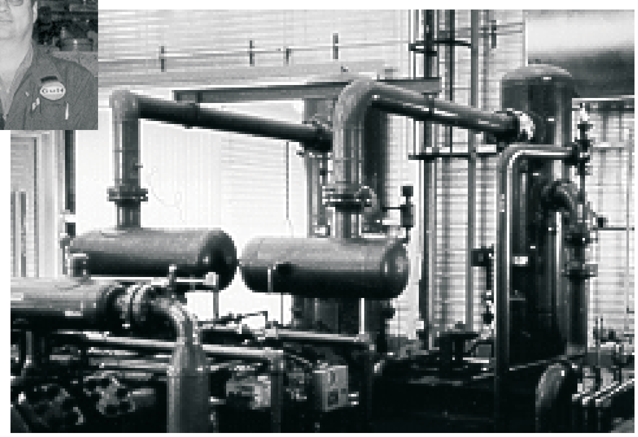
THE BETA BULLETIN

BETA

Machinery Analysis

FIRST Digital Acoustical Model In the World 1975

Steve Kozak, Maintenance Foreman at Gulf Westerose, says “We’re still making good use of it.”



Recently, we had the opportunity to re-visit Gulf Westerose, the site of the very first digital acoustical model of a reciprocating compressor. The compressor (shown above) was modeled in early 1975, and Steve Kozak, the Maintenance Foreman, says “It’s still going strong.”

Beta’s current president, Dr. Bryan Long (then R & D director) began the research for this service early in the 1970’s. He notes that initial studies were done on a large computer installed at the University of Calgary, with punch card input and externally mounted large tapes as the only storage mechanism.

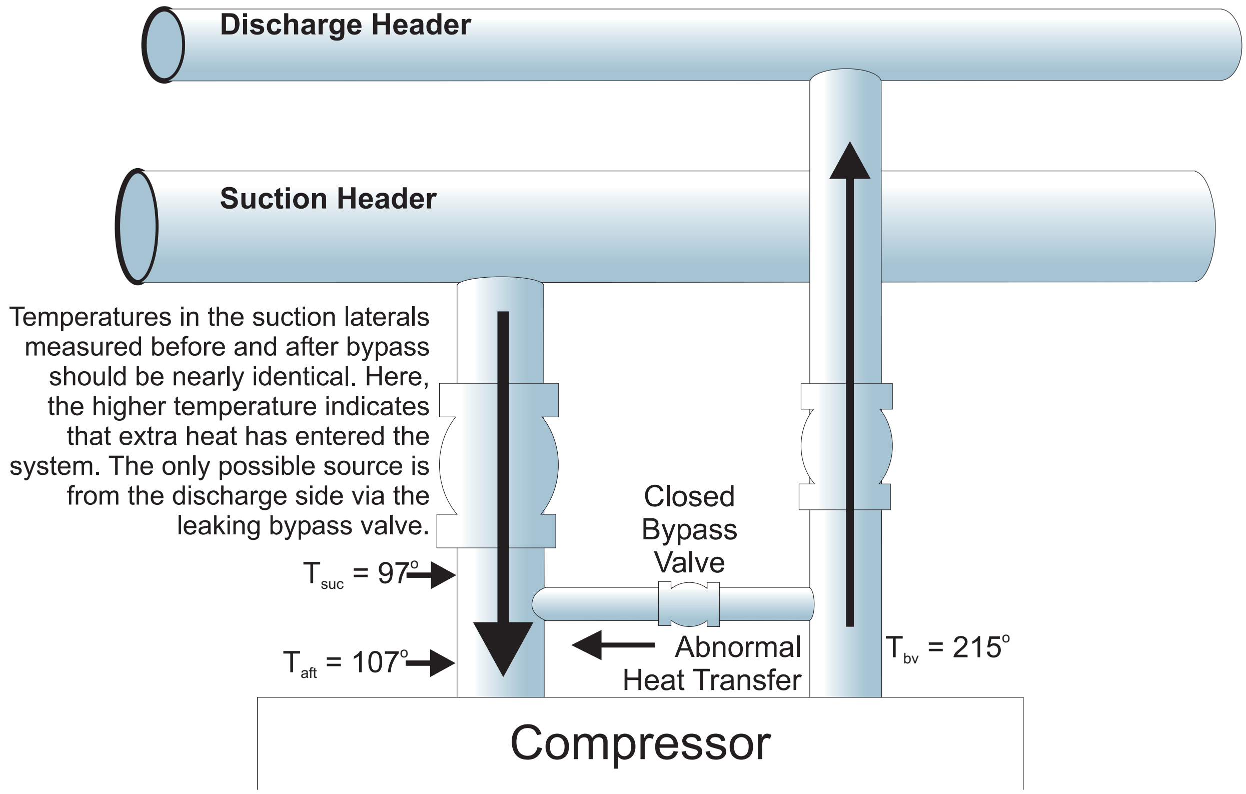
Back then, all other acoustical modeling was done on analog computers. Bits of wire, connectors, resistors and capacitors were mounted on a board to simulate a compressor system. The size of the system that could be modeled was limited by the size of the board, and no other system could be modeled until the current one was taken down and another put up. This meant that introducing a change a few months or years down the road was just as time-consuming and expensive as doing the initial study. It also meant that it was difficult to include piping extending out past the cooler or out as far as an inlet separator.

By contrast, a digital model such as our MAPAK (Mechanical Acoustical PAcKage) uses a standard computer, and the sections of pipe, vessels, etc. are modeled using a numerical description. It is easy to model lots of conditions and lots of speed ranges, and just as easy to do an extra modification three months later as it was to do the original ones.

Since the first MAPAK, we have modeled over 1200 different reciprocating compressor sites. Now, most of our jobs come from repeat customers - they get addicted to trouble-free start-ups and smooth operations.

INSIDE VOLUME 8 #1

Machinery Optimization Group saves $23,000



The increased temperature reflects the heat transferred to the mass of the suction gas. The temperature change is proportional to the mass, therefore, the leak % can be calculated as follows:

$$Leak\ \% = \frac{mass\ of\ leak}{mass\ of\ suction\ gas} = \frac{T_{aft} - T_{suc}}{T_{bv} - T_{aft}}$$

Leak % for this case was over 9%. Using a fuel cost of $2 per MCF and LHV of 950 BTU per cubic foot, the “lost” gas was worth over $17,000.
Let’s assume that Maintenance Cost Per HP-hr was ½ cent ($0.005). The additional cost of maintenance due to the leaked gas would be 0.005 x 1540 HP x 8000 x 0.093 = > $5500.
Total cost of this leak was more than $23,000.
Beta’s Machinery Optimization group routinely checks for bypass valve leaks, because of the available savings. The check is simple, and the return can be great.

How to Determine if a Predictive Maintenance Program is for you

Q: Can machinery analysis technologies be utilized to bring about improvements in machinery operation and/or maintenance?
A: Unquestionably; well established; no further proof needed.
Q: Can these results be achieved *cost effectively?*
A: Generally, yes, if the technology is applied with discretion and judgement.
Q: So are you saying that predictive maintenance programs will always be beneficial?
A: Absolutely NOT.
Q: So what determines success or failure?
A: Not the technology. Success or failure is correlated almost 100% with the expectations of the key stakeholders. If you believe PdM will work for you, it will. If you believe PdM will not help you, your expectation will come true. It is not a matter of perceptions of success or failure. Rather it is the belief system driving behaviors which cause the expected result.
Q: That doesn't sound so bad.
A: Actually it's rather intimidating. You can control the technology, but the expectations or belief systems in the organization are a very complex issue. Some people truly don't believe, probably through lack of information. Others choose not to believe; they perceive PdM to be counter to their self-interest. Typically the greatest resistance is encountered in first level supervisors (just the people who are critical to routine, every day execution of a PdM program) because these new ideas appear to be contrary to their wealth of experience.
Q: So it's hopeless?
A: No it's not hopeless, but you must be realistic about the culture in your organization. If it tends to be change resistant and very focused on self interest rather than group success, you have a big challenge to bring about the needed culture change.
Q: So how should I decide whether to take on that challenge?
A: Partly it's assessing how big the challenge is and how you could meet it. But first you should evaluate the benefits that might be achieved for your organization. Consider the table on the bottom left side of this page. These factors are key results that PdM programs can influence. Rate each machinery success factor from 0 to 10 to indicate **your view** of their importance to your company.
Rating guide:
10 = critical to Company health
8 = a major need
6 = opportunity for significant improvement
4 = possible opportunity for some improvement
2 = we are doing as well as possible
0 = don't mess with success

If your company is one in which major culture change will be required in order to successfully implement predictive maintenance, then the rewards must be large. That is, you should have some ratings of eight or higher to make the effort worthwhile. If your ratings are in the opportunistic range (say four to seven), then perhaps the change averse organization should not consider adopting PdM or should limit any program to what will likely be accepted; e.g. oil analysis.
Q: That seems like a logical approach. But what if my company is more open to change?
A: Perhaps we could summarize the situation with the second table below. We classify culture in three levels ranging from change averse to open and accepting.
The need perceptions are similarly expressed as three levels. Then each location in the table provides some thoughts about the appropriate approach to predictive maintenance for that situation.

Personalized Maintenance Approach

Obviously, a newsletter is not the forum for giving you your own personalized system. However, our PdM experts would be happy to work with you to develop a program that suits your company's culture, needs and machinery fleet.
We can work within the status quo, work to gradually improve the climate, or even provide training at all levels to fast-track a systemic change. We will make an initial evaluation at no charge. Just call.

Success Factor	Significance Rating (0-10)
Increased Reliability	
Reduced Maintenance	
Increased Throughput	
Increased Availability	
Reduced Energy Cost	
Reduced Lost Production	
Increased Safety	
Reduced Emission	

Need vs Culture

Culture → / ↓ Need	Highly Resistant	Neutral	Open and Accepting
Major (Scores 8 - 10)	Create a battle plan. Go to war.	Involve staff. Train, inform. Plan and implement.	Get on with it. Deal with pockets of resistance.
Oppor-tunistic (4-7)	Match program to acceptance.	More aggressive program.	Match program to opportunities.
Status Quo (0 - 3)	Forget it.	Forget it.	Explore potentials

Free Seminar Program

	Recip Pulsation and Vibration	Beyond Predictive Maintenance	Torsional Analysis	Gas Turbines/ Centrifugal Compressors
General List of Contents	Vibration Basics Forcing Functions Resonance Pressure Pulsation --Frequency Content --Extent and Effects Unbalanced Forces Pressure Drop Guidelines -Mechanical -Acoustical	PdM Methods Performance Analysis Shutdown Inspections Economic Analysis Risk Management Case Studies	To Do or Not To Do … Design vs Field Study Guidelines Design Optimization Torsional Analysis Process Torque Effort Curves Torsional Natural Freq. Mode Shape Resonance Shaft Stress	Introductory. Performance (efficiency, curves, surge). Condition monitoring. Performance testing. Mechanical systems. Vibration analysis.
Benefits	Understand how acoustical & mechanical analysis gives you smooth startups and trouble-free operation. Learn to specify compressor studies.	Learn how to use new machinery analysis techniques to improve the bottom line.	Be able to determine the need for a study. Understand the wide scope of cost effective solutions. “A flywheel is not the only answer”.	Be able to determine the need for outside help with condition & performance testing. Get an overview of the issues involved in machinery optimization.
Who Will Benefit	Engineers and technologists who build or operate recip compressor packages. Owners of problem compressors.	Personnel responsible for planning and implementing cost effective operations. Operations & maintenance personnel.	Field engineers and project supervisors who design and operate recip compressors.	Personnel responsible for gas turbines and/or centrifugal compressors (operators, maintenance workers, engineers, and supervisors).

Please see calendar (included with this issue), or call for dates and locations.

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Check out the bulletin board.

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