



Implementing a Model Based Enterprise with the IIMS/CTP-OS



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MBE is Founded on an Intelligent TDP



- The Model-Based Enterprise (MBE) is about effectively sharing an “intelligent TDP”
- To Enable MBE, all aspects of the Enterprise that interact with the TDP must be interoperable, enabling collaboration throughout the entire lifecycle of a product—from concept to disposal
- All 3D product definition and subsequent annotations, relevant associations, etc. within the TDP must be accessible across the enterprise, enabling rapid, seamless, and affordable product deployment



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What is an Intelligent TDP?

- Consists of technical data such as:
 - 3D Models
 - Associated annotations
 - Specifications
 - Standards
 - Design Configuration
 - Assembly Instructions
 - Performance requirements

⇒ Form, Fit and Function

- To seamlessly support:
 - Conceptual Design
 - An Acquisition Strategy
 - Production
 - Engineering
 - Logistics support
 - Sustainability
 - End-of-life phase-out
 - Disposal

⇒ All MBE Stages



Current Enterprise TDPs



- Almost all current TDPs are still based upon modern versions of centuries old methods limited to 2D drawings with associated notes and documentation
- This was confirmed by the 2009 Supplier Assessment* by NST Manufacturing Extension Partnership (MEP) where the vast majority of suppliers professed were at MBE Readiness Levels 1–3—still using 2D drawings—as well as others such as the Aberdeen Group Study**



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* <http://model-based-enterprise.org/docs/2009-MBE-Assessment-Draft.pdf>

** http://images.autodesk.com/adsk/files/aberdeen_3dmodeling_benchmark.pdf



Realizing an Intelligent TDP for MBE



- Enterprises need a solution that allows their existing legacy systems to be integrated with those of their suppliers
- The solution must be flexible and fast as the enterprise processes are very dynamic and constantly changing, working with different suppliers and business units across the world to create new products and technologies while sustaining and transitioning the old
- This requires a cultural shift and system-level implementations that incorporate:
 - modern repositories to store digital documents and their associated metadata
 - architectures utilizing cloud technologies to facilitate LAN and WAN accessibility
 - advanced workflow tools for enterprise processes fundamental to MBE
 - configuration management, security, and governance to control access and versioning
 - intelligent and analytical tools to ensure smooth operations and guarantee performance



MBE Solutions for the 21st Century



- Are built with Service Oriented Architectures (SOA)
- Utilize Open Source Software (OSS) to leverage specific private and functionality
- Operate in the Cloud for world-wide accessibility
- Can be rapidly built-up and torn-down to plug in new components and functionality, meeting the dynamic needs of a large-scale enterprise while enabling innovation
- Scale easily and efficiently—i.e., to meet the needs of a small supplier to the large enterprise
- Deliver high-performance and stability



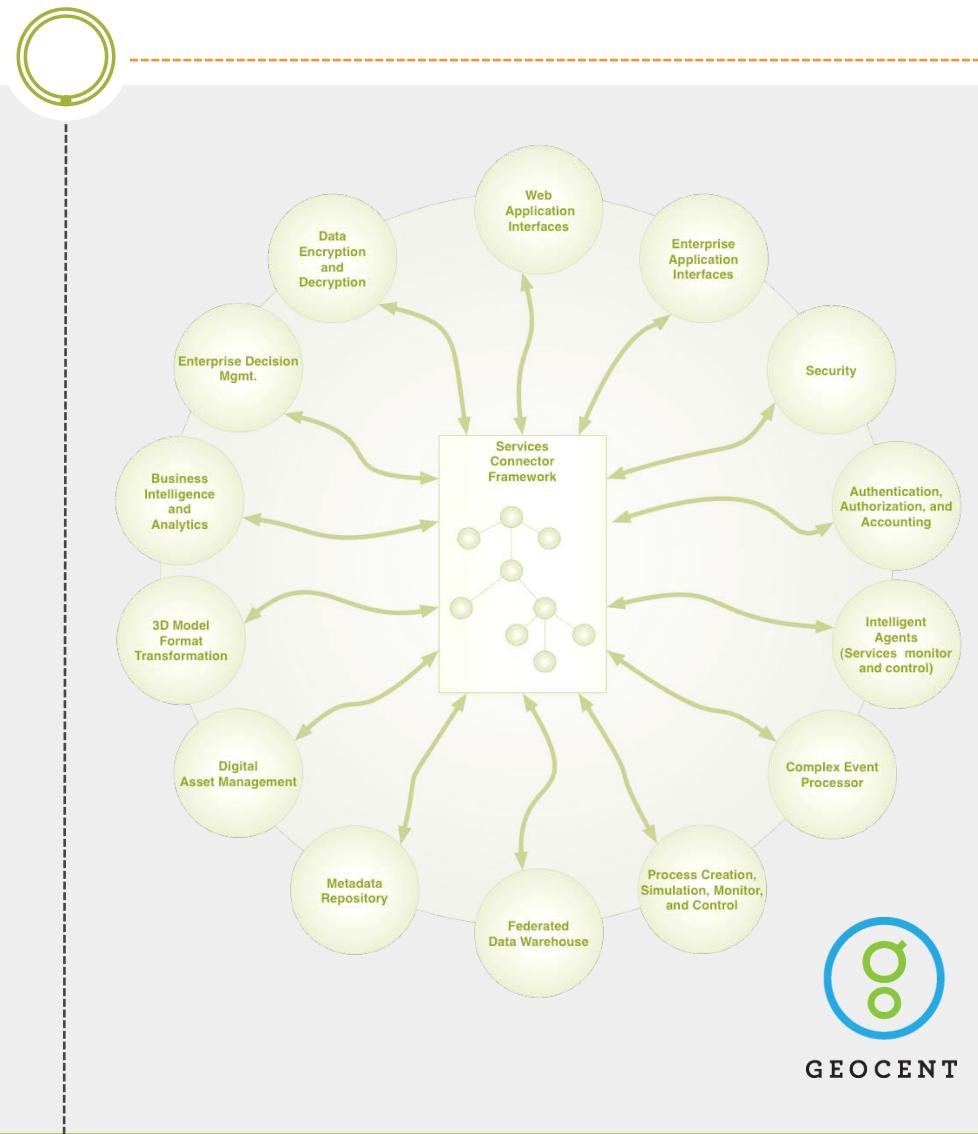
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How the IIMS/CTP-OS Enables Fast, Scalable MBE

Interoperability

- The IIMS/CTP-OS has a Service Connector Framework (SCF) at its core that enables interoperability between the enterprise's legacy systems and with its suppliers via SOA web services
- The SCF uses a cutting-edge, open-source technology called RabbitMQ to push messages through the system with a capability throughput of 1 million messages/sec, enabling high performance interoperability
- Built on a telcocommunications technology that ensures only time-to-wthin 9 nines. very stable



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How the IIMS/CTP-OS Enables Fast, Scalable MBE

Logical Data Aggregation

- TDP data throughout the enterprise must be logically aggregated
- The CTP-OS utilizes two high-performance open source databases:
 - Hadoop, a map-reduced database for the Federated Data Warehouse (FDW) system processing monitoring and systematic transactional data
 - Alfresco, a digital asset management (DAM) repository for drawings, 3D models and all associated documents



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How the IIMS/CTP-OS Enables Fast, Scalable MBE

Governance with TDP Content Management

- Governance is achieved with Alfresco, the leading world-class Enterprise Content Management (ECM) system
 - First open source software to pass the rigorous U.S. Department of Defense (DoD) 5015.02 standard certification*
 - Users log into project workspaces to collaborate, sharing documents & viewing their assigned tasks according to predefined project roles and associating them with comments, questions and answers with particular documents
 - This is particularly relevant to STEP documents—as they are clear-text, Alfresco can search these documents for project codes, parts, infomation, etc.
- * See <http://jtcf.hud.iamsil/recomgt/standards.htm>



The screenshot shows the Alfresco Share User Dashboard in Mozilla Firefox. The dashboard includes sections for 'My Calendar' (No upcoming events), 'Getting Started' (Welcome to your Dashboard, Learn about Alfresco Share, Your Profile), 'Alfresco Network' (Get more out of Alfresco, Configure), 'Create a Site' (Create a site and start collaborating with others, Create Site), 'Alfresco Global Feed' (Configure, Alfresco Strengthens Open Source ECM Market Leadership with Record Q4 and 2009, Alfresco CEO & CMO to Present on Cloud-Based Content Management at SugarCon 2010), and 'My Tasks' (No tasks to display).



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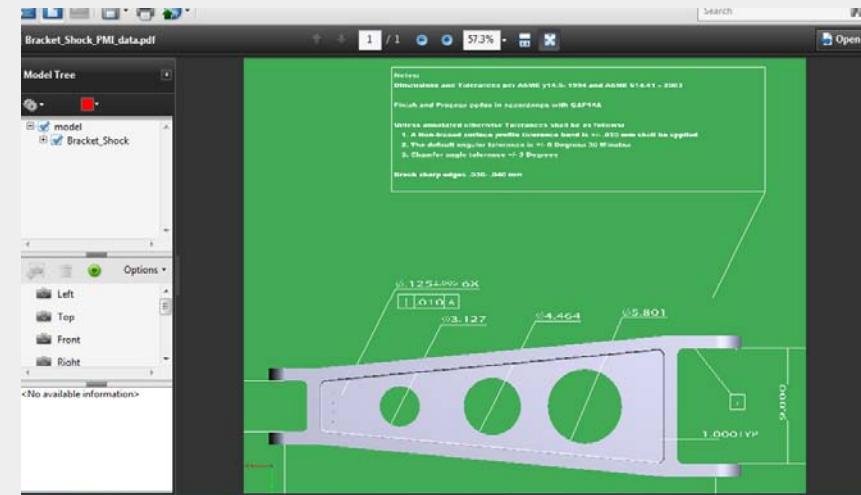


How the IIMS/CTP-OS Enables Fast, Scalable MBE

Collaboration

- Engineers work with the Digital Asset and Technical Document Management (DAM/TDM) systems when working with specifications, 3D CAD Models, requirements, etc. in the Project workspace created, which keeps track of all project related metadata and automatically creates a light-weight 3D PDF rendering for downstream reuse
- Comments and questions can be added and are automatically associated with all related documents (specifications, CAD files, etc.)

*See <http://jtcf.hu.dismil/recongt/standards.html>



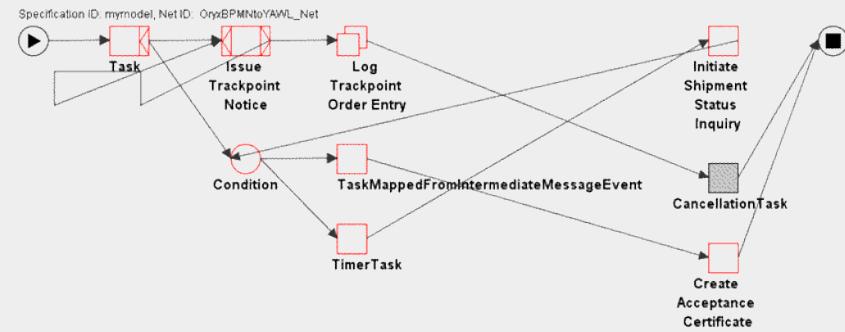
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How the IIMS/CTP-OS Enables Fast, Scalable MBE

Business Process Workflows

- In the Enterprise, successful automation is supported by business processes that enforce effective workflows using the YAWL Service
- Hundreds of process models are invoked by a variety of events in the system ensuring that appropriate personnel are notified, files are moved, processes are started, etc. when needed
- YAWL is based on Petri Nets—all processes built are mathematically sound—i.e., all processes will reach conclusion



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How the IIMS/CTP-OS Enables Fast, Scalable MBE

Business Intelligent Intelligence

- In addition to the many services providing seamless integration between the IIMS/CTP-OS agents are employed to:
 - Monitor systems
 - Process data
 - Conduct decision support
 - Notify appropriate personnel of aberrations or problems
 - Ensure system stability
 - Acquire short and long-term trend data and associations, etc.
- The data is assimilated and displayed in graphs, dashboards, etc. by the IIMS/CTP-OS Jasper* service
- These agent services which are working with the other IIMS/CTP-OS services help to implement a more intelligent TDP



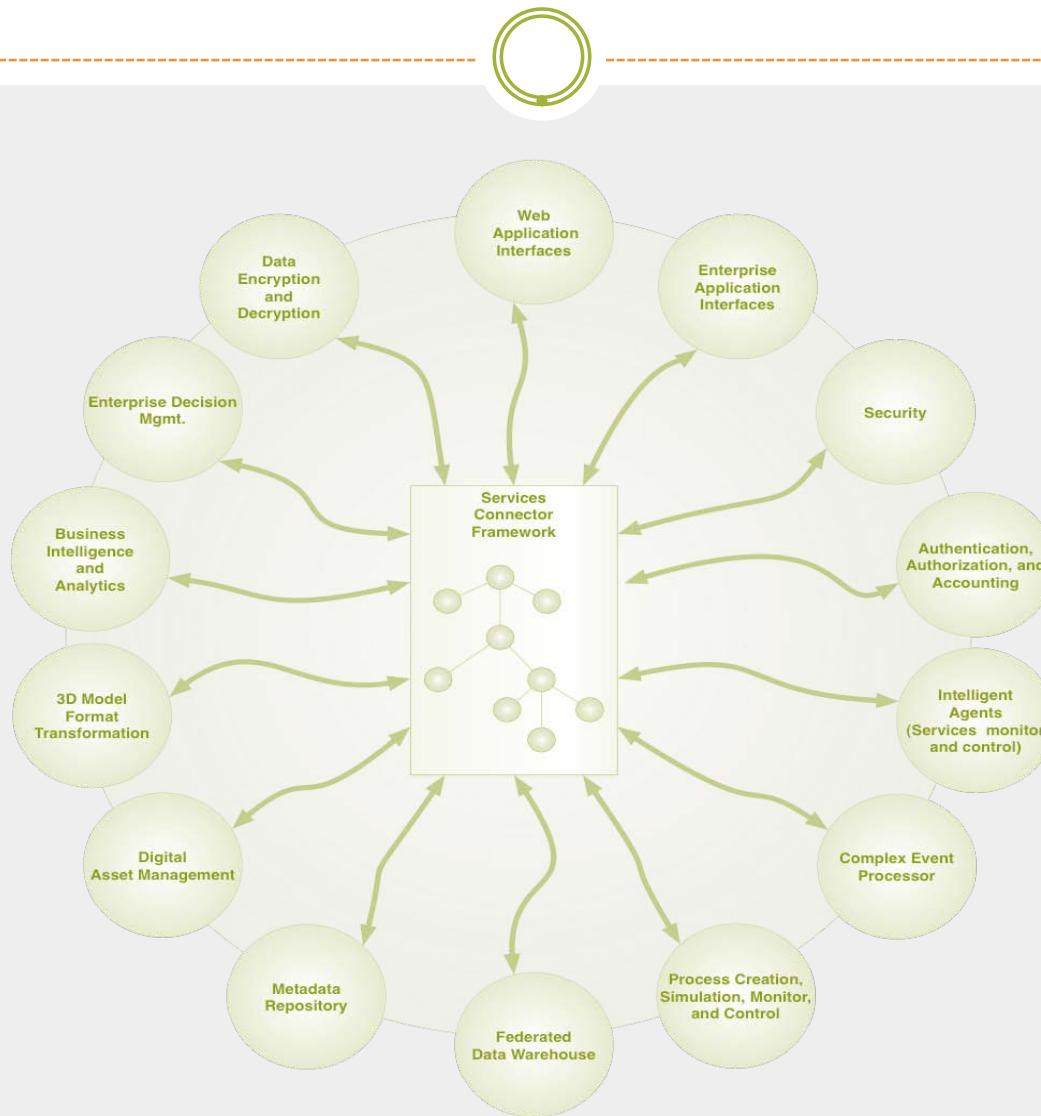
*Jasper is the leading world wide open source BI analytical tool



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All Together...



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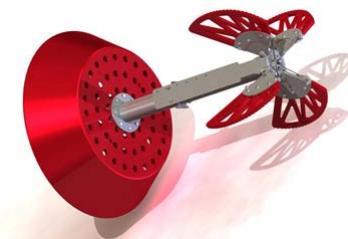


So Why is an Entire Platform Needed?



- **Barriers to Effectiveness:**

- Disparate Legacy systems
- Interoperability with Suppliers
- Difficulties Enforcing Processes
- Lack of Flexibility/Adaptability
- Isolated Business Logic & Applications



- Each gap in data represents inefficiency in the enterprise and has a price



STEP + PM + BOM



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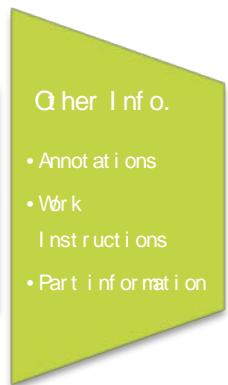
Revisiting the Main Goal...



- **Goal : Reuse central 3D CAD model + its associated data by all extended enterprise members throughout the product's entire life cycle**



- Interface CAD with ERP
- Handle ECO efficiently
- Incorporate supplier's parts easily
- Track engineering timeline
- Automatically associate all meta data
- Automate Processes
- Encapsulate Digital Work Instructions



STEP + PM + BOM

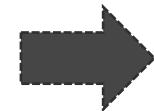
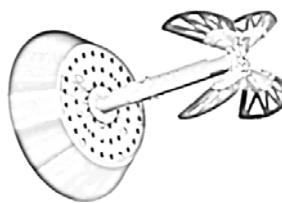


MBE Stages

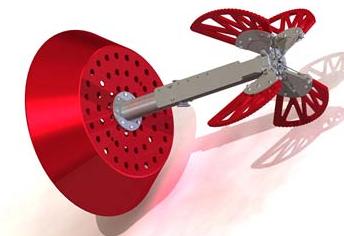
Proposal



Concept



Design



Production



End of Life



Sustainability



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Some Challenges Implementing MBE



- Correct CAD Transf ormations and Preservation of Metadat a
 - What allows correct CAD transformations and metadat a (Product Manufacturing Information, PM) to be accessible?
- Model Validation – CAD Application Evolution
 - Containing application changes at some future point are not backward compatible with older CAD models
- Supply Chain Accessibility
 - How do suppliers and the Enterpris e effectively share TDPs?
- Long-Term Data Access
 - How is data accessibility ensured as the Enterprise evolves?



MBE Digital TDP Example with CTP-OS



- In the CTP-OS, a TDP is equivalent to a Space (a Space being analogous to a folder) in which all related artifacts (models and process data) are collected and associated
 - An Administrator creates a new project space from template
 - All workflows/rules are automatically copied into the new project space
 - The administrator inputs project account using codes-which is tracked as Project Members accept tasks and perform work
 - Project Members are assigned from Groups of Roles that corresponds with their skill and their availability
 - Project Members can search via account using codes, project name, Project Members who have accepted tasks, document contents, etc.
 - All of the data within the TDP is versioned—a clear audit trail is available



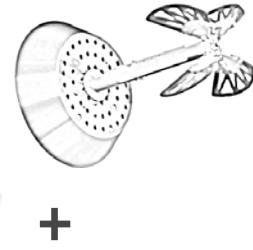
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MBE Digital TDP Example with CTP-OS



- The Main 3D CAD file is created from project templates, populated with appropriate specifications, parameters and control led with versioning and governance
- The Lead Designer starts working by accessing the specifications document from the DAM and placing it into his local CAD workspace
- She then accesses a 3D CAD file template from the TDM and places it into a folder invoking an event that transfers specifications parameters into a new 3D CAD file
- As she saves incremental changes, the 3D CAD file is versioned and automatically rendered as a light-weight 3D PDF for later downstream use
- When traveling, she accesses the TDM via a web browser and performs a checkout of the 3D CAD file to a local workspace
- By using TDM check out/in capabilities, she ensures that the 3D CAD file is locked to other colleagues while she is working and that revisions are appropriately versioned



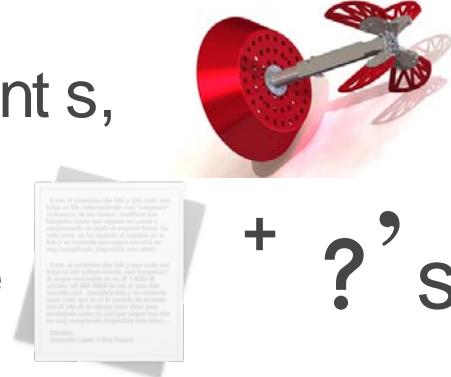
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MBE Digital TDP Example with CTP-OS



- The 3D CAD file and relevant documents are automatically linked and associated with comments, questions, etc. during collaboration
- The Design Engineering Manager accesses the TDM via a browser with a secure connection to the 3D CAD file
- The Manager may run a TDM Find Document function, searching by the Lead Design Engineers' name
- From the search results the Manager chooses the Specifications and 3D CAD files
- The Manager ensures that she can correlate the most current design changes reflected in the Specifications document to the 3D CAD files
- Comments and questions are added as notes within the TDMOM system which are automatically linked with the 3D CAD file, Specifications document, and the 3D PDF
- When the Design Manager and Lead Engineer collaborate on the progress of the project, both are able to review and add notes for additional comments, clarification, or task assignments



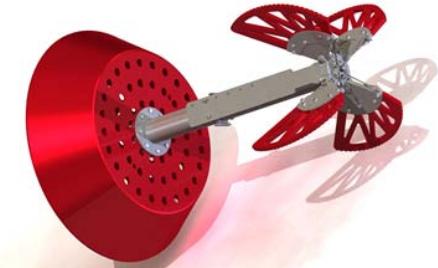
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MBE Digital TDP Example with CTP-OS



- If the 3D CAD file is in a format that is not supported by a review Engineer's local CAD station, the file's **STEP format** is used
- By using a single standard format and one master file for the TDP, versions of inconsistencies with one-of-a-kind products such as light-weight renderings are eliminated
- The CTP-OS has been using Anark for its transformations for over a year to produce 3D PDF versions with associated formats



One file: STEP format



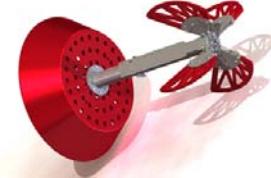
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MBE Digital TDP Example with CTP-OS



- The implementation of Digital Engineering Change Orders are streamlined and efficient.
- Upon approval of a DECO, the Lead Design Engineer researches the issue and notes that the bolt in question is a recent import to the CAD tool part library.
- She finds that the published dimensions and the actual parameters within the CAD part file are inconsistent. The DECO is updated and associated personnel are automatically notified.
- The Lead Design Engineer finds an alternative Supplier in the Product Data Management (PDM) system that provides a bolt with the same specifications.
- She imports the CAD part file from the alternative Supplier, ensures it will work, suggests the change, and places the DECO in Management Approval mode.
- Once approved, changes can be saved and the versions updated, spawning a new review/approval process that automatically notifies personnel of the pending tasks.



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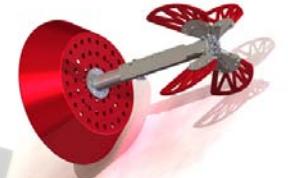
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MBE Digital TDP Example with CTP-OS



- Suppliers can be affordably connected to the CTP-OS to further close the digital thread
- Many Manufacturers will benefit from Suppliers as a partner ship where the Supplier is more than a purveyor of pieces and parts—i.e., they are an extension of the Enterprise.
- This type of relationship requires transparency in core business processes using the technology to enforce appropriate access, security, and general governance.
- A Product Engineer eases the problem in the Supplier workspace. Suppliers are automatically notified if files are updated and may review the TDP Specifications, BOMs, project Demand Metrics, anticipated spare parts needs, the notes/issues discovered with the design, and the remediation taken, etc.
- The Product Engineer notes that the Suppliers have accessed the specifications and associated documents and were notified of their updates. An escalation notice alerts via email to the Suppliers of the hard due dates for proposals and bids. Each Supplier is able to quickly update and validate their proposal, pricing matrices and other values added proposals and submit a package securely to the project space.
- The Product Engineer validates parts being delivered by the Supplier packages for review and consideration. After approval, the package is forwarded to the legal and purchasing departments for execution of the Supplier contract.



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MBE Digital TDP Example with CTP-OS



- During production the Digital Manufacturing Work Instructions (DMW) associated with the 3D PDF rendering aid operators in effective factory floor operations



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- A DMW is created from employee notes associated with TDP information from the design, review, validation, and approval process workflow to detail the manufacturing steps of a product.
- Once approved the DMW is used by the Product Information Scheduler.
- When an Operator logs in he is presented with a list of orders to be completed during shift. The DMW first instructs the Operator to choose and attach an adhesive RFI Dot to a specific location on a battery housing panel and activate it so that the wireless node receives the RFI Dot data (serial number).
- The Business System Module then receives a message that a battery housing is now in a Work In Process (WIP) state and records the corresponding serial number. The Inventory System Module then adjusts inventory accordingly, right inline with the Accounting department.
- Next, the DMW indicates steps to perform quality control or maintenance measurement tasks, where a pneumatic wrench is used to measure torque on each bolt in assembly. The torque reading is transmitted to a wireless node for capture and compared to the control limits. This step helps ensure that the product meets specific requirements, extending its quality and PLC GEOCENT





Revisiting Challenges Implementing MBE



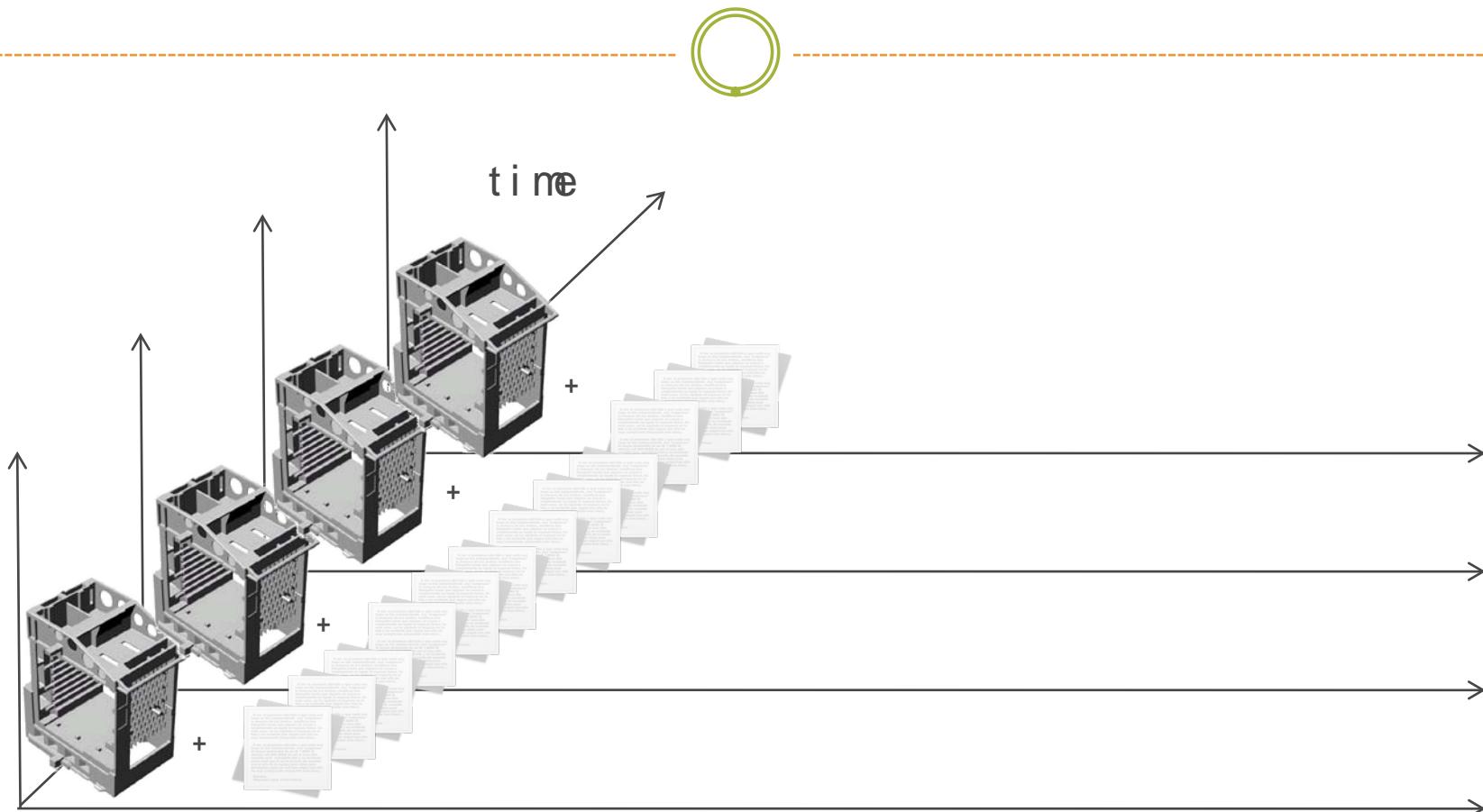
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Vision: A 4D Model Based Enterprise



3Dview of a 4D TDP for a casing part life cycle



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What Differentiates the IIMS/CTP-OS?



- With all the tools out there that claim interoperability and configuration management, how can Geocent's work help a large enterprise?
 - There is **NOTOOL** that we are aware of that is developing an **entirely open source solution** of the scope of the IIMS/CTP-OS
 - We have specifically chosen **high-performance open source tools** that deliver the needed functionality across the Enterprise to implement **MBE** with intelligent **TDP**
 - How can we do all of this? Because we are not reinventing **the wheel** –each major service makes use of existing, capable, open source technologies to provide system functionality



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What Differentiates the IIIMS/CTP-OS?



- The **SOA** that allows the IIIMS/CTP-OS to connect legacy systems is the same thing that allows it to leverage specific, high-performing technologies to achieve extensive functional integrity—it *works much like the Internet*
- The IIIMS/CTP-OS uses **JSON with embedded XML** as a common interface with its SOA services, allowing a company's disparate applications to be integrated, regardless of their platforms
- Everything is web-based, so company LANs and WANs can be integrated allowing horizontal and vertical connectivity throughout its facilities



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Conclusion



- By using SOA and SOF designs, the IIMS/CTP-CS—much like Internet—is able to manage many of the complexities involved with sharing and governing the TDP in the extended Enterprise.
- Using services to expose processes, data, machines, equipment, etc. while abstracting the implementation and details, effectively virtualizes the manufacturing regime helping to implement MBE.
- Responding to complex dynamics involved with supply chains, new products lines, changes, global operations, etc., is implemented with the abstract paradigm exchange of data and implementation of reusable application logic already in place. This allows for rational scaling, effective operations and affordability in interoperability.



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Thank you!

Questions?



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