, reductions in working capital and/or improvements in product quality.

ABB has extensive domain knowledge and experience in process, automation and electrical technologies, and also understands change management well. All of this knowledge can be even more potent when it is leveraged by ABB's extensive benchmarking and performance assessment knowledge base.

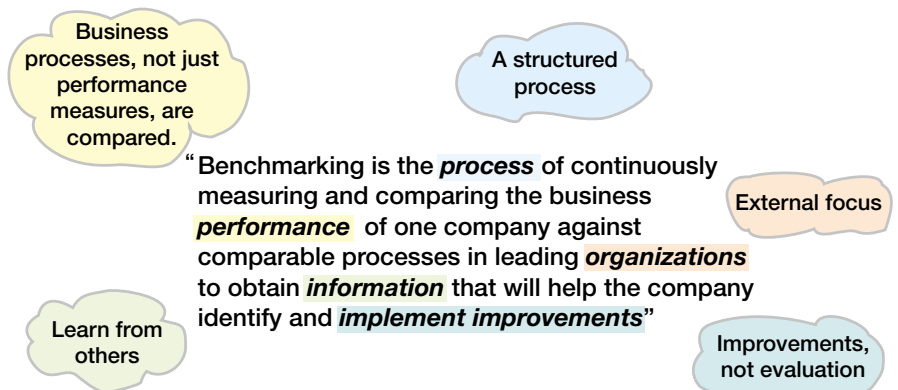
ABB's benchmarking capabilities cover areas from product development and introduction, process control, facilities management, maintenance and reliability, all the way to manufacturing plants, supply chains and entire organizations.

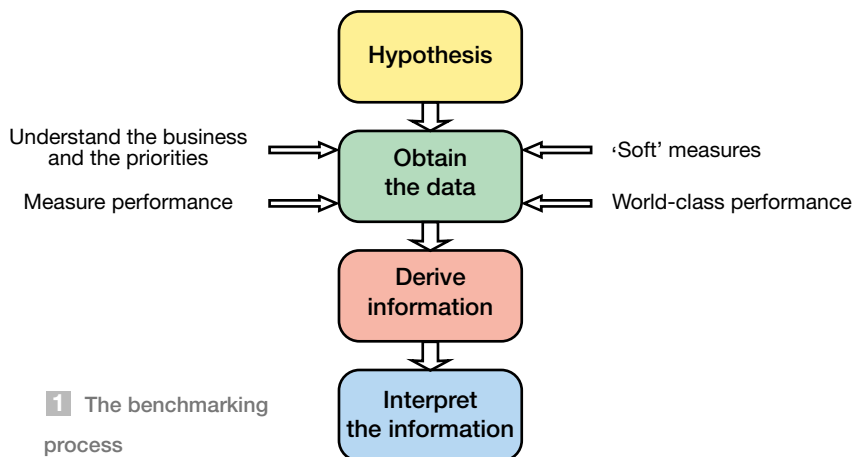
Benchmarking may be applied before an asset is built, to improve performance

during its operation, or as a key step in the due diligence phase of acquisition. While the details may differ from case to case, the basic process is common to each. It is when the results are to be interpreted that the importance of experience becomes apparent.

Benchmarking begins with a hypothesis

As can be seen from **1**, the benchmarking process comprises four main stages. In the first stage, a hypothesis is developed for the operation being benchmarked. It is ABB's experience that the following general hypothesis can be applied to all operations:





The Manufacturing Performance Assessment is based on a consistent and validated hierarchy of measures that apply to all manufacturing plants and that will meet the company financial targets **2**.

This basically says that a world-class organization will have an outstanding environment and an exceptional health and safety culture. Motivated and innovative personnel, supported by excellent suppliers, will deliver excellent customer service from well-run operating processes.

If this is achieved, then the operation or organization will meet set performance targets, such as a high return on capital, long mean times between failure, low operating costs and so on.

ABB's view is that being world-class is like winning the Olympic decathlon – you have to accumulate the maximum number of points, but you do not, and probably could not, win every event. Rather, you must win some events and be above average in all others. Similarly, a world-class organization must be outstanding in those parameters that are critical to its success and above average in others.

Obtaining the data

Four sources provide the data used in benchmarking:

- An understanding of the business and its priorities
- The operation/organization performance
- A feel for the 'soft' measures
- World-class benchmarks

The business and its priorities

The first priority in benchmarking is to understand the business being examined.

In a product-focused business, customer service will be critical, whereas in a business where the rapid introduction of new products is vital, innovation will be more important. On the other hand, in a capital-intensive business, special importance will be attached to asset operational effectiveness.

Information about the business is obtained by means of a very carefully structured set of questions. These have to be answered personally by the manager responsible for the business or operation concerned. As with any such exercise, it is just as important to also determine what is *not* important.

Obviously, since managers are normally very busy, the Q&A session has to be carried out quickly and efficiently.

Also important are the financial and organizational figures. These have to be collected to allow fast presentation of performance improvement incentives. Since such information is inevitably sensitive, ABB treats the whole benchmarking process as a confidential discussion between the operation manager and the ABB benchmarking assessor. Only the former is handed a copy of the data and the report. Just as importantly, ABB stores all the data securely and anonymously. Third parties have no access at all to any of the information.

Measuring performance

The performance data tell us what a business actually delivers. But what should be measured, and how exactly? To answer this, years of experience are necessary, and the set of variables should be kept as small as possible. The trick is to know exactly how many measurements are needed, not to go for the maximum number.

History shows that clearly formulated definitions are critical. Often, a common performance criterion will be calculated differently by different companies or industries. ABB uses a robust set of definitions that are tried and tested in the field.

'Soft measures'

These are indicators of performance that are not represented by numbers. They

are determined by the assessor 'walking the operation', from the reception to the storeroom. The indicators include first appearances, the way work is organized, employees' attitude and body language, presentation of measurement information, and so on. They allow the assessor to check the business information he has obtained against his general perception of the company.

ABB has a proven methodology that it uses to capture this information in a structured way. Applying this methodology, the soft measures can be checked and also used to validate the factual information already obtained.

World-class benchmarks

Assessors are always being asked about the source of world-class benchmarks. Often, organizations feel that they are 'special' and that the benchmarks do not apply to them. However, as said earlier, the purpose of benchmarking is to compare an organization with leading organizations, even those that might not be in the same line of business.

For example, it is recognized that the chemical industry sets the world-class standard for safety. Companies like DuPont and ICI regularly achieve 5 million working hours without a reportable accident. Based on this, ABB, although a supplier and not a chemical company, sets its safety world-class benchmark at 7 million hours.

Similarly, in the area of customer service it is those organizations closest

to the customer that set the standards. Supermarkets, fast food service organizations, etc, are only too keen to display their performance figures for all their customers to see.

It is at the operational level that there may be some dependency on the nature of the operation or organization. For example, the way in which an olefin plant and a direct line insurance company will measure performance is sure to differ slightly. Here, ABB benefits from its global spread; a database of over 500 companies provides access to benchmarks for a vast array of operations and organizations. These can be analyzed to allow any individual organization to compare itself with similar organizations worldwide.

In the area of supplier performance there are several sources of benchmarks. For example, most organizations are themselves suppliers so they are aware

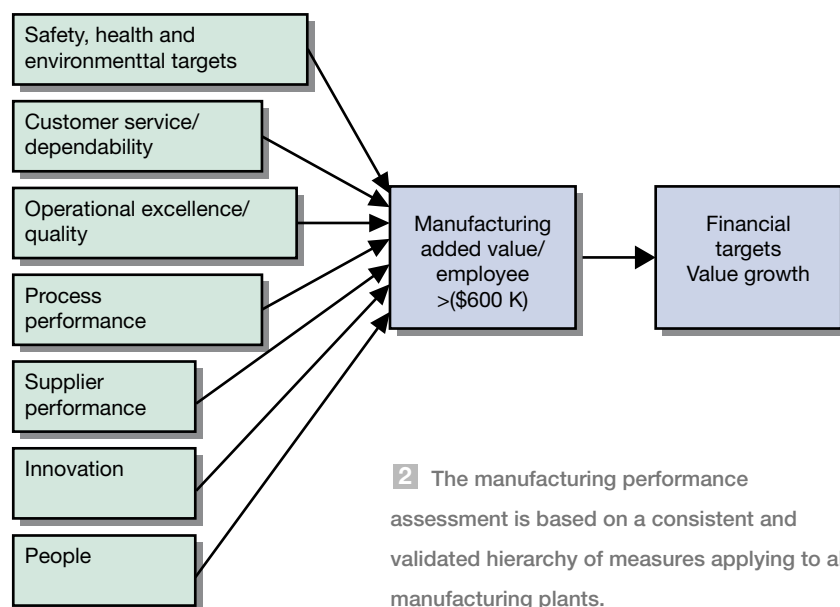
of the performance metrics demanded by their customers. (ABB itself supplies over 10,000 customers worldwide). Another source is the Supply Chain Council [2].

To measure people performance, comparisons can be made with organization performance statistics provided by government and trade organizations.

Finally, in the innovation area organizations look to the most innovative companies for their benchmarks. Innovations are usually prominently reported.

The above show how it is possible to develop a set of world-class benchmarks from publicly available information. Adding the wide range of benchmarks available through its own database gives ABB a truly robust set of world-class benchmarks.

It is interesting to note that the world-



2 The manufacturing performance assessment is based on a consistent and validated hierarchy of measures applying to all manufacturing plants.

class standards for all industries and organizations are evolving toward one common set. This is not surprising given that the best any organization can achieve is 100% compliance, and the world-class standards are rapidly approaching this figure **3**.

3 A typical assessment report

ASSESSMENT RESULTS			
Plant name(s) and site	XYZ Plant		
Region	Europe		
Country	England		
Sector	Rubber & Plastics		
Broad process type	Discrete Manufacture		
	Your result	World Class Benchmark	MAGX Score
OPERATIONS ADDED VALUE/EMPLOYEE			
Manufacturing added value per manufacturing employee for the plant (GBP K)	15.81	>\$300K	0.8
Ratio of total manufacturing/value adding employees	1.36	1.35	9.8
CUSTOMER SERVICE			
% On time in full (OTIF) to customer delivery performance	99.9%	>99.5%	9.9
Customer complaints %	2.9%	<0.01%	0.8
Adherence to production plan -%	80.0%	>98%	6.8
Inventory record accuracy %	98.8%	>99%	9.4
Finished goods/days of cover	21	3	5.2
Same day delivery	30.0%		
QUALITY			
Right first time (%) - as required at bottleneck stage	98.0%	93%	9.1
Quality rate (%)	98.0%	99%	8.0
Process capability Cpk	3		
MAKE			
Product rate-average % of MPR	75.2%	98%	0.0
Maximum proven rate	16.1	15	10.0
Scheduled downtime- % of capacity	12.0%	<3%	
Unscheduled downtime- % of capacity	1.0%	<2%	
Average availability	50%	>99%	0.0
Overall equipment effectiveness	37.2%	85%	0.0
% capacity used for changeover	10.0%	<0.05%	
Manufacturing velocity %	0.0%		
WIP stock turn/days of cover	12	1	4.6
Maintenance spend as % of replacement asset value	3.2%	3%	7.4
Engineering spares/days of cover	9	7	9.4
EMPLOYEE ENGAGEMENT			
Absenteeism-%	3.45	<1%	3.6
Average training days/manufacturing employee	17	12	10.0
LICENSE TO OPERATE			
Safety performance: Reportable injury rate per 100 000 working hours	0.86	<0.05	0.5
Environmental loss of containment (total number- A,B,C,D categories)	0	0	10.0
SUPPLIER PERFORMANCE			
Supplier OTIF	99.9%	>99.5%	10.0
Raw material/days of cover	30.00	5	2.7
Supplier Cpk	0		
Total days of cover	38	19	
Operational Performance Index			55.1

Deriving information from the data

Having obtained the data, the next step is to extract beneficial information and quantify improvement potential. Three ways in which this can be done are given in the following:

The first is to use a 'box and whiskers' diagram to compare the particular operation with others in the database **4**. Tools like this make it clear to the client where his organization lies relative to other plants and industries.

5 shows a second example which quantifies, in clear financial terms, the size of one of the identified opportunities – in this case the difference between the actual performance of the plant and the performance it would achieve if it were to move to world-class status (the so-called 'hidden plant').

The third example plots the data in terms of a RONA tree (Return on Net Assets) **6**. This is useful for illustrating the sensitivity of the financial performance to the proposed measures, as well as for displaying the impact of the performance improvement.

In each of these examples the benchmarking process described earlier is applied to develop a hypothesis, collect the data and then convert the data into information for interpretation.

Interpreting the information

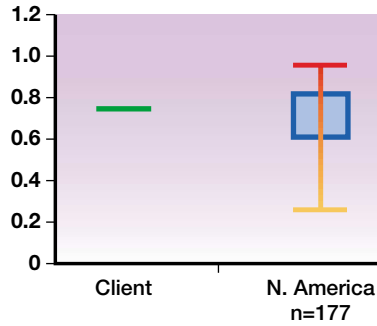
Unlike an audit, in which something is measured against a checklist, benchmarking relies on an assessment or mature judgement.

The following three examples, from different industries, give an indication of just what this means (the displayed set of performance benchmarks has been reduced for the sake of clarity).

Supply chain

7a shows figures typical of a company supplying the fast-moving consumer goods (FMCG) market. This is an area where product development and speed to market are critical.

In such a business, the assessor would be looking for a high added value per employee, excellent customer service and high-quality products. The figures indicate an average added value per employee of £150k. Rather more critically, however, there are 2.2 times more non-value added employees than added value employees, suggesting an organization with excess layers of management. Some of this has to do with the quality and materials



handling organization necessary due to the low 'right first time' (RFT) performance (94%) and the relatively high level of customer complaints (1%). This is typical of an average manufacturer in this sector.

The high absenteeism (5.2%), coupled with the poor safety performance (a reportable accident every 50,000 working hours), indicates poor morale and would support the observation of a hierarchical organization that is not empowering the employees.

4 Overall equipment effectiveness. The 'box and whiskers' diagram (here showing results for the USA only) indicates the best found, the worst found and the second and third quartile spread.

n Plants in database

It is interesting to note that while this company's customers are demanding, and getting, an 'on time in full' (OTIF) delivery performance of 98%, they themselves accept an OTIF of only 72% from their suppliers. This, again, is typical.

For a batch plant of this type the poor overall equipment effectiveness (OEE) of 46.3% is not critical given the more important issues above. There is no case for further capital investment to expand capacity until the OEE can be

5 An improvement opportunity identified by applying ABB's proprietary software

The opportunity has been calculated assuming demand requires the plant to run every hour of the year. Without increasing existing hours the output opportunity is £2 million in sales, adding \$0.85 million to the profit. The working capital opportunity remains the same.

FG Finished goods

WIP Work in progress

RM Raw materials

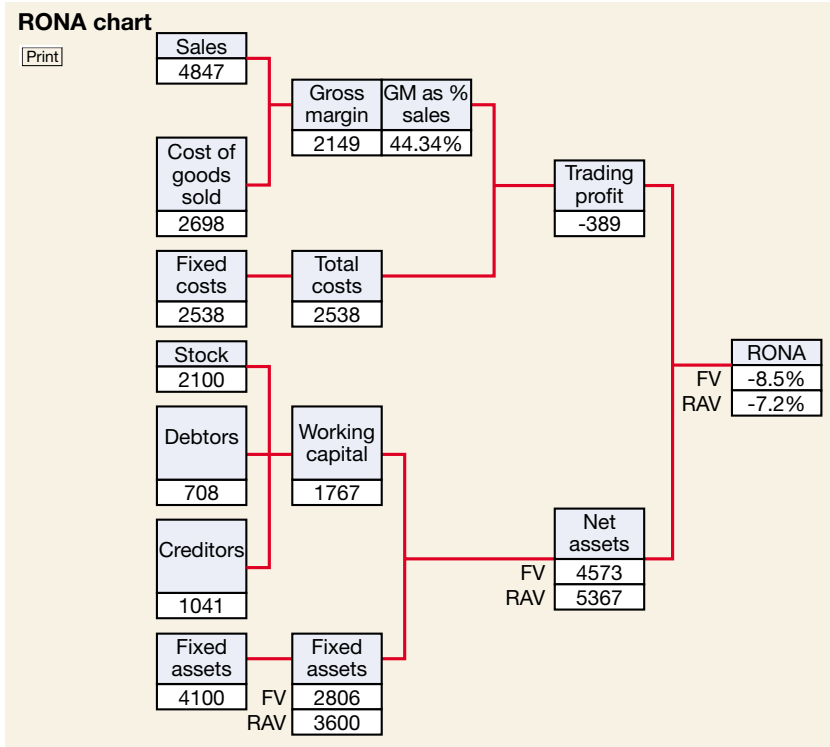
Gap opportunity

Manufacturing Opportunity Calculation

Annual turnover		0	7716	Consistency of units & %		Gross margin		0	44.9%	Message The plant availability of 0.5046 is less than the world class value. We therefore recommend that you do not cut costs until the availability is close to world class.
Target OEE			80%	World class		World class		0	85.0%	
Target inventory days of cover		FG	10 days	World class		World class		FG	3 days	
		WIP	2 days					WIP	1 days	
		RM	15 days					RM	5 days	
Estimated asset replacement cost			6250 K	Replace ratio					0.03 %	

Manufacturing Improvement Opportunities

Plant Name				Cost of capital		12.0%							
Business		Thermoplastic compounds		Extra Sales p.a.		Extra margin							
OEE improvement		From	37.2%	to	Target	80.0%	implies	0	8875	0	3988		
Inventory days cover improvement		From	21	to	Target	10	implies	0	236	0	250		
		WIP	12			2		0	0	Interest savings p.a.			
		RM	30			15		0	14	0	30		
The total expected improvement in first year		Extra Sales		0		8875		Extra margin		0		40	
Engineering spares saving:		0		0		0.095							



6 Example of a RONA (Return On Net Assets) tree

FV Fixed value

RAV Replacement asset value

raised closer to the world-class figure for a batch process of 85%.

An assessor would recommend here that the company focus on improving its RFT performance and on reducing the level of customer complaints. Part of this recommendation would be to apply to their suppliers the same performance targets as their customers apply to them, and to continually increase the quality specifications. As RFT performance increases, supplier OTIF and quality should improve, customer complaints will decline to parts per million levels and the organization will be able to move to a leaner structure with

consequential improvements in added value per employee.

Experience would suggest that this journey would take around two years of focused effort.

New product development

Two factors critical to the success of a pharmaceutical company are customer service and the success of its innovation cycle **7b**.

At first sight the added value per employee of £109k is very low for the pharmaceutical sector, where margins are generally high. The problem lies in the small size of the Australian market.

This factory has to have all the quality, inspection and materials-handling resources of any pharmaceutical company (as indicated by the high ratio of total to added value employees of 2.4) despite supplying a relatively small home market of only 20 million people.

OTIF is excellent and customer complaints are very low, which indicates that all the quality systems are working well. Absenteeism is average, but the high training investment and above-average safety performance of 200,000 hours per reportable accident indicate a reasonably motivated work force.

Again, this company accepts a low supplier OTIF of 56% while delivering an OTIF of 99% to its own customers. Although companies often maintain that they have insufficient purchasing power to influence a supplier, there is an effective way to overcome this. As assessors, ABB would suggest that they define their supplier performance measurement scheme, measure the performance and publicly display the results as league tables in the foyer of the factory. This always works.

Again the OEE is adequate if considered separately, and at first sight this is not a priority. Rather, as assessors we would highlight the real issue, which is matching the manufacturing requirements of an Australian pharmaceutical company to the size of its home market.

To make the factory economic it would have to become world class in all the performance areas, including OEE, and to find export opportunities to

increase overall demand. Hence, ABB's recommendation would be a program to increase OEE, which in this case would focus on improving the plant availability and production rate.

An asset-intensive manufacturing operation

Any large olefin manufacturing operation will have a significant amount of money invested in its operating assets. The key requirement is to manufacture the product at the lowest cost **7c**.

The relatively high added value per employee of £256k coupled with the low ratio of total manufacturing to value-adding employees of 1.8 suggests that the plant performs well. However, since olefin manufacturing is a highly competitive business and a 1% cost difference is very significant, these are not world-class figures.

The main customers are at the end of a pipeline connected directly to the plant output, so the high OTIF of 99% and the low finished goods cover of 5 days are

not surprising. What is surprising, given that the plant has relatively few orders, is the 2% customer complaint rate.

(Experience does, however, show that large continuous production plants typically receive more complaints as a percentage of orders than fast-moving consumer goods plants, which receive far more orders.)

This company also accepts a supplier OTIF of only 66% while delivering an OTIF to its customers of 99%.

The real issue here is the low OEE of

7 Assessment results

- (a) Typical figures for a company supplying the fast-moving consumer goods (FMCG) market
- (b) A set of benchmarks for an Australian pharmaceutical company (new product development)
- (c) Benchmarks for an olefin manufacturing operation (asset intensive)

ASSESSMENT RESULTS			
Plant name(s) and site	Fragrance company		
Region	North America		
Country	USA		
Sector	FMCG		
Broad process type	Batch & packaging		
	Your result	World-class benchmark	MAGX score
OPERATIONS ADDED VALUE/EMPLOYEE			
Manufacturing added value per manufacturing employee for the plant (GBP K)	150.00	>£400K	6.0
Ratio of total manufacturing/value adding employees	2.20	1.35	5.0
CUSTOMER SERVICE			
% On time in full (OTIF) to customer delivery performance	98.0%	>99.5%	8.5
Customer complaints %	1.0%	<0.001%	3.1
Finished goods/days of cover	55	3	2.0
QUALITY			
Right first time (%) - as required at bottleneck stage	94.0%	99%	7.6
MAKE			
Product rate - average % of MPR	88.0%	98%	6.5
Average availability	56%	>99%	1.0
Overall equipment effectiveness	46.3%	>85%	0.5
Maintenance spend as % of replacement asset value	4.0%	2%	5.2
EMPLOYEE ENGAGEMENT			
Absenteeism - %	5.2%	<1%	1.2
Average training days/manufacturing employee	3	12	2.0
LICENSE TO OPERATE			
Safety performance: Reportable injury rate per 100 000 working hours	2.00	<0.05	0.0
SUPPLIER PERFORMANCE			
Supplier OTIF	72.0%	>99.5%	2.3
Operational Performance Index			36.4

a

Pharmaceutical plant		
Australasia		
Australia		
Pharmaceuticals		
Batch & packaging		
Your result	World-class benchmark	MAGX score
109.00	>£400K	4.8
2.40	1.35	4.6
99.0%	>99.5%	9.6
0.0%	<0.001%	8.0
75	3	1.1
96.0%	99%	8.2
70.0%	98%	6.5
72%	>99%	1.0
48.3%	>85%	0.9
5.5%	2%	3.6
3.0%	<1%	4.8
8	12	8.0
0.50	<0.05	6.0
56.0%	>99.5%	1.2
Operational Performance Index		48.8

b

Olefin plant 5		
Europe		
Holland		
Petrochemicals		
Continuous		
Your result	World-class benchmark	MAGX score
256.00	>£400K	7.6
1.80	1.35	6.8
99.0%	>99.5%	9.6
2.2%	<0.001%	2.7
5	3	8.8
93.5%	99%	7.9
92.0%	98%	8.0
92%	>99%	1.0
79.1%	>97%	2.4
3.1%	2%	6.7
3.2%	<1%	4.5
4	12	5.6
1.00	<0.05	3.0
66.0%	>99.5%	3.4
Operational Performance Index		55.7

c

About the authors

ABB recently acquired Eutech, a UK-based process manufacturing and engineering consultancy with extensive benchmarking experience. Eutech has provided a range of benchmarking services to a worldwide customer base of over 300 for the past six years [1]. Clients include specialty chemical companies like National Starch and Chemicals, QUEST Fragrances and Fisher Scientific; continuous process companies such as Huntsman, ICI and Petronas; and pharmaceutical firms like Astra Zeneca.

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79.1%. Due to the capital-intensive nature of these plants, it is essential that they achieve an OEE of over 90%. Further discussions identified the causes as below-average operations practices and above-average maintenance interruptions (2-year intervals). As assessors, ABB would propose a reliability improvement program, coupled with a review of the process efficiency, to identify why the production rate is not world-class. This is often an indicator of poor process control.

These three cases show that a wide range of issues arise from a performance benchmarking study and that the assessor's broad experience is important when interpreting the results.

Experience in interpretation

Practice has shown that interpreting the information gathered is more of an art than a science, as it depends to a large degree on the experience of the person doing the assessment. Expert systems and route maps can assist, but the bottom line is that the individual concerned must have the experience and judgement to see patterns in the data and interpret them correctly. Ultimately, the assessor is the one who puts his or her reputation on the line when suggesting next steps to the client.

Art and science

Benchmarking is both a science (collecting and analyzing the data) and

an art (interpretation), where the wisdom that comes from experience is used to identify the way forward, often on to improvements where the benefits are spectacular.

Benchmarking ensures that funds used for performance improvement can be targeted on the areas that yield the biggest financial benefit. Typically, the ratio of investment to improvement is 1:5, and the increase in performance is close to 10% per year in the relevant parameter. These are very significant numbers.

It is ABB's experience that those companies that benchmark, and invest in continuous improvement, progress at a rate faster than the market they serve. In other words, standing still is the fastest way to failure, while benchmarking can show you the direction you have to run in.

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