

OIL MOVEMENTS-1

Automation of oil movement systems prevents mistakes, saves money

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Experiences illustrate how oil movement and storage (OM&S) system automation can be justified and its benefits proven.

From such examples, refiners can determine sources of project benefits and how project costs can be reduced without causing equivalent reductions in benefits.

A number of examples also demonstrate the importance of designing an integrated information system, as opposed to a stand-alone OM&S system.

This first of two articles covers project justification opportunities. Part two will discuss automatic data reconciliation, refinery information systems, yield reconciliation, and the decision to design or purchase an automated OM&S system.

Background

Many refiners are turning their attention to improved automation of OM&S facilities. Typically neglected over many years, OM&S systems tend to have only basic instrumentation, and their operation is manpower-intensive.

Refiners are facing the problem of identifying sufficient benefits to justify the cost of such an upgrade (see box). This is by no means simple and many refiners have, quite rightly, decided that no economically viable project exists. Others, however, have invested millions of dollars obtaining realistic returns on this investment.

Project benefits

Identification of benefits can be considerably more difficult for OM&S than for the process area. The main opportunities for benefits in processing are in correcting sustained deviations from target. Such benefits can be readily quantified in retrospect.

OM&S, on the other hand, is primarily a batch process, and opportunities tend to be unique incidents. Records of such incidents are usually sparse and kept only if related to safety.

OM&S project costs are usually high compared to similar projects on process units. These high costs often necessitate a compromise on the scope of the project to ensure a reasonable return on investment.

There are now, however, a number of lower-cost technologies which have been applied successfully. There are also areas in which benefits are not immediately obvious. Neglecting alternative technologies and these "hidden" benefits can result in an unnecessarily smaller project scope, or in the worst case, none at all.

Fig. 1 illustrates how projects can be wrongly scoped. It can be seen that, for only a slightly greater project scope (top graph), greatly increased benefits can be realized.

Blending

The major source of benefits is likely to be in the product-blending area. These benefits often constitute about one third of the total refinery process-control benefits. Savings arise mainly from giveaway reduction, but a reduction in reblending can produce significant savings in inventory and man-

power.

Depending on existing process equipment, blend automation can be a very attractive investment—sometimes justifying the entire OM&S upgrade. The unscrupulous might ignore the fact that most of the benefits can be achieved by investing only in the blender, rather than in an upgrade throughout the oil movements area.

This is understandable if the whole project is truly justified and "cheating" is just a shortcut to project approval. This approach, however, will likely result in the oversight of other valuable opportunities at the design stage, which may later prove too costly to retrofit.

Estimating benefits from improved blending is not always straightforward and requires a complete understanding of the refiner's objectives and economics. The key is to identify the mechanism for eliminating quality giveaway.

For example, eliminating octane giveaway in gasoline will initially result in less high-octane material (e.g., reformate) being used in the blend. Some action, however, must then be taken to correct for the resulting increase in reformate inventory.

This might be corrected by reducing reformate octane so that production matches blending requirements (Fig. 2). The impact of this change on reformer yields must be estimated when calculating benefits.

Alternatively, the imbalance might be corrected by reducing reformer feedrate, in which case an alternative use for reformer feed must be considered.

Similarly, elimination of cold property giveaway in gas oil might result in a change in cutpoint strategy on one or more fractionators, thus affecting other product draw-off qualities. And reducing fuel oil viscosity giveaway will release cutter stock, which will have a product value determined by its alternate use.

If added to the gas oil pool, the cutter stock is certain to prompt a

OM&S JUSTIFICATION

OM&S automation can help...

- Eliminate product giveaway
- Select profitable feedstocks
- Operate with lower inventories
- Reduce demurrage charges
- Reallocate tankage
- Reduce slop production
- Avoid routing errors
- Prevent shipping errors
- Improve safety
- Increase flexibility
- Operate with fewer personnel
- Reduce oil loss
- Increase maintenance effectiveness
- Save inspection costs
- Decrease tax payments
- Reduce the number of claims
- Detect operating problems early

Project costs can be reduced by...

- Installing radio-based instruments
- Using portable data terminals
- Applying only monitoring techniques

Project benefits can be maximized by...

- Integrating information systems
- Planning organizational changes
- Making the right make/buy decisions

Fig. 1

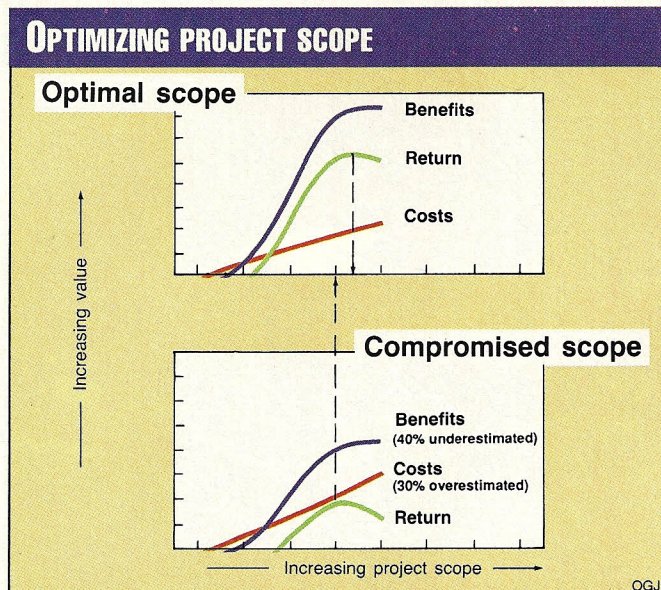
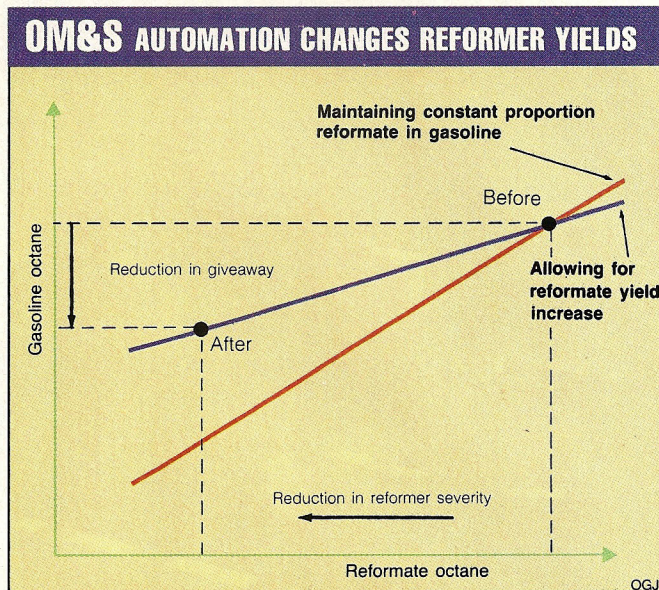


Fig. 2



blend reformulation. Its economic impact will need to be carefully determined.

As another example, reducing sulfur giveaway will likely result in the selection of a different feedstock, which will clearly affect the whole refinery.

This article is not intended to provide detailed evaluation of blending benefits. It is instead designed to give an indication of their magnitude. For this purpose, some relatively simple examples have been taken from selected refineries.

Examples

One refiner, exporting 35,000 b/d of gasoline, eliminated a vapor pressure (Rvp) giveaway of 0.05 kg/sq cm (0.7 psi). This was achieved by injecting 350 b/d additional butane. At a differential gasoline/butane price of \$15/bbl, this was worth about \$2 million/year.

Another refiner producing 60,000 b/d of gas oil eliminated a cloud point giveaway of 0.5° C., thus reducing the need for blending kerosene by 2,300 b/d. The kerosene, sold instead as jet fuel at a price differential of \$1.30/bbl, increased refinery profitability by more than \$1 million/year.

Eliminating a fuel oil density giveaway of 0.006 also reduced kerosene-blending requirements by 15 tons/day. Upgrading this to jet fuel at a differential of \$120/ton produced a benefit of \$650,000/year.

The realization of such benefits may not always be straightforward. Many refineries blend finished products using a recipe blender. A recipe blender fully controls the blend by sequentially pumping predetermined volumes

of the components through the same pipework. Fig. 3 illustrates the preferred configuration.

The benefits achieved by this system are usually large enough to justify the cost of the on stream analyzers and control system. If additional pumps, piping, and flowmeters are required, however, a full blend automation project may not be economically viable.

Alternatively, some of the benefits can be captured by other means:

- The monitoring of component and finished product tank levels will ensure that component volumes are more tightly controlled.
- Integration with the laboratory information system will ensure more reliable predictions of blend quality and better checking of the final blend.
- Records of previous blends can be used to improve inaccurate blend correlations.

Planning

Some refineries are in a position to process spot cargoes. The decision to purchase such cargoes usually must be made quickly in order to beat the competition and secure the profitable opportunity.

A refinery must be able to assess the worth of the cargo immediately to negotiate a good price. To do this, it must assess not only product yield, but also the logistical impact of processing the cargo. This requires coordination between the refinery and the supply and marketing groups, plus such information as current and projected inventories of crude and products, a crude import and product shipping plan, a crude processing plan, and a blending plan.

In one refinery, a fully integrated OM&S system was attributed with the benefits gained through spot purchases of, on average, 250,000 bbl/month of crude. At an increased margin of 10¢/bbl, this was worth \$300,000/year.

Inventory reduction

Many refineries have statutory minimum stock levels for strategic reasons; others have determined optimum inventories to match supply, production, and marketing requirements. Operation above these levels incurs financing costs, or in more extreme cases, requires additional tankage to hold the surplus.

It is unlikely that a refiner will take tanks out of service once constructed. It is difficult to persuade people to give up flexibility, particularly as tankage operating costs are small compared to construction costs.

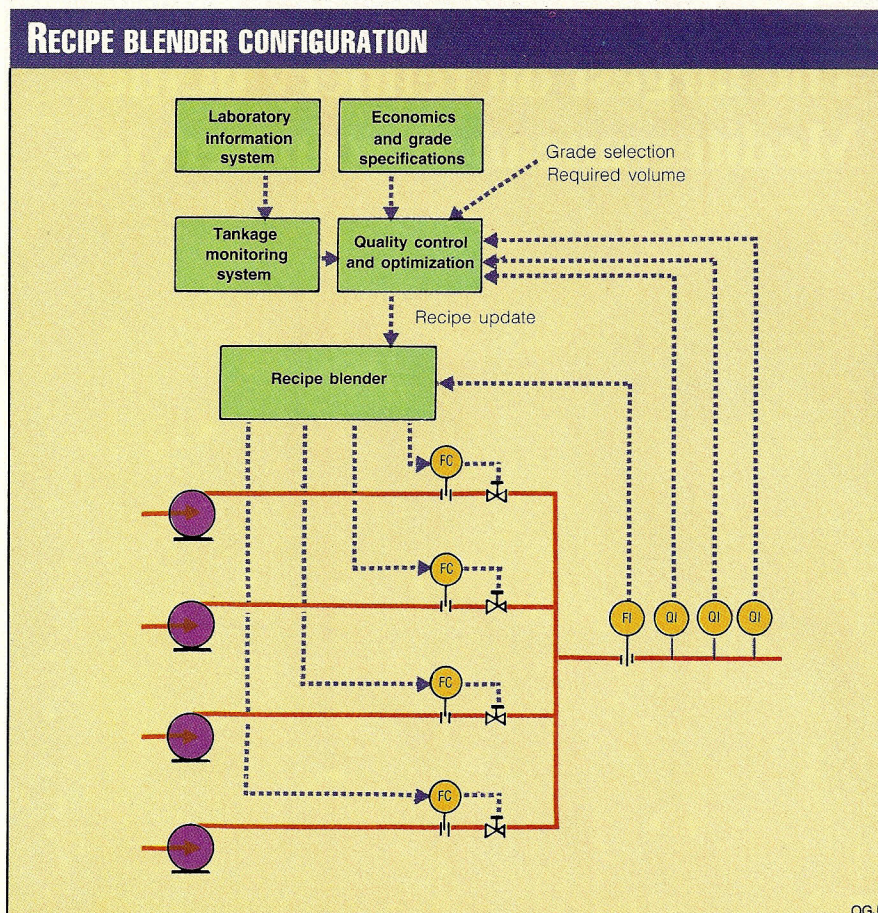
Some refineries have planned to build tanks as a part of a refinery expansion project. Careful analysis, however, shows that, with automation of the tank farm, it is possible to operate the expanded refinery without increasing tankage. The resulting savings can be greater than the cost of automation.

As an example, one refiner kept, on average, 15,000 tons of excess product in inventory. OM&S monitoring could reduce this by 3,000 tons. At an average product price of \$200/ton and an interest rate of 15%, this corresponded to a \$60,000/year savings.

Demurrage

One refiner was incurring demurrage costs of \$2 million/year. These were primarily caused by berth occu-

Fig. 3



pancy problems, limited loading rates, unavailability of product, and early arrival of ships. A number of scheduling aids based on data available in the OM&S system were attributed with reducing these costs by 5%, or \$100,000/year.

Another refiner realized the potential to feed blenders directly from the process and reallocate intermediate product tanks to finished product. This reduced loading times and hence demurrage charges. It also allowed segregation of two similar products.

Previously, one product had been made to the more limiting of the two product specifications and was used to satisfy both requirements. The additional tankage enabled the elimination of giveaway against the less-demanding specification.

In another refinery, it was noted that jetty scheduling problems occasionally forced the refinery to operate in a less-than-optimum manner. Although not quantified, the impact on refinery profitability was known to be large.

Slop

As a minimum, recycling slop incurs a processing cost—typically about \$0.75/bbl. This cost can be much

greater, however, if it involves units such as reformers and hydrocrackers, because the slop material may have an adverse effect on those operations.

In one refinery, recycling a naphtha-type slop through a condenser-limited crude distillation unit (CDU) required a reduction of about 6 bbl crude/bbl of slop processed. At a crude processing margin of \$0.50/bbl, the debit of slop processing would be increased from \$0.75/bbl to \$3.75/bbl. OM&S automation was attributed with reducing slop production by about 50,000 bbl/year, saving about \$190,000/year.

Slopping often occurs inadvertently, without any changes in metered flows. This can happen after start-ups or large upsets, when valves may be left cracked open by one shift and remain unnoticed by the next. Monitoring for changes in slop production rate in the tankage area will at least draw attention to the problem and provide a diagnostic aid to help identify the source.

Routing errors

The majority of routing error incidents are not formally recorded, even if they incur large rerunning or downgrading costs. Refinery personnel are

unlikely to volunteer information, particularly if they feel partly to blame. Persistence in uncovering such problems, however, will pay dividends.

In one study, a five-fold increase in the number of incidents identified was achieved by informally talking to a number of operators in a lubes distillate tankage area. In this case, it made the difference between a justifiable and an unjustifiable project.

Routing errors are almost all eliminated by fully automating the OM&S area. Similar results, however, have been achieved with only monitoring. Simple functions such as alarming the detection of a tank level change cause the operator to determine whether the product movement is unplanned or if the movement plan had simply not been entered.

Continuously reconciling source and destination inventories for tank-to-tank transfers can detect product that is wrongly leaving or entering the transfer. And reconciling change in inventory against integrated process flowmeters will detect misrouted product rundowns.

Continuation of a movement past planned completion time or transfer volume is also alarmed. Similarly, detecting a late start to movements may prevent scheduling problems later.

In one refinery, two such incidents likely could have been avoided with OM&S automation. One involved downgrading 50,000 bbl of jet fuel by misrouting it to a gas oil tank. At a differential price of \$2/bbl, this cost the refiner \$100,000.

Another incident involved reprocessing 60,000 bbl of gas oil. Reprocessing cost \$0.75/bbl, but lost capacity was estimated to cost an additional \$1.50/bbl. Total cost was therefore more than \$130,000.

Assuming similar incidents would be avoided once every 5 years, the benefit attributable to OM&S automation would be about \$50,000/year.

Premature action

One refiner was experiencing problems with the occasional shipping of off-grade products. This was caused primarily by limited storage capacity, combined with an urgent need to load the product. Insufficient time was given to checking whether the laboratory had tested and released the product.

The cost of such incidents varied, but on one occasion, the product was returned to the refinery for reprocessing. This caused a number of scheduling problems. Although not quantified, this probably cost the refiner at least \$100,000.

There were other occasions where the product was sold at a discounted price. Products containing significant giveaway were also shipped. On many of these occasions, the refiner could have rebled to correct the problem, and thus increased its profit margin.

Another refiner had to do an emergency shutdown of its CDU because the crude being processed had not yet been drained of water and tested by the laboratory. The shutdown resulted in equipment damage costing about \$50,000 to repair. It also involved several days lost production, costing \$250,000.

The installation of an integrated oil movements system would require the operator to explicitly override the stop on shipping or processing product not yet released by the laboratory, thus avoiding such incidents.

Safety

Alarm annunciators can fail, or offsites control rooms frequently can be unmanned for lengthy periods, causing alarms to go unnoticed.

OM&S systems can provide more intelligent alarming than simply detecting high and low levels. The more sophisticated techniques predict when limits will be reached, thus reducing the probability of spills from overflowing, damage from landing the roof, and pump cavitation.

Where meters are not available, inventory changes can be used to estimate flows and ensure that maximum loading rates are not exceeded, thus preventing the buildup of static. Excessive tank drainage can be avoided, preventing product loss or contamination. Leak detection methods also can be applied.

One refiner estimated the savings from these functions to be equivalent to avoiding one incident every 10 years equivalent to the loss of 10,000 bbl of gasoline. At \$30/bbl, this saves about \$30,000/year.

Unusual routings

Many refineries have complex piping arrangements in the offsites area. There is often a "jumpover king," who over the years has installed a number of beneficial additional routings. These are usually a mixed blessing; they add flexibility but can also be the cause of misrouting incidents.

Such incidents usually happen because documentation is out-of-date, or because the rarely used routings have been forgotten by the operators. One advantage of OM&S automation is that it provides the necessary discipline to properly document routings,

usually in the form of operator graphics.

Most systems also have the necessary logic to identify all feasible routings and to detect conflicts. In unusual circumstances this can have a particular advantage. There are many examples of refineries resolving potential routing conflicts through the use of a little-known jumpover that was probably installed for an entirely different reason.

In one case, a refiner was unexpectedly able to continue fuel oil blending with a supposedly vital part of the blender out of service. This single incident was estimated to save the refiner over \$2 million in otherwise lost production.

Incident analysis

In one refinery, the kerosine feed to the Merox treating area suddenly turned black. The feed tank proved to have been contaminated at some stage, but the kerosine currently supplied to the tank was clear.

The tank had been simultaneously feeding the Merox and receiving kerosine from the CDU for several months. Examination of the records from the monitoring system showed that CDU production had initially exceeded Merox feedrate. With a change of crude, production dropped and the tank level began to fall.

The theory that the contamination

had occurred several weeks before and had been contained in a layer in the tank was confirmed by determining that when the tank level was previously the same as the current level, there had been an operating upset on the CDU.

It was known that black oil had been routed to a common slop system during this period. On checking, it was found that the valve between this system and the kerosine rundown was allowing the products to mingle. If this had gone unnoticed, the contamination would have been repeated the next time the slop system was used.

The incident cost the refiner over \$200,000 in lost production, product reprocessing, and tank cleaning. A savings of at least \$200,000 was attributed to OM&S automation. In addition, a small continuous loss of kerosine to slop probably would have gone undetected for several months.

Man-hours

One refinery laboratory used the OM&S system to predict when finished product testing would be required. This enabled the lab to better schedule its work and perform the majority of the tests during extended day shifts. The refinery now operates with only skeleton laboratory coverage overnight.

In the offsites area, several refineries have been able to reduce the number of operators, usually by at least one shift position. In a five-shift system, this can mean a savings of up to \$500,000/year.

A well-designed operator interface significantly improves the effectiveness of the console operator. Reductions are possible because this enables operators to spend time traveling to remote offsites areas.

Other manpower savings occur throughout the refinery. In the oil and cost-accounting groups, automatic data collection and transfer reduces errors and speeds up reconciliation. And in the planning group, less time is spent collecting and validating OM&S data.

In one refinery, the total savings in these areas was equivalent to two full-time personnel. In practice, these savings were spread among a number of groups and there was no reduction in personnel. Instead, the refiner chose to value the effectiveness as a multiplier on salary-related costs, arguing that peoples' contribution to the business is worth more than they are paid.

In this case, a multiplier of three was applied, producing savings of about \$600,000/year. ■

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