Rechart Operational Processes to be Data-Driven

The straight line from data to competitiveness

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Purpose of the session:

A “data-driven” maintenance operation is defined as one that harnesses its CMMS and other data to augment the experience and judgement of role holders as they plan, organize, conduct and control their processes.

Should a maintenance operation set out to become data-driven, it will find itself rethinking its processes.

Per the adage, “When we change the way we look at things, the things we look at change.”

If we rethink maintenance management through the eyes of data-drivenness, our processes will change.

The session works top-down through the steps to rethink the management processes of a maintenance operation through the lens of what data and analytics make possible.

“Payload” approach to the session:

The presentation is formed as what I call a **“payload-style,”** defined as one formed to deliver, within the very limited allowed time, the full scope of information such that when you leave you will **“know what to do.”**

The criteria characteristics of a payload-type presentation are as follows:

- Introduces “all”—rather than “pieces”—that you **“must know that you must know”** for reaching data-drivenness.
- For every “must know,” map to “hands-on” instructions for self-directed learners.
- Non-expert attendees can, in turn, disperse the “know what to do” across their own organizations by emulating the presentation.

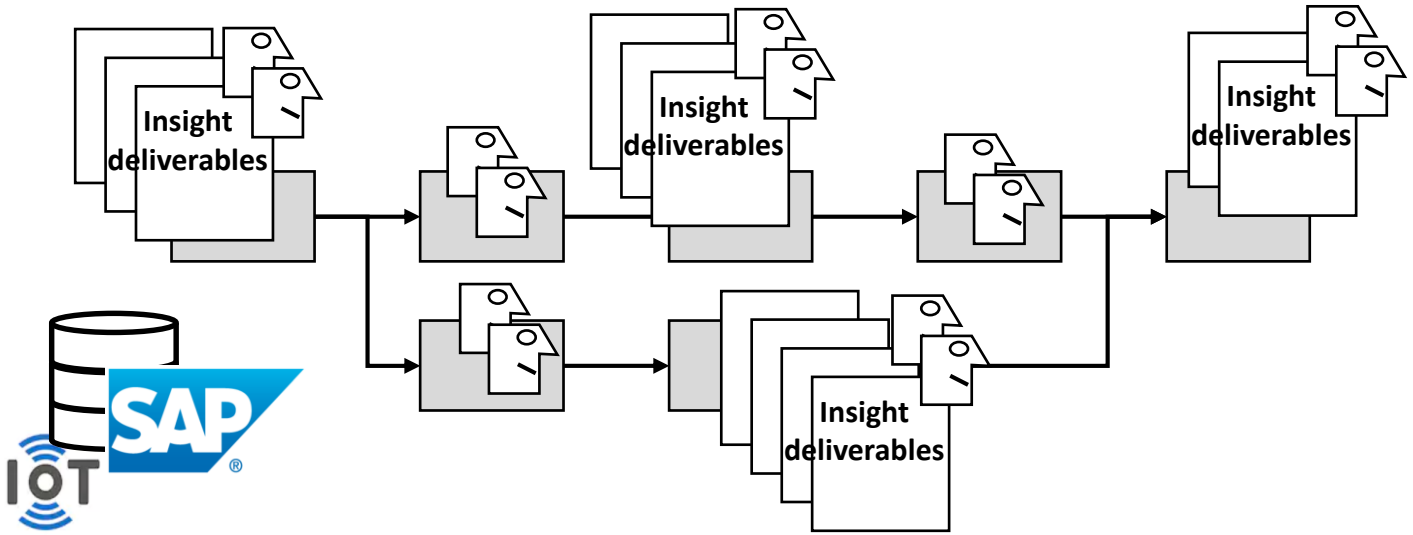
Agenda:

- ❑ **Foundation perspectives**
- ❑ Competitive North Star for maintenance
- ❑ Maintenance processes beneath the North-Star
- ❑ Processes recharted to the North Star
  - ➢ Mandatory practice and process
  - ➢ Workload and service interval processes
  - ➢ Maintenance capacity processes
  - ➢ Recountive insight processes

The big picture is that an organization simply improves its processes to include all augmenting **“insight deliverables”** that will make a difference

At some places along any process, the “**best outcomes**” can only be realized when experience and judgement are augmented with “**insight deliverables**.”

At each such place, a suite of system reports, tables, charts and models is recognized, built and worked to realize the best of outcomes.

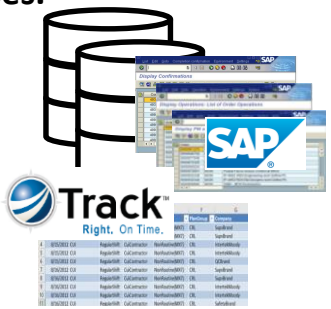


None, one or more of four types of insight deliverables may be relevant to the outcome at sectors, paths and steps along an operational process

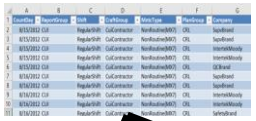
Category	Description
System reports	Taken from operating systems.
Know-thy-data	Data is presented in descriptive, graphic and statistical perspectives as a means to understand issues with data and what it depicts for the source processes.
Recountive	Insight direct from data—without processing through analytics—to ask and answer questions of who, what, when, where and how much, audit compliance and metrics.
Modeled	Insight gained upon data flowing through analytic models that ask and answer questions of relationship, difference, time series, duration and apparency.

The insight deliverables can be built at the **“Grassroots”** because there is a triad of software to all insight that we already have use of or rights to as standard and open-source

Data in multiple operating systems and possibly multiple data bases.



Data from process tasks conducted with Excel.



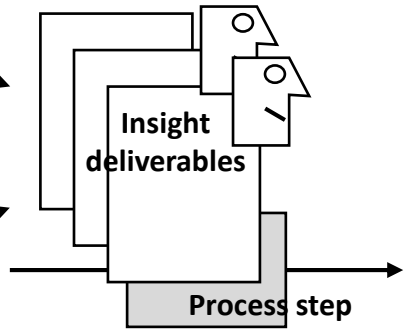
Build super tables from sourced data.

- Pivot as dashboards.
- Tables and calculations.
- Conventional charts.

- Descriptive statistics.
- Layered charts with ggplot2.
- Machine learning and artificial intelligence based analytics.

FREE!

Experience and judgement augmented with a full range of relevant insight deliverables.



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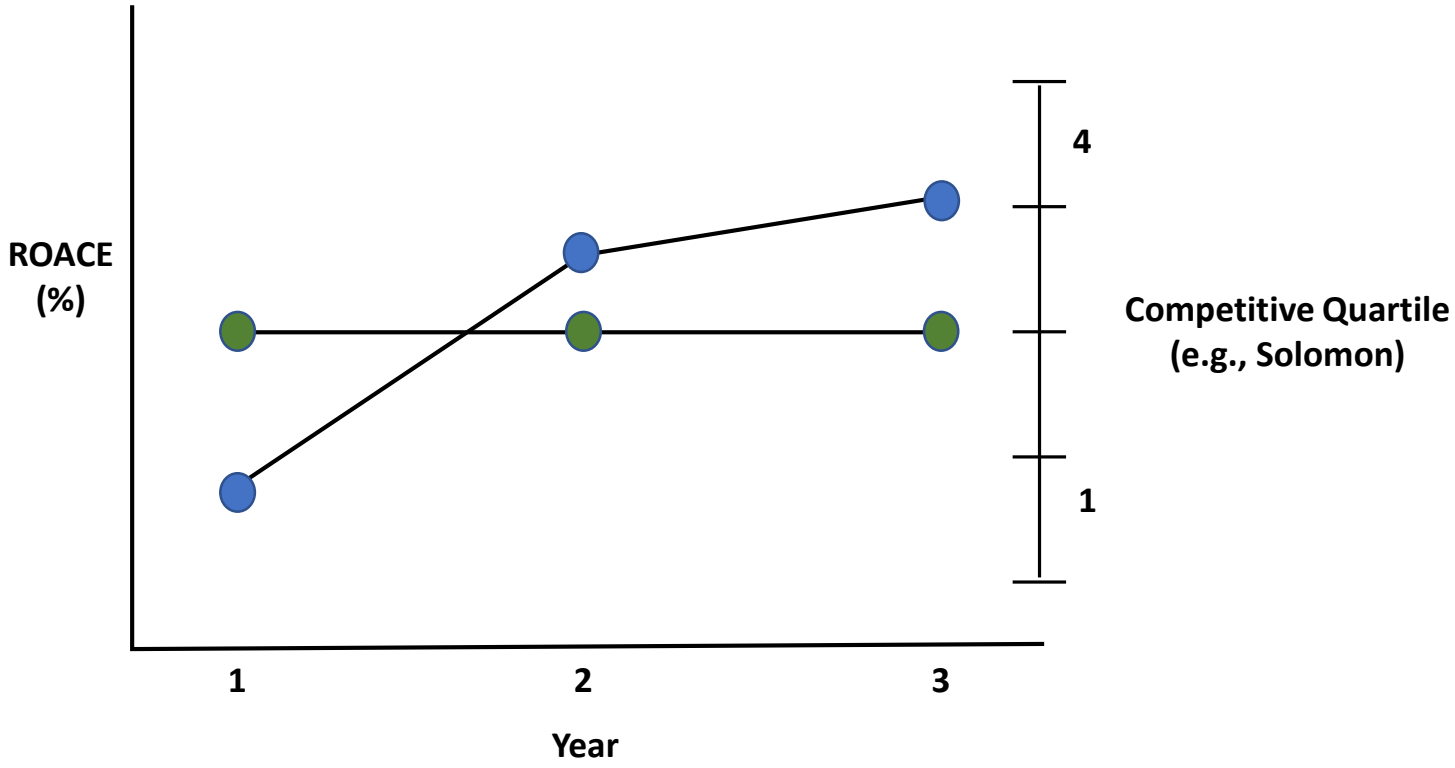
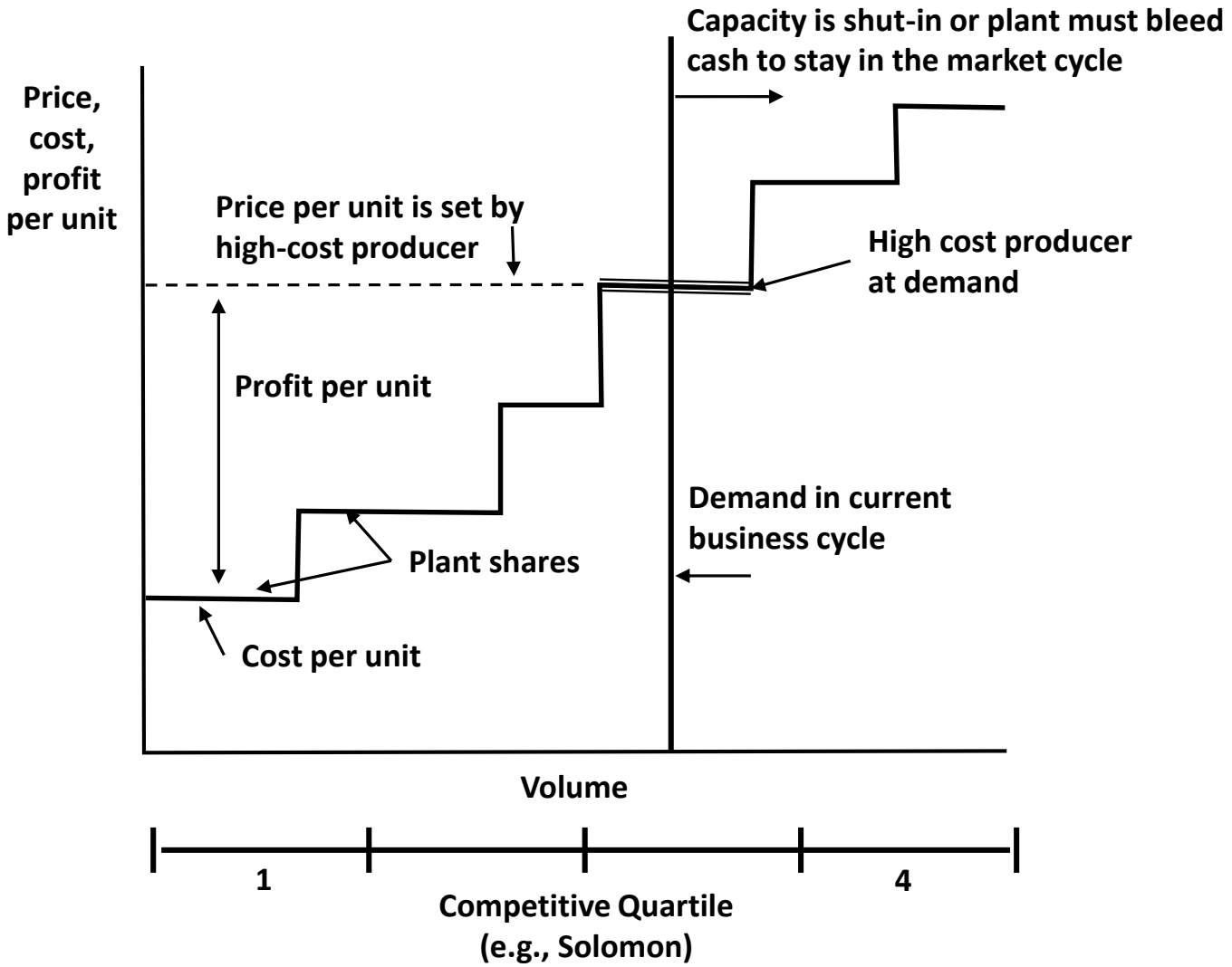
All firms compete for a rate of return above their industry's average—those that lose suffer at the hands of those that win



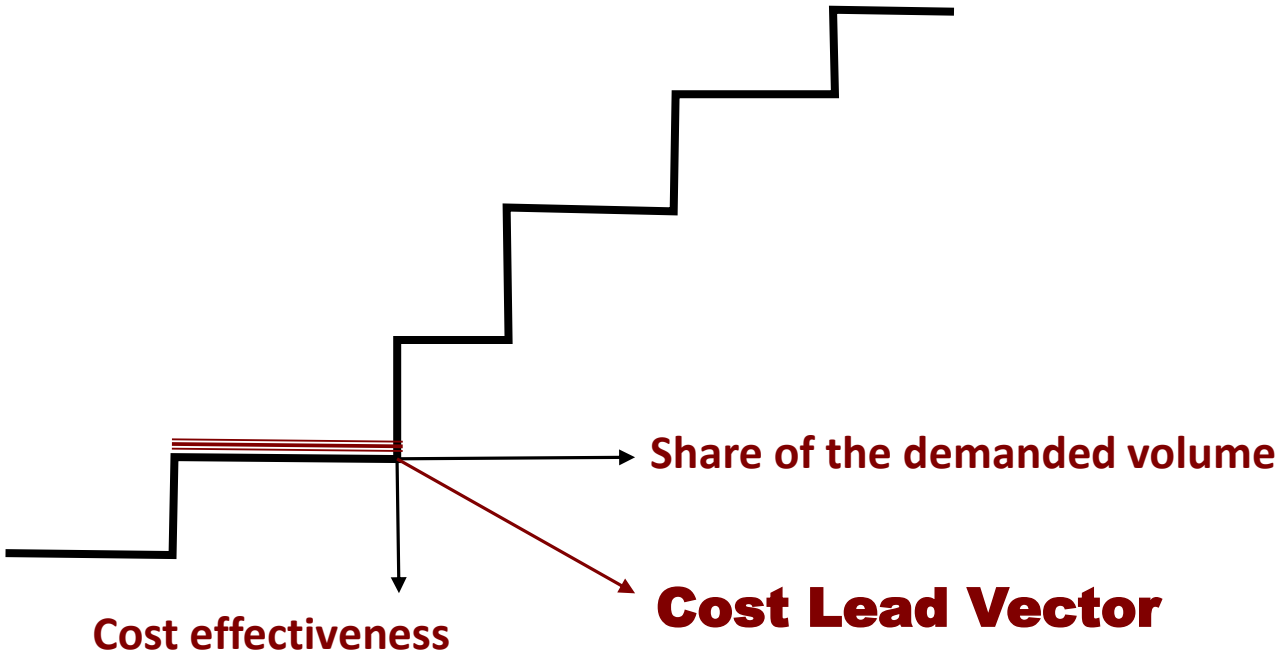
See

Pdf-Book, "Maintenance Reinvented and Business Success," Chapter 3: Strategy for Competitiveness and Returns. Lamb, 2009.
https://analytics4strategy.com/mntcreinvented

To link plant maintenance and reliability to competitiveness let's look at the core-most basis of competitiveness to commodity industries—cost leadership



The competitive purpose of maintenance and reliability can be depicted as a firm's place in an industry's hierarchy of cost leadership



The overall objective is to drive the Cost Lead Vector to the right and downward.

Maintenance operations have a direct mandate with respect to the **Cost Lead Vector**

- Recognize and do the work at all levels of the maintenance operation to:
  - Sustain the readiness of production assets to deliver the aggregate and weekly production plan.
  - Stay abreast of site and facilities deterioration.

- Establish and function with the maintenance capacity that matches the workload of readiness and deterioration—craft and staff head count, parts and materials, equipment and facilities.

Note:

- Presented here as generalized, the mandate is nuanced by the basis of competition and forces for any industry, competitors and plant. See referenced pdf-book.
- Maintenance capacity is the workload that can be conducted by a plant's system of crafts and support headcount and skills, parts and material inventory, equipment, facilities, training and instructions, processes in the plant's working environment.

See Pdf-Book, "Maintenance Reinvented and Business Success," Chapter 3: Strategy for Competitiveness and Returns. Lamb, 2009.

A maintenance operation's success in the mandate can be measured as a readily constructible proxy to ROACE (Return on Average Capital Employed)

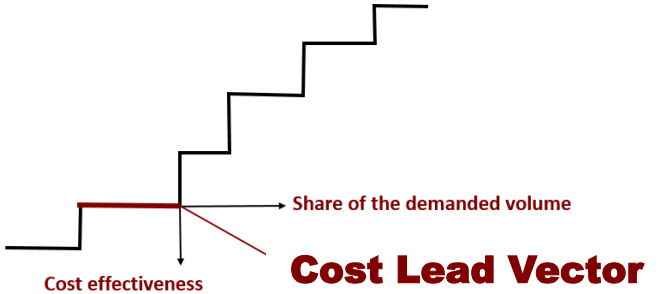
$$\text{ROACE} = \boxed{\text{Unit profit as Percent}} \times \boxed{\text{Ratio Revenue to Assets}}$$

$$\text{Proxy ROACE} = \left[\frac{\text{PricePerUnit} - \text{MaintenanceCostPerUnit}}{\text{PricePerUnit}} \times 100 \right] \times \frac{\text{PeakProductiveCapacity} \times \%\text{Uptime} \times \text{PricePerUnit}}{\text{AssetReplacementValue} + \text{MaintenanceAssets}}$$

See

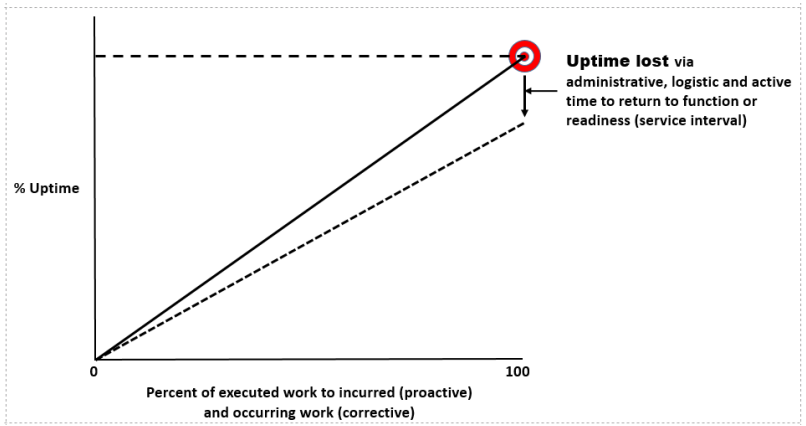
- **Paper, "ROACE: Financial North Star to Maintenance and Reliability Operations" for explanation of standard ROACE.** https://analytics4strategy.com/roacenorthstar
- **Pdf-Book, "Maintenance Reinvented and Business Success," Chapter 5: Returns Sensitivity Analysis for Maintenance. Lamb, 2009.** https://analytics4strategy.com/mntcreinvented

Uptime and cost per unit in the Cost Lead Vector are linked to two specifiable, manageable dimensions of a data-driven maintenance operation

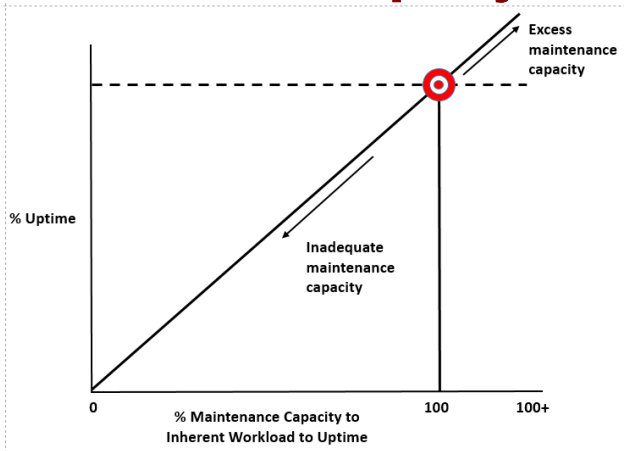


Cost Lead Vector

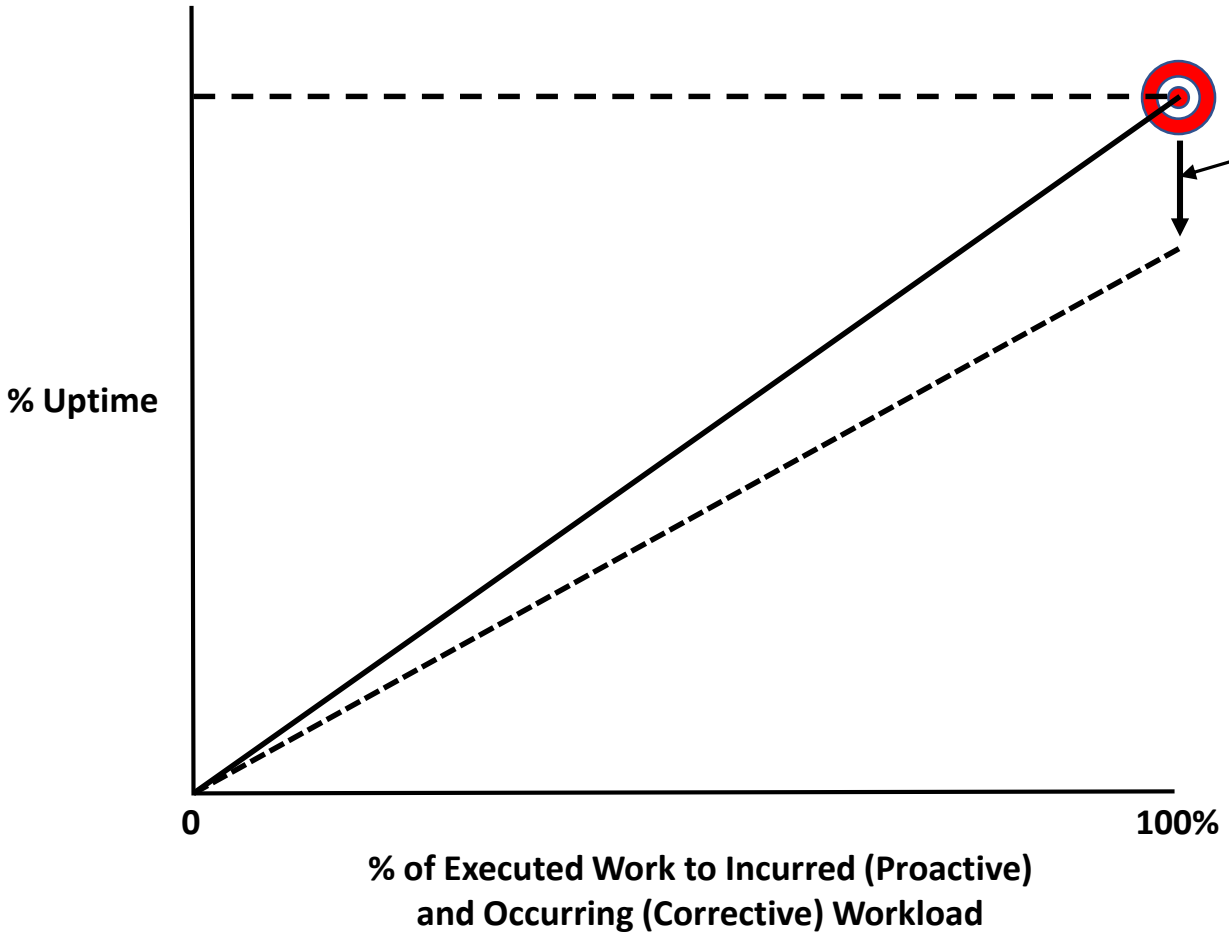
Workload and Service Interval



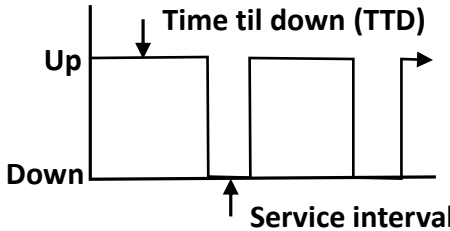
Maintenance Capacity



All plants have a workload inherent to targeted uptime and deterioration control, and an inherent service interval to both

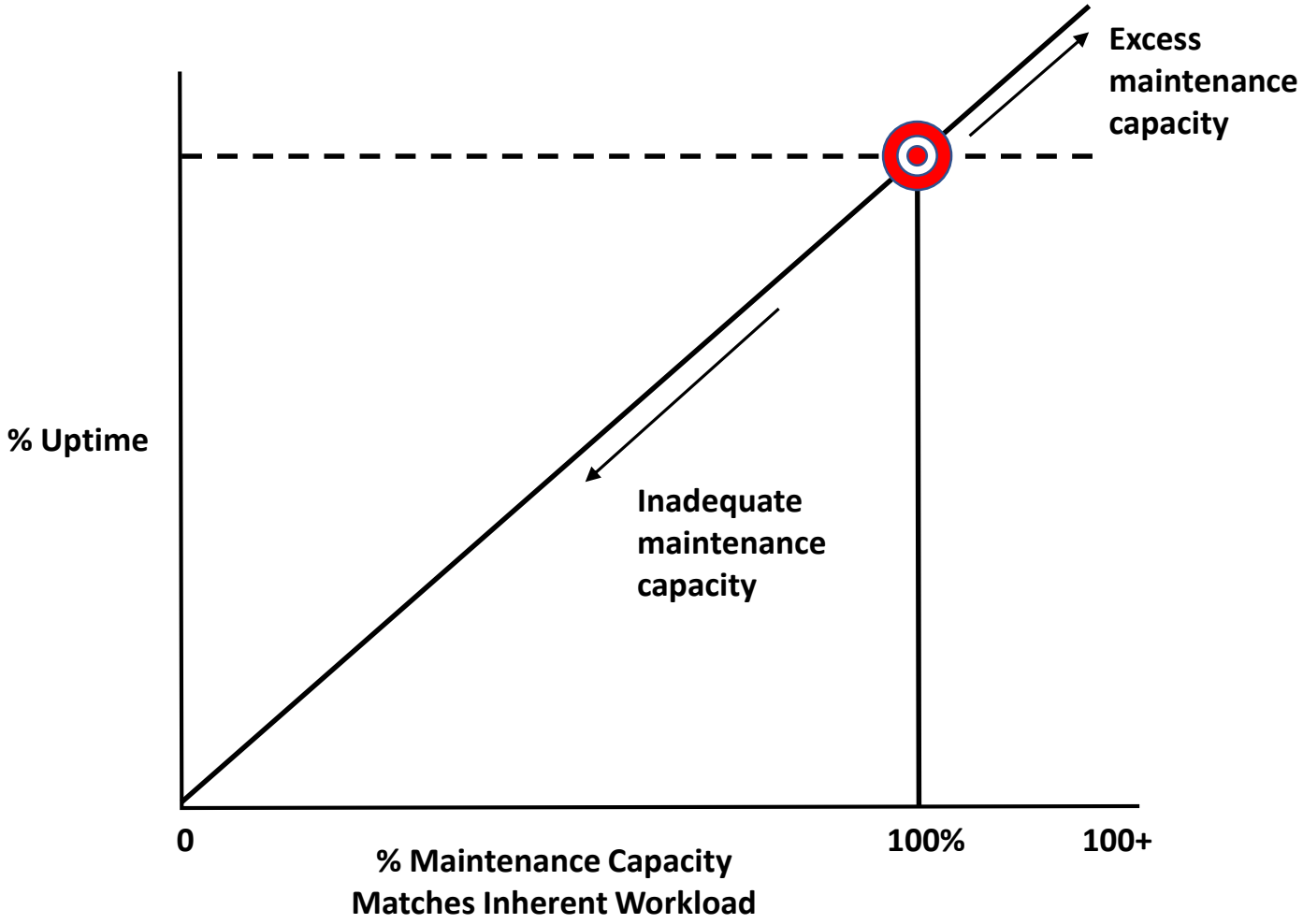


Uptime lost via administrative, logistic and active time to return to function or readiness (service interval)

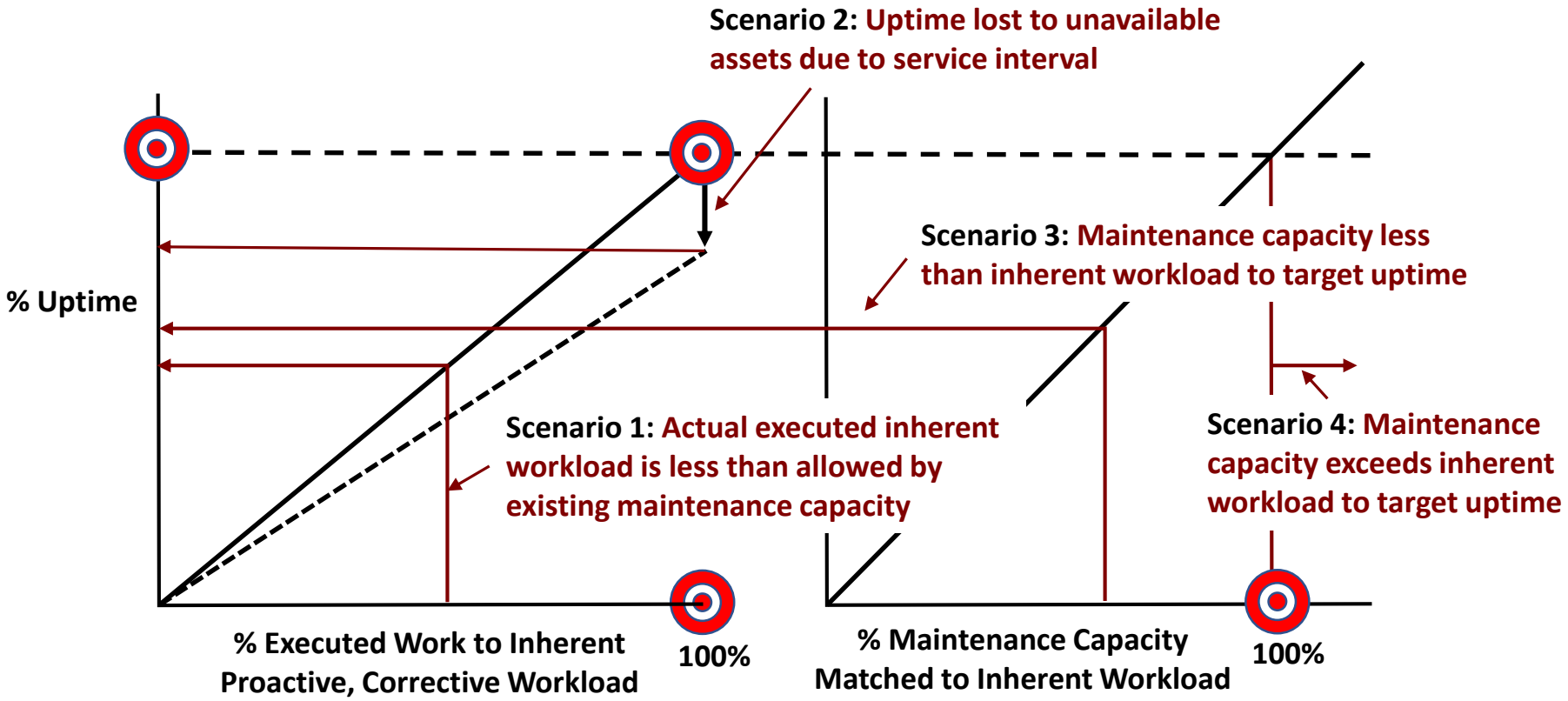


$$\%\text{Uptime} = \frac{\text{TTD}}{\text{TTD + SI}} \text{ X } 100$$

Maintenance capacity decides whether or not inherent workload can be executed, but excess capacity reduces P-ROACE



A plant's inherent workload, service-interval effect and maintenance capacity can interplay in four **scenarios** contrary to P-ROACE



We must identify where the four scenarios could, or now, present themselves and then design our maintenance operation to block or diminish them

Scenario	Consequence for Proxy-ROACE	
	Unit Profit as Percent	Ratio of Revenue to Assets
1. Executed workload less than inherent workload—with adequate maintenance capacity.	Reduced by increased maintenance cost per unit.	Reduced by lost uptime.
2. Uptime lost to unavailable assets due to excessive service interval.	Unchanged.	Reduced as uptime at risk is actually lost.
3. Maintenance capacity is less than inherent workload	Unchanged.	Reduced by lost uptime.
4. Maintenance capacity exceeds inherent workload to target Uptime	Reduced by increased maintenance cost per unit.	Unchanged.

P-ROACE = Unit profit as Percent X Ratio Revenue to Assets

Multiplicative impact

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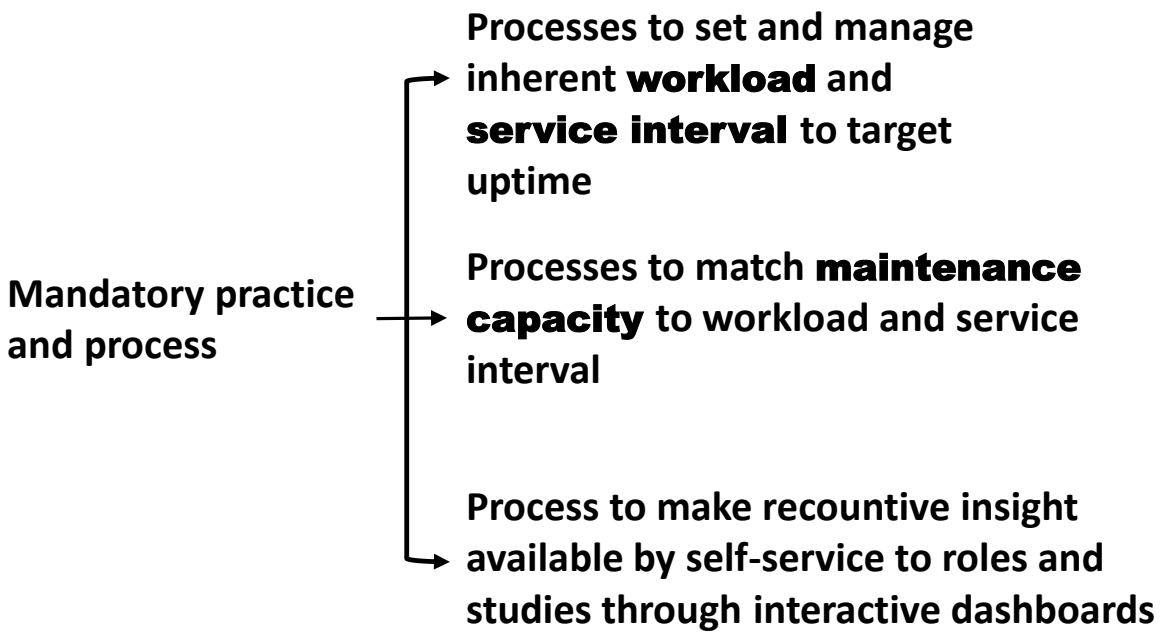
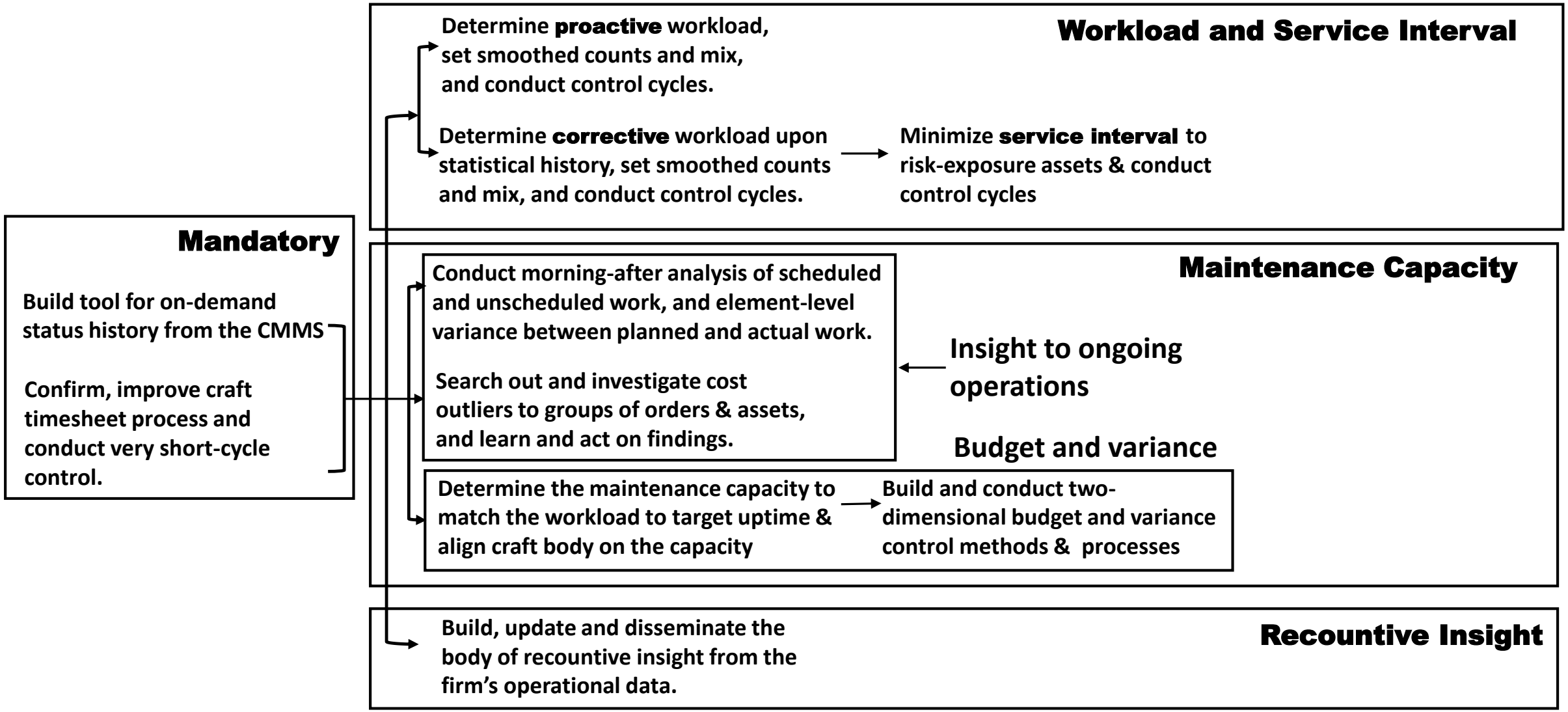
Downward from the outcomes of workload, service interval and maintenance capacity to P-ROACE are groups of particular data-driven processes



Working down from the proxy P-ROACE; there are top-level process in which all other maintenance and reliability best practices are subordinated—each to be explained in the remaining sections



In the charted processes, the placement of insight deliverables will be annotated as the following code

Code	Insight Deliverable
KID	Know-thy-data
RID	Recountive
MID	Modeled

Throughout all data-driven processes there are control cycles as will be coded in their flowcharts

Code	Definition
VSCC	**Very Short Control Cycle:** Cycle is less than weekly, next or same day.
WCC	**Weekly Control Cycle:** Done with respect to a completed business week.
MCC	**Monthly Control Cycle:** Occurs in conjunction to the reporting cycles at the closing of the books at the month.
YCC	**Yearly Control Cycle:** Control annually and year-to-date.

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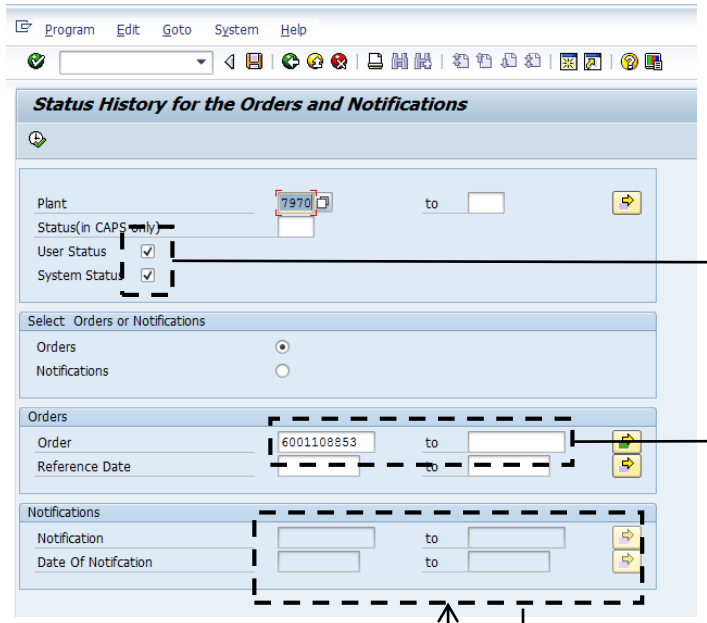
Without two types of data—captured in all CMMSs—a plant will be unable to determine and manage workload, service interval and maintenance capacity

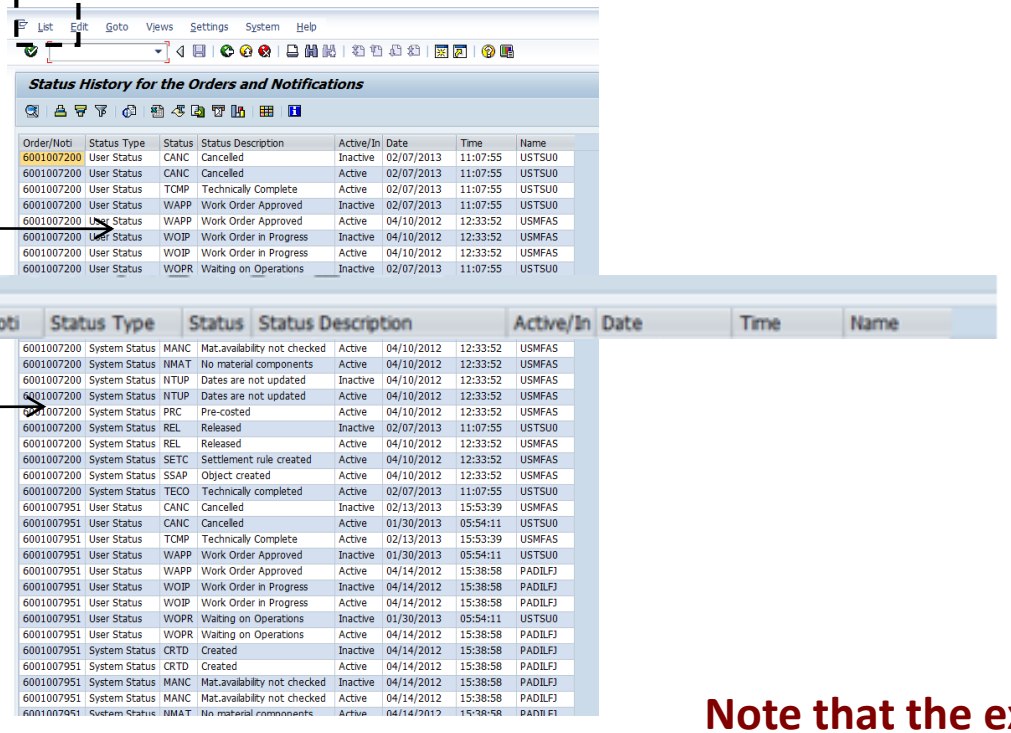
- **Status history to lists of work orders.**
  - Incredibly CMMS's do not offer the report, but the history data is captured automatically as work orders progress from notification to full close out.
  - Status history is actually a simple query that data engineers can develop as a standard on demand report from the CMMS.
  - Creating and deploying the data as on-demand report is an easy several day project to one of the firm's data engineers.
- **Craft hours accurately recorded to the work done.**
  - It is not unusual to find that hours are recorded to less than 50 percent of the work orders.
  - It is also not unusual to find the users of hours data are not aware that they are working with the resulting misinformation.
  - Cause is typically poorly designed or unenforced timesheet processes.
  - Redesign and compliance requires management support one level up from the organizational units that conduct the daily and weekly steps to record craft hours to the plant's payroll process.

Mandatory Practice: Build tool for on-demand status history from the CMMS

SAP transaction: ZPM_WO_HISTORY



Export to Excel Table



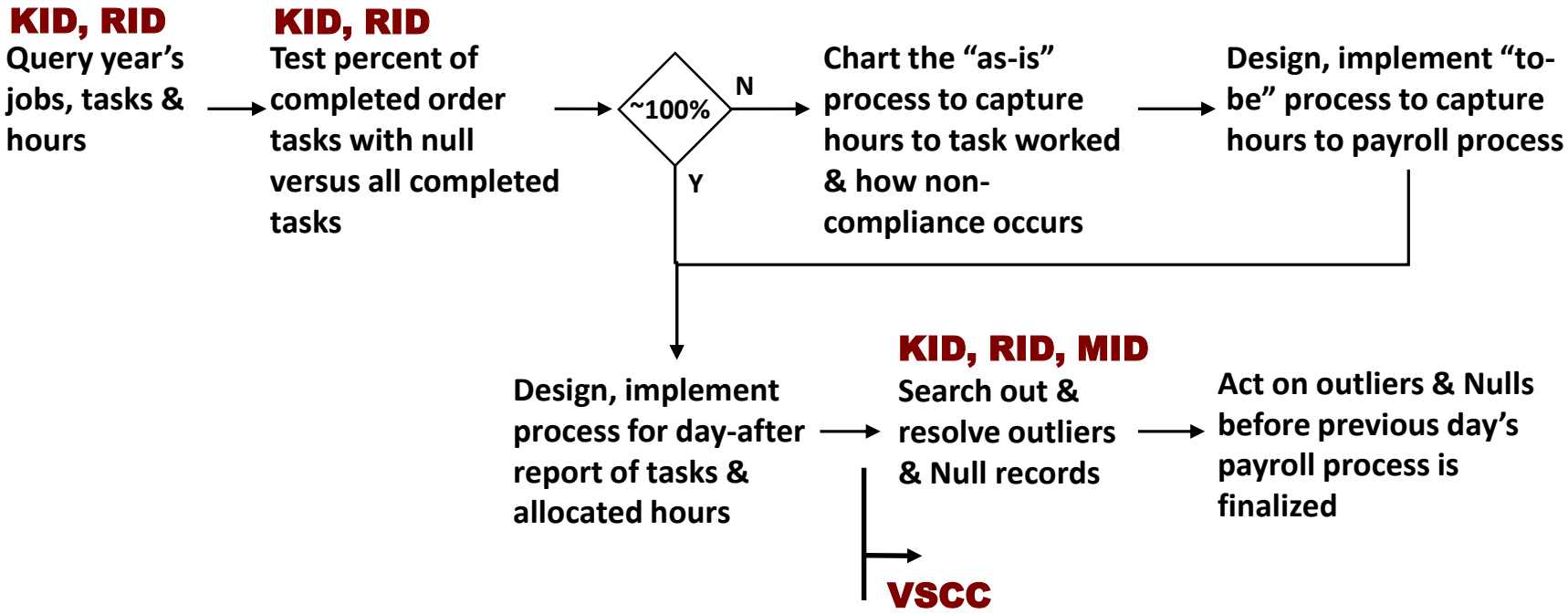
Take same route with respect to notifications

1	Notification
2	Order
3	Description
4	User status
5	System status
6	Cost center
7	Planner group
8	FunctLocation
9	Created on
10	Changed on
11	Description2
12	Main WorkCtr
13	Notif.date
14	Notifictn type
15	Priority

Join the status history to the detail of the notifications through SAP IW29: List of notifications (Done with MS Access query functionality)

Note that the example (SAP CMMS) delivers the what-when detail that is foundational to the analyses and control of any operation through its processes

Mandatory Process: Confirm, improve craft timesheet process and conduct very short-cycle control



- Day-after VSCC is warranted because accurate allocation is life-is-blood data to maximizing P-ROACE.
- Without accuracy, data is only valid at the boundary that a particular body of crafts operate, all below that data is misinformation.

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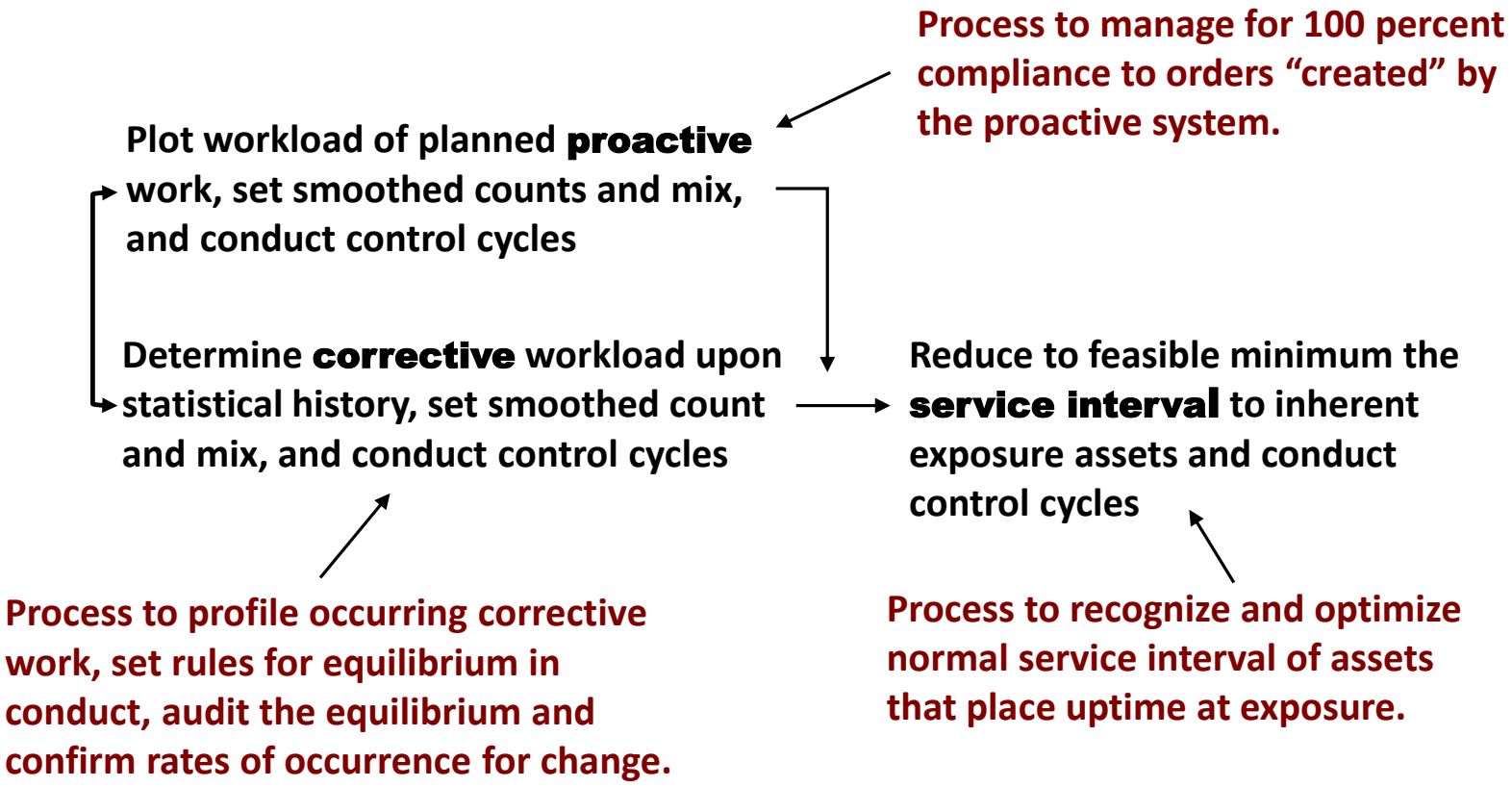
The platform determinate of realizing targeted uptime and protecting asset value is to quantify and timely execute the workload to sustain both



There is a set of principles that are inherent to establishing the year's workload

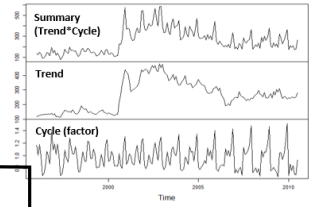
- **All plants have an inherent workload to any given level of aggregate production for the year.**
- **The workload is quantifiable by plan (proactive maintenance) and by statistical analytics (corrective maintenance).**
  - **See paper: "Setting the Budget for Maintenance Workload."** https://analytics4strategy.com/setbdgt4mntcwrkld
- **The link from workload to maximally cost effective matching maintenance capacity is the outcome of smoothing the count and mix of work orders.**
  - **See paper: "Size Maintenance Craft Capacity on Forecasts, Not Backlog."** https://analytics4strategy.com/szcrftcpctyonfrcst
- **Time series analytics looms large to determining inherent workload and smoothing.**
  - **See paper: "Explore what Did and May Happen with Time Series Analytics."** https://analytics4strategy.com/timeseriesqs
- **Duration analytics looms large to determining maintainability for risk exposure assets.**
  - **See paper: "Find the Time that is Money By Asking Durations Questions."** https://analytics4strategy.com/tmismnyqstns
- **The determined workloads are the target metrics to plant function rather than rule-of-thumb to maintenance metrics.**

Process: Plot workload of planned **proactive** work, set smoothed counts and mix, and conduct control cycles

RID
Extract year's workload from proactive work system

MID
Set year's rules for month, week and day smoothing of count and mix

Time series questions



Receive short-term workload from proactive work system

Set week, daily schedules on smooth rules

VSCC
RID
Confirm previous day's execution & adjust remaining week for schedule compliance.

WCC
RID
Audit week's execution of scheduled work

RID
Generate Monday-after reports:
- Percent of work scheduled per system to completed work.
- List of work not completed & responsibility.
- List of work completed, but not shown as completed status.
- Bogus orders and questionable intervals.

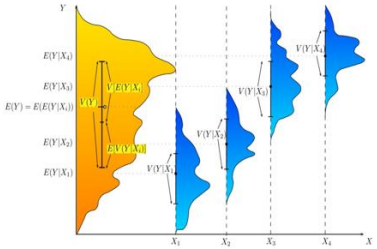
Difference questions

Catchup to 100 percent while sustaining current week

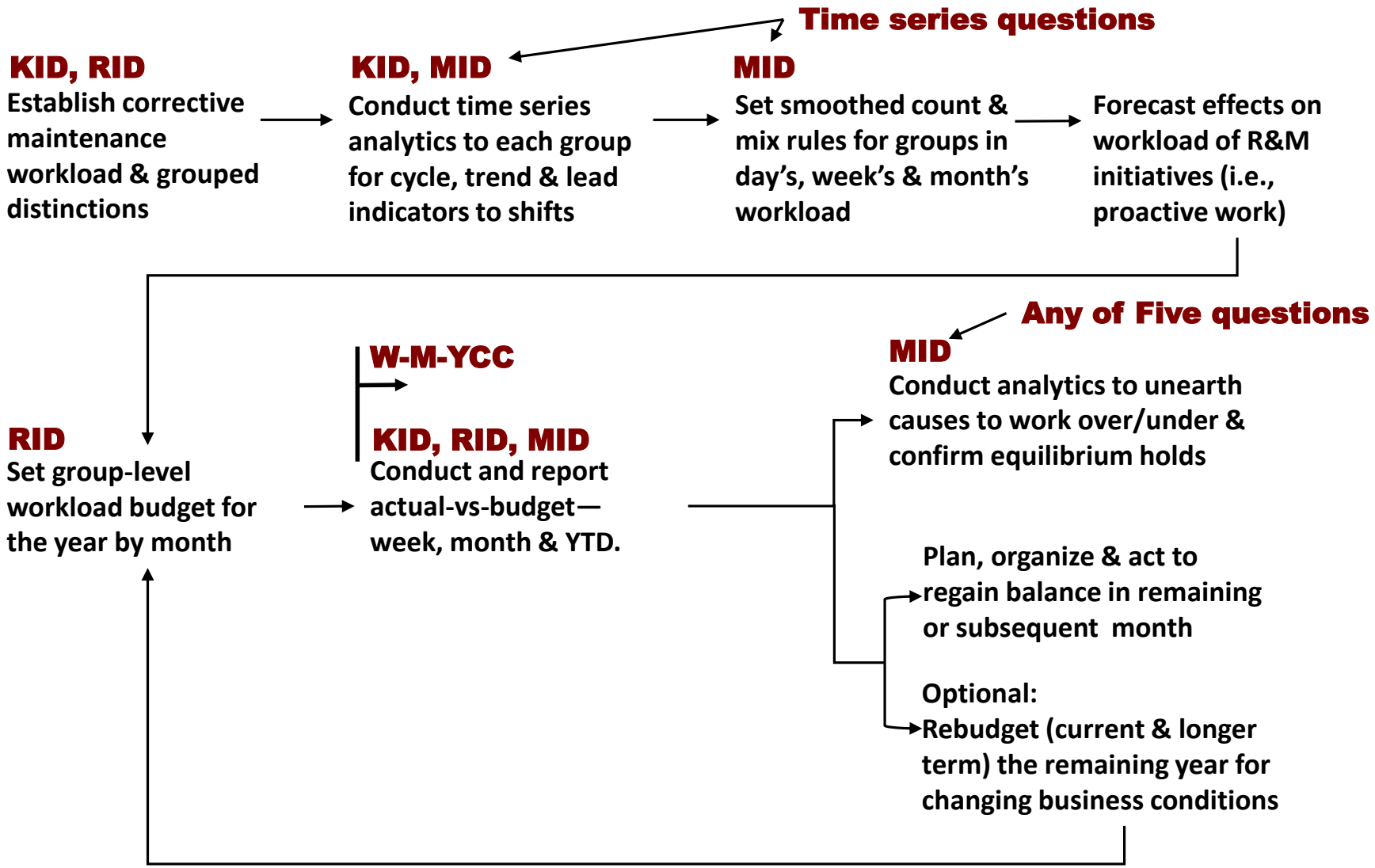
Update CMMS records and devise new audit devices (RID)

Submit to RCM specialists for cleansing or review of rules

MID
Conduct difference analytics to confirm efficacy of proactive strategies and programs.



Process: Determine **corrective** workload upon statistical history, set smoothed count and mix, and conduct control cycles



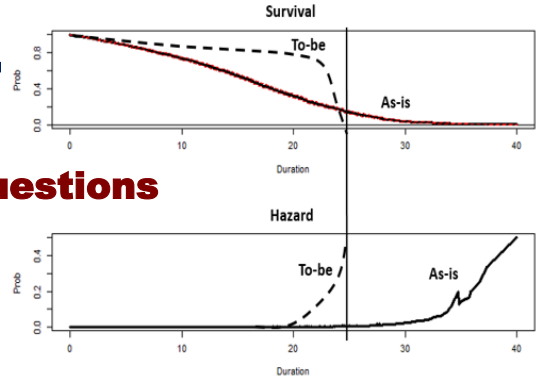
Process: Reduce to feasible minimum the **service interval** to inherent-exposure assets and conduct control cycles

Establish the asset groups of inherent exposure to uptime while not at readiness

KID, RID
Query 1-2 years of work order statuses history for the select asset groups

Establish statuses that decide service interval until readiness

Duration questions



KID, RID, MID
Conduct analysis of actual durations—retention, exit & shape for each status

Establish (with work planners) nominal durations for stages.

RID, MID
Establish table of actual to nominal & outlier durations to each

Set rules for retention and exit of each status with regard for priority

RID, MID
Generate audit metrics and reports.

- Orders past retention rules.
- Rate of exit when past retention.
- FIFO to exit for groups and priority rules.

W-M-YCC

MID
Investigate & remediate non-compliances

Any of five questions

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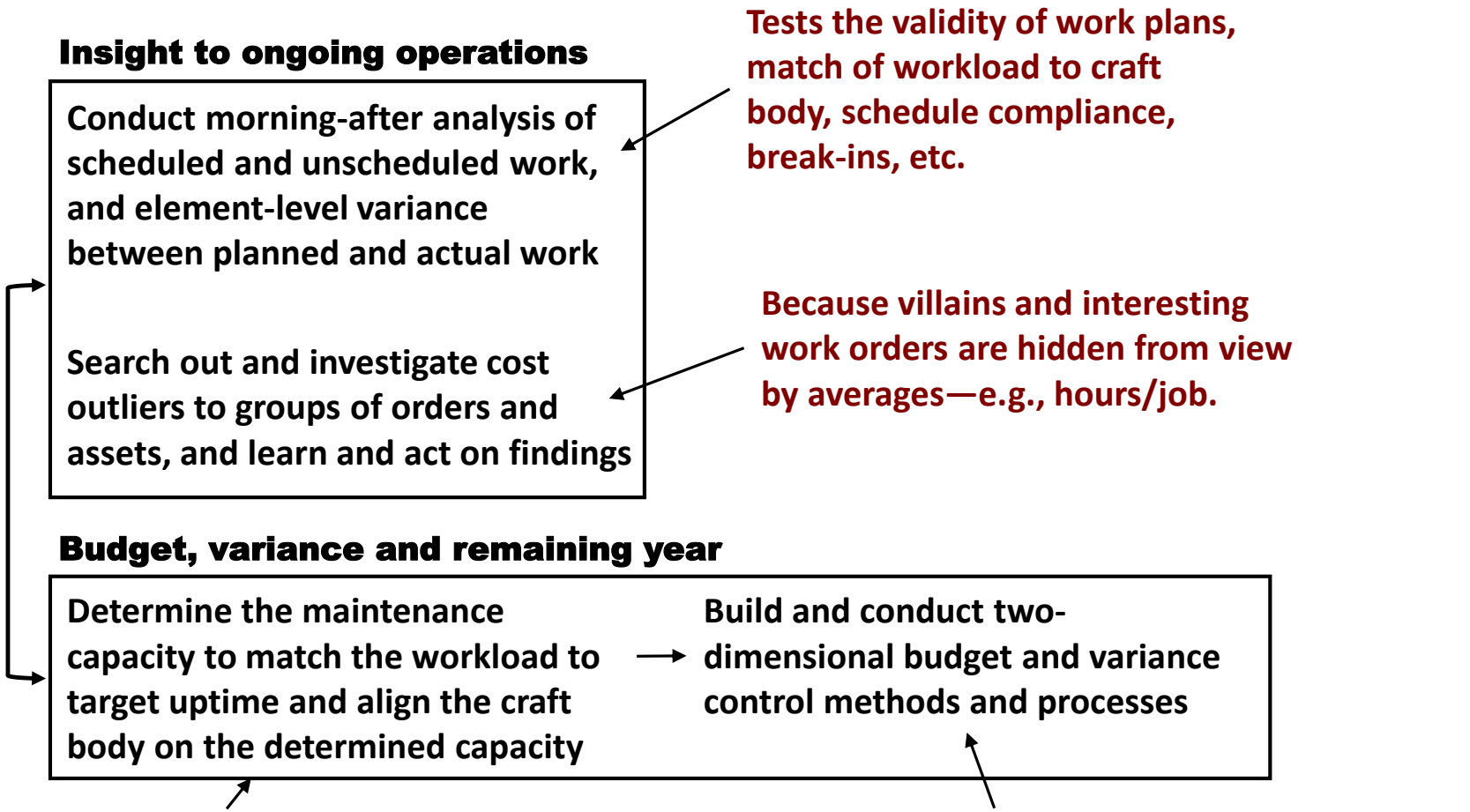
Maintenance Capacity is. . .

The workload that can be conducted by a plant's system of crafts and support headcount and skills, parts and material inventory, equipment, facilities, training and instructions, processes in the plant's working environment.

Maintenance capacity decides the cost of maintenance per unit of production, but we should note the characteristics of the cost

- Maintenance may be the largest cost per unit; after production materials and plant energy.
- Most cost elements are inherent to the work done rather than controllable—e.g., maintenance parts and materials.
- The assets of maintenance capacity—parts and materials, equipment and facilities:
  - If not expensed, pass through denominator of the turn-over side of the P-ROACE calculation.
  - Because of relative size to RAV, P-ROACE is largely insensitive to them.
  - Can loom large in their influence on the service interval for inherent-exposure assets.
- Craft labor is felt directly and significantly in maintenance cost per unit of P-ROACE.
  - Is also the most influenceable cost of maintenance capacity.
  - Actual hours per work order are decided by crafts in a plant's current maintenance capacity rather than the work job plans.
  - Maintenance SMEs believe that maintenance cost is excessive by 15 to 35 percent—something that can only be largely driven by craft body.

The processes of maintenance capacity focus on the match of the plant's quantified workload to the resources to execute them



Process: Conduct morning-after analysis of scheduled and unscheduled work, and element-level variance between job plans and actual work

Set schedule for day: tasks, crafts, headcount, hours, interval → Record craft hours to day's scheduled & unscheduled work → **KID, RID** Join previous day's schedule detail and timesheets in running super table → **VS-M-YCC** **KID, RID, MID** Conduct morning-after & longer interval variance analyses (1):

- Craft head count to plan.
- Hours by craft to plan.
- Compliance statistics.

↓

KID, RID, MID

Capture, act on lessons learned to:

- Tighten or loosen job plans.
- Tighten ability to derive craft body.
- Block failures of compliance.

(1)

Element-level variances visible through super table:

- Craft types
- Headcount for craft type.
- Hours per craft type.
- Active and delay, logistic hours in a day's workload.
- Scheduled, break-in work.

Process: Search out and investigate cost outliers to groups of orders and assets, and learn and act on findings

$$\text{Z-score Standardize} = \frac{\text{Case} - \text{Average}}{\text{StdDev}}$$

$$\text{Min-Max Normalize} = \frac{\text{Case} - \text{Min}}{\text{Max} - \text{Min}}$$

KID, RID
Build table of standardize and normalize limits for work types & elements of interest

M-YCC
MID
Search for changing trends & spreads in performances:

Time series & difference questions

RID
Filter orders of completed status during period of interest

KID, RID
Contrast orders & tasks against the outlier variables & filter outliers

VS-W-MCC
RID
Report on outliers :
- Group % outliers to all groups
- % outliers by group.
- List of outlier orders & tasks to investigate.

Any of the five question types
MID
Investigate outliers, trends in outliers learn & take actions

We seek outliers because, without process to find them, they will go unnoticed in typical averages-type presentations—e.g., hours per job

The search is a dragnet to all sorts of anomalies.

- **Find hidden excess maintenance capacity.**
- **Unusual events during the period of interest.**
- **Bad actors revealed as outliers in hours, parts and materials, status and related work orders.**

Process: Determine the maintenance capacity to match the workload to uptime and align the craft body on the determined capacity

History input:
- Smoothed workload by groups from uptime processes.
- Most current budget or total allowed

Analytic input:
- Craft averages from history of planned work
- Insight from collective morning-after analytics
- Insight from collective outlier analytics

YCC

Any of the five question types

RID
Compute implicit costs to workload groups as allowance/workload

MID
Evaluate implicit costs against analytic inputs to judge them, thence set expectations

RID
Draft budget by reallocations for miss-sized groups, thence remove excess or increase for shortfall

Translate labor of the budget to should-be craft body—headcount per craft type.

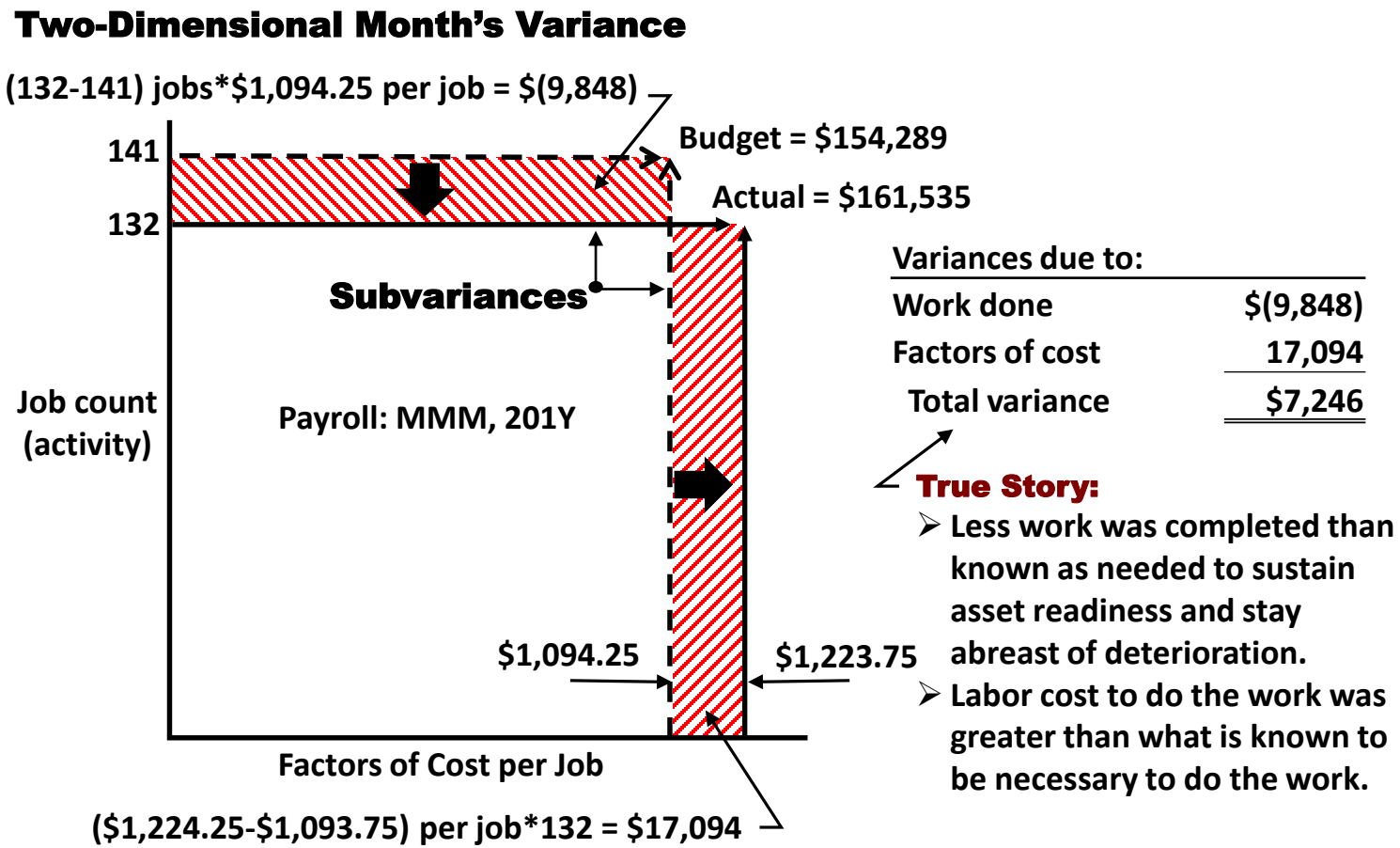
Determine, form strategy to adjust craft body—if gap is unacceptably significant

Adjust draft budget to strategy for craft body

Set year's target for P-ROACE against which will be contrasted monthly & YTD

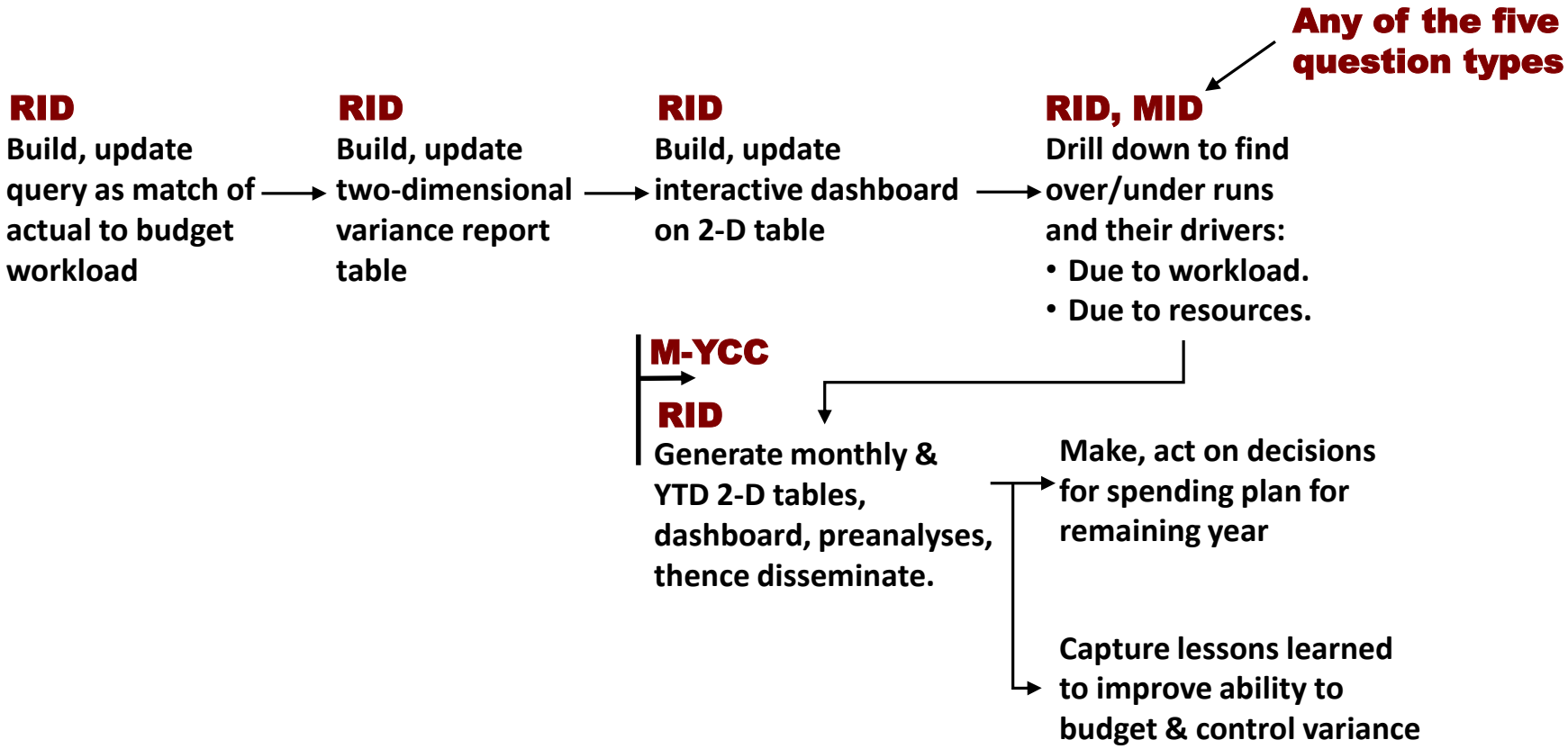
Method: Model with craft-to-task assignment functionality of scheduling software (e.g., MS Project)

A month's and year's to date true variance can only be known through dimensional subvariances



See paper: "The Secret is to Budget and Control Maintenance Opex Dimensionally."
https://analytics4strategy.com/scrtbdgtcntrlmntcopxdmly

Process: Build and conduct two-dimensional budget and variance control methods and processes



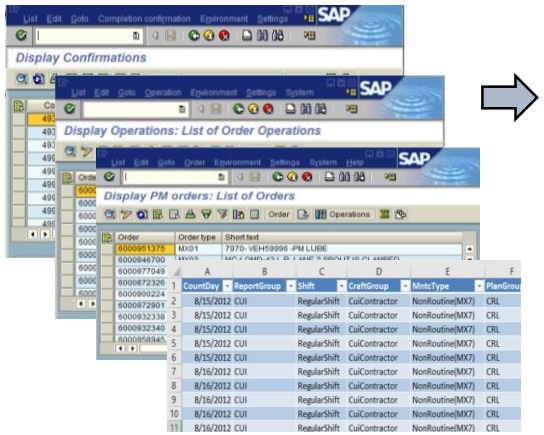
See

- Paper, "The Secret is to Budget and Control Maintenance Opex Dimensionally," (https://analytics4strategy.com/scrtbdgtcntrlmntcopxdmly)
- Actual case, "Activity-Based Budget and Control," (https://analytics4strategy.com/casecostmgt)

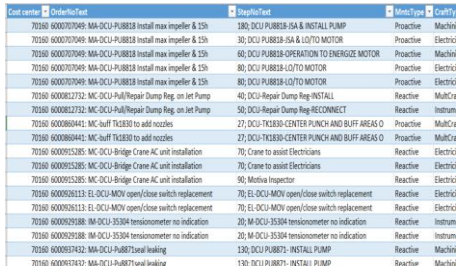
Agenda:

- ❑ Foundation perspective
- ❑ Competitive North Star for maintenance
- ❑ Maintenance processes beneath the North-Star
- ❑ Processes recharted toward the North Star
  - ➢ Mandatory practice and process
  - ➢ Workload and service interval processes
  - ➢ Maintenance capacity processes
  - ➢ **Recountive insight processes**

Recountive insight is the plant's body of data transformed to all possible insights that are inherent to the data, without purpose other than insight



Single tables have some of all needed variables to all envisioned insight deliverables.



A "**super table**" does not, cannot and never will exist in any one operating system.

Interactive **Dashboards** transform the massive data of super tables into a consumable table and visual form.

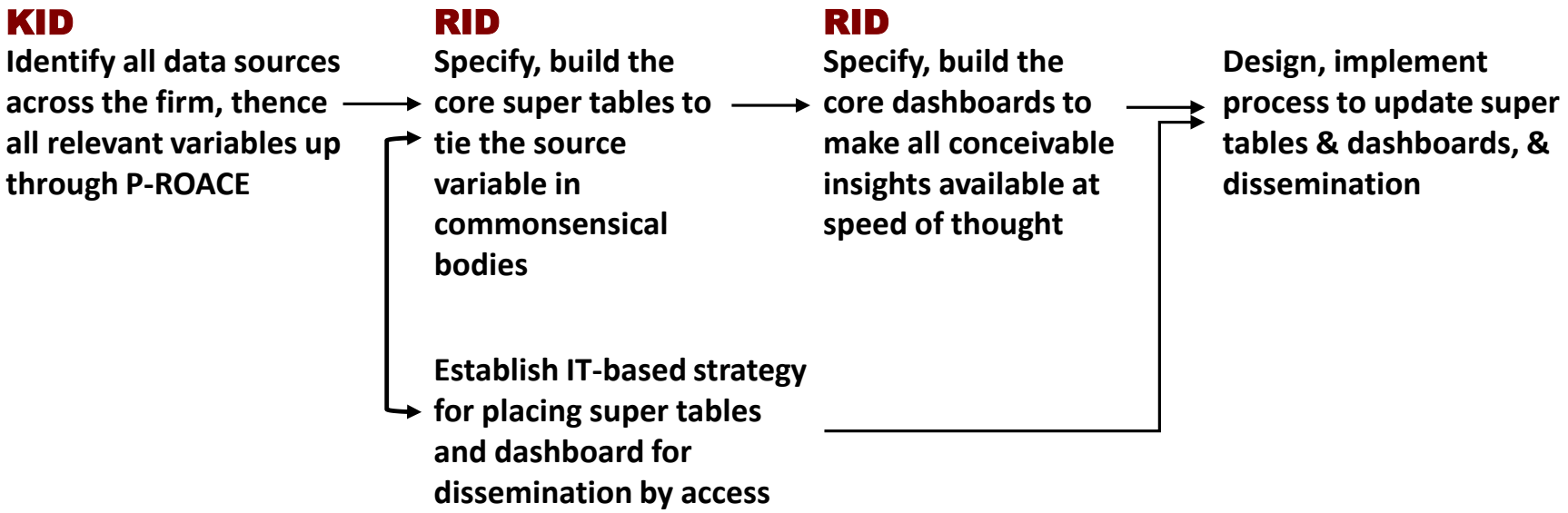
The structure of recountive insight has three layers:

1. Identified individual tables available in operating systems or Excel spreadsheets records.
2. Individual tables joined together in a super table by the unique identifiers they have in common.
3. Dashboards that rollup or drill down into the data of one or more super tables.

It is important to recognize that the ease by which we can play in the three layers has changed the "rule" that all insight must be connected to a user need

- Cost of data is not an issue to all types of insight because operating systems are natural sources through their role in a firm's operations.
- Building and updating super tables upon the firm's natural data has become largely effortless done with click-and-drag.
- Recountive insight can be open-ended because. . .
  - Every imaginable variable of interest to constructing insight resides in tables behind the curtain of one or more operating systems or other sources.
  - Every imaginable recountive insight can be constructed upon one or more of the imaginable variables.
  - Every recountive insight does not need to be predefined, is generated at speed-of-thought with interactive dashboards.
- Recountive insight is prepared automatically or by one for many—real-time, daily, weekly, monthly and annually.

Process: Build, update and disseminate the body of recountive insight from the firm's operational data



Note:
How to build super tables is explained by the slides for download at the webpage to the training session, "Build Super Tables from Operational Data." (https://analytics4strategy.com/train-builddatatables)