MBE Insertion Plan Development

Ted Huang / Lorenzo Landin Eng Process & Tools Boeing Network & Space Systems



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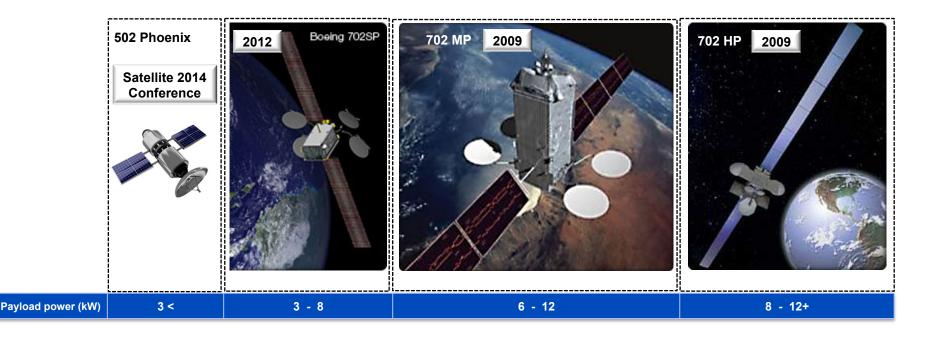


Boeing Satellite Product Line

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Expanded offerings to excel in competitive marketplace

- Scalable payloads to >12kW
- Common bus system/unit approach
- Hosted payload capability



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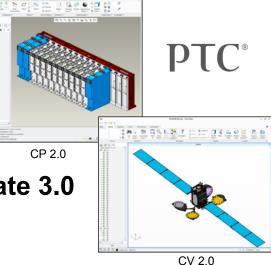


Tools

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• CAD

- Design Creo Parametric 2.0
- LEV (Visualization) Creo View 2.0
- Thermal Analysis Thermal Modeler 6
- Structural Mechanics Creo Simulation 2.0
- Work Instruction Authoring (MBI) Creo Illustrate 3.0



• PDM

- Site PDM/PLM Teamcenter Enterprise 8.1
- CAD Data Manager Windchill/PDMLink 10.1

TEAMCENTER

- Windchill
- Common Systems (Operations & Supplier Management)
 - MESci (eBOM/MBoM mgmt, Planning/Shop Floor Control, NCM)
 - CC, NWP, BRAIDSS, ARES, TIPQA, IBI

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CAD Data Types

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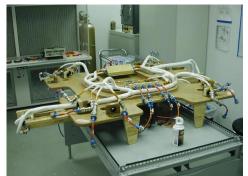
- General type: part, assembly and drawing (.prt, .asm, .drw file extensions)
- Specialty Types (heavy tool customizations developed over the years to speed up the design process)
 - Communications Repeater Subsystem (piping)
 - Routed Systems Harness, Propulsion (cabling)
 - Thermal Blankets (sheet metal, mold design)
 - Structural Panels
 - Reflectors (point cloud based surfaces)



Reflector



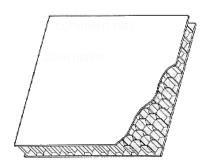
Comm. Repeater Subsystem



Harness Routing



Thermal Blankets



Structural Panels



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Modeling Techniques

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- CAD technology level approaches to product definition
 - Top-Down Relational Design The "Top-Down" methodology, uses Master Geometry which will define the shape and position of Detail Parts and interface information for the overall product.
 - Relational Design is a methodology for managing product configuration by establishing geometric relationships (links) between detail parts and assemblies and the high-level Master Geometry.
 - In Creo Parametric, the Master Geometry is known as skeleton models. The Skeleton model is typically a part file which can contain surfaces, points, coordinate systems, planes or solids. Multiple skeleton models are permissible.
 - In CATIA V5, the Master Geometry is broken down into MDF, MDS, ICM, & RLM
 - Layering used to organize data and support customizations
 - Top plus one assembly files created for assembly and installation drawing creation



Modeling Techniques

- Areas of Boeing Satellites improvement:
 - Bottom-up release
 - Assembly retrieval issues
 - Missing references
 - Regeneration errors
 - Circular references
 - Assembly cuts outside of model
 - Limited Planner/ME RAA
 - Only 10% of suppliers are MBD approved
- Possible area of industry improvement
 - Establish a standard to facilitate creating 2D drawings from 3D models to support as-needed drawings





Engineering Release

- Integrated Two Tier PDM Engineering Release
 - CAD objects approved in CAD Data Manager (Windchill/PDMLink)
 - 2D PDF of drawing is auto-generated & uploaded to site PDM/PLM (TcEnt)
 - Engineering signoff and release occurs in TcEnt





Engineering Authority

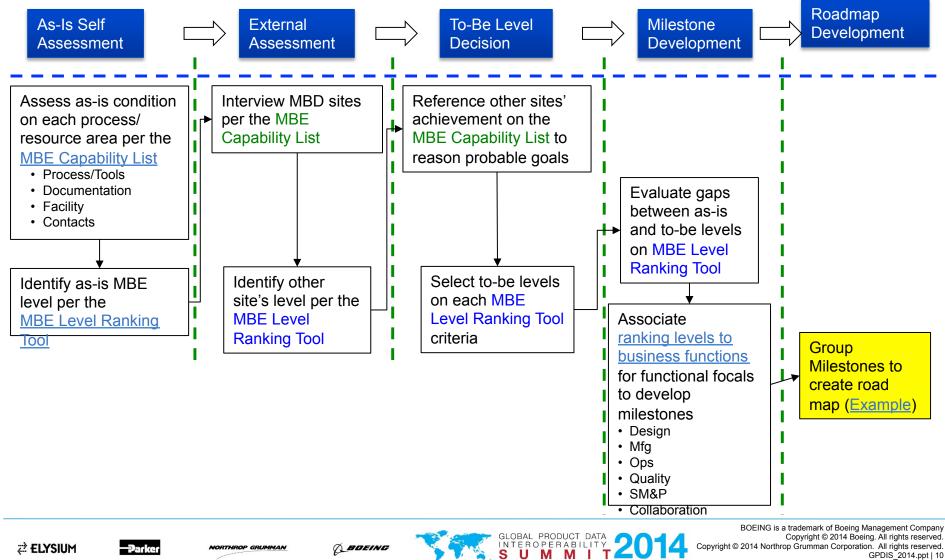
- Boeing Satellite is primarily Drawing Centric
 - 2D Drawings released into the site PDM (TcEnt) are the master authority (also releases some STEP models)
 - Low-level of Reduced Dimension Drawing (RDD) is released:
 - 2D drawing + STEP model
 - Machined parts primarily
 - Some inseparable assemblies (i.e. machined parts w/nutplates, pins)
 - Structural panels are the only commodity that are MBD
 - Native Creo Parametric files released into PDM for downstream fabrication





Roadmap Development Process and Tools

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MBE Level Ranking Tool

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- Original tool acquired from model-based-enterprise.org
 - ITI TranscenData reviewed the tool in a 5/21/2014 webinar
- Tool is a spreadsheet that defines four MBE Stages with seven levels
 - Drawing Centric level 0
 - Model Centric level 1-2
 - Model Based Definition level 3-4
 - Model Based Enterprise level 5-6



 Boeing Satellites revised the tool for clarity, granularity, and business applicability

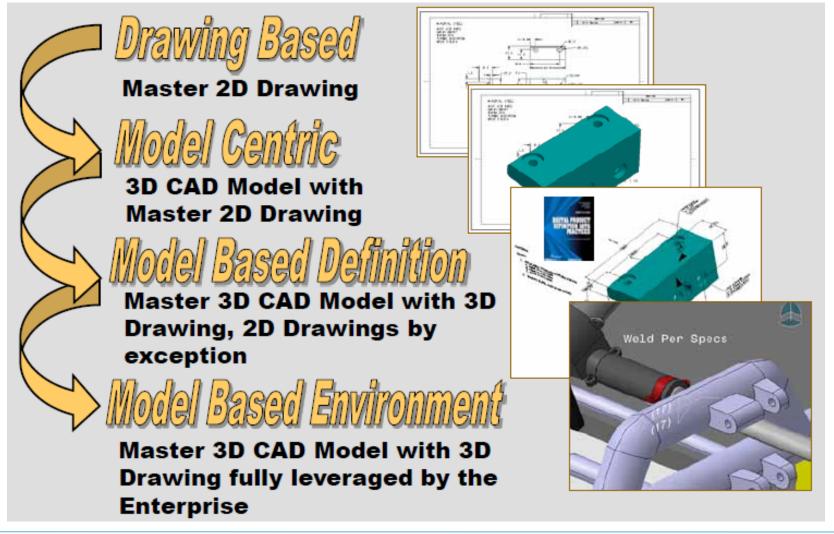
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MBE Phases

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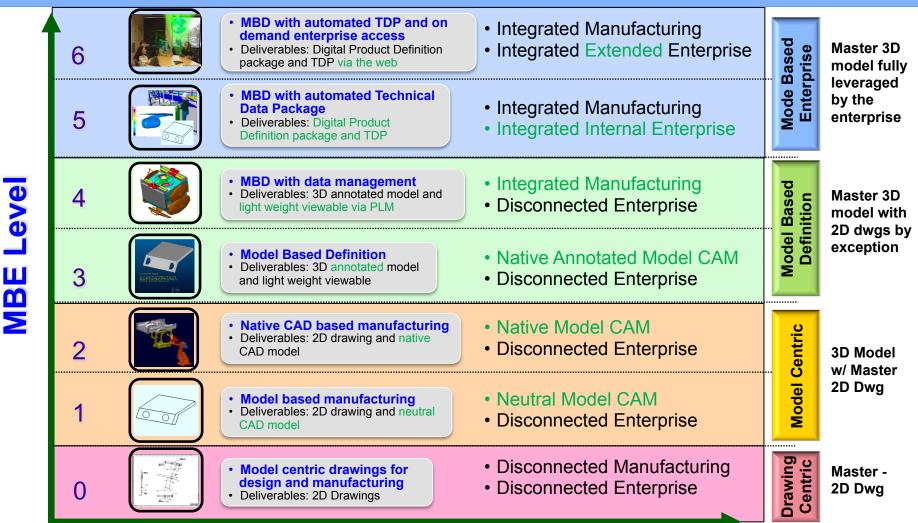
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MBE Levels

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Green text are changes from the prior level



arker *Norm*

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MBE Level Ranking Tool (Original Form)

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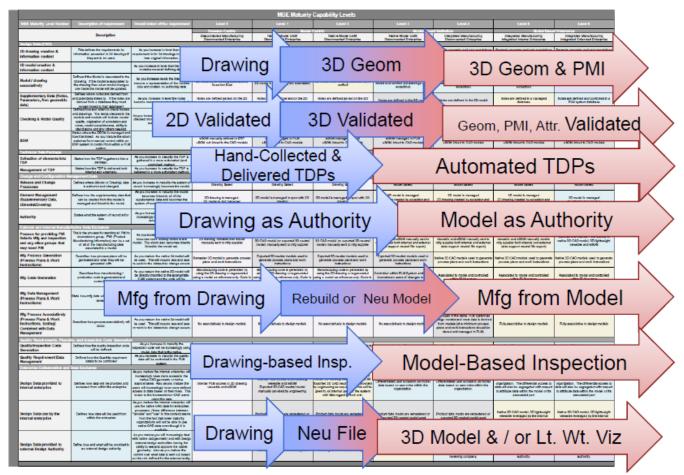
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Level Transition*

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Courtesy of model-based-enterprise.org

*Courtesy of Asa Trainer 5/21/2014 ITI webinar

MBE Level Ranking Tool and Process (Original Form)

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1. Assess acros	S		Phase	Dwg Centric	Model	Centric	ME	3D	М	BE
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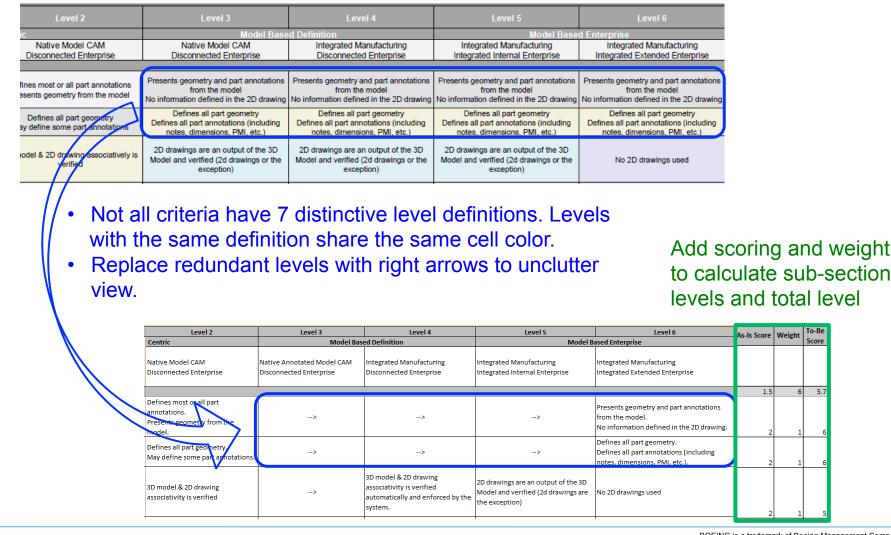
NORTHROP GRUMMAN





Boeing Satellites Ranking Tool Changes – Format

Global Product Data Interoperability Summit | 2014







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Boeing Satellites Ranking Tool Changes – Fundamentals

- Equating "native model" with "auto-synchronized neutral model," assuming auto-synch'ed neutral model contains the same and timely updated product definition as the native model.
- PLM can be one all-encompassing system, or a single PLM system integrated with specialty PDM systems like CAD PDM and MES





Boeing Satellites Ranking Tool Changes – Level Definitions

Row	Criteria (12 with levels changed, 3 new criteria)	# of Level Before	# of Level Now	44 New Definitions	5 Refined Levels
8	Model/Dwg Associativity	5	6	L5	
11	BOM	2	3	L1,L2/3/4	L5/6
13	Collection of Elements into TDP	3	4	L4	
14	Management of TDP	2	5	L0,L1/2,L5	
17	Release Element Mgmt	4	5	L1	
21	Mfg Process Generation	3	6	L1,L5,L6	L3
22	Mfg Code Generation	3	5	L3/4,L5,L6	
23	Mfg Data Mgmt	3	6	L0-L3	
24	(New/Redefined Criteria) Mfg Process Associativity (simulations, mfg. tolerance analysis, nonconformance & work/re-work Instructions, tooling) Combined with Data Management	3	6	L0,L1,L2,L3,L4,L5/6	
25	(New Criteria) Tooling, testing, electronic tooling and support equipment utilize similar processes as aircraft hardware (tools use as a medium of inspection will require their own processes)	N/A	5	L0,L1,L2,L3/4,L5/6	
27	Quality/Inspection Code Generation	5	5		L6
28	Quality Requirement Data Management	2	5	L0,L1,L2/3,L4	
29	(New Criteria) Quality/Tooling Qualification	N/A	4	L0,L1/2,L3/4,L5/6	
32	Design Data Use by the Internal Enterprise	3	7	L0,L1,L2,L3,L4,L5	
33	Design Data Provided to External Design Authority	5	6	L2	L3,L4





Boeing Satellites Ranking Tool Changes – Old and New Forms

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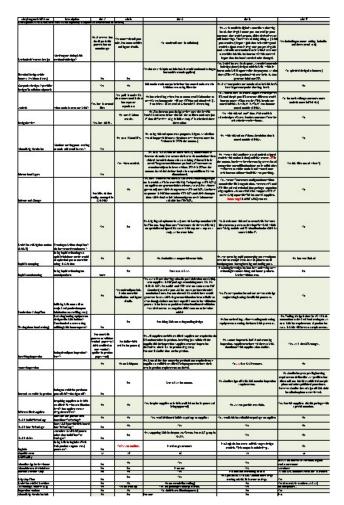


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MBE Capability List

- Purpose of the list
 - Facilitate interviewing other sites to identify their MBD capability and MBE deployment scope
 - Capture notes on processes, tools, command media, training, and facility, etc.
 - Information from interview helps Boeing Satellites to identify other site's level on the MBE Ranking Tool
- Colored cells show where a site has capability.











MBE Capability List

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Contains a list of MBD capability topics

Mechanical Design (relational, top down, drawing, etc.)	Electrical Design (harness, board)	Specialty Design (Composite, tubing, piping, etc.)	Mechanical Analysis (FEM, thermal, mechanism, etc.)		
Design Visualization and Review	Virtual Mfg Simulation	Dimensional Mgmt	Release and Change		
Tech Data Package	Model Based Mfg/ Instruction	Rapid Prototyping	Rapid Mfg		
Production/ Shop Floor	Integration, Tooling and Testing	Source Inspection	Model Based Inspection (Quality, Receiving)		
MBD Approved Suppliers	SM&P, Buy/Build To Package	Tech Publishing	Maintenance and Support		

Also contains MBD facility types

• Virtual design review room, immersive lab, NC, CMM, and additive manufacturing etc.







MBE Capability Interview Examples

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Capability Areas	Site A	Site B	Site C	Site D	Site E
Mechanical/Systems Design	Yes	Yes	Yes	Yes	Yes
Electrical Design (cable harness, PWB board, etc.)	No	No	Yes	Yes	Yes
Specialty Design	Yes	Yes	No	Yes	Yes
Mechanical Analysis	Yes	Yes	Yes	Yes	Yes
Design Visualization and Review	Yes	Yes	Yes	Yes	Yes
Virtual Mfg Simulation	Yes	Yes	Yes	Yes	Yes
Dimensional Mgmt	Yes	Yes	Yes	Yes	Yes
Release and Change	No	Yes	Yes	Yes	Yes
Model Based Instruction (MBI)	Yes	No	Yes	Yes	Yes
Rapid Prototyping	Yes	Yes	Yes	Yes	Yes
Rapid Manufacturing (using parts in actual products)	No	No	No	No	No
Production / Shop Floor	Yes	Yes	Yes	Yes	Yes
Integration, Tooling and Testing	No	No	No	Yes	Yes
Technical Data Package	No	Yes	Yes	Yes	Yes
Source Inspection	Yes	Yes	Yes	Yes	Yes
Model Based Inspection (Quality, Receiving)	No	No	No	Yes	Yes
MBD Approved Suppliers	Yes	Yes	Yes	Yes	Yes
SM&P, Buy/Build-To-Package	Yes	Yes	Yes	Yes	Yes
Tech Publishing	No	No	Yes	Yes	Yes
Maintenance and Support	No	No	No	No	Yes
Number of Capable Areas with some implementation	12	14	16	19	20

* Small percentage of MBD suppliers

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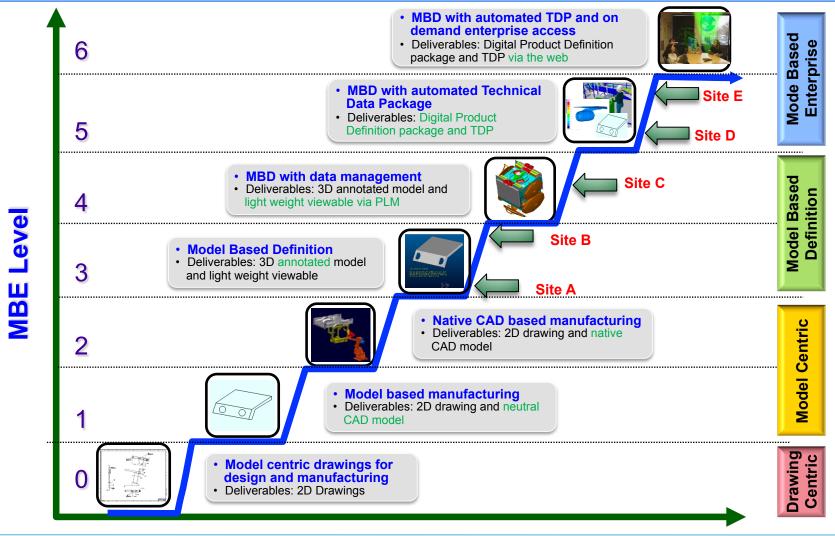
MBE Level Assessment Examples

Lev	vel 0 Level 1 Level 2 Level 3 Level 4 Level 5 Level
Design Data	 Native drawing + Native/Neutral solid model(s) Drawing is master. Some model quality check. Fully contained native/neutral MBD model + optional full or minimally dimensioned dwg Model is master. Semi-automated model quality check
Technical Data Package	 PDF drawing, Separate Parts List Semi-automated TDP collection and delivery Creo Parametric/3D PDF/STEP/JT models, optional PDF drawing, SPL Automated collection, manual delivery
Config. and Change Mgmt	 Drawing/Neutral Model based release and change 2D PDF and 2D/3D native data separately managed 2D PDF and 2D/3D native data separately managed
Internal/External Manufacturing Data Exchange	 Mfg data based on / associated with 3D models. Mfg data not managed in PLM. Tooling design not in MBD. Mfg data based on 3D model. 50% associated with 3D models. 50% mfg data managed in PLM. Tooling design in MBD.
Quality Req'ts, Planning, Inspection	 Some quality data based on 3D neutral data. Quality data not managed in PLM. Quality data not managed in PLM. Quality data managed in PLM.
Enterprise & Data Exchange	 PDF and 3D neutral data provided (pull) to internal/ external users (some exceptions) 50% or less internal users use 3D data in their processes. Automatically notify internal/external users of 3D data availability for them to pull 50% internal users use 3D native or synchronized neutral data in their processes.
Overall	X Improving Capability

Example MBE Level Assessment



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Ranking Results>Functions->Milestones

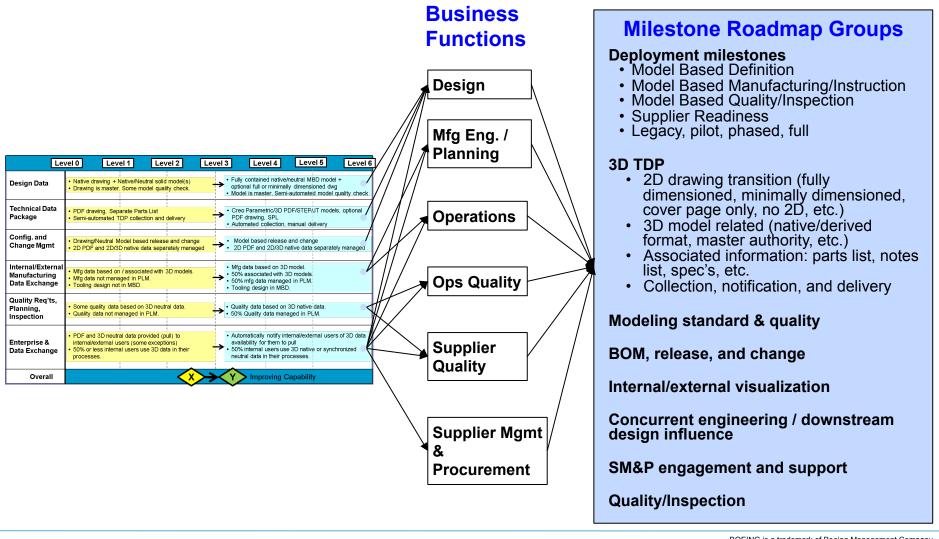
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Example MBE Roadmap - Design

Design Data <	 Drawing + Native/Neutral Solid Model(s) Drawing is master. Some model quality check. Fully Contained 3D MBD Model + 3D PDF, STEP/JT Model is master. Semi-automated model quality check.
Modeling Standard	Incorporate industry/ enterprise standards in command media; provide focal training \bigtriangleup \bigtriangleup Establish site-wide modeling standard \bigtriangleup Implement standards compliance
Quality Check	Assess model quality; Pilot model cleanup Deploy model quality check and cleanup Automate model quality check and cleanup Assess model quality; Pilot Deploy model quality check and cleanup Automate model quality check and cleanup
Model Content	Establish a single product Establish structure process engineering intent
BOM / Parts List / Notes List	Determine eBOM and CAD BOM synchronization level
Legacy CAD Data handling	Develop strategy to convert legacy CAD drawings to model centric
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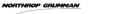
Example MBE Roadmap – Supplier Quality Global Product Data Interoperability Summit | 2014 Quality Reg'ts. Planning, · Some quality data based on 3D neutral data. · Quality data based on 3D native data. · Quality data not managed in PLM. • 50% Quality data managed in PLM. Inspection **Enterprise &** Automatically notify internal/external users of **Data Exchange** • PDF and 3D neutral data provided (pull) to internal/ 3D native data availability external users(some exceptions) • 50% internal users use 3D native or • 50% or less internal users use 3D data in their processes. synchronized neutral data in their processes. Review current non-MBD **Review current MBD** approved supply base approved supply base ∧ Review site A/B \land Increase MBD supply base supply base Define requirement for the MBD audit (prove to certifier) \wedge Support engineering to define critical features 3D FAI \triangle Define what needs to be on the FAI \triangle Define what is needed for source inspection \wedge Supplier MBD viewer access SQE/SQR MBD Supplier MBD Training software training BOEING is a trademark of Boeing Management Compa GLOBAL PRODUCT DATA Copyright © 2014 Boeing. All rights reserved 2 ELYSIUM Copyright © 2024 Northrop Grumman Corporation. All rights reserved. A BOEING GPDIS 2014.ppt | 28

Q&A

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• Thank You.











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Boeing Satellites' Challenges on using the MBE Level Ranking Tool

- Some level definitions are not clear, so a team can take some time to clarify and reach consensus on the meaning.
- Some adjacent levels advance capabilities too quickly. In other words, not enough granularity on levels.
- Levels sharing the same definition have repeated wording, which clutters the spreadsheet.
- Hard to use the tool to assess other sites
 - Other sites would need to understand the definitions first.
 - The 21 ranking criteria are more data centric, instead of process centric. Process centric topics are easier to follow, discuss, and acquire information.





Boeing Satellites MBE Level Ranking Tool (1/3)

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A	В	С	D	E	F	G	н	I.	J
MBE Level Assessme									
	Description of requirement	Overall intent of the	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Green - New Detail Part Blue - Assembly/Legacy			Drawing Centric Disconnected		Centric	Model Bas Native Annotated Model	ed Definition		sed Enterprise
Yellow - Detail and Asm			Manufacturing	Neutral Model CAM	Native Model CAM	CAM	Integrated Manufacturing	Integrated Manufacturing	Integrated Manufacturing
Salmon - To Be			Disconnected Enterprise	Disconnected Enterprise	Disconnected Enterprise	Disconnected Enterprise	Disconnected Enterprise	Integrated Internal Enterprise	Integrated Extended Enterprise
Design Data (CAD)									
	This defines the requirements for	As you increase in level, the	Defines all part		Defines most or all part				Presents geometry and part
2D drawing creation & information content	information presented in 2d	requirement is for 2d drawings to	annotations. May also define part	>	annotations. Presents geometry from the	>	>	>	annotations from the model. No information defined in the 2D
Information content	drawings if they are to be used.	contain less original information.	geometry.		model.				drawing.
3D model creation &		As you increase in level the model	May or may not exist.		Defines all part geometry.				Defines all part geometry.
information content		contains more/all defining data.	May define part geometry	>	May define some part	>	>	>	Defines all part annotations (inclu
		contains morerail denning data.	only.		annotations.				notes, dimensions, PMI, etc.).
	Defines if the model is associated to the drawing. If the	A - you is seen to us to she downing a					2D drawings are an output of	3D model & 2D drawing	
	associated to the drawing. If the model is associated to the	As you increase levels the drawings become a representation of the	3D model & 2D drawing	3D model & 2D drawing are	3D model & 2D drawing		the 3D Model and verified (2d	associativity is verified	
Model / drawing associativty	drawing then when model	models only and contain no	associativity does not	associated	associativity is verified	>	drawings are used only by	automatically and enforced by the	No 2D drawings used
	changes are made the drawing will		exist				exception)	system (2d drawings are used only	
	be updated.	-						by exception)	
	Defines where notes are derived								
	from and potentially linked to. If the notes are derived from a	As you increase in level the notes	>		Notes are defined as text on the	>	Notes are defined in the 3D	Notes are defined in a managed	Notes are defined and controlled i
Parameters, Non geometric data)	database they must remain linked	become more managed and	>	->	2D drawing	>	model	database	PLM system database
	to that database?	controlled.							
	Defines how and when to check							00	
	models and drawings. The items			2D drawing contents validated.		3D model geometry and part	3D model geometry and part	3D model geometry and part annotations validated - Semi	
	checked in the models and	As you increase in levels the	2D drawing contents	3D model has some validation	2D drawing apportations	annotations validated.	annotations validated.	automation using PLM based	3D model geometry and part
Checking & Model Quality	models will include: model quality,	models are checked more	validated.	on naming convention and	validated.	2D drawing validated not to	2D drawing validated not to	tools.	annotations validated - Semi
cincolling a resolution quality	origination of annotation and	thoroughly and in a more	3D model NOT validated.	modeling requirements the	3D model geometry validated.	define any annotation	define any annotation content	2D drawing validated not to define	
	notes, model completeness, ability to stand alone and any	automated fashion.		site chooses to enforce.		content.	(Semi Automation using discrete tools).	any annotation content (Semi	-
	others needed.						discrete tools).	Automation using discrete tools).	
	States where the EBOM is								
	managed and how it is linked. As		eBOM manually defined in				eBOM managed in PLM/ERP.		eBOM managed in PLM.
вом	you mature the eBOM switches		ERP.	>	>	>	eBOM and CAD BOM manual	>	eBOM linked to CAD model or
	from manual control within an		eBOM not linked to the				consolidation process existed		consolidation is automated.
	ERP system to control from within a PLM system.		CAD models.				and mandated.		
Technical Data Package		As you increase in maturity the		1	Ad-hoc, manual collection of		1	1	1
Collection of elements into	States how the TDP is gathered	TDP is gathered in a more	>	>	3D TDP data (digital and	Structured manual collection	Semi-automated collection of	>	Automated collection of digital 30
TDP	into a package.	automated (and controlled)	í í	, i	physical data)	of digital 3D TDP data	digital 3D TDP data by PLM		TDP data by PLM
	States how the TDP is delivered	As you increase in maturity the	Does not manage/deliver		Ad-hoc manual digital or		Structured digital delivery of full	Automated digital delivery of full	Automated digital delivery of full 3
Management of TDP	both internal and externally.	TDP is delivered in a more	3D TDP data	>	physical delivery of 3D TDP	>	3D TDP data	3D TDP by PLM.	TDP by PLM.
Change and Configuration		automated method.			data				
	Defines where (Model or	As you increase in maturity the						1	
Release and Change	Drawing) data is authored and	system of record increasingly	>	>	Drawing Based	>	>	>	Model Based
Processes	changed.	becomes the model.			2				
		As you increase in maturity the	2D drawing and	2D drawing, 2D supplementary				3D model and supplementary data	
Element Management	Defines how the supplementary	model becomes linked to all of the	supplementary data are	data are managed.	3D model and supplementary			are managed.	3D model and supplementary dat
(Supplementary Data, 3D	data that can be created from the	supplemental data and becomes	managed.	3D model and supplementary	data are managed in sync with	>	>	2D drawing and supplementary	managed.
model/Drawing)	model is managed and linked to the model.	the system of record for the	3D model and supplementary data are	data are managed. 2D and 3D data are not	2D drawing and supplementary data			data are created by exception and	No 2D drawing nor supplementar are created.
	de model.	supplemental data.	Not managed.	managed in sync.	aava			managed in sync with 3D model.	are oreated.
						Geometric definition is			
		As you increase in maturity the				defined by the B-REP of the			
Authority	States what the system of record	model increasingly becomes the	>	>	2D drawing	3D, and 2D drawing defines	>	>	3D model
. rationality	is for data	system of record for all data.	~	~~	and a starting	the PMI Both are	~,		
						considered authoritative for			
		1	1	1		there respective data	1	1	1

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Boeing Satellites MBE Level Ranking Tool (2/3)

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19	External and Internal Ma	nufacturing Data Eschange								
20	Process for providing PMI data to Mfg, Inspection and any other groups that may	This is the process for sending all PMI to downstream group. PMI (Product Manufacturing Information) can be a set of all of the manufacturing data associated to a model.	As you increase in maturity the PMI becomes more directly linked to the model. The eBOM also becomes directly linked to the model set.	2D drawing viewable and eBOM manually sent to mfg supplier		2D drawing viewable, eBOM and native 3D CAD model (or exported 3D neutral model) manually sent to mfg supplier	>		Native 3D CAD model, 3D lightweight viewable and eBOM manually sent to mfg supplier both internal and external (also support neutral file export)	External and Internal PLM access to native 3D CAD model, 3D lightweight viewable and eBOM
21	Mfg Process Generation (Process Plans & Work Instructions)	Describes how process plans will be generated and what they will be generated with.	As you mature the native 3d model will be used. This will require less and less re-work to the dataset as change occurs.	Remaster 3D model to generate process plans and work instructions, or do not use 3D models at all.	are used to generate work	Exported 3D neutral models are used as reference to generate process plans and work instructions	>	Native 3D CAD models or auto-synchronized neutral model are used as master to generate process plans and work instructions	Native 3D CAD models or auto- synchronized neutral model are used as master to generate process plans and work instructions. Mfg is notified of model changes.	Native 3D CAD models or auto- synchronized neutral model are used as master to generate process plans and work instructions. Mfg process is linked to model.
22	Mfg Code Generation	Describes how manufacturing <i>I</i> production code is generated and controlled.	will be directly imported to the	Manufacturing code is generated by using the 2D drawing. Code is stored independent from 2D drawings and/or models.	>	Manufacturing code is generated by using a model as reference only. Code is stored independent from 2D drawings and/or models.	>	Manufacturing code is generated by using a native or auto-synchronized neutral model as master. Code is stored independently from models.	Manufacturing code is generated by using a native or auto- synchronized neutral model as master, and some codes are controlled within PLM system. Coders are notified of model changes.	Manufacturing code is generated by using a native model or auto- synchronized neutral model as master, and controlled within PLM system. Code is linkd to model.
23	Mfg Data Management (Process Plans, Work	State how mfg data will be controlled and saved. Examples: Process to bonding: usage of consumable materials across products; SCGWI (analgous to BPI) on how tooling interacts with flight hardware; Inspection process on dimensions and quality.	As you mature the mfg data will need to be controlled in the same environment as the design data. This correlated to other requirements that state the mfg data will increasingly be linked to the native CAD models.	Managed in separate mfg database (0% of the plan and WI's are in PLM)		Managed in separate mfg database (50% in PLM)	Managed in separate mŕg database (75% in PLM)	Managed in the same PLM system as design models and most data is derived from models (at a minimum process plans and work instructions should be stored and managed in PLM) (90% in PLM)		Managed in the same PLM system as design models and all manufacturing data is derived from models. (100% in PLM)
	Mfg Process Associativity (Process plans, simulations, mfg tolerance analysis, nonconformance & work/re- work Instructions, tooling) Combined with Data Management	Describes how process associatively will occur.	As you mature the native 3d model will be used. This will require less and less re-work to the dataset as change occurs.	No associativity to design models	Some associativity to model copies not in sync with native models	25% direct associativity to native design models or auto- synchronized neutral models	50% direct associativity to native design models or auto- synchronized neutral models	75% direct associativity to native design models or auto- synchronized neutral models	>	Fully associative to native design models or auto-synchronized neutral models
	Tooling, testing, electronic tooling and support equipment utilizes similar processes as aircraft hardware (tools use as a medium of inspection will require their own processes)	Are all aspects of the manufacturing environment covered as part of the MBE environment. This includes end product (satellite, plane, helicopter) as well as tooling used to produce the end product, as well as equipment used to test the end product.	As organization moves toward MBE, ensure all aspects of product design are included, including on- orbit configuration (and equivalent for aircraft) tooling groups, test groups, and other support functions, in addition to the spacecraft/aircraft parts groups.	No groups considered for MBE transition	Only oustomer purchased parts (what the oustomer is actually buying, whether its spacecraft or aircraft) considered for MBE transition	Only aircraft/spacecraft parts groups considered for MBE transition	>	Tooling and support organizations are transitioning to MBE	>	All aircraft/spacecraft parts processes apply to all areas of the organization. Tooling and support functions perform under the same MBE environment as aircraft/spacecraft part manufacture

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Boeing Satellites MBE Level Ranking Tool (3/3)

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26	Quality Requirements, F	lanning, and Inspection Cod	e Generation	•	1	1	1			· · · · · · · · · · · · · · · · · · ·
27	Quality/Inspection Code Generation	Defines how quality inspection code will be defined.	As you increase in maturity the inspection code will be increasingly using model data that is the native.	Do not use 3D, or remaster 3D model, to generate NC / CMM programs	Exported 3D neutral models used to generate NC / CMM programs	>	Use copies of native 3D design models or auto- synchronized neutral models to generate NC / CMM programs	Use native 3D design models or auto-synchronized neutral models to generate NC / CMM programs	>	Use native 3D design models or auto- synchronized neutral models to generate NC / CMM programs (Parallel Process - Quality directly access models in PLM)
28	Quality Requirement Data Management	Defines how Qualitity requirment datails will be controlled	As you increase in maturity the quality data will be controlled in the PLM system.	Managed in separate database/repository outside of PLM (0% in PLM)	Managed in separate database outside of PLM (25% in PLM)	>	Managed in separate database outside of PLM (50% in PLM)	Managed in separate database outside of PLM (75% in PLM)	>	Fully managed in PLM
29	Quality/tooling qualification	Defines how tooling requirement data will be controlled over the life of the tool, and define end of life for MOI tooling.	Ensure mechanical tools are built and maintained to spec (does not include electronic test equipment).	Mechanical tooling managed separately (does not include electronic test equipment)	>	Tooling (hardware) is included as part of MBE initiative, but does not carry inspection requirments.	>	Tooling requirements are included as part of MBE, including initial tooling fabrication	>	Tooling requirements are included as part of MBE, including initial tooling fabrication and media of inspection (MOI) tooling.
30	Enterprise Collaboratio	n and Data Exchange				-				
31	Design data provided to internal enterprise	Defines how data will be provided and accessed from within the enterprise	Also as you mature the users will increasingly have more defined access to data based on their roles. This is due to the increased non- CAD users using this data.	Internal PLM access to 2D drawing viewable and eBOM	Internal PLM access to 2D drawing viewable and eBOM. Exported 3D CAD neutral model manually provided by engineering.	Internal PLM access to native 3D CAD model, 2D drawing viewable and eBOM. Exported 3D CAD neutral model provided by engineering as requested. This will be given to all internal users of the system with little regard to their role.	>	Differentiated user access to all model data based on user roles within the organization.	>	Differentiated access to all model data based on user roles within the organization. The differential access to data will also be segregated with respect to attribute data within the model or it's associated part.
32	Design data use by the internal enterprise	Defines how data will be used from within the enterprise	As you mature the internal enterprise will use the native CAD data for enterprise processes. (Note: difference between "provide" and "use" in this context) stems from the fact that lower maturity organizations will not be able to use native CAD data even though it is available.	remastered, or 3D Product data is not used	50% Product data inputs are exported 3D neutral models	100% Product data inputs are exported 3D neutral model	25% Product data inputs are native 3D models or auto- synchronized neutral models.	50% Product data inputs are native 3D models or auto- synchronized neutral models.	75% Product data inputs are native 3D models or auto- synchronized neutral models	Native 3D CAD model (or auto- synchronized neutral models), 3D lightweight viewable leveraged by 100% of the internal enterprise
33	Design data provided to external Design Authority	Define how and what will be provided to an external design authority	As you mature you will increasingly deal with native CAD geometry and with design external design authorities having the ability to see and approve the native geometry. Also as you mature the control over what data is sent out based on the role defined for the external entity.	2D drawing viewable and eBOM manually sent to external enterprise	2D drawing viewable, eBOM and exported 3D CAD neutral model manually sent to external enterprise	2D drawing viewable, eBOM, native 3D CAD model, and 3D lightweight viewable manually sent to external enterprise.	Native 3D CAD model, 3D lightweight viewable and eBOM sent to external enterprise (or portal for external access) using automated methods	Native 3D CAD model, 3D lightweight viewable and eBDM sent to external enterprise (or portal for external access) using automated methods. Able to automatically control oreated pack ages based on the role of the receiving company.	>	External PLM access to native 3D CAD model, 3D lightweight viewable and eBOM. Access to native models, Neutral models, and metadata deoided by the type of relationship with external design authority.

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MBE Level 6 Definition

- Highest level of capability
- Considered a stretch goal and no organization has known to reach this level, nor is the technology available to achieve it.
- Summary
 - 3D Models are the master
 - No Drawings are allowed (not even by exception)
 - TDP generation, collection and delivery are fully automated
 - There is full connectivity with the extended enterprise
 - The model and its meta data are available across the extended enterprise (internal and external)
 - Internal and external use of Product Lifecycle Management tools

