

LARGE CUSTOMER REAL TIME VERIFICATION: LESSONS LEARNED SINCE THE 1995 EVALUATION CONFERENCE

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Introduction

It was the best of times, it was the worst of times. And Jorge died hungry.

The best because Jorge Pluman, a good engineer and want-to-be statistician, was able to exercise his aspirations to the latter. The worst because he found statistics can be a false god.¹ And he walked into the light.

Jorge was a friend of ours and we're glad you joined us to hear his story. Jorge was Wisconsin Power & Light's (WP&L) verification engineer. His role was to perform impact verification for the WP&L large customer energy savings program, Bright Ideas for Business²

We do not provide details of the large customer verification program here, but discuss a few attributes relevant to this presentation.³ These attributes include:

- Confidence Interval and Precision
- Real Time Nature
- Feedback for Improvement

We will discuss what we have learned about these attributes in the last two years and what improvements have been made as a result of this knowledge.

We wish to make is clear from the beginning that our verification process review and changes are appropriate to the driving forces and goals for Wisconsin Power & Light. You need to determine if your evaluation needs are similar to WP&L's before acting on our conclusions. The evaluation needs of the utility industry are as diverse as the approaches to competing in the future and expectations of the public utility commissions.

¹Part of the falseness of the god is based on mis-application of intent. Often we want to minimize our cost and therefore do not use the appropriate robustness of verification. Thus the results, though appearing statistically valid, have great unidentified biases or uncertainties.

²This program is discussed in detail in reference 1. "On-Going Real Time Verification Process: Adjusting to the Dynamic Environment."

³The WP&L large customer verification project is discussed in the first reference.

Who was Jorge Pluman

Jorge was an engineer. Now, we all have stereotypes of engineers. For many this is of a person who wants to learn about everything to the nth degree - where n = infinity. Jorge fit this stereotype. When he was asked to use the triple ratio analysis technique, his secret thought was "why not quadruple ratio? He understood the power of statistics in providing precision and confidence in analysis. He was a nuclear engineer. We want nuclear engineers to be precise and confident, don't we? He knew he could transfer his knowledge of probability statistics into numerical statistics. This project was the opportunity to learn a new dimension of this field. OH, HAPPY DAY!

What was Jorge asked to do?

Señor Pluman was asked to reach beyond his comfort zone. Statistics was not the only dimension of the impact verification program that was important to WP&L. For fun WP&L asked Jorge to optimize the value of the verification project under two other constraints.

Jorge was asked to ensure that the verification project provided real time qualification of project results and a quicker than typical reporting of the statistical results at the end of the year.

Further, Jorge was asked to develop a feedback process that would allow WP&L to correct errors in real time.

Jorge was no wimp; he rose to the challenge. He was a student of Deming's SPC philosophies, this project provided a chance to practice them.

Oh, by the way, this was to be done under a limited budget and he was asked to try to reduce the budget in the second year. So what! Jorge took engineering economics courses.

How would Jorge achieve good confidence and precision in realization rates?

Jorge used a verification process designed by a consultant.⁴ This verification process relied on the Triple Ratio Analysis techniques recently discussed by Wright and

⁴So much for accounting for internal constraints. All kidding aside, the design was a good one.

others.⁵ The three levels of verification for which the ratios were to be developed were:

- Document Review
- On-site Inspection
- Measurement of Post-Installation Use

Each level was a sub-sample of the previous level as discussed by Maini.⁶ The ratio estimator analysis allowed Jorge to efficiently apply costly, high resolution monitoring results from a small sample to calibrate less precise engineering estimates for a larger sample of projects.

Jorge knew that each higher level of verification, while providing more certainty, costs arithmetically more. The monitoring level was especially expensive. He knew that measurements taken to estimate savings for impact verification cost between \$1,000 and \$10,000 per project, depending on the technology and parameters that needed to be measured. He was expected to get the best possible results at the cost of \$1,000 per measured project. He was aware that for \$1,000 he would generally only be able to measure one parameter (probably equipment demand profile for one or two weeks of operation.)⁷ Finally, he knew that he was constrained to monitoring only after the project was completed. If the sales representative implementing the conservation project measured usage before the project, Jorge might have actual pre- and post-installation use data.

Within the bounds of these constraints, Jorge endeavored to provide the most precise results from the measurement level of verification - keeping in mind the unquantifiable "measurement error" provided by the process limits for each level of verification.

What was the real time nature of the project?

Prior to this project, WP&L was using billing analysis to perform impact verification of savings estimates. This required that all projects in the sample be completed at least one year prior to beginning impact verification of the projects. The results of the verification program were typically not available for eighteen to twenty four months after the completion of the conservation program year. Unfortunately, by the time the results were available to the marketing department, they had changed the program. The

⁵See the second reference, "Double Ratio Analysis: A New Tool for Cost-Effective Monitoring"

⁶More detail is given in reference 1. "On-Going Real Time Verification Process: Adjusting to the Dynamic Environment."

⁷With today's technologies, sufficient numbers of projects that are geographically close, and high involvement of utility representatives, greater measurement capability is possible at lower costs. Many programs do not have these advantages.

results were typically only useful for reporting to the Public Service Commission. Results could not be used to improve the conservation programs.

WP&L knew this situation would be unacceptable in the emerging competitive utility industry. The consultant designed the new impact verification program to collect and verify projects every two months. The verification engineer was to complete at least the first level (document review) of verification within two months of receiving these records.

Under the real time process, Jorge had verification results for projects within four to six months. It also meant that he was able to produce the final report within six months of the end of the conservation program year (instead of eighteen to twenty four months.)

This was good. Jorge was able to maximize his precision and still provide results three to four times faster than in the past. He felt he was providing useful, real time results.⁸

Also, the bimonthly reports of individual project results provided feedback on the *present* conservation program. Changes could be made to tune the conservation program process during the year of the program.

However, as Jorge found, there are some negative aspects of the real time approach. For one thing, using billing analysis as a verification tool is limited because few after-project billing periods have passed. Also, seasonally operated equipment may not have been operated before the verification, increasing uncertainty of savings capability. Further, some times the project is not yet completed (though the program requires it be before submitting the project.) This also, increases uncertainty in the proposed operation and resulting savings estimates.

How did Jorge provide useful feedback?

Utilities that want to be competitive must have impact verification programs that do more than provide program level realization rates. One way this has been done is by providing realization rates by technology groups rather than just for the program as a whole.⁹ The improved level of detail allows the marketing department to focus on finding ways to improve the savings estimation techniques for the technologies in groups with low realization rates. However, WP&L knew this would be an inadequate improvement.

⁸**Real time is relative!** We define real time as within the time the program being evaluated is still being implemented - within the same program year. For some persons real time related to measurement is nearly instantaneous. Program planners and implementers need to have on-going general verification results so they can tweak the program design. Systems operators need nearly instantaneous feedback so they can improve the process.

⁹For example, developing individual realization rates for motor, lighting, HVAC, process and other groups.

Jorge was expected to provide specific feedback on how to improve the program based on what he learned during the project verifications. This included specific recommendations for improvements to the savings estimation techniques used by the sales representatives. They were provided in the bimonthly report.

This feedback also included providing indices for realization rates compared to representative, SIC, and technology types as well as reasons for adjustments.

Several objectives. How does one optimize?

Jorge accepted the objectives of precision, real time delivery, and feedback for improvement with alacrity. He knew about system optimization. You don't try to maximize accomplishment of one objective, you optimize accomplishments among the objectives. This requires achieving a balance in meeting the weighted objectives, and it produces the most useful results.

Spending the available resources to maximize the precision of the realization rate leaves less resources for providing the most useful feedback for improvement. Gaining the appropriate precision for the least cost would allow WP&L to improve the program through increased feedback.

Similarly, more levels of verification require more time to deliver results. If adequate precision can be achieved with fewer levels, the feedback can be more timely.

We'll miss you Jorge!

Well, it was a long year for Jorge, 1995. Improving processes, reporting realization rates in real time and providing useful feedback to the marketing department and the sales representatives. Further, to ensure that the verification program could be implemented at a lower cost in 1996, Jorge investigated the cost-effectiveness of the triple ratio estimation technique for the WP&L BIB program.

We knew Jorge well, he liked his numbers. Don't get me wrong, he liked helping people too, providing feedback for improvement was enjoyable. But, any time the engineer in him could produce more precise results, he didn't mind the extra effort.¹⁰

Jorge spent considerable time reviewing not only the results of the triple ratio analysis of realization rates, but also its cost-effectiveness. Given the cost of the measurement level of verification, he needed to know if this level was worth continuing. Could a double ratio analysis employing only document reviews and on-site inspections provide realization rates with similar precision for the required confidence level? He repeated his analysis several times

before falling ill. In the end, the comparison of results from using the double ratio and triple ratio analyses proved fatal.

Jorge could not defend continuing the triple ratio analysis technique. With all the verifications complete for the 1995 conservation program, he analyzed the results using both double and triple ratio analyses. The sample size was set to achieve $\pm 10\%$ precision at the 90% confidence level. The verification process had achieved a $\pm 11\%$ precision at the 90% confidence level using the triple ratio analysis. This is what the technology group error ratios and the budget produced.

The good Señor repeated the analysis sans the results of the measurement level data. He found that the verification process using the double ratio analysis provided a $\pm 14\%$ precision at the 90% confidence level. "Que Va?," he belched. His heart sank. The precise engineer was effectively dead. Given the other program constraints imposed by the measurement level of verification, the double ratio analysis provided greater overall value to WP&L. What's 3% precision among friends.

But there is more

Not only did Jorge learn that the measurement level of verification did not provide cost-effective improvement of the precision of the realization rates, it also hampered the real time capabilities of the project and caused stress between the representatives and him. The representatives were strongly united against the effort required for monitoring and the customer hassle related to measuring energy use after the project was completed.

Jorge found that performing the document review took from one to four weeks and the inspection added another one to four weeks. The measurement level extended the completion of verifications for some projects up to four months. This was most likely the case for technologies that operate seasonally (i.e. HVAC.)

Also, the measurement extended the date on which the final report could be completed. WP&L wanted to complete the first year report by April 1, 1996. This was not possible because of delays in monitoring savings. In some cases, measurement delays would not have allowed completing the 1995 verification project until July or August (i.e. air conditioning.) However, not measuring some projects that would delay the completion of the final report, could introduced bias.

Jorge realized the measurement level of verification provided significant impediments to the delivery of real time results, causing an imbalance in optimizing success of the objectives.

Finally, the \$1,000 limit for measurement allowed only limited data collection and analysis. This suggested potential for high, yet unmeasurable, measurement error at the third verification level.

¹⁰This translated to improved reactor safety to this nuclear engineer. Remember Chernobyl!

What did Jorge's efforts teach us about real time capabilities and value

The first year effort provided knowledge well beyond determination of program realization rates. WP&L learned some things about improving real time delivery capabilities as well.

First, there is a drastic improvement in the availability of project documentation, under the real time process. With the old process, getting the project records was often formidable to impossible. Twelve months or more after a project was completed, many records had a way of disappearing. Also, when the records were available, it was often hard to find the persons who could explain what assumptions were made and why. Representatives were no longer available and customer contacts had changed. By starting verification of projects two to three months after completion of the projects, it is very likely that the records can be located and that the persons involved in the project are still available. This leads to much more reliable verification results.

Second, the real time approach provides the sales representatives with "independent, third party" verification of savings within several months of submitting the project. This is useful to the representative wishing to provide feedback to his/her customer for building relationships.

Third, quickly providing the representatives with feedback on how to improve savings estimates is helping them develop more accurate estimates for similar projects implemented after the original project.

Fourth, the representatives have the opportunity to review any adjustments and challenge them. This provides a two-fold benefit. The representatives feel better about the process and are more accepting of it. Also, the final analysis is more precise when the verification engineers' assumptions or findings are improved.

As if that wasn't enough

WP&L also learned a few things about providing useful information back to the marketing department and the field. The marketing department uses verification information to track program savings accuracy for several parameters. It also, uses the information about savings estimate errors by technology to improve the program.

Tracking reliability of savings estimates by representative allows management to assess the representative's performance.

Information provided by SIC code and technology type allows the marketing department to evaluate changes needed in the program relative to these dimensions. Similarly, tracking the realization rates helps the marketing department know its adjusted savings estimates in real time so adjustments to the program can be made during the year. Before, changes could not be made because problems were not identified until well after the program year.

The marketing department is able to improve the Technology Guidebook based on specific information regarding errors in savings estimation techniques.¹¹ This is done soon after they receive the report. Improvements are sent to the representatives to update their Guidebooks. Further, the technical training staff receive the information to improve their training approaches, materials and tools. These improvements are done in several months, much quicker than was possible previously.

In memory of the man - Changes made to the program

WP&L has learned several important things from Jorge's work and has implemented some changes for the 1996 and 1997 verification programs.

First, measurement has been dropped from the verification process. This means that in 1996 the double ratio analysis technique was used.¹² Ratios for the double ratio technique are developed from the document review and inspection levels of verification. To compensate for the potential loss in precision, the sample fractions have been increased for both levels. WP&L will attempt to determine if this impacts the precision of the realization rates. The cost savings are already obvious.

Another improvement is the acceleration of the real time nature of the process. WP&L now draws the project sample monthly. This allows them to send the project records to the verification engineers quicker and has accelerated the results reporting and feedback by one month. More attention is paid to tracking the sample sizes for each technology group at each level of verification. This is necessary to ensure the appropriate sample sizes exist at the end of the year for the precision and confidence desired.

The acceleration of feedback not only allows the representatives to get back to the customer sooner, but allows the training and marketing materials to be updated more quickly, leading to better program results. WP&L hopes this, in turn, will reduce the verification sample size and project costs in the near future.

The 1996 verification project has improved feedback to marketing and the representatives. The monthly reports include a feedback section that showcases a "technology of the month." This feature explains some basics of a technology and how savings estimates can be improved.¹³ The format of this feedback section is such that the representative

¹¹The technology guidebook is a resource guide that shows how to calculate savings estimates for a variety of technologies.

¹²The double ratio analysis technique will continue in 1997.

¹³In 1997 the program will include the development of spreadsheet tools with consistent format and ease of use.

can insert it into the Technology Guidebook in the section relevant to the specific technology.

WP&L believes providing useful tools as part of the verification process helps to mitigate the naturally adversarial nature of the program and will lead to more accurate estimates of savings. Again, reducing the number of projects that will be verified and bothering the representatives less.

WP&L has also improved the data provided to the marketing department. This is indicated in the following table.

Information Provided to Marketing	
1995	1996
Realization rate by representative	Realization rate by representative
Realization rate by technology type	Realization rate by technology type
Realization rate by SIC code	Realization rate by SIC code
Reasons for adjustment	Reasons for adjustment
	Adjusted payback
	Project savings % of billing use
	kWh/ft ² or therms per ft ² by meter
	kWh/employee or therms/employee by meter

The new information is useful to the marketing department for a variety of analyses. First they can adjust technology payback estimates. They have a quick indicator of the realism of the projected savings estimates by comparing the savings percent of the customers total bill. They can also, develop energy use profiles and intensities for customer types by SIC. This information is provided to improve the capabilities of the marketing department and the sales representatives and allow them to better understand their customers.

Removal of the measurement level of verification freed up available funds for WP&L to improve the feedback component of verification through the changes identified above.

Jorge paved the path to these program improvements. In memory of him, WP&L intends to continue improving the verification process so that it provides more value to the company beyond just statistically valid realization rates.

Lord Kelvin once said, "When you cannot express it in numbers, your knowledge is of a meager and unsatisfac-

tory kind." But another giant of science, Alfred North Whitehead, warned of "the fallacy of misplaced correctness." The engineer and statistician often are members of the Kelvin school. The liberal arts graduate often draws support from the Whitehead quote.

Jorge moved to a balance between these in his rebirth. He is able to balance the value of each objective. "Be neither moribund by the hunger for accuracy, not flamboyant in ignoring it," he says. "Winning in the competitive environment by helping your customer save energy is a nobler approach than my former self would have seen."

La Conclusion!

"It is a far better thing I have done than I have ever done before." These were the final words of the staunch engineer, Jorge Pluman." He gave up his former life to ensure that WP&L would get increasing value from the impact verification project.

From his work, WP&L has learned that:

- The marginal improvements in realization rate precision are not always the best use of available evaluation funds. We must clearly define the driving forces, and hence goals of the verification, to compare the need for increased precision to the value of increased feedback.
- The response time is lengthened measurably by the measurement level of verification. In some cases, too long for the value gained in precision improvement.
- Monitoring of energy use negatively impacts the attitude of the representatives toward the verification projects, negatively impacting the reliability of results.
- The response time for information about problems with savings estimates and techniques can be much shorter than it has been in the past.
- Providing real time results allows the utility to respond better and quicker to the challenges of the industry and the needs of its staff and customers.
- Providing feedback to the representatives allows them to improve project savings estimates. This allows them to provide their customer better service and reduces the verification requirements and cost. This is called statistical process control and is the real advantage of the verification process.
- Providing improved information to the marketing department allows them to improve their programs and allows the techni-

cal training persons to improve their training and materials.

- There is always room for improvement of the verification process that will further its value to the company. Further improvements are being implemented in 1997.

While the changes made by WP&L are clearly in *its* best interest, each utility must make its own assessment. We hope this paper will save *your* Jorge from some pain.

References

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