The Carnot Group approach to

Compressed Air Projects

by

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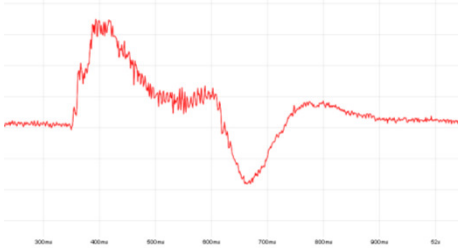
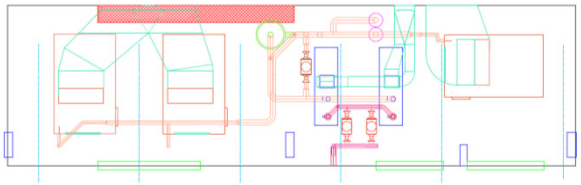
The Carnot Approach to Compressed Air Projects

Overview – The Carnot Group

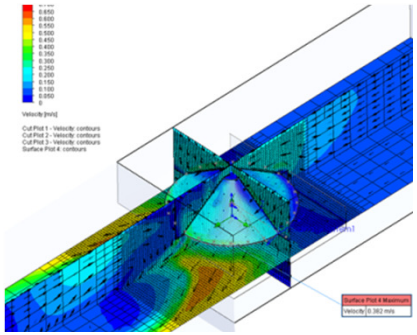
- Mechanical and Materials Engineering Consultants
- Melbourne based
- Established 2002
- Troubleshoot, upgrade old, design new - equipment, processes and plant services.
- Manufacturing, mining and water utilities.



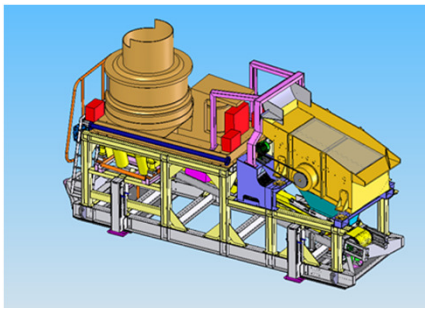
Pressure difference across a dust collector during a cleaning valve pulse. Logged at 1 millisecond intervals



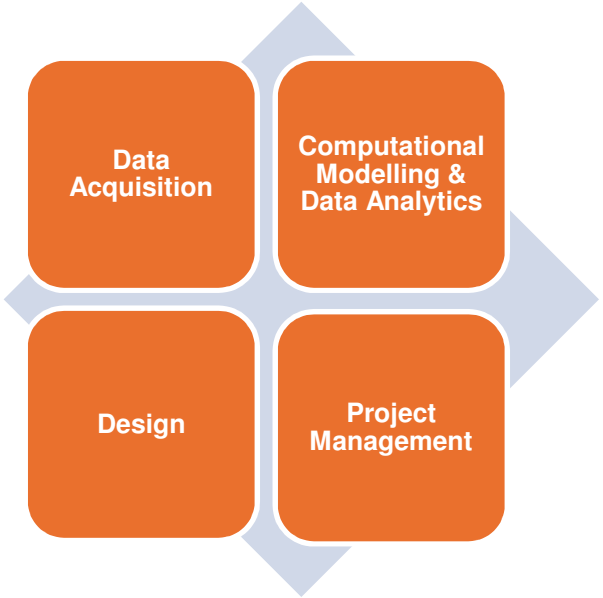
Compressor room upgrade equipment layout. Compressed air piping and cooling air ducting design includes detailed pressure drop analysis Design and drawing by The Carnot Group.



CFD - Water velocities at a conical filter screen. Design and modelling by The Carnot Group



Underground Mine, Modular Ore crusher By The Carnot Group: Design, 3D model, FEA of Static and Dynamic stresses.



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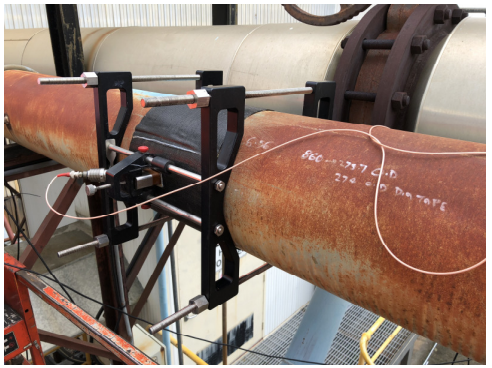
Overview – Compressed Air Engineering



- Twenty plus years in Compressed Air (CA).
- Five standard air surveys, Supply Side status (Compressor Log), Air Leaks, Pipe mapping and analysis, Air Savings Opportunity, (production) Equipment Design Reviews.

Activity Priorities – customer priorities are our priorities

1. Troubleshoot CA system, compressor room and production equipment. “Get things working properly”.
2. Improve production rates and compressor room reliability.
3. Energy efficiency. Often already savings from 1 and 2.

Project Sequencing

At least 3 stages each with reports and review meetings.

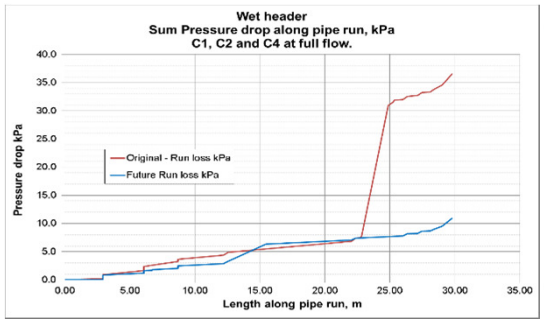
1. System Status → 2. Directions Report → 3. Implementation

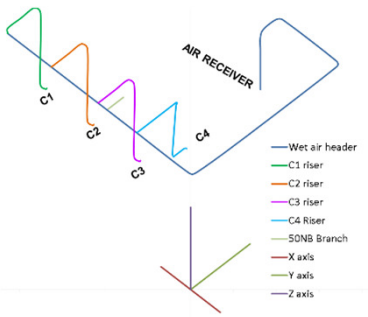
Do targeted incremental surveys, not multiple at once as a “site wide audit”. Best bang for buck.

Priority 1 - Trouble Shoot

CASE STUDY 1

- Logger survey identified compressors faulting due to high pressure drop from compressors to receiver.
- Pipe mapping survey and pressure drop analysis found flow measurement section too small.
- Header redesign and new flow meter reduced pressure drop - problem solved

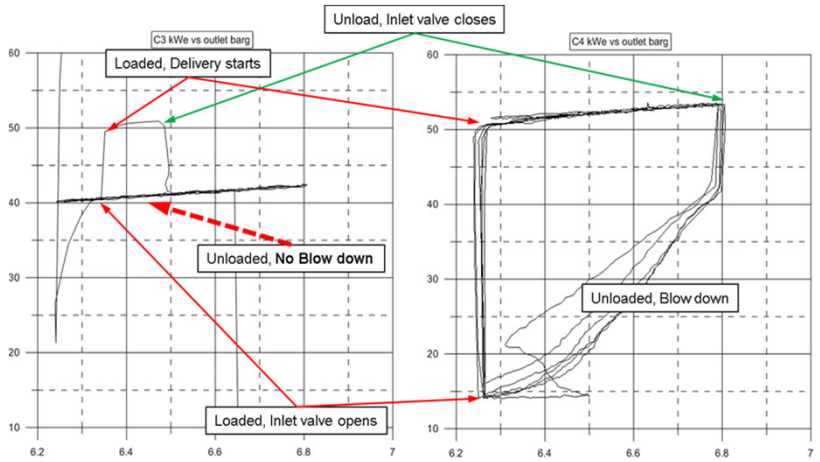




CASE STUDY 2

- Logger survey found trimming compressor with faulty control (blow down) valves, 5.5 % of power for 1.5% of air compressed.
- Left trend is faulty machine, Right is good

One in 5 sites have a compressor valve fault

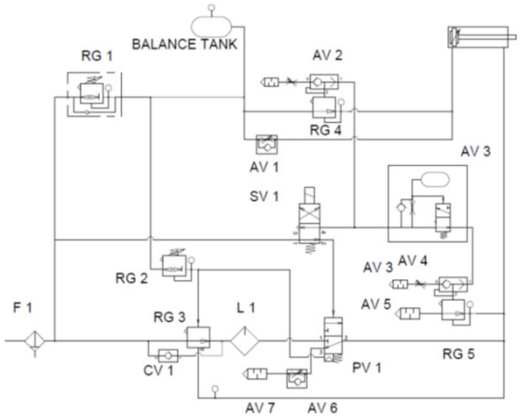


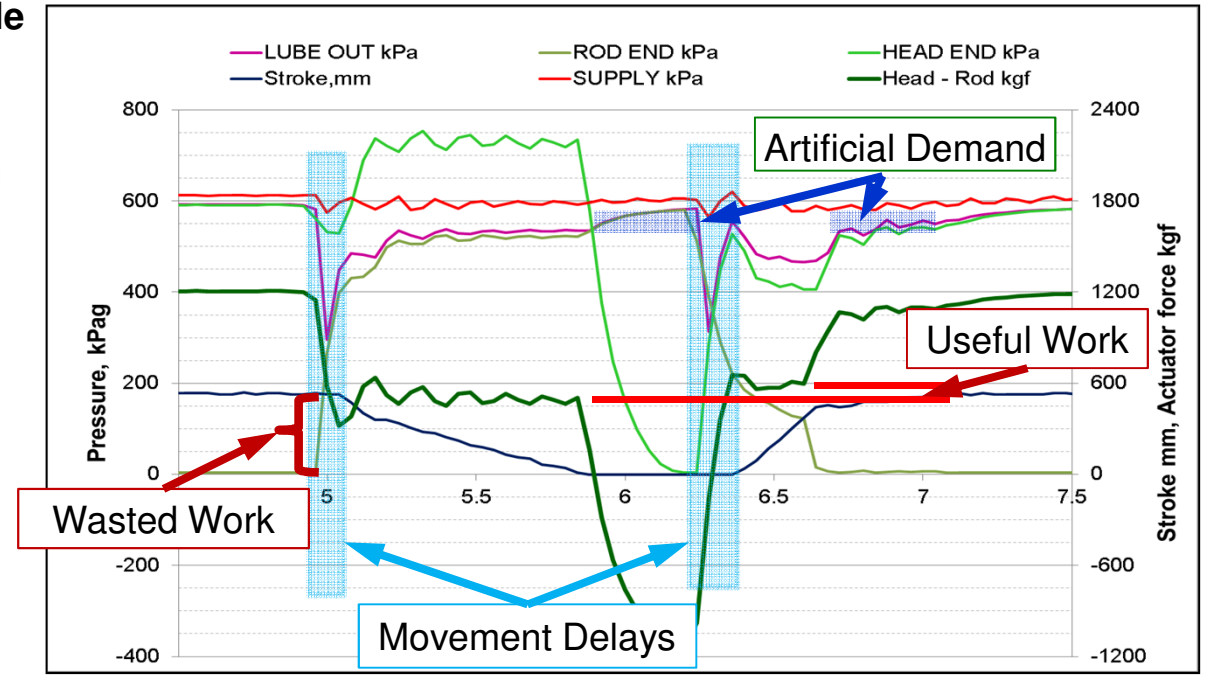
Priority 2 - Improve production rates and reliability

- Equipment limits production line and site wants to increase output.

- Equipment Design Review fast logged at 25 Hz to see pressure changes as actuator moved:
  - Slow solenoid valve operation and movement delays were > 30 % of time from electrical control signal change to end of actuator movement.
  - Air waste due to Artificial Demand and Wasted Work

- Redesigned, high performance pneumatic circuit :
  - **Reduced cycle time for > 53 % output gain**
  - **Saves >80 % air/cycle**



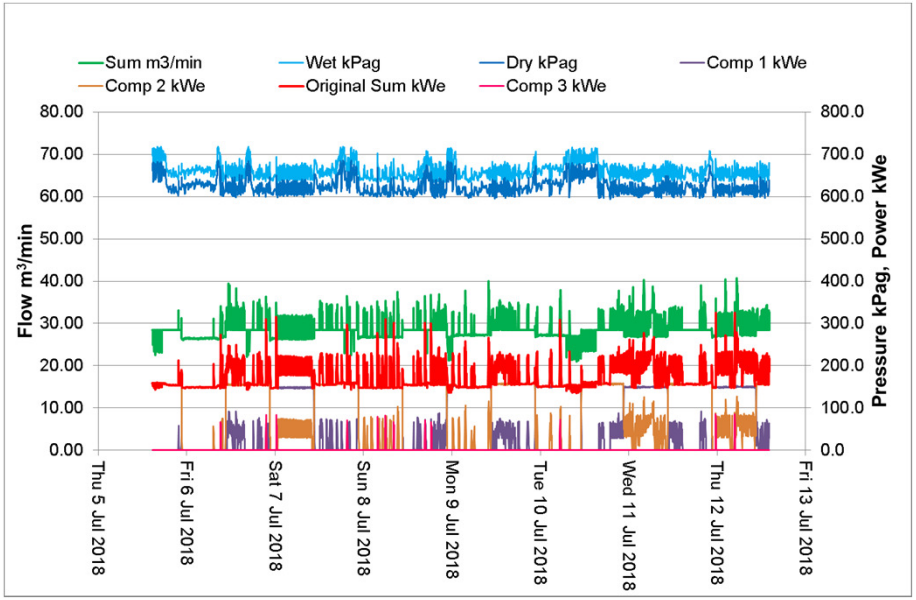


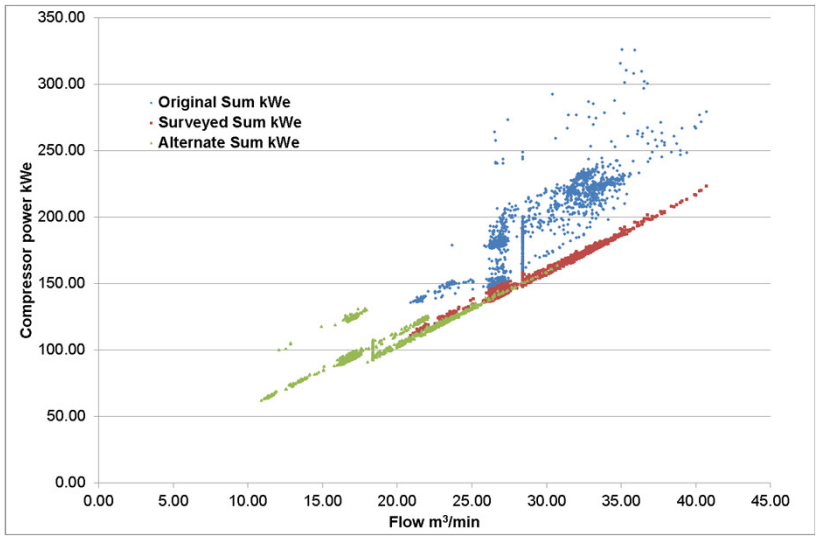
Priority 2 (continued)

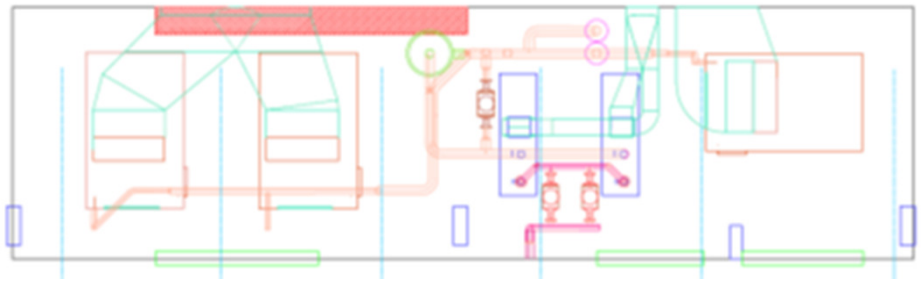
Old compressors starting to suffer “End Of Life “ reliability problems.

Carnot:

- Logged compressed air system.
- Ran new equipment tender for customer.
- Tender reviews included detailed modelling of compressor and dryer power consumption. Surveyed flow and pressure data with and without future air savings.







Do permanent air saving work before buying compressor:

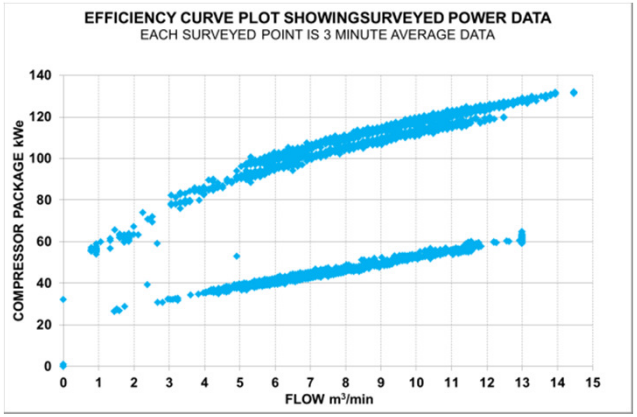
- Allows smaller new compressor – capital neutral
- Lower future power and service costs.

Priority 3 - Energy Efficiency

The best “bang for efficiency buck” needs all compressor(s) to be working correctly and operating the system at best efficiency. The Efficiency Curve shape highlights the most cost effective projects

Interpreting the Energy Efficiency Curve

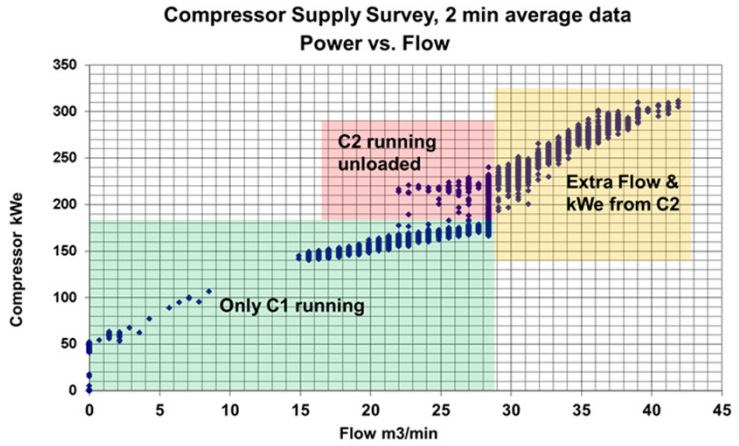
1. “Domed” (convex) or “multi trend” → control projects
2. “Spoon” (concave) → targeted peak demand reduction projects
3. “Straight”→ Demand Side (air saving) projects, Pipe mapping and redesign projects



Example of a “multi trend” Efficiency Curve
At same flow big compressor (top trend) uses 2 x power of small compressor.

By only using small compressor site saved:

- Compressor power.
- Servicing cost



Example of a concave shaped Efficiency Curve
C2 used 15 % of power for 5 % of air compressed.

Process control changes stopped C2 running saving $$

Priority 3 (continued)

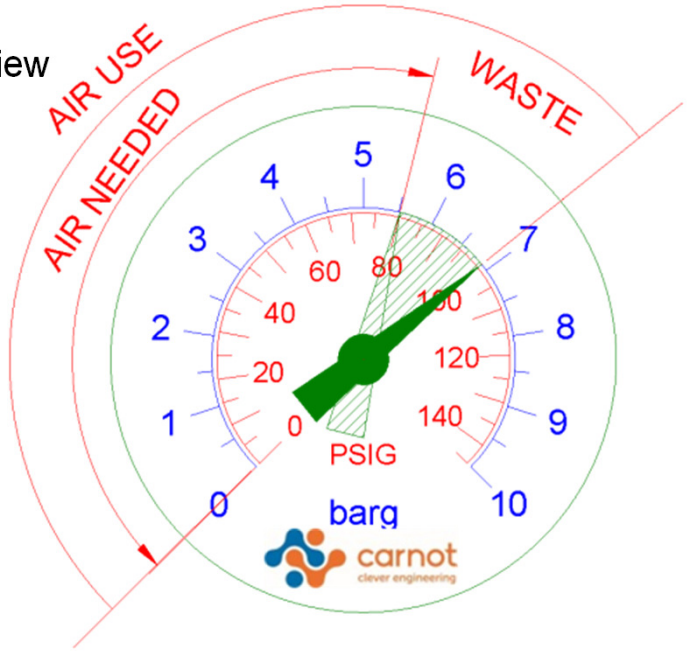
Demand side projects reduce compressed air use and system pressure needs:

Permanent air savings:

- Surveys:
  - Demand Side savings opportunity survey – Overview
  - Equipment Design Review - detailed to a process

- Require changes to equipment:
  - What equipment is used
  - How it is operated and its control settings.
  - Pneumatics and/or mechanical design.

- Realised using the “Six Savings Methods”:
  1. Artificial Demand - Excess pressure at device
  2. Artificial Demand - Excess “air on” time.
  3. Artificial Demand - Excess volume.
  4. More efficient devices
  5. Wasted work
  6. Air reuse



Air Leak surveys and repairs typically only achieve short term air savings. Air leaks usually occur due to wear so reappear in 3-5 years.

Thank you