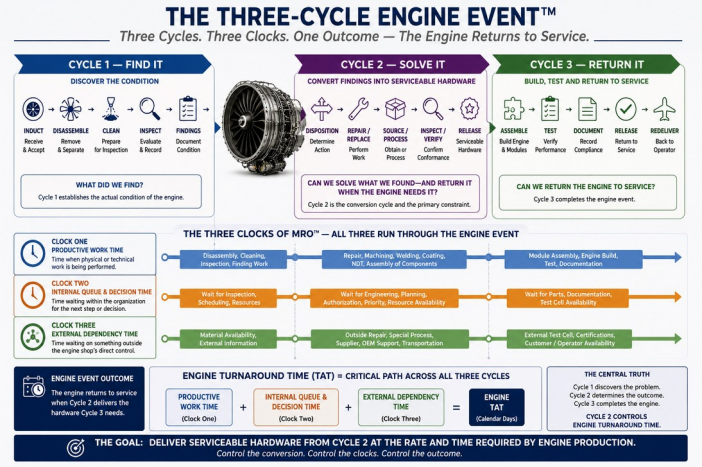
# LAST DANCE WITH MARY JANE™

## Why the Traditional MRO Operating Model Is Running Out of Time

**FLOW PATH EXECUTIVE WHITE PAPER 001**

Version 1.0 | 2026

***CAPACITY ≠ CAPABILITY™***




**FLOW PATH CONSULTING LLC**

**PRECISION. DIRECTION. IMPACT.**

August 2026

# Executive Summary

Aircraft engine MRO has never had more demand. It may also have never been more constrained in its ability to convert that demand into predictable engine output.

That contradiction is the subject of this paper.

Global commercial aviation MRO demand reached approximately $136 billion in 2025 and is expected to approach $193 billion by the end of the decade. Engine MRO remains the largest and fastest-growing segment of the market. At the same time, supply-chain, labor, material, durability, and repair constraints continue to extend turnaround times and disrupt airline operations. [1]

The industry is adding buildings, engine stands, tooling, repair capability, people, and supplier capacity. Yet the central leadership question remains:

> ***Will more capacity actually produce more completed engines?***

Not necessarily.

An MRO can have bays, technicians, tooling, test capability, and engines waiting for induction while still being unable to return those engines to service predictably. The problem is not simply capacity. It is the ability to convert capacity into executable capability.

For decades, much of the engine MRO operating model assumed that once an engine was disassembled and its condition understood, the organization could repair or replace what it found and move forward. That assumption is increasingly unreliable.

The battleground is increasingly Cycle 2: repair, replacement, material, engineering disposition, special processing, supplier performance, and recovery.

> ***Cycle 1 finds it. Cycle 2 solves it. Cycle 3 returns it.***

When Cycle 2 cannot deliver at the rate required by engine production, physical shop capacity becomes increasingly irrelevant. This leads to the central premise of this paper:

## CAPACITY ≠ CAPABILITY™

A shop can be full and still fail to flow. A repair can meet its labor standard and still return too late to protect the engine. A supplier can achieve a component metric and still move the engine delivery date. A highly utilized repair resource can look efficient while creating a queue that damages overall throughput.

*The title Last Dance with Mary Jane™ is a metaphor for an industry continuing to dance with familiar operating practices even as the environment that once made those practices successful disappears.*

# 1. The Last Dance

Strong markets can hide weak operating models.

The MRO market is strong. Demand is rising. Investment is expanding. Yet beneath that growth sits a different operating reality: material is less predictable, external repair capability is constrained, experienced technical labor is difficult to replace, modern engine material is expensive, and technical decisions can become critical-path events.

A full shop can make almost any operating model appear successful. A long induction queue looks healthy. More engines on stands look productive. High utilization looks efficient. But none of those conditions necessarily represents completed output.

> ***Activity is not output.***

An engine waiting on a stand is still WIP. A component sitting at an outside repair source is still incomplete. A module waiting for material is not moving simply because every mechanic in the building is busy.

The leadership question therefore cannot remain: How many engines can we induct?

> ***How many engines can we predictably return to service?***

# 2. Capacity ≠ Capability™

Capacity is easy to see. Capability is harder to measure.

- A new building is capacity.
- Another engine stand is capacity.
- A newly installed machine represents potential capacity.
- Additional headcount represents potential capacity.
- A larger induction schedule represents potential capacity.

Executable capability exists only when the elements necessary to perform the work function together:

> ***Technical Data + Qualified People + Tooling + Equipment + Material + Repair Capability + Engineering Decisions + Inspection + Supply Chain + Standard Work + Operating Discipline***

Break one critical link and the system can stop. An organization can appear completely full while producing insufficient flow.

# 3. The Three-Cycle Engine Event™

An engine shop visit can be viewed through three interconnected operating cycles.

## Cycle 1 — Find It

Induct → Disassemble → Clean → Inspect → Determine Findings

Cycle 1 establishes the actual condition of the engine. For mature programs, the method of discovering those findings is comparatively mature and predominantly within the MRO's direct control.

## Cycle 2 — Solve It

Disposition → Repair → Replace → Process → Source → Recover

Cycle 2 converts findings into serviceable hardware. It can include machining, welding, blending, coating, heat treatment, NDT, dimensional restoration, component repair, repair engineering, special processes, inspection, material, outside repair, OEM support, logistics, and supplier capacity.

Some of that work occurs inside the MRO. Some occurs outside it. Some requires hours of productive labor. Some consumes weeks of calendar time.

## Cycle 3 — Return It

Assemble → Test → Document → Release → Redeliver

Once serviceable hardware becomes available, the engine can move through assembly, test, documentation, release, and return to service.

> ***Cycle 1 discovers the problem. Cycle 3 completes the engine. Cycle 2 determines whether either matters.***

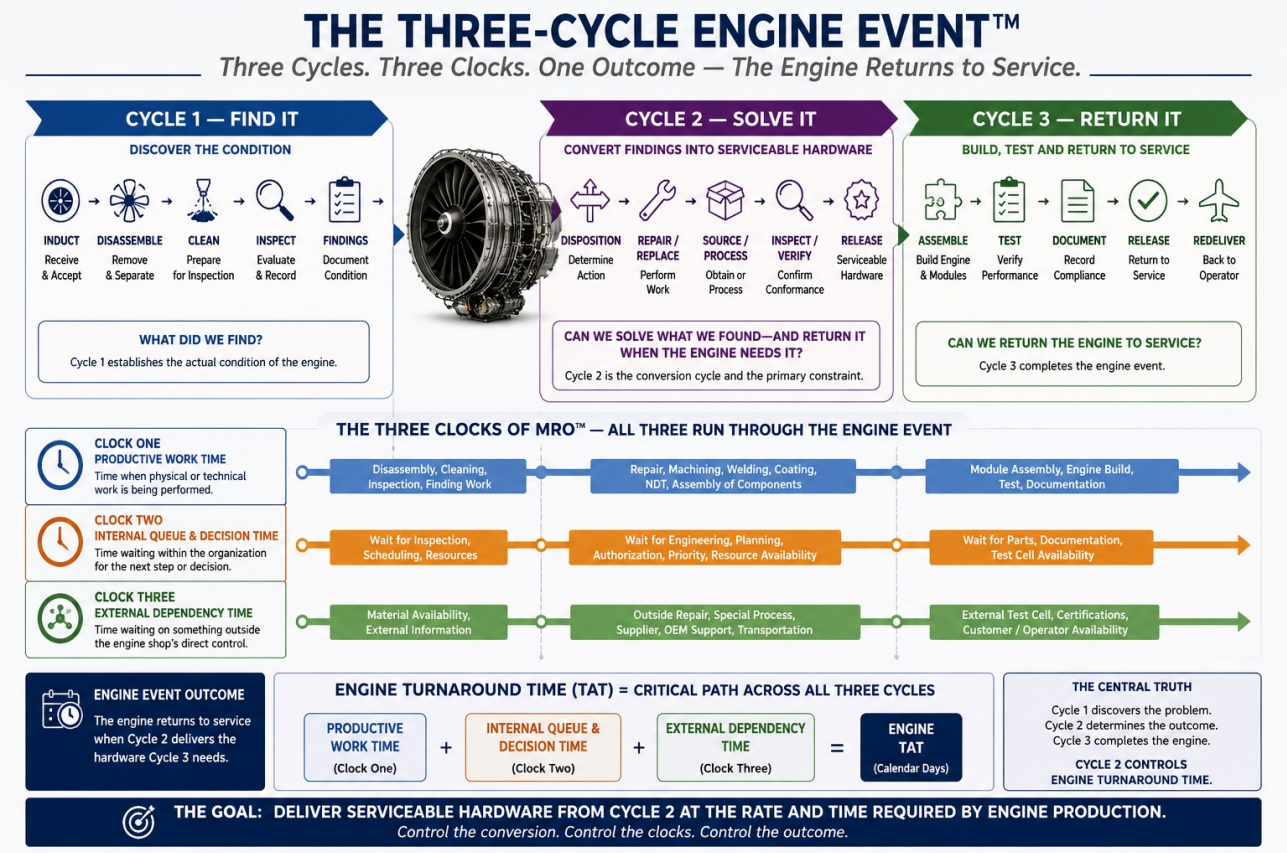



Figure 1. The Three-Cycle Engine Event™ and The Three Clocks of MRO™.

## 4. Cycle 2 — The Conversion Constraint

Cycle 2 is where findings become serviceable hardware. It is the conversion cycle.

The conversion can cross multiple internal and external boundaries: Finding → Disposition → Repair → External Process → Inspection → Rework → Release. At every boundary, another opportunity for elapsed time enters the system.

The challenge is not only performing the repair. The challenge is returning serviceable hardware at the rate and time required by engine production.

**Limited Internal Repair Capability**

**Constrained External Repair Capacity**

**Material Shortages**

**Engineering Decision Latency**

**Supplier Variability**

**UNCONTROLLED ENGINE TAT**

Industry investment increasingly reflects this integrated constraint. Safran's LEAP MRO expansion combines engine-shop growth with test capability and expansion of the engine-parts repair network, targeting 1,200 annual LEAP shop visits by 2028. [5][6] Pratt & Whitney's 2026 U.S. investments similarly combine engine capacity, used serviceable material, repair development, quick-turn capability, and process technology. [3]

***Increasing engine capacity requires increasing the repair and support capability necessary to feed it.***

## 5. The Cycle 2 Trap

One engine induction does not create one Cycle 2 transaction. It creates findings.

A single engine can generate many component-level requirements involving repair, replacement, engineering disposition, special processing, inspection, material action, or outside repair. More inductions therefore create multiplied downstream demand.

***Increasing induction capacity can increase total engine TAT if the corresponding Cycle 2 capability has not been industrialized.***

The front of the shop becomes increasingly capable of discovering work that the middle of the shop cannot solve. That is the Cycle 2 Trap.

## 6. Work Content Is Not Engine Time

Traditional MRO performance measurement places significant emphasis on labor. That is appropriate. Standard hours, actual hours, and labor efficiency matter. But they answer a different question from elapsed engine time.

Consider an illustrative repair with 12 standard hours. The repair team performs approximately 12 hours of productive work. Against the labor standard, performance appears acceptable. Yet the component can still experience ten calendar days from queue entry to return to the engine.

| Stage | Calendar Time |
|---|---|
| Queue before repair | 3 days |
| Clean / initial inspection | 1 day |
| Engineering disposition | 2 days |
| Physical repair sequence | 2 days |
| Final inspection / release | 1 day |
| Return to engine line | 1 day |

***Standard Hours measure work content. Calendar TAT measures engine consequence.***

## 7. Standard Hours, Required Repair Output and Calendar TAT

Standard hours establish expected work content. Required repair output connects engine demand and expected findings to the rate at which serviceable hardware must return. Calendar TAT measures the complete elapsed component journey.

Repair operations are variable; they should not be oversimplified into a single repetitive takt calculation. The demand principle remains: the repair system must return serviceable hardware at a rate capable of supporting engine production.

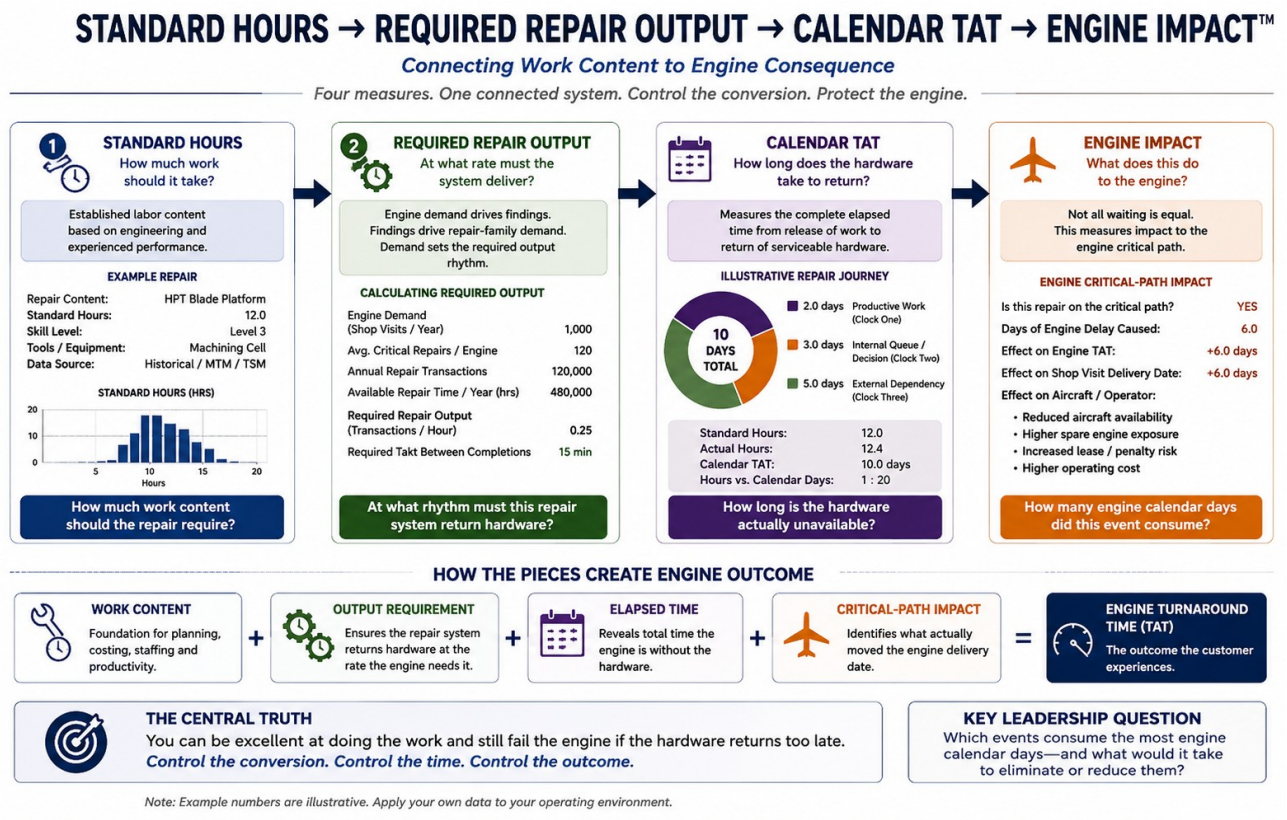



Figure 2. Standard Hours → Required Repair Output → Calendar TAT → Engine Impact™. Example numbers are illustrative.

# 8. The Three Clocks of MRO™

Turnaround time is often discussed as though all elapsed time were maintenance time. It is not.

### Clock One — WORK: Productive Work Time

Physical or technical work is occurring: disassembly, inspection, machining, repair, special processing, assembly, testing, and technical closeout.

### Clock Two — WAIT: Internal Queue and Decision Time

The engine or component remains within organizational control but is not advancing: waiting for inspection, engineering, planning, authorization, quality, priority, release, or the next available resource.

### Clock Three — DEPEND: External Dependency Time

Progress depends upon something outside the engine shop's immediate control: material, outside repair, OEM support, external processing, transportation, supplier capacity, or external testing.

> ***Component Calendar TAT = WORK + WAIT + DEPEND***

# 9. The 24-Hour Engine Clock™

Standard hours have a beginning and an end. The engine clock does not.

When a technician completes a repair at 4:00 p.m. and inspection does not occur until the following morning, the standard hours may have stopped. The engine clock continued.

When engineering receives a finding Friday afternoon but disposition occurs Monday, the engineering labor associated with the decision may be small. The engine experienced the weekend.

When hardware reaches an outside supplier but waits for an available production slot, no labor may be charged to the engine. The engine clock continued.

> ***Every hour is an engine hour.***




Figure 3. Traditional MRO vs. Future MRO and The 24-Hour Engine Clock™.

## 10. The Engineering Decision Loop™

One of the least visible forms of Cycle 2 inventory is hardware waiting for a decision.

A technical finding may require thirty minutes of engineering analysis. If the finding waits three days before evaluation begins, the engine did not experience a thirty-minute decision. It experienced a three-day decision.

***Finding → Information Complete → Evaluation → Decision → Release → Work Resumes***

The useful measure is not simply technical analysis time. It is total decision elapsed time. Decision latency is therefore a leadership issue, not simply an engineering issue.

## 11. Cycle 2 in the Real World

**GTF — SYSTEM CONSTRAINT**

### 648 AIRCRAFT | 28% OF FLEET

At the March 2025 peak, GTF-powered aircraft were grounded while awaiting shop visits, spare engines, or parts. Pratt & Whitney's response has combined MRO capacity with USM, repair development, quick-turn capability, and process technology. [2][3]

**Lesson: engine capacity cannot compensate for insufficient Cycle 2 capability.**

**CFM / LEAP — CAPABILITY + CAPACITY**

### CAPABILITY + CAPACITY

CFM's 2026 MRO strategy pairs capacity growth with repair development, supplier-delivery improvement, spare-parts inventory, and technical-data maturity. Safran's expansion likewise combines engine shops, test, and parts-repair capability. [4][5][6]

**Lesson: the aftermarket response is system-level, not stand-level.**

*Different engines. Different constraints. Same operating principle: the engine experiences the entire system.*

## 12. Cycle 2 Sovereignty™

The answer is not complete vertical integration. No economically rational MRO can — or should — own every capability.

The objective is strategic control. An MRO must understand which dependencies can control its engine and decide deliberately whether those dependencies should be owned, partnered, buffered, duplicated, or actively managed.

***Cycle 2 Sovereignty™ is the degree to which an MRO controls the technical decisions, repairs, material, external processes, and supply-chain dependencies required to convert engine findings into serviceable hardware on a predictable schedule.***

**REPAIR CONTROL**

Can the organization perform — or reliably access — the repairs that repeatedly control engine TAT?

**ENGINEERING CONTROL**

Can technical dispositions be made at the speed production requires?

**VISIBILITY CONTROL**

Can component-level risk be identified before it becomes engine-level delay?

**MATERIAL CONTROL**

Does the organization have predictable access to material required to protect the engine critical path?

**SUPPLIER CONTROL**

Are critical suppliers measurable, recoverable, and appropriately redundant?

**RECOVERY CONTROL**

When the planned path fails, is an executable alternative already available?

***Not everything must be owned. Everything capable of controlling the engine must be understood and deliberately controlled.***

# 13. Repair Economics and Human Capital

### COMPONENT COST ≠ ENGINE VALUE

Repair economics must include engine-level consequence, not only component transaction cost.

A capability can create value by removing critical-path calendar days, reducing WIP, protecting stand utilization, limiting premium material, and improving schedule stability.

**Ask: What does this capability do to the engine?**

### HEADCOUNT ≠ CAPABILITY

Boeing projects demand for approximately 710,000 new aviation maintenance technicians over twenty years. [7]

Headcount is potential capacity. Judgment, technical depth, knowledge transfer, and experience applied at the point of execution create capability.

**Ask: Can the operating system reproduce the knowledge it depends on?**

***Component Cost ≠ Engine Value***

***Headcount represents potential capacity. Knowledge applied at the point of execution represents capability.***

# 14. The Future MRO Operating Model

**TRADITIONAL MRO**

- Measures induction capacity
- Optimizes departments
- Emphasizes labor efficiency
- Maximizes asset utilization
- Treats supply chain primarily as procurement
- Centralizes many technical decisions
- Expedites after plans fail
- Measures activity

**FUTURE MRO**

- Measures completed-engine throughput
- Optimizes the engine critical path
- Connects standard hours to calendar return
- Balances utilization against flow
- Treats supply-chain resilience as operational
- Moves authority closer to execution
- Designs recovery paths before failure
- Measures waiting as aggressively as work

***Yesterday's MRO managed activity. Tomorrow's MRO must manage time, dependency, and flow.***

# 15. Seven Questions Leadership Must Answer

1. **Which Cycle 2 repairs most frequently control engine TAT?**
2. **What is their standard-hour content versus actual calendar return?**
3. **Does repair output capability support expected engine findings?**
4. **Where are the largest WAIT and DEPEND clocks?**
5. **Which suppliers or capabilities can stop an engine?**
6. **Which capability investment removes the most engine critical-path calendar days?**
7. **When the primary Cycle 2 solution fails, what is the recovery path?**

If leadership cannot answer these questions, it does not fully understand its engine event. If it does not understand the engine event, it cannot reliably control the customer commitment.

## Conclusion

Aircraft engine MRO will continue to grow.

Growth alone will not protect every organization participating in it.

The next generation of MRO performance will increasingly be determined by the ability to convert findings into serviceable hardware at the rate and time required by the engine.

That requires more than capacity. It requires executable repair capability, material, engineering speed, supplier resilience, knowledge, visibility, recovery — and control of calendar time.

| | |
|---|---|
| **STANDARD HOURS** | How much work should occur. |
| **ACTUAL HOURS** | How efficiently the work was performed. |
| **REQUIRED REPAIR OUTPUT** | How frequently the system must deliver. |
| **CALENDAR TAT** | How long the hardware was actually unavailable. |
| **CRITICAL-PATH IMPACT** | Whether any of those measures ultimately mattered. |

The engine does not care which department achieved its target. It does not recognize shift change. It does not stop aging while engineering considers a disposition. It does not stop because a component crossed the MRO's property line.

***The 24-Hour Engine Clock™ continues.***

Organizations that understand that clock — and control Cycle 2 — will increasingly control engine throughput. Those that do not will surrender their schedules to the queues, decisions, material shortages, suppliers, and dependencies that do.

**MRO IS NOT GOING EXTINCT.**

**BUT THE TRADITIONAL MRO OPERATING MODEL MAY BE APPROACHING ITS LAST DANCE.**

***The music isn't stopping for MRO. It's stopping for the organizations that refuse to change how they dance.***

# References


**[1]** Oliver Wyman, “Global Fleet and MRO Market Forecast 2026–2036,” 2026. Global MRO demand reached $136 billion in 2025 and is expected to approach $193 billion by the end of the decade; engine MRO is the largest and fastest-growing segment.

**[2]** International Air Transport Association (IATA) / Emerton, “Single-Aisle Aircraft Engines MRO: Strategic Levers to Address Supply Chain Challenges,” June 2026; and IATA, “Urgent Action Needed to Ease Engine MRO Bottlenecks,” June 24, 2026. At the March 2025 peak, 648 GTF-powered aircraft (28% of the fleet) were grounded awaiting shop visits, spare engines, or parts.

**[3]** RTX / Pratt & Whitney, “Pratt & Whitney Invests More Than $100M to Expand MRO Footprint in the U.S.,” April 21, 2026. The program combines GTF engine capacity, USM, repair development, quick-turn capability, and additive repairs; Pratt identifies material constraints as a major MRO delay driver.

**[4]** CFM International, “CFM Expands, Strengthens Open MRO Ecosystem,” July 2026. CFM describes investments in capability and capacity, high-yield repair development, supplier delivery, spare-parts inventory, and technical manual maturity.

**[5]** Safran Aircraft Engines, “Safran Invests Over €1 Billion to Develop Global MRO Network for Its LEAP Engine,” October 29, 2024. The plan targets 1,200 LEAP shop visits per year by 2028 and includes expansion of the engine-parts repair network.

**[6]** Safran, 2025 Integrated Report. Safran describes continued CFM56 shop-visit demand alongside LEAP aftermarket industrialization and its €1 billion LEAP MRO capacity program.

**[7]** Boeing, “Pilot and Technician Outlook 2025–2044.” Boeing projects demand for 710,000 new technicians over twenty years and emphasizes retirement, attrition, and knowledge transfer.

**[8]** IATA, Aviation Supply Chain materials and 2026 World Maintenance & Engineering Symposium remarks. IATA identifies parts availability, aftermarket access, visibility, and human capacity as major aviation supply-chain priorities.


# Flow Path Intellectual Architecture

The following terms are used in this paper as Flow Path analytical frameworks: Capacity ≠ Capability™, Three-Cycle Engine Event™, Cycle 2 Sovereignty™, The Three Clocks of MRO™, The 24-Hour Engine Clock™, and Engineering Decision Loop™.

Standard industry terms — including standard hours, actual hours, calendar TAT, critical path, repair output, WIP, and engine TAT — are used in their conventional sense.

*This publication is an executive operating-model analysis. The illustrative repair example and numerical values shown in Figure 2 are explicitly modeled examples and are not presented as customer-specific performance data.*


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*Precision. Direction. Impact.*


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