Integrated Mining Operations for Improved Performance ; Applying ISA S95 as an enabling Framework

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invensys™
Operations Management

Avantis Eurotherm Foxboro IMServ InFusion SimSci-Esscor Skelta Triconex Wonderware

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Agenda

- Industry Challenges
- Changing Landscape
- ISA-S95
- Mine to Port Example
- Induration Furnace Example
- Questions

What Are the Challenges ?

Industry Challenges Facing Mining CEO's

- Financing and managing capital projects
- Mining transactions and industry consolidation
- Improving performance and operational effectiveness
- Managing risk
- Complying with regulatory & reporting requirements
- Addressing sustainability issues
- Recruiting and retaining a skilled workforce

What Are The Business Requirements ?

Business Requirements	Critical Success Factors
Plan with utmost accuracy	• Planning and Scheduling processes tightly coupled with Supply Chain and Operations Management
Operate optimally, reliably and safely	• Tight integration of the Plan and Schedules to the Execution System:
Measure performance with accuracy	• Well implemented Real Time Data Base , LIMS, Mass & Energy Balance, Production Accounting • Accurate plant models
Agility to Absorb Dynamic Changes of the market/site conditions	• Adaptive Architecture • Templates and Standards that can be automated
Improve continuously through agile decision-making based on reliable information	• Well designed business processes and work flow management leveraging state-of-the art technology and industry standards

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What is One Way of Addressing These Challenges ?

Use Technology to solve business
Issues (Achieve a high performing operation)

What is a High Performance Organization?

- Strategies are important and Execution is key.
- Processes are well defined (measured and accountable).
- Everyone understands how their actions are measured and so how they impact the Scoreboard plus the Operations staff are empowered to make decisions that impact the Scoreboard.
- Goal of organization is to exceed targets by 3-5%(within constraints of the environment and safety)

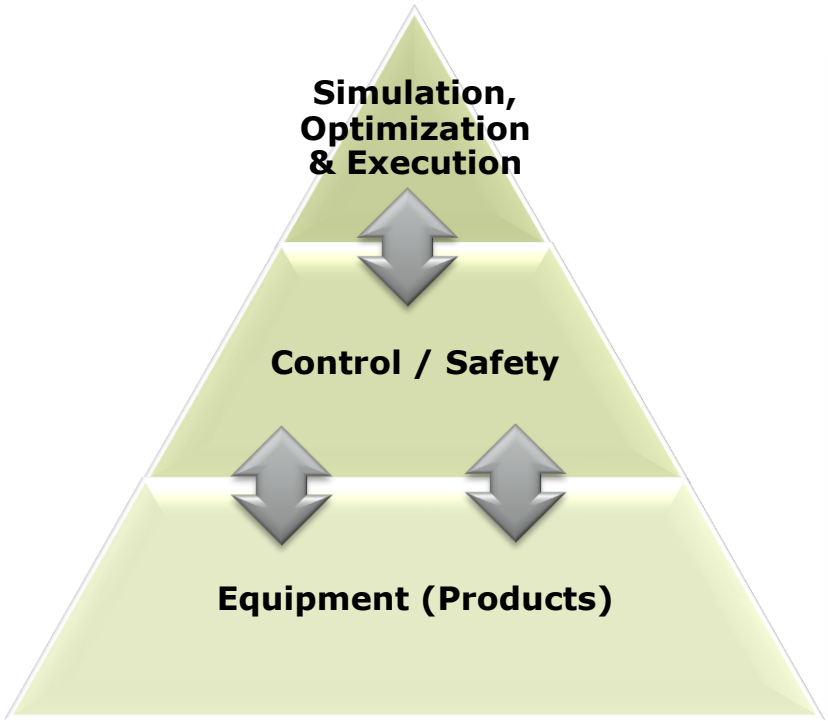
What is Required to Achieve the Vision?

- Well defined Business Processes – Bring technology to bear on business issues
- Structured and linked performance measures that are financially driven where appropriate – Dynamic Performance Measures
- Flexible and Extensible Technology Solution
- Accountability – Workflow
- Clear concise scoreboards

What is Going On in the World of Technology?

A Shift In Focus

The Traditional Automation Industry Focus



Operations Management Focus

- Enterprise Applications
- Comprehensive Simulation, Optimization, Production and Performance Suite
- Extended Control and Safety
- Equipment and Instruments

A Unified, Enterprise Control System

Changing Face of User Base

Workforce Transition

Knowledge Workers

Digital Natives

Rotating Roles

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Changing Operator Role

Trend	Operator Impact
Plants are larger, more complex	• Increased Monitoring Load • Lack of Understanding
Increased Levels of Instrumentation	• More Data to Manage • Lost in the Details
Increased Levels of Automation	• Operators Become Disengaged • Role Is Reduced To Dealing With Upsets
Centralized Operations	• Loss of direct awareness
Procedures	• Safety and Compliance
Operators Business Managers	• Improve Profitability of Operations

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Mineral Processing Solution Map

Business Systems

- Geological Model & Reserves Optimization
- Enterprise Resource Planning
- Mine Planning/ Scheduling
- Plant Maintenance
- Customer Relationship Management

Mine

- Resource Data Management
- Resource Mapping
- Geological Statistics
- Strategic Mine Planning
- Mine Resource Modeling
- Mine Planning
- Mine Scheduling
- Drill & Blast Mgmt
- Mine Grade Control
- Vehicle Mgmt
- Vehicle Monitoring/ Tracking
- Fuel Mgmt
- Stockpile Mgmt
- Laboratory Information

Beneficiation

- Energy Management
- Downtime Management
- Condition Monitoring
- Strategic Mine Planning
- Pinch Point Management
- Asset Prognostics
- Crushing/ Mill Optimization

Site Production

- Operational Analysis/ Reporting
- Quality Tracking
- Alarm& Event Mgmt
- Electronic Log Book
- Production Account
- Product Grade Control
- Inventory Movement Mgmt

Site Management

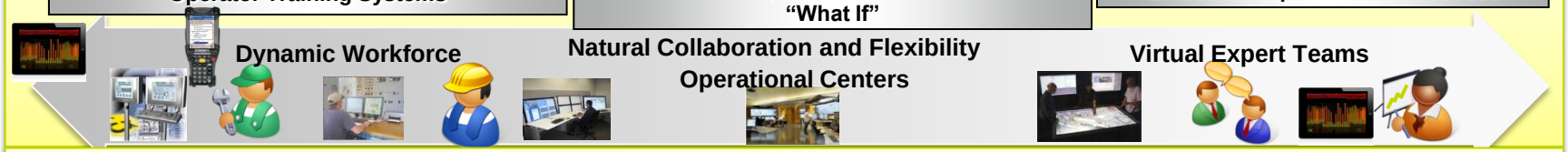
- Water Balance
- Utilities/Power Mgmt
- Mass Balance Reconciliation
- Environmental Mgmt
- Health & Safety
- Risk Mgmt
- Energy Mgmt

Port/ Rail/ Pipeline

- Port Scheduling
- Shipping Documentation
- Ship Tracking
- Train Planning
- Train Tracking
- Inventory/ Stockpile Mgmt

Distributed Operational Team work

- Operator Training Systems
- Decision Support Models Simulation "What If"
- Embedded Operational Processes



Unified Distributed Information System

- Unifying Industrial Information/ Data Historian System with data in context
- Distributed Unifying Application Model/ Data Integration

Mine Monitoring & Control

- Asset Health Monitoring
- Blend/ Grade Control
- Mobile Equip
- PLCs/ Process Data Capture
- Fixed Equip

Process Monitoring & Control

- Fixed Plant
- Weigh Bridges
- Asset Health Monitoring
- PLCs/ DCS
- Quality Exec

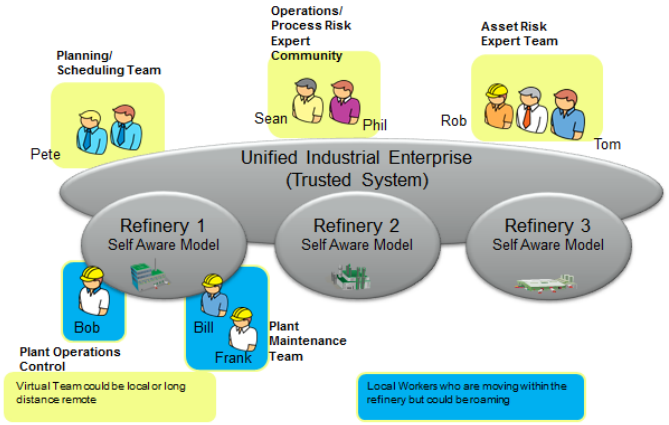
Utilities Monitoring & Control

- Asset Health Monitoring
- Access Control
- PLCs/ DCS/ RTUs

Port/Rail Monitoring & Control

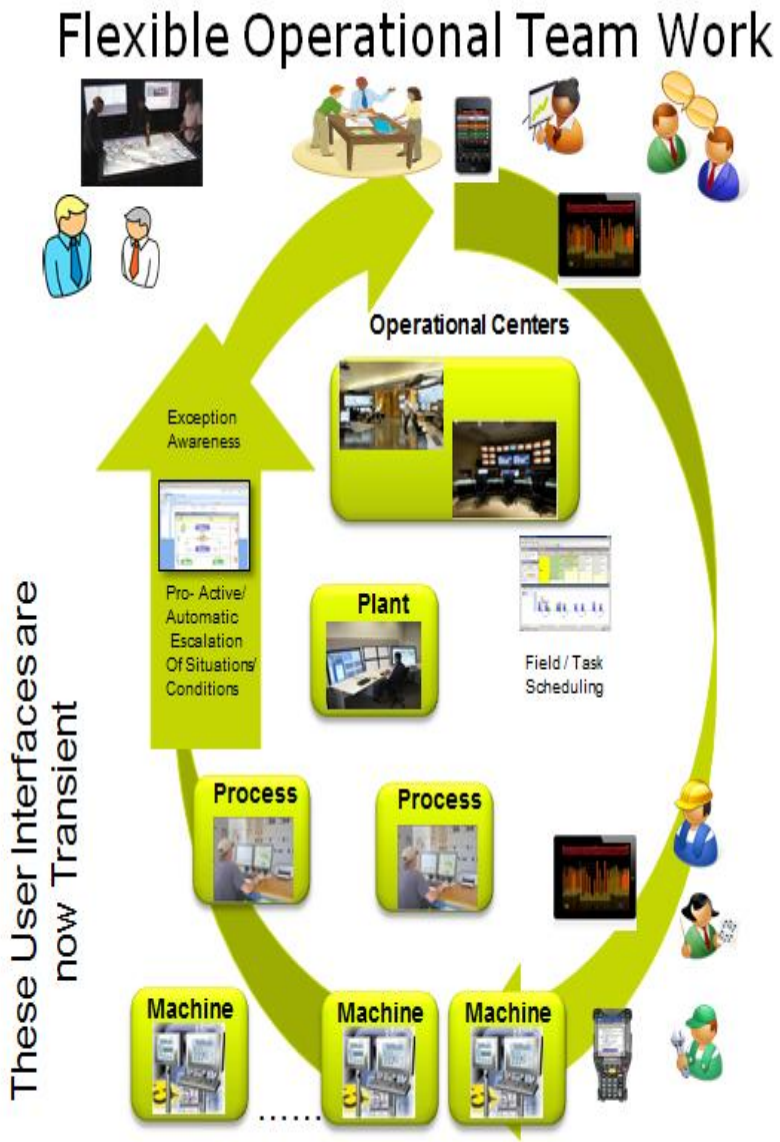
- Mobile Equip
- Weigh Bridges
- Asset Health Monitoring
- Fixed Equip
- PLCs/ DCS

Virtual Users being able to connect and see the same data



Operational Center is central hub where the "controller" co-ordinates all aspects of operations

These Operational User Interfaces(UI) are Transient, but all actions can be done there



Mining Information Challenges

- Too much data creating confusion.
- Present information for easy analysis/ solving problems
- Avoid mul… …s and data rep… …of

- Early collection of relevant data
- Accessible on near real time basis
- Reduce asset maintenance costs.
- Reduce total cost of ownership

- Integration platform to serve the various users i.e. operation, maintenance, management
- Data integration, trustworthy analytics and business workflows to identify/solve/escalate problems
- Ente… …rs anytime,

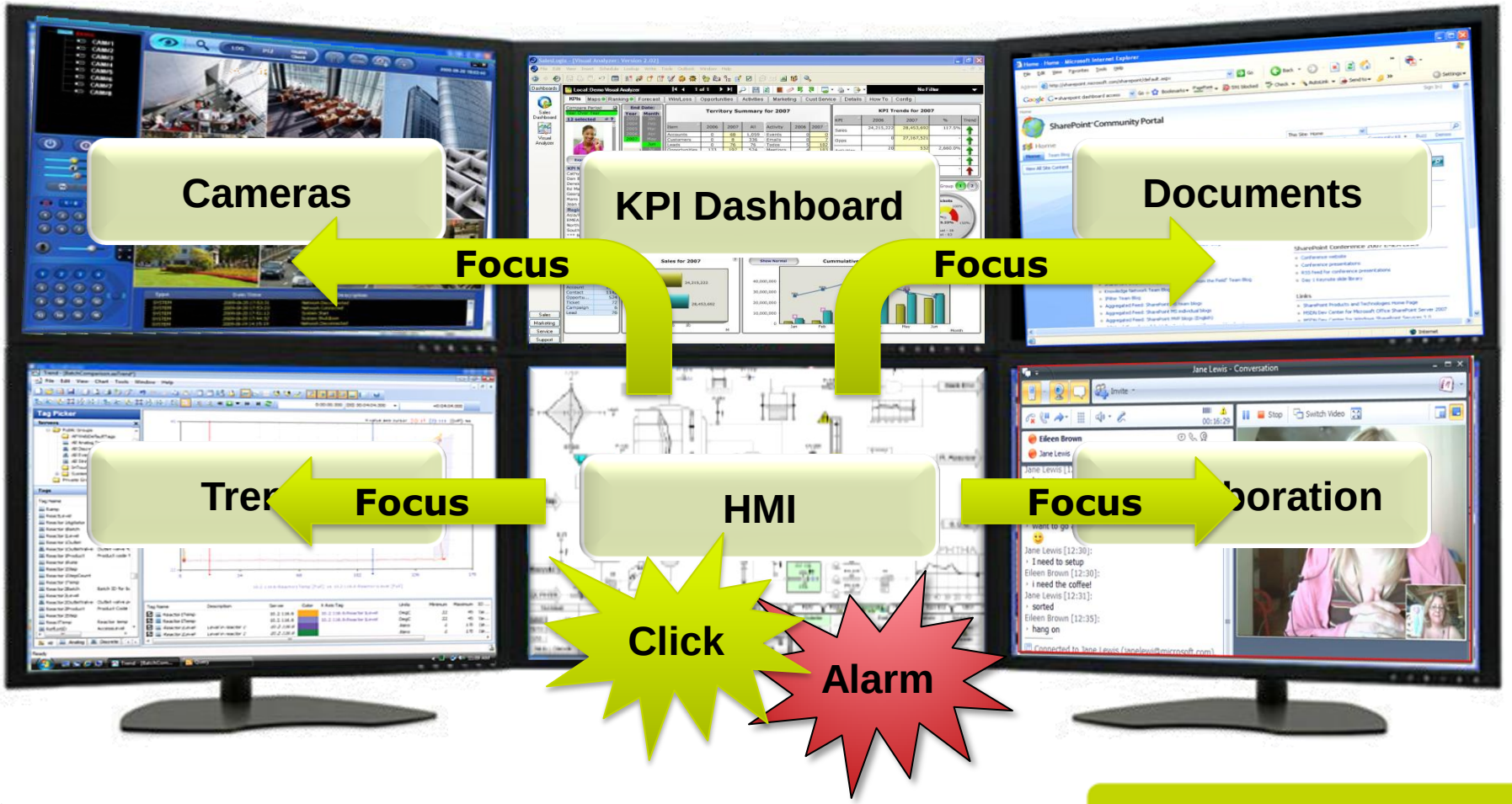
Context Driven Information

Agile & Scalable Architecture

Collaborative Environment

…ata …on …ynamic workflows which can evolve over years

How Can this be Improved ?



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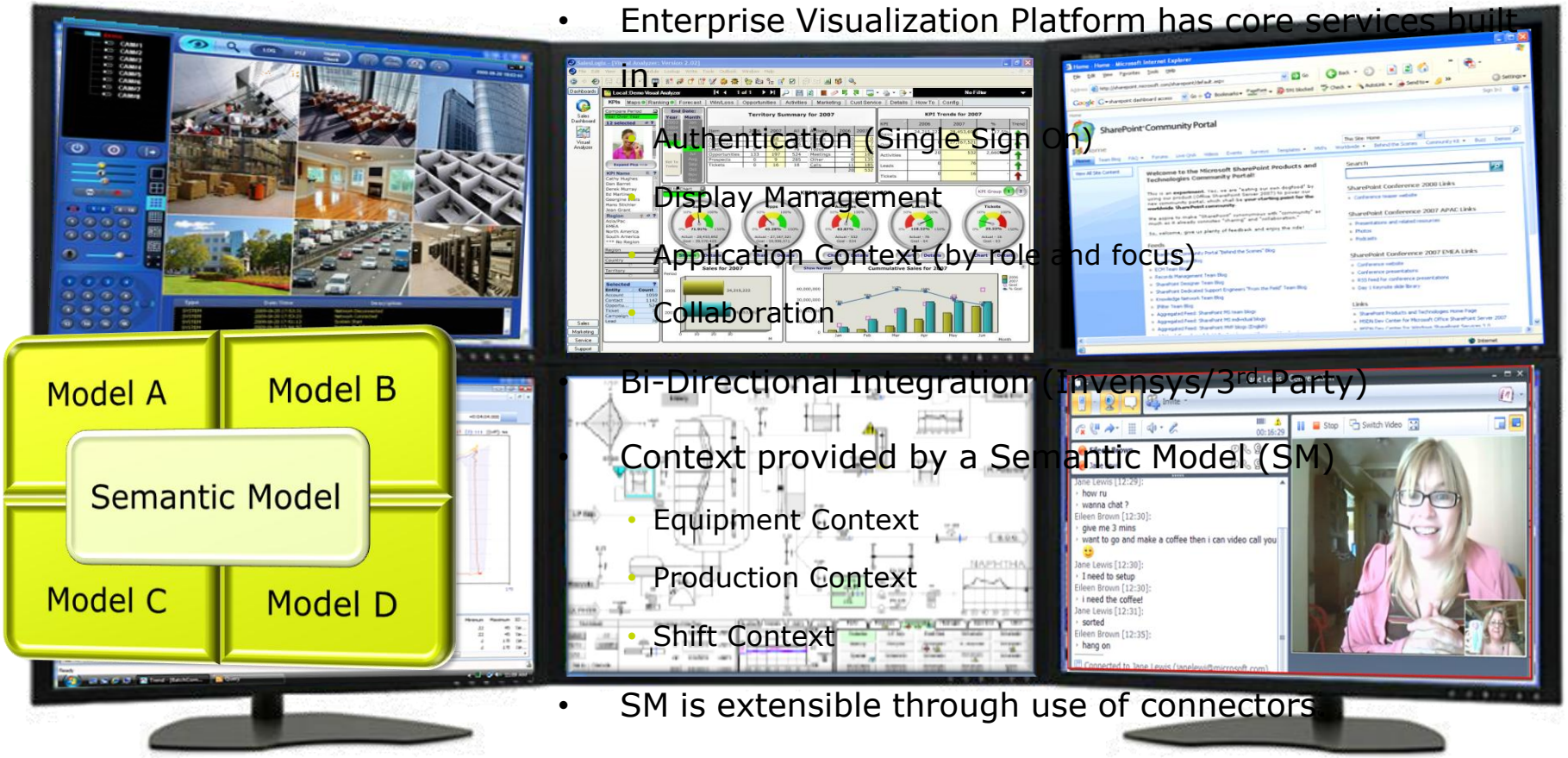
Enterprise Visualization Platform



- Enterprise Visualization Platform has core services built in
  - Authentication (Single Sign On)
  - Display Management
  - Application Context (by role and focus)
  - Collaboration
- Bi-Directional Integration (Invensys/3rd Party)
- Context provided by a Semantic Model (SM)
  - Equipment Context
  - Production Context
  - Shift Context
- SM is extensible through use of connectors.
- Connectors linking Applications to the SM are reusable.

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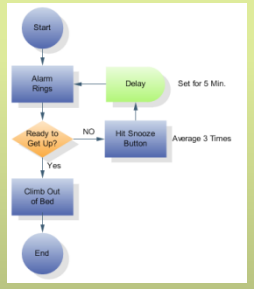
Collaboration – Connecting People and Systems Together

Video

Audio

Messaging

Presence/Skills



Work Flow

Sharing

Log-Book

Context

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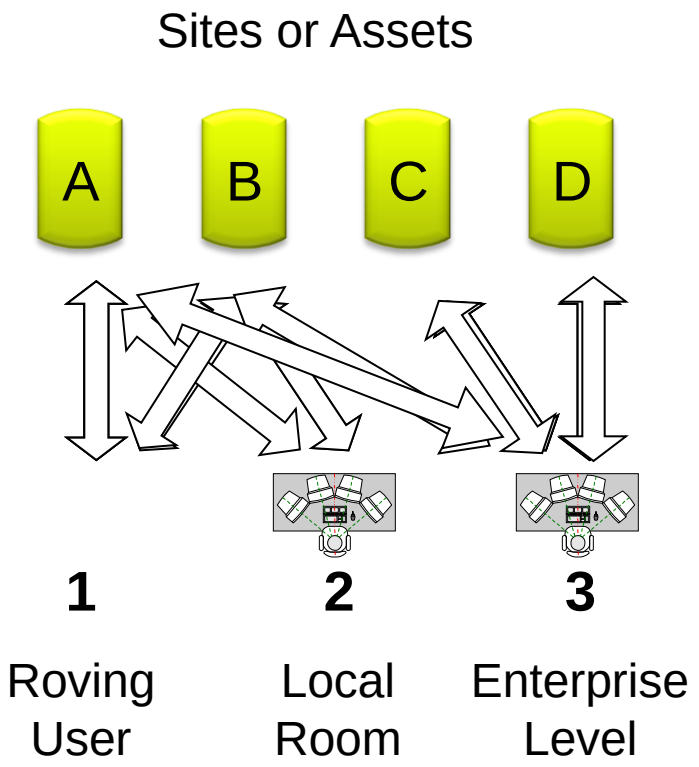
Adapting Collaboration between Ops Centers and Field

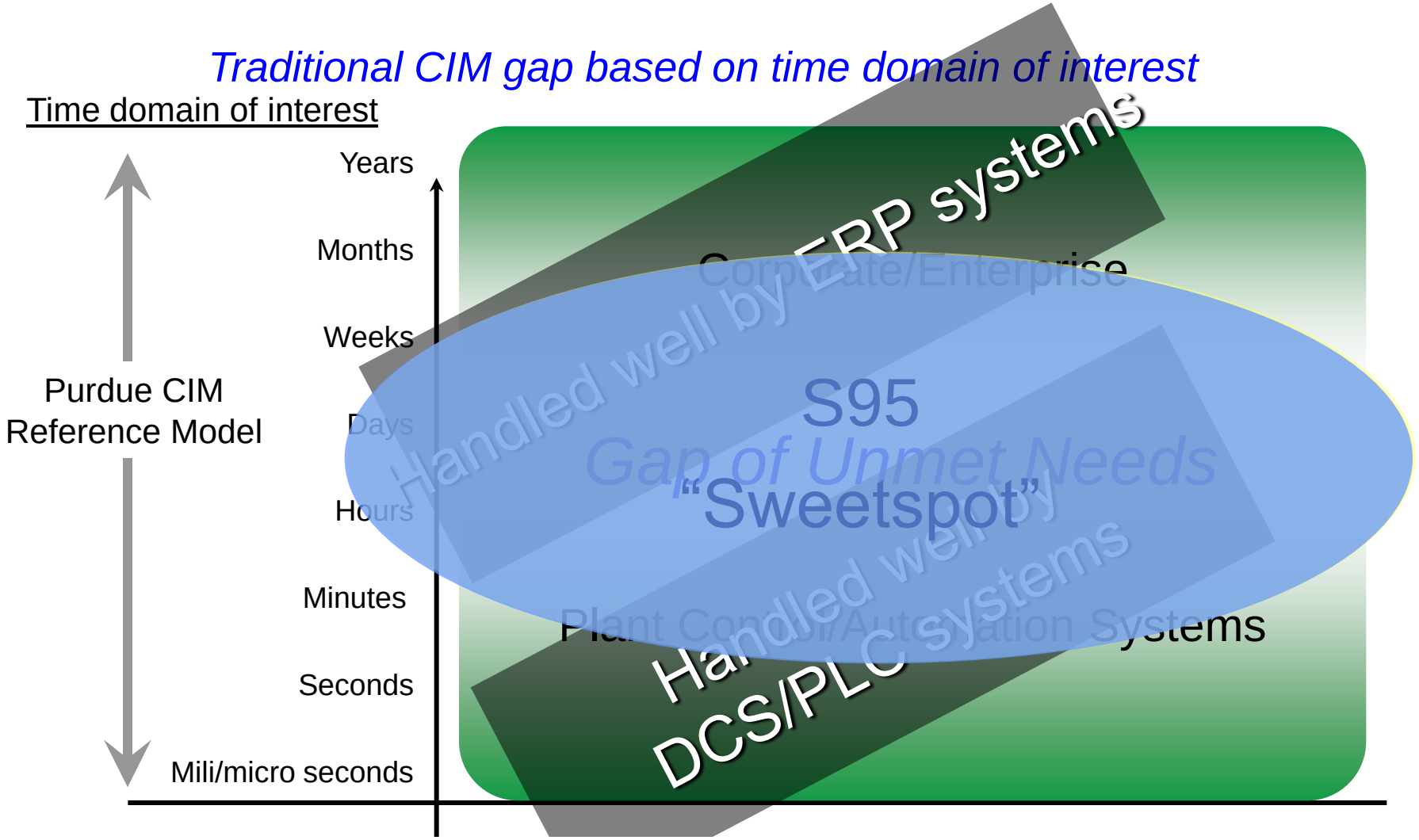
- Scope moves to the worker as conditions change
- In this example, Roving User handles Operation areas “A” & “B”
  - If Operation “A” needs focus, then Local Control Room supports area “B”
  - Overlapping support handles transitions between locations
  - Relaxed conditions allow all operations to be supported from CIGO



What is the Missing Ingredient?

INFORMATION FLOW

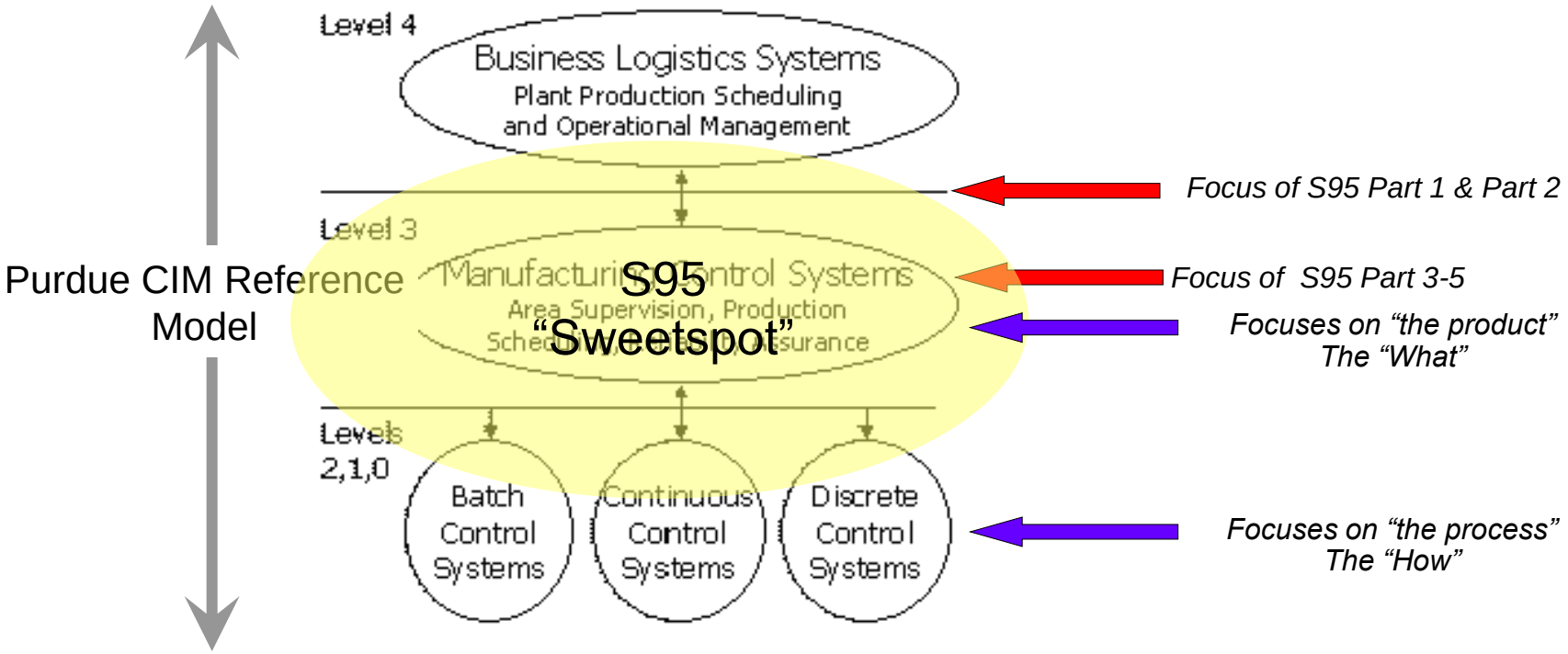
S95: Defines domain between Controls and ERP…



Result: disconnect between that which is planned & that which is, can, or ought to be done

S95: Hierarchy Model (Domains)

A simplified version of the complete model defined in the Purdue Reference Model for CIM (Computer Integrated Manufacturing), combined with the MESA (Manufacturing Execution Systems Association) model for activities in the manufacturing control domain.



What is ISA S95

Parts 1 and 2 of the S95 standard focus on the interfaces between Level 4 enterprise and Level 3 manufacturing control systems.

Part 3 of the S95 standard focuses on the activities within manufacturing ,and is the subject of discussion today

Parts 1 and 2 deal with models, terminology and model attributes.

Part 4 deals with Manufacturing Management and Part 5 deals with Business to Manufacturing Transactions.

Over all the ISA-95 Model bridges the gap of technology, people and organization within the manufacturing operations structure

Within ISA-95 Part 3, are 4 levels. The levels are:

Level 0 -the actual physical process

Level 1 – defines the activities involved in sensing and manipulating the process (time frames are seconds and faster)

Level 2-defines the activities of monitoring and controlling the process (typically operates on time frames of minutes, seconds and sub seconds)

Level 3- defines the activities of workflow, and steps the process through states to produce the required end products. It includes the process of maintaining records and coordinating the various processes. It operates on time frames of days, shifts, hours, minutes, and seconds. It also operates on areas and work centers.

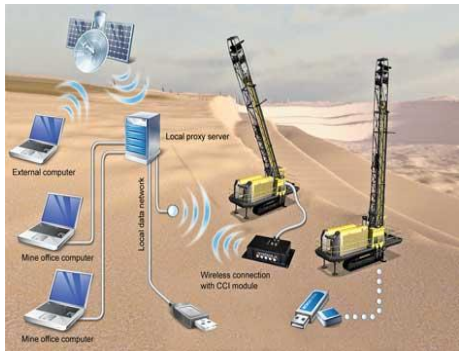
Level 4-defines the business related activities needed to manage a mining organization. Level 3 information is critical for Level 4 activities. Level 4 typically operates on time frames of months, weeks, and days and interfaces to Enterprise solutions.

S95: A Work-in-Progress…

It is not a compliance-rich Standard –
It is a set of guidelines and a framework:

- to align with,
- not comply to

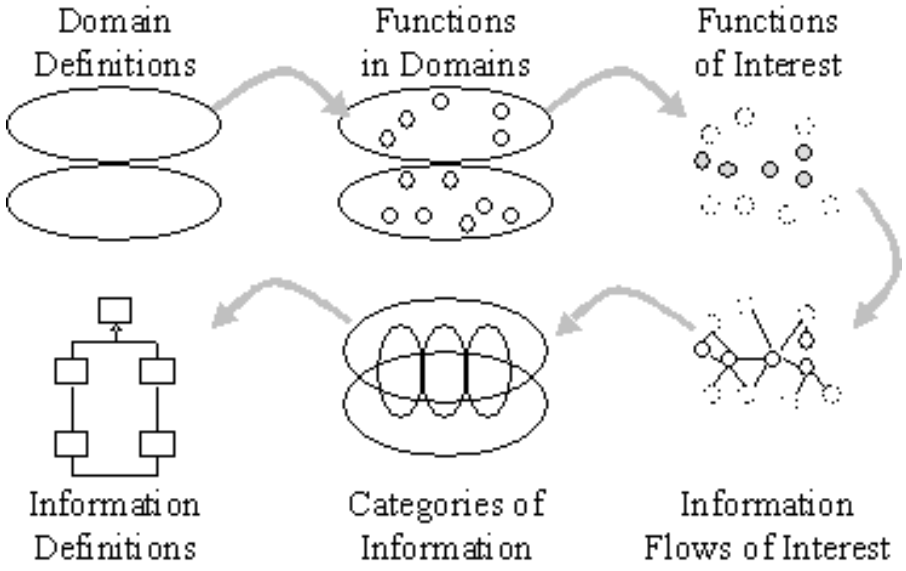
- S95 describes generic structures (name/value properties) for data exchange but does not address how to enforce the meaning of the contained data
  - A S95 ‘compliant’ message generated by Vendor A application may not be meaningful to Vendor B’s application which supports S95 ‘compliant’ message interface. The International Rock Excavation Data Exchange Standard, IREDES, was established in order to develop standards for electronic data-exchange in the mining process chain.



  - Require extra infrastructure to support exchange of data..

Progressive Detail and Exposure of S95 Communication Objects

- The S95 standard uses multiple models to explain the elements of Enterprise/Control System Integration.
- The initial models in the standard are very abstract, and the final models are very detailed and specific.
- Each model adds a level of detail and definition and builds on the information in the previous model.



- The standard starts with a definition of the domain of manufacturing control and the general activities in the manufacturing domain.
- This is followed by a model of the functions within a manufacturing enterprise that relate, or interact, with the actual manufacturing control functions.
- The functions that are directly related to the scope of the standard are given additional definition and descriptions, and then the information that flows between these functions is defined.

Value of ISA S95

As a stand alone tool does not provide value

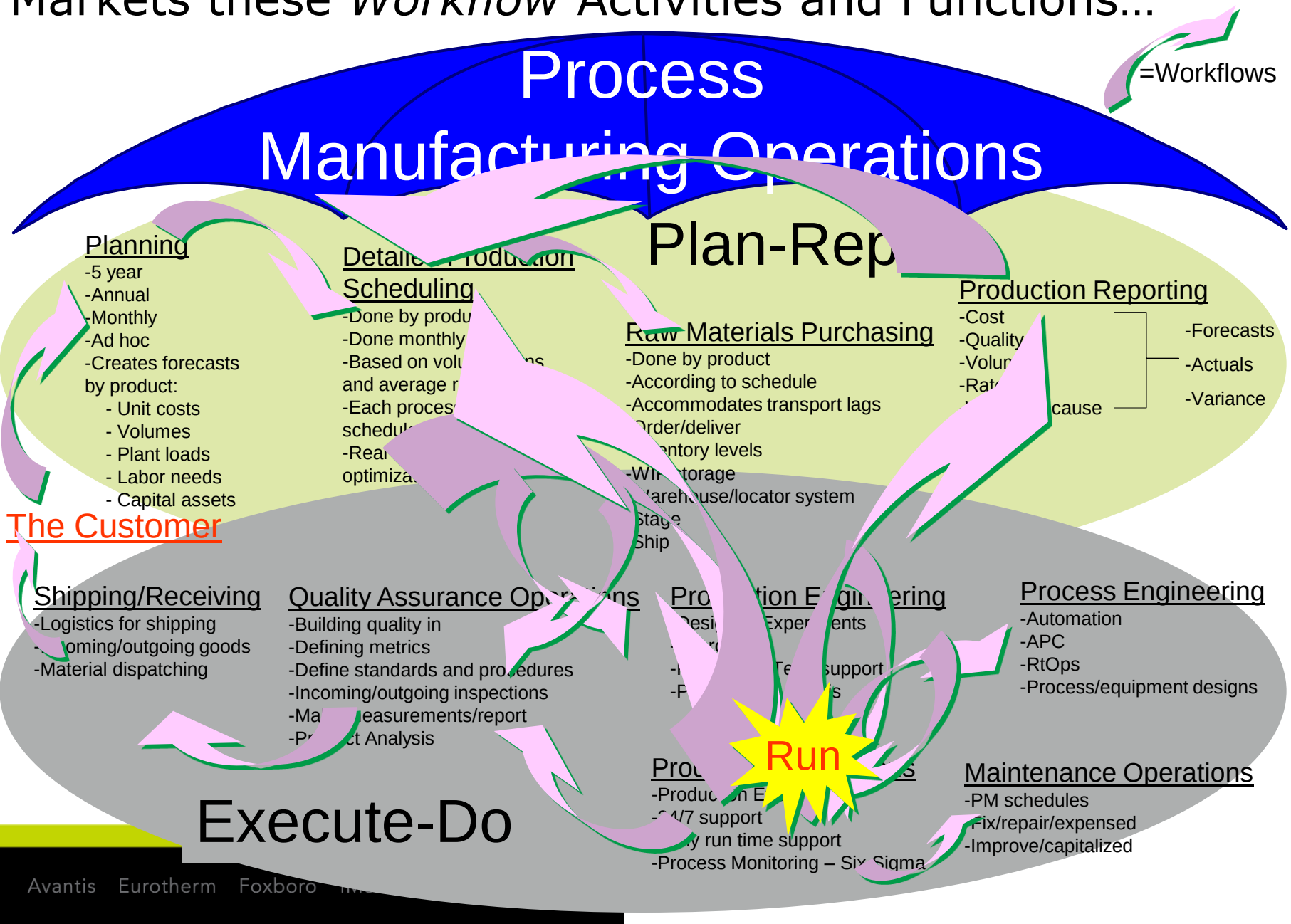
When used with other business solutions

Gap Assessments(Spider Diagrams)

Business Value Models

Provides Strategic Alignment and Performance improvement

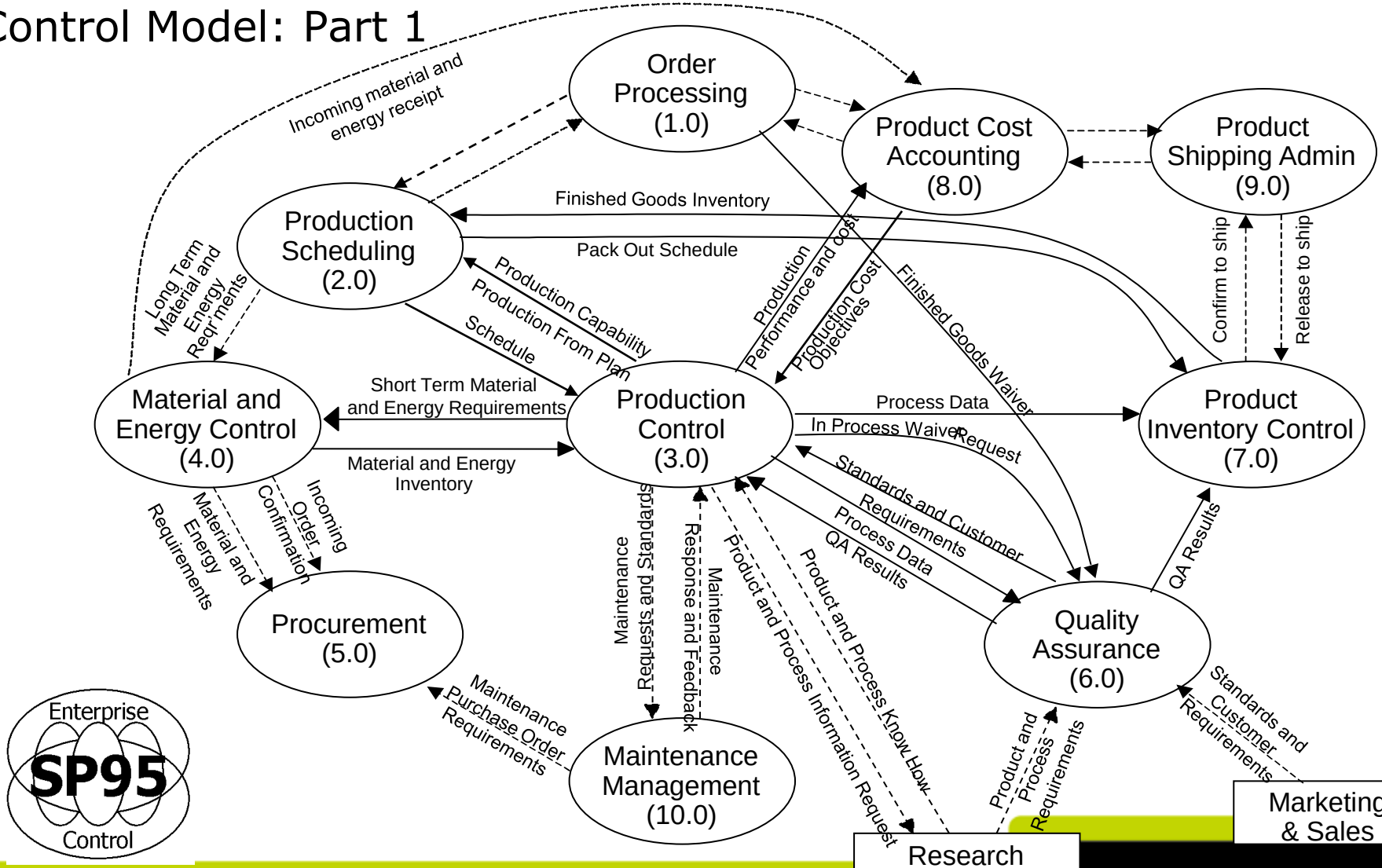
S95 Seeks to Formalize and "Generisize" for All Process Markets these *Workflow* Activities and Functions…



This Is What That Looks Like in S95-speak:

Functional Enterprise

Control Model: Part 1

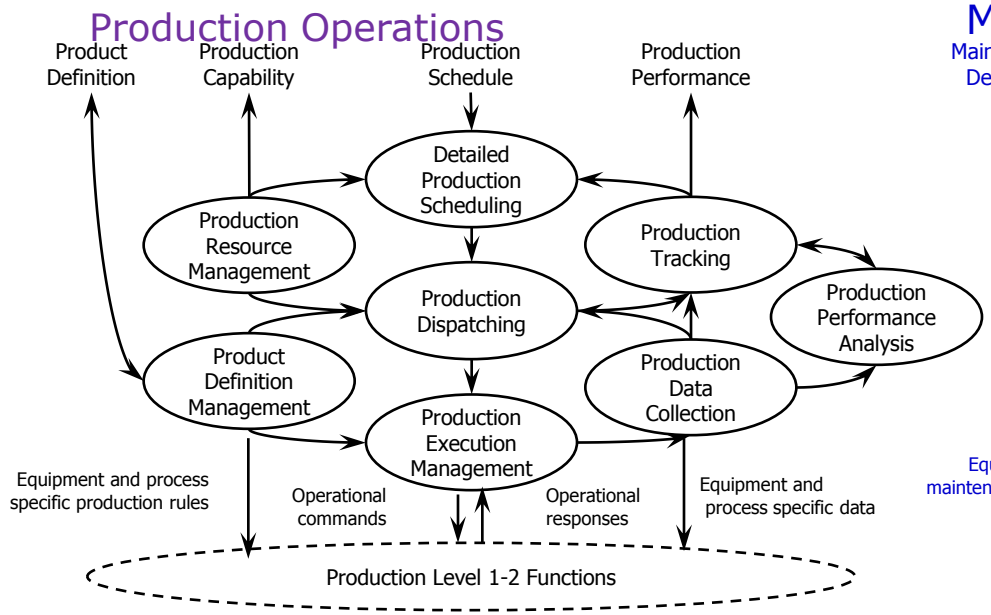


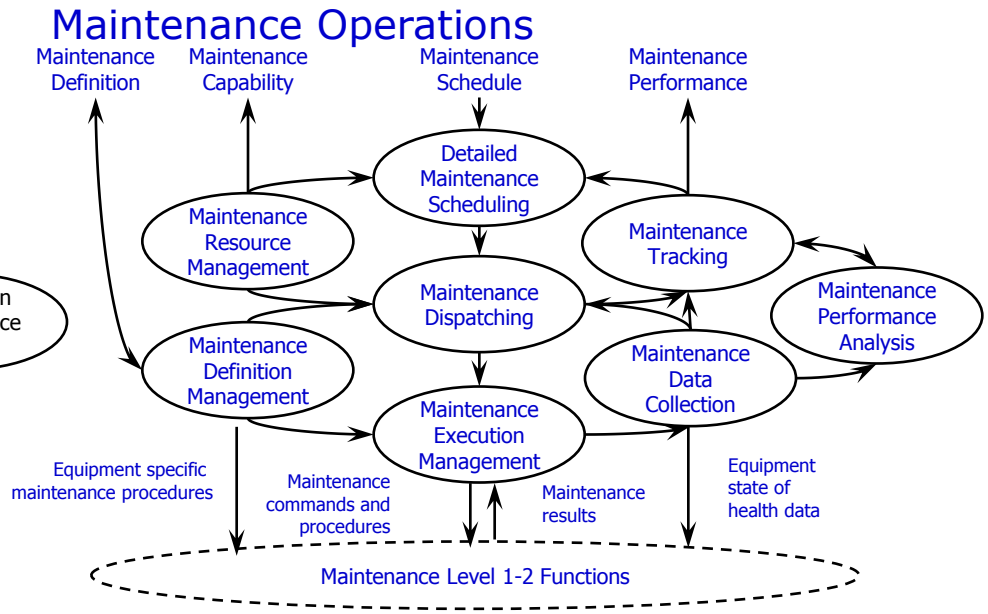
ISA Models

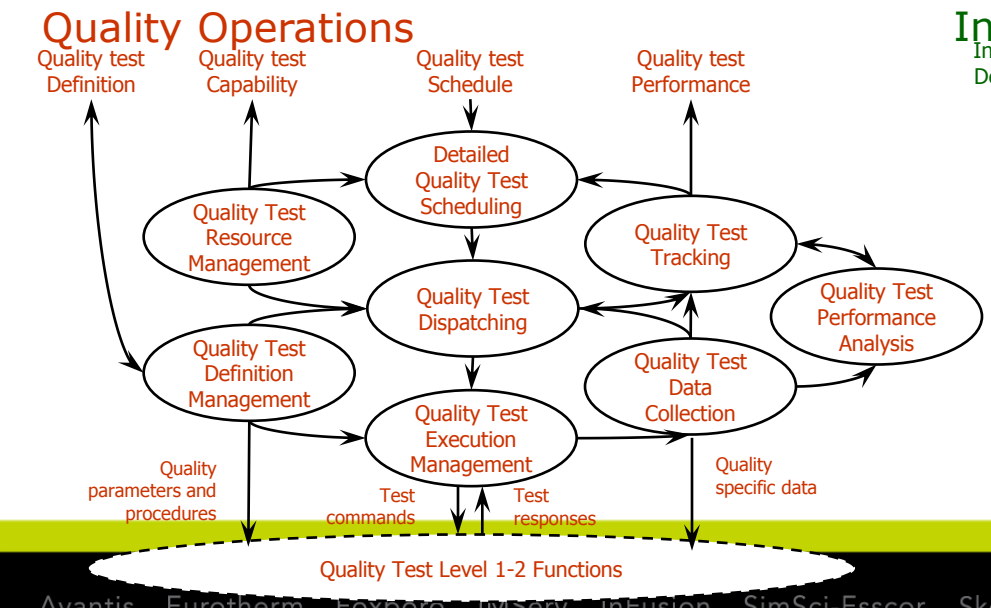
Four formal models are defined within the standard (**Production operations, maintenance operations, Inventory management, and quality management**)

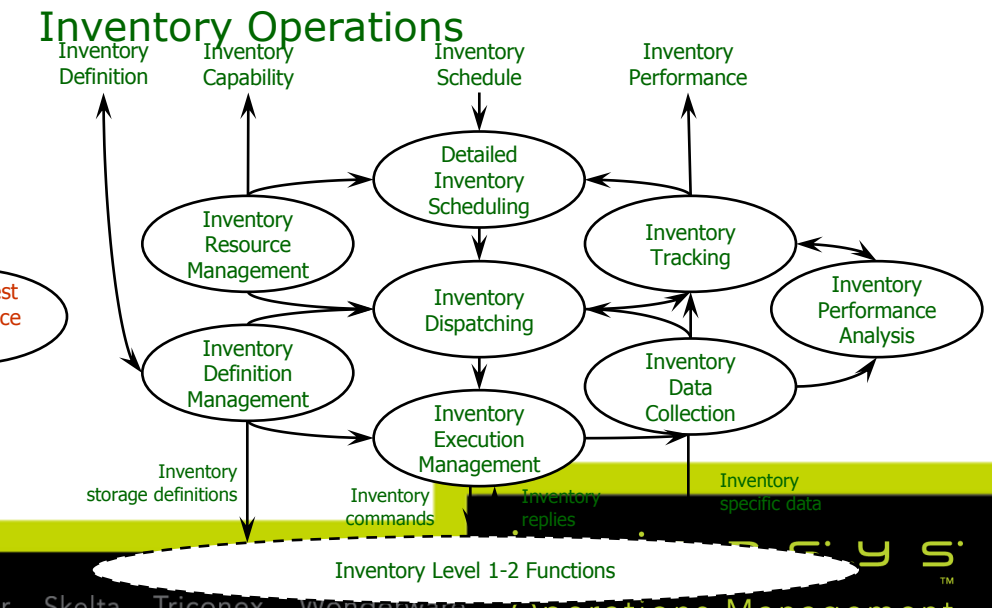
The **production operations** management model includes the activities of production control (3.0) and a subset of various models such as the production scheduling (2.0) defined as operating as Level 3 functions. Similarly the models **for Maintenance, Quality and Inventory** operate the same way.

ISA-95 Part 3 Operation Models

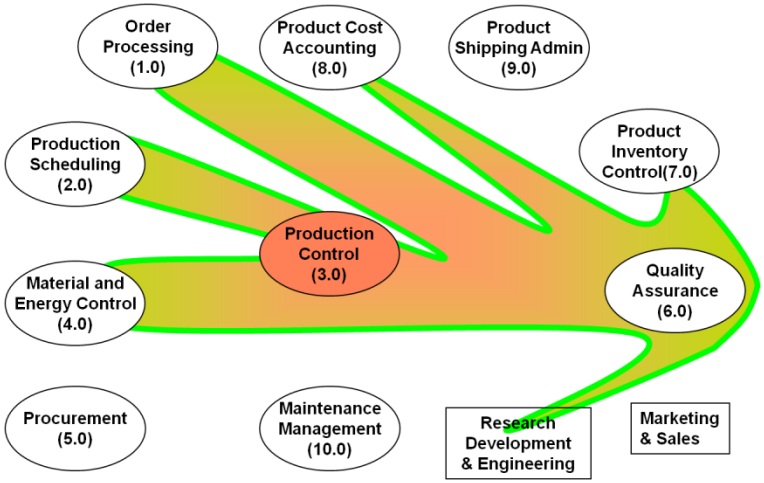


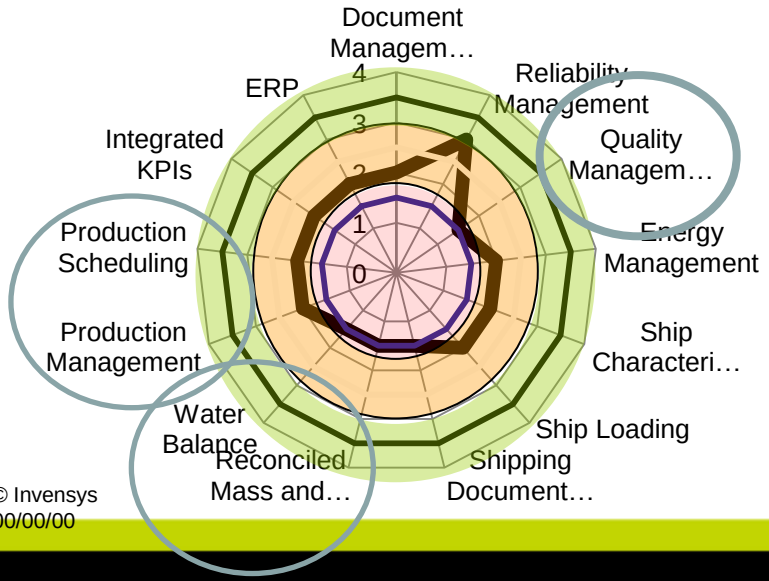






ISA SP95 Mapping LIMS(Example)





- Mine, Concentration, Pipeline, Filtering, Port
- Supports both short term quality control and long term planning
- Particle size, moisture, chemical
- 2 hour sampling (shortest)
- Automated sampling, auditing (barcodes), analysis, reporting (certificates)
- Sources for Integration: LAB equip, Manual DE
- Destinations for Integration: PIMS, , MES, DASHBOARDS

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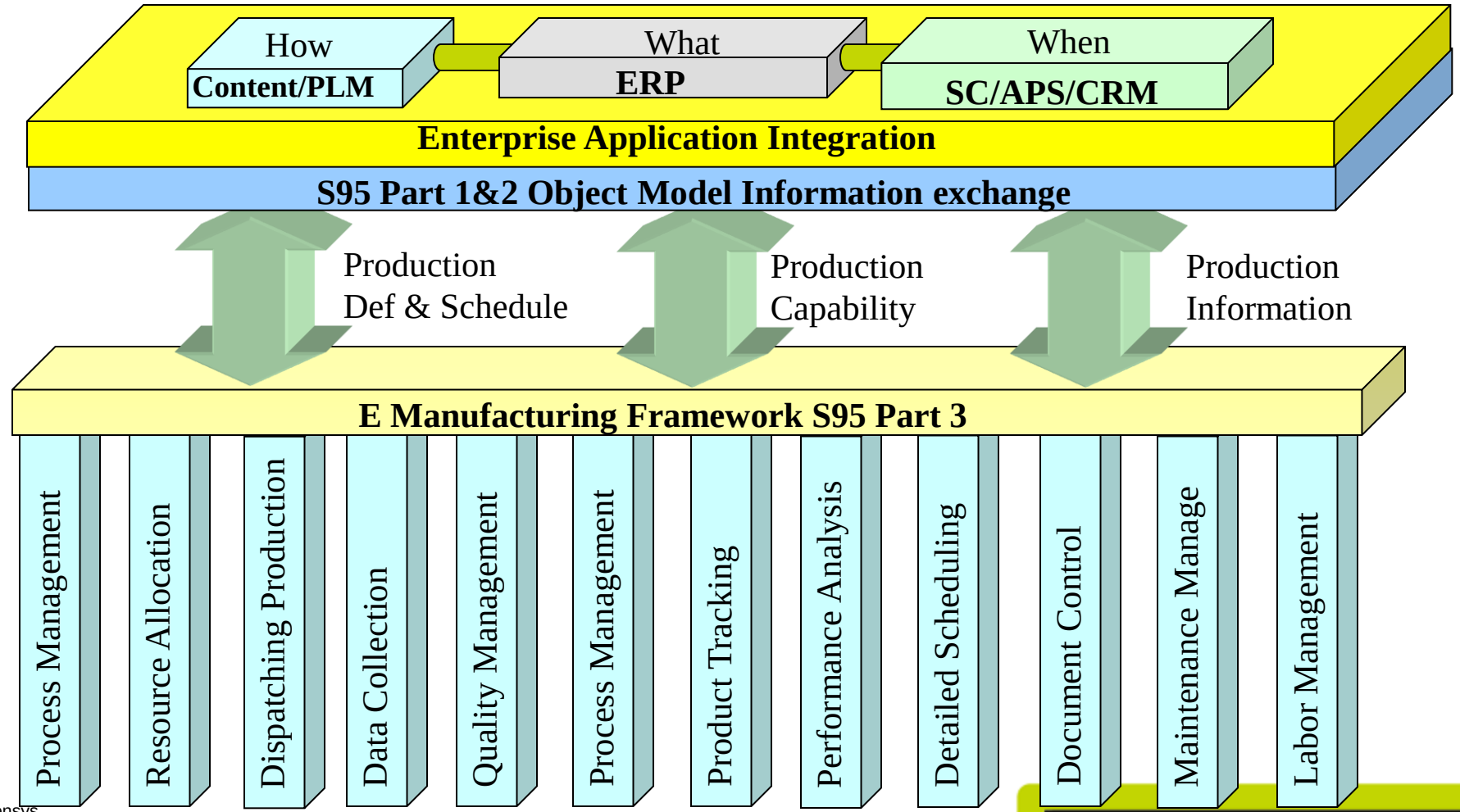
S95 e-Business Architecture



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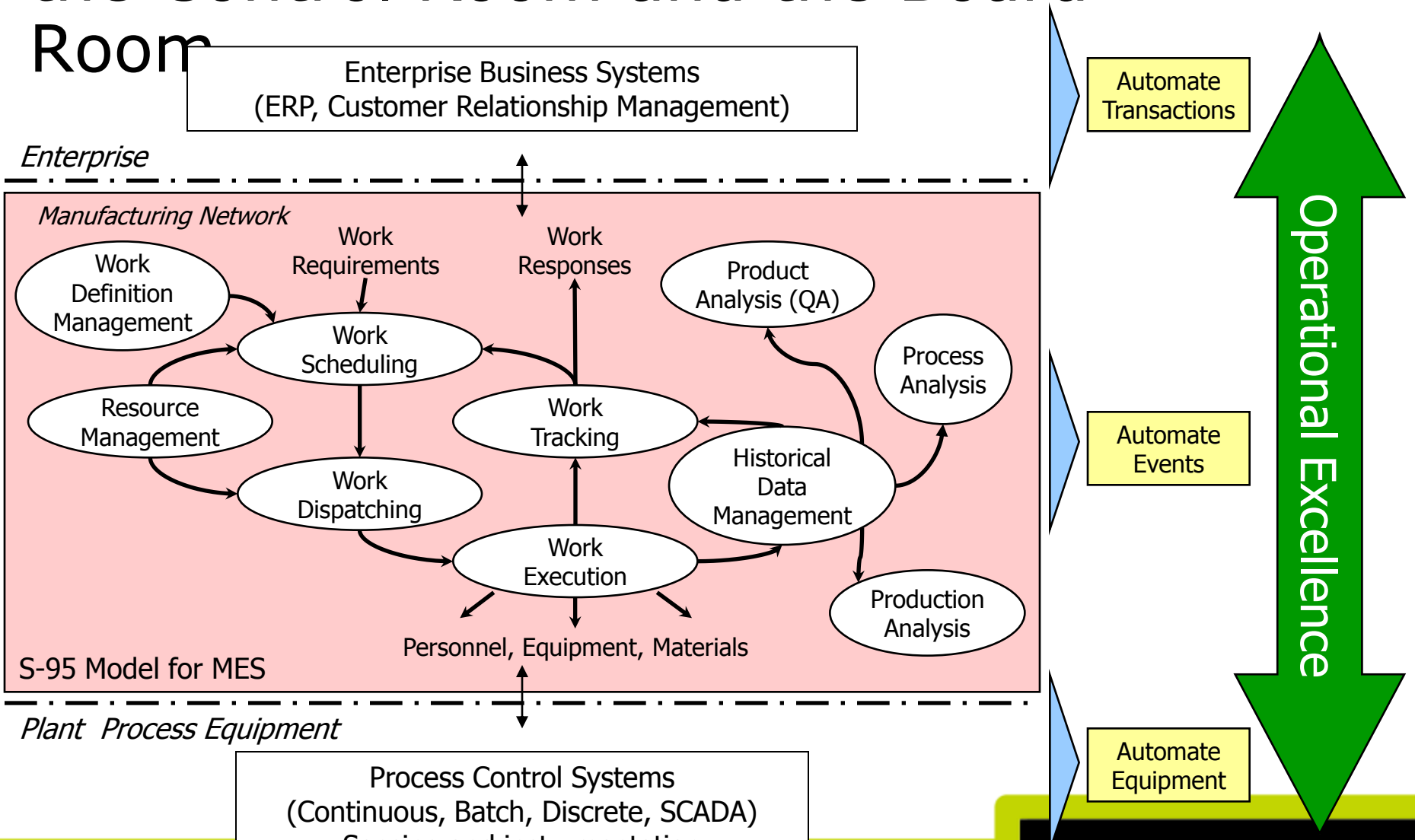
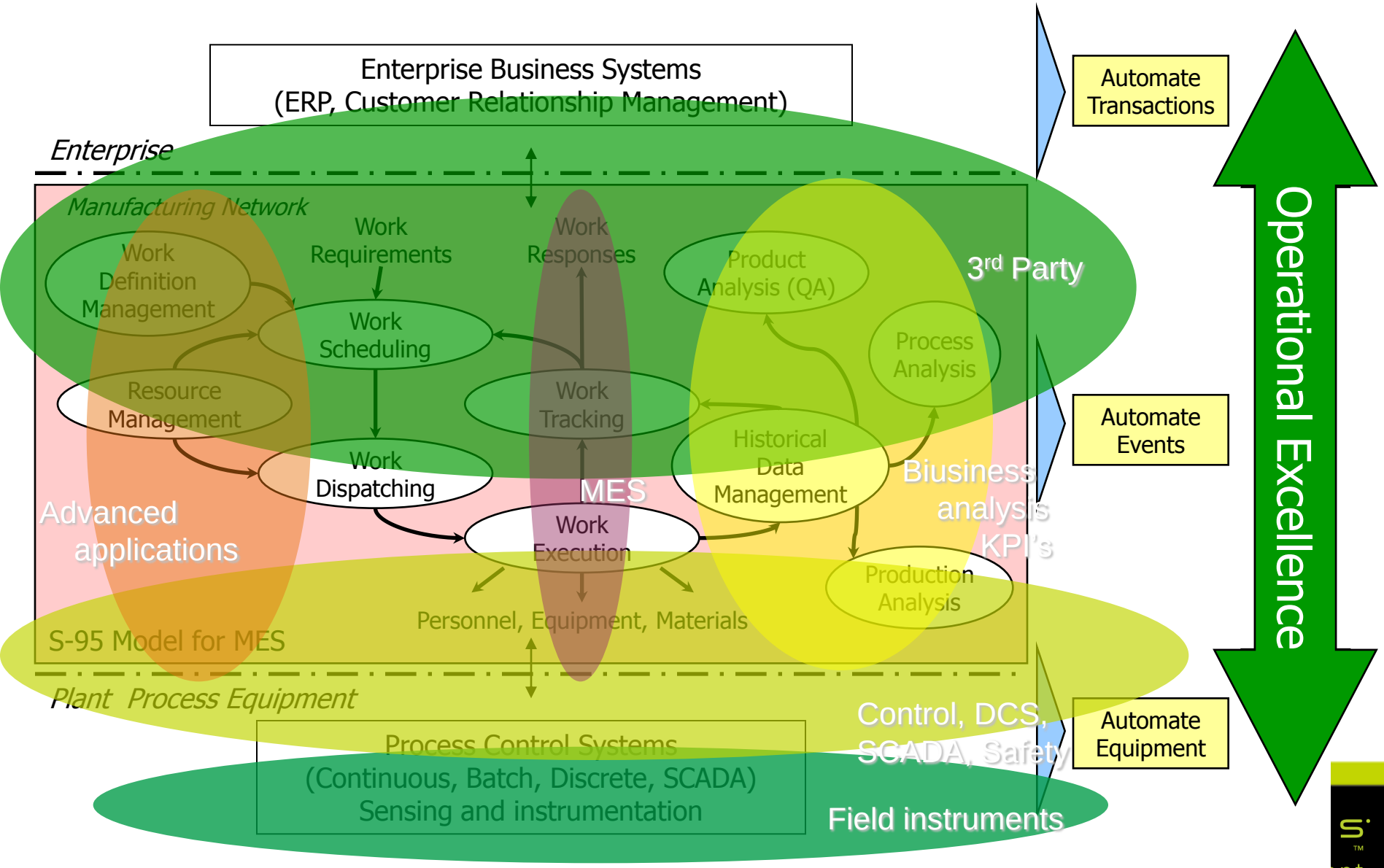
The Next Opportunity is Between the Control Room and the Board Room



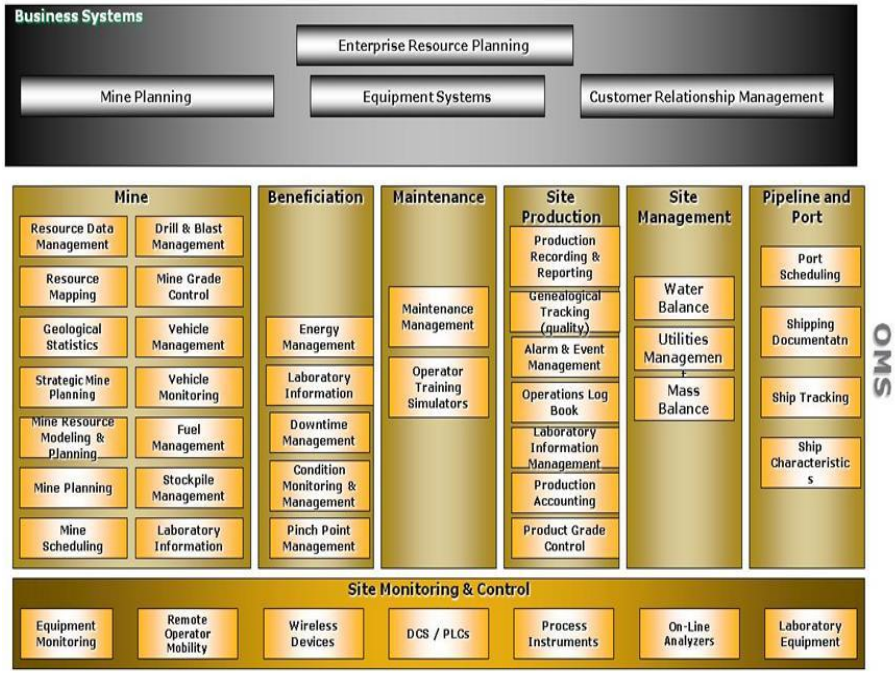

Enterprise Business Systems
(ERP, Customer Relationship Management)
Enterprise
Manufacturing Network
Work Definition Management
Work Requirements
Work Responses
Work Scheduling
Resource Management
Work Tracking
Work Dispatching
MES
Work Execution
Product Analysis (QA)
Process Analysis
Historical Data Management
Production Analysis
3rd Party
Biusiness analysis KPI's
Advanced applications
S-95 Model for MES
Personnel, Equipment, Materials
Plant Process Equipment
Process Control Systems
(Continuous, Batch, Discrete, SCADA)
Sensing and instrumentation
Control, DCS, SCADA, Safety
Field instruments
Automate Transactions
Automate Events
Automate Equipment
Operational Excellence

S95's Impact on Operating Companies

- Provides for rigorous documentation around common standards
- Supports common workflow processes
- Allows for cross-industry migrations quickly(Captive power/water plant)
- Promotes repetitive activities in support of standard
- Tighter linkage – repeatable, documented – between control/execution and reporting/planning

S95 Perspective for Mining Operations
-Mine of the Future-

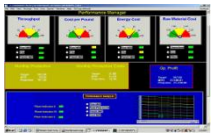
- **Strategic alignment:** providing deliberate top-down analysis of strategy throughout the organization *in combination* with a bottom-up approach implementation of appropriate, critical strategic measures called *Dynamic Performance Measures.*
- **Providing Visibility**: Performance metrics are made available to personnel at all levels in a timeframe, format and resolution that is appropriate to their job roles, typically in a dashboard format.
- **Alignment of strategic goals**: This approach means that *all* component operations (mining, concentration, shipping, management) will be measured and have available corresponding measures that *all* drive towards the *same* strategic goals.

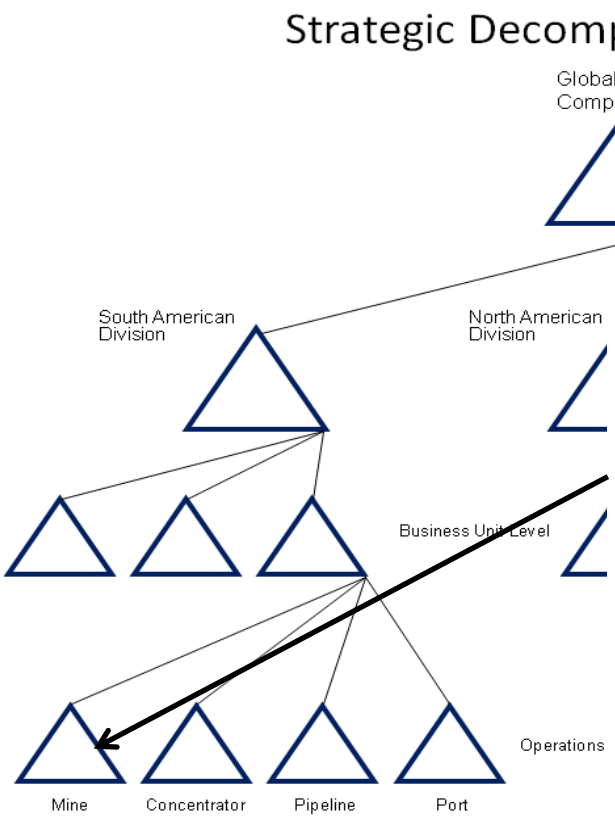


Now What?

Once the work flow solutions are designed, the Value analysis , the Best practice and Gap assessment may begin.

Mine to Port -Decomposition Process assessment Example 1





Fine Crushing

Strategy:
Optimize production of desired product size at lowest cost for as long as normal maintenance allows.

Action:
- Crusher Scheduling
- Maintenance Planning
- Operating Procedures
- Operator Training
- Control Scheme

Measure
- Tons/hr.
  - KW/T
  - Utilization/Availability
- Quality
- Cost/ton

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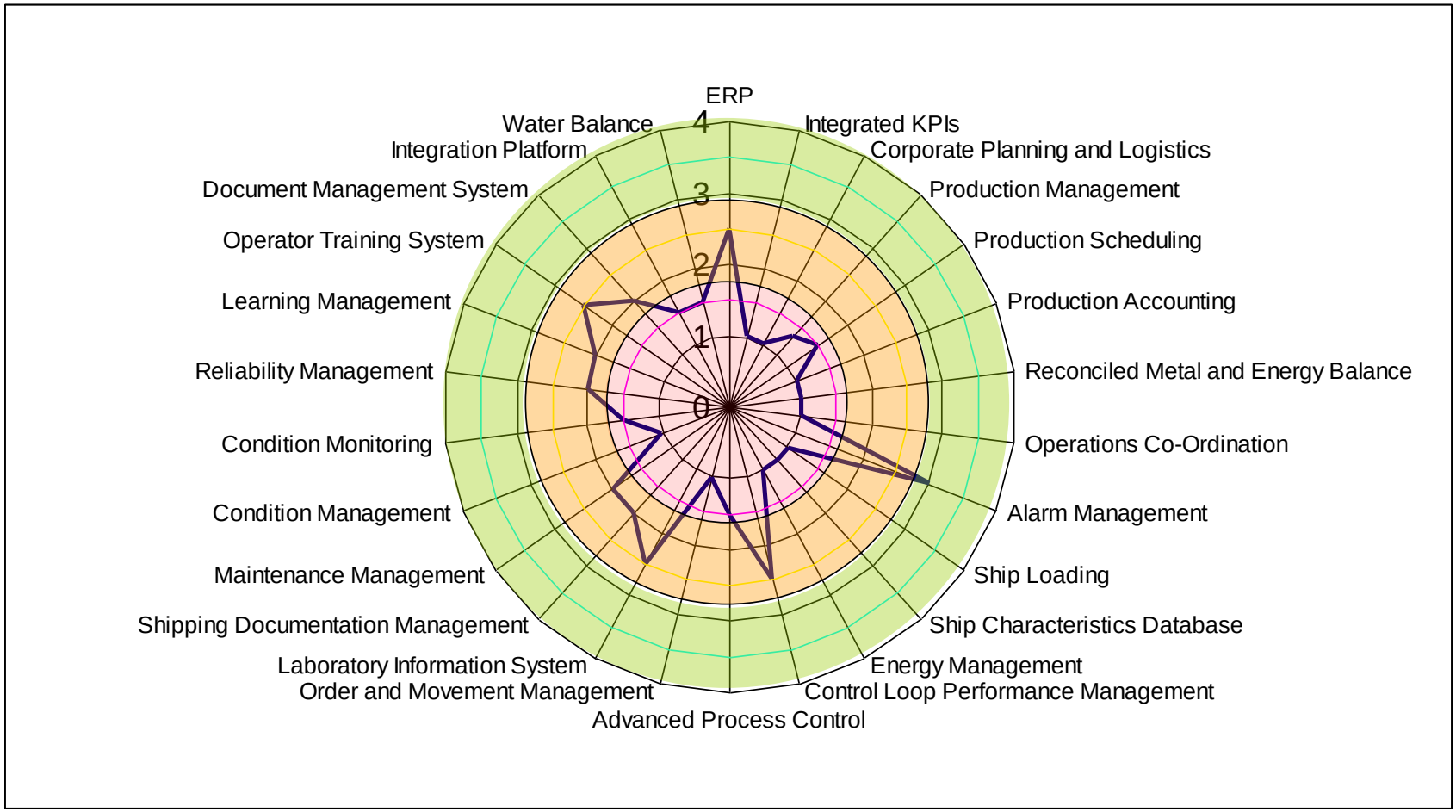
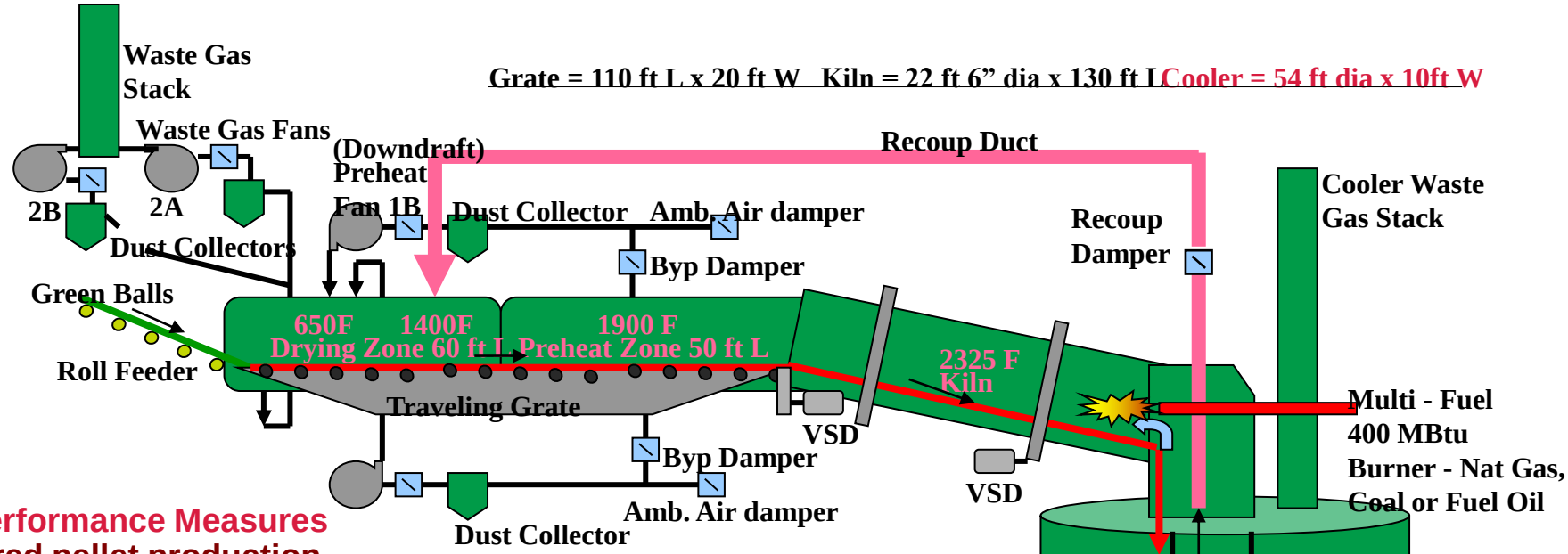
Best Practices “Spider Diagram”



Induration lines 1-2 (Example 2)
Which runs more economically ?



Performance Measures

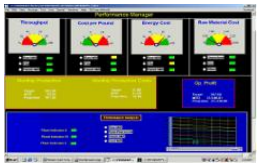
Fired pellet production rate

Fuel & process fan energy - usage/ton

Goal

5% reduction in fuel/process fan energy consumption/ton of product

Line 1



Line 2

Conclusion

With all of the challenges facing the mining industry across the globe from dynamic environmental regulations, graying workforce, volatile pricing, resource limitations, and sustainable operations , it is even more challenging for mining operations to thrive and improve operations. Successful mining operations have adopted practices and ways of doing business that have enabled them to be better performers across global enterprises with sustained agility and efficiency. The use of ISA S95 plus Business Value solutions provides an enabling frame work for creating value.

THANK YOU