CASE STUDY: Enhancing Test Execution Efficiency

Improving Data Quality and Increasing Throughput by 40%

Project Snapshot

Industry: Aerospace / Combustion Engineering
Challenge: Manual test operations led to limited data capture, post-processing delays, and repeat testing.
Result: 40% increase in daily data points, 50% staffing reduction per test, and $2M of savings over 10 years (>$10M potential across five cells).

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1. Opening Hook – The Challenge

A major aerospace test organization sought to improve the *efficiency and quality* of their combustion test campaigns. Each test day required collecting about **40 distinct data points** over **6–8 hours**, running roughly **two tests per week**. Post-processing consumed another full day due to data alignment issues, and 15 % of data points required repetition.

The goals were to:

- Increase valid daily data points by **≥ 20 %**
- Eliminate post-processing delays
- If possible, Reduce manpower and improve test repeatability

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2. Problem Definition

Inefficiencies fell into four main categories:

1. **Manual Valve Control:**
   Engineers manually entered and adjusted valve setpoints to hold target conditions, requiring constant attention.
2. **Fuel–Air Drift:**
   Variations in airflow caused fuel flow adjustments throughout the run to maintain burner flame temperature—“chasing” the setpoint.
3. **Rigid Control Logic:**
   Even in *auto mode*, fixed fuel-flow setpoints failed to adapt when airflow shifted, yielding off-target data and repeat tests.

Non-Integrated Systems and Staffing Needs:
Tests relied on **three separate PCs**—for controls, data acquisition, and dynamics—requiring **two engineers** per run. Manual coordination caused delays and operator fatigue.

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3. My Approach

We broke down the entire test execution sequence and designed an integrated automation and control solution comprising **five key improvements**:

1. Stabilizing Airflow – Hardware Upgrade

The previous butterfly-type air valve produced oscillations. We replaced it with a **linear globe valve** for smoother control, and added a **PID-controlled hot-vent line** to modulate inlet pressure within ± 0.5 psi.

- **Investment:** ≈ $130 K (two valves)
- **Effect:** Significant reduction in air-flow drift and pressure instability

2. PID Automation on Frequently Adjusted Valves

We enabled individual PID loops for all critical valves. This required only software configuration and tuning—no new hardware.

- **Effect:** Consistent control precision without operator intervention

3. Dynamic Setpoint Management

We built a dynamic spreadsheet-driven method to compute and update valve setpoints automatically. Controllers adapts fuel flow to airflow changes to maintain the **target flame temperature**, the key “critical-to-quality” metric.

4. Automated Test Sequencing and Data Quality Logic

The system reads a test matrix, adjusts controls automatically, and evaluates **test-point quality metrics** in real-time. When all critical parameters fall within specification bands, the system flags the point *green* (steady-state) and triggers acquisition.

5. Synchronized Data Capture

All three PC systems—controls, data acquisition, and dynamics—were synchronized using a **trigger signal** initiated from the controls machine. Once a steady-state flag occurs, the signal automatically commands both acquisition systems to record the point.

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4. Implementation and Validation

- **Development and deployment:** ≈ 26 weeks total
  - 22 weeks of software development, testing, and tuning
  - 4 weeks for system integration and validation
- **Total investment:** ≈ $275 K (hardware +\ software)

Pilot testing confirmed:

- Stable automated runs
- Elimination of post-processing alignment work
- Seamless data synchronization across subsystems

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5. Results and Impact

- **Data throughput:** Increased from 40 to ~56 data points (+ 40 %) per 6–8 hr test day
- **Labor utilization:** Reduced from 2 engineers to 1 per run (− 50 %)
- **Annual financial savings:** ≈ $210 K per test cell
- **Payback period:** ≤ 2 years
- **10-year inflation-adjusted impact (3 %/yr): ≈ $2.4 million** for one test cell

With **five similar test cells**, scaling this solution company-wide yields potential savings of **>$10 million** over a decade while providing data with exceptional quality.

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6. Takeaway & Forward Value

This project exemplifies how **automation, adaptive control, and system synchronization** can transform test quality and efficiency. By addressing both human and technical bottlenecks, we enabled faster testing, reliable data, and repeatable performance—reducing total testing cost while enhancing insight generation.

The same methodology now underpins our broader work in combustion test optimization, driving smarter data systems and scalable value across multiple test environments.

Note: Inflation-adjusted savings assume a **3 % escalation rate per year** compounded over 10 years, reflecting future-value gains relative to current spending levels.