Nintendo engineers.

By

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Jack was on the phone with George. “I have a problem, George, all the blades on the new high head Francis turbine at St. Mary are cracked, and it has only been in operation for a couple of months” George knew of the powerplant, having read about it in a journal. The turbine manufacturer was well known, and specialized in large Francis turbines. The owner had a competent turbine department, and had reviewed the design. So what had gone wrong?

He asked a few more questions, but nothing seemed out of the ordinary. Then he fell back on basic principles and asked how many wicket gates, and the answer was 20. How many blades, and the answer was 16. George was flabbergasted “don’t you know that turbines must have an even number of wicket gates and an odd number of runner blades so that the blades will not interact with the vortices and shock waves coming off the wicket gates?” Jack said “no, where is that written down” Here George was at a loss. This was a basic principle discovered many, many years ago, and had never been recorded since all in the industry knew about it.

During his career, George had worked closely with the turbine manufacturer on many projects, and all had turned out well. But he recalled a conversation with the manufacturer’s telephone operator, when he was trying to get in touch with one of the turbine engineers about 15 years ago. He had a list of nine engineers, all of which he knew well, and he had called each one, but all had retired. In desperation, he asked for the president, whom he also knew, and the operator replied “Oh, he is at his retirement party, and is leaving tomorrow”. Resigned, George asked for the name of a salesman, and arranged a meeting for the next day.

Next day George met Allan, and was given a tour of their new design facility. The turbine work was now all undertaken with computational fluid dynamics (CFD) programs, and their hydraulic model test facility had been closed. There were several young engineers at the computer keyboards, and none seemed to be older than 30. All drawings were now on CAD systems, and the old mylar drawings had been relegated to a storage vault. They even had a new light and airy office building, a vast improvement over their former 70 year old brick building with no air conditioning.

With the new design facility, they had gone from strength to strength, with many successful turbines. And as computer performance improved, the CFD programs became more accurate, with more nodes in the areas of possible cavitation, and eventually they were able to produce cavitation-free runners. But here was a disaster – a cracked runner. When the problem was explained, the engineers were eventually able to combine the CFD program for the stay vanes-wicket gates with the CFD runner program, and reproduce the harmonic interaction of the shock wave emanating from the wicket gate vanes with the runner blades, as observed in the operating turbine. Normally, there are three CFD programs, one for the spiral casing, stay vanes and wicket gates, another for the runner, and one for the draft tube. Due to the large number of nodes, current computers would take too long to run through a program combining all three, hence the shock wave problem was not observed. (However, another manufacturer has recently achieved the goal of combining all three programs, using a very large computer).

Having confirmed the cause, a new runner was designed with **17** blades, installed and operated without further problems. It had been a very expensive lesson, since the manufacturer had to dismantle the generator to obtain access to the turbine and runner, install and re-assemble the turbine and generator at their own cost.

Lesson learned.

The transfer of knowledge from one generation to the next is becoming a major problem with manufacturers and utilities. (A few articles have been written on this subject recently, see HR Vol. XXIII, #4, page 10 “Training future hydropower staff at Reclamation”) This is particularly important with work now mostly on computers, and young engineers not experienced enough to spot errors due to incorrect inputs - a colleague recently described them as “Nintendo Engineers”. The use of retired and senior engineers as mentors should be encouraged.

Another consideration, is the lack of a suitable forum for dissemination of practical advice. Journals such as Water Power are now magazines, and no longer publish long articles on detailed designs and descriptions of power projects. The ASCE Energy Journal has been discontinued. The Canadian CEA Transactions, where there were excellent articles describing hydro projects, has also been discontinued. The problem is the cost of publishing detailed technical articles, it is just not commercially viable. Some organizations have recognized this obstacle and now produce electronic journals. This would be particularly suitable for an engineering journal, since it would be possible to include Excel spreadsheets with programs. Perhaps someone will take up the challenge.

Finally, the standard reference books used by hydro engineers (“Water Power Development” by Mosonyi, “Hydro Electric Handbook” by Creager and Justin, “Handbook of Applied Hydraulics” by Davis, to name only a few) are out of date, and no replacements are being produced. The Norwegian University of Science and Technology has recognized this deficiency and has recently published a 17 volume series of books on Norwegian hydro experience. What is needed is a new handbook, with recent examples of equipment and projects.