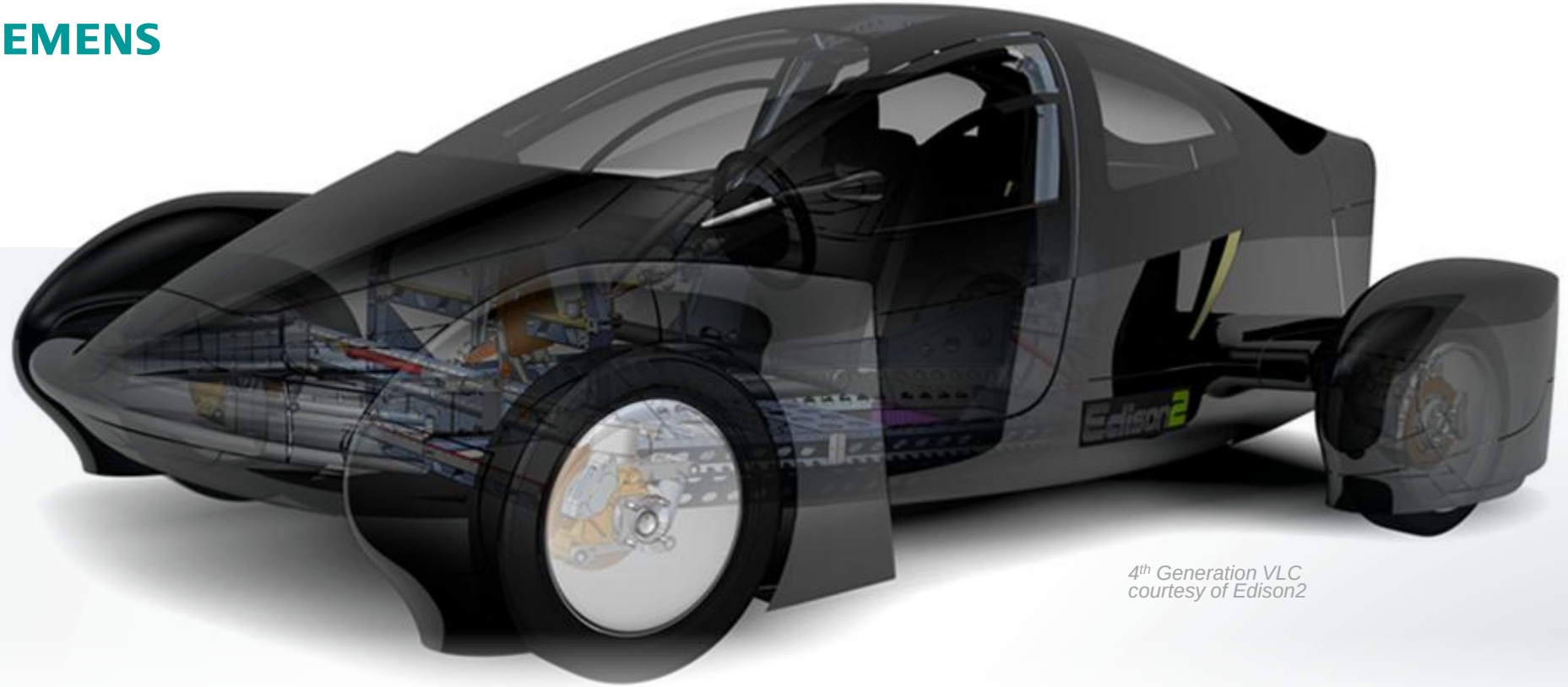
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4th Generation VLC
courtesy of Edison2

122 - A Resilient Modeling Strategy

Richard Gebhard, President, Assembly Technology Inc.

SOLID EDGE
UNIVERSITY 2013

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#SEU13

About: Richard Gebhard

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Richard Gebhard
President
Assembly Technology Inc.

Richard Gebhard, President of Assembly Technology Inc and Saratech's representative in Arizona, is an Electrical Engineer with experience in radio communication and telemetry (9 yrs), computer design (6 yrs), semiconductor manufacturing (20 yrs) and mechanical design using CAD (21 yrs). Yes, he is older than dirt! He served as a Sargent in the Marines (1955 to 1958). He also has strong links to Asia having lived there for 2 years & 5 years (1982-1989) as a consultant helping electronics companies' setup business relationships in Asia. Richard holds a 5 year Bachelor's Degree (1963) in Electrical Engineering from the University of Minnesota. His passion is scuba diving (PADI Divemaster) and has a diving travel company (Asia Divers). He also has a private pilot's license but finds it hard to find people who will fly with him. He has been married for 52 years, has 3 children, 7 grandchildren and 2 great grandchildren.

What you will learn

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This session presents a “Resilient Modeling Strategy“ (RMS) that results in robust, obvious and reusable CAD models.

Any designer following this modeling strategy when creating models can significantly improve model stability without compromising design intent.

An additional benefit of using this strategy is that it enables model checking using a documented checklist. The result is the “Holy Grail” of solids modeling, a “Best Practices Manual”.

Anyone who creates or manages solid models (not just Solid Edge) will benefit from attending this session. Attendees will receive a copy of the “Best Practices” checklist and see live examples.

Editing Solid Models

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Feature Based Models are Editable But…

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Model editing is a four step process

Step 1: Relearn the tree

- Only the author knows the tree…
  - If he remembers
- The primary learning tool is “replay”
  - Usually once isn’t enough

Step 2: Determine the strategy

- Edit an existing feature
- Insert new features
- Replace features

Step 3: Execute the change

- Change a value, extent or relationship
- Add, move or replace features

Step 4: Verify the model

- Does it regenerate correctly ?
- Has anything else changed ?
- Fix all the new errors & warnings
  - Repeat until all errors are fixed

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The Downside of Parent-Child Relationships

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Parent-Child Relationships can be booby traps that are triggered by the first edit

- A mainstream way to capture design intent but…
  - They are dormant until the model is edited
- Parts are seldom edited during the design process thus…
  - The parent-child relationships are untested
  - The first edit is the “Moment of Truth”
- The “Part from Hell” appears stable before editing but…
  - It is a “House of Cards” waiting for a wind

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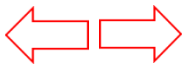
An Obsession with the Feature Tree

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Food for thought !!!!

- We design parts without any regard to editability but…
  - We blame the tree when the model fails after editing (domino effect)
- We hate dumb solids because they don't have a feature tree but…
  - We redo models rather than editing if the tree is a "House of Cards"
- We make cryptic feature trees that only the creator understands
  - If the creator leaves or forgets, the model isn't editable
- We never reuse models by copying a similar part and editing
  - But management thinks this is the main benefit of solid modeling

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The Resilient Modeling Strategy (RMS)

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Resilient Modeling Strategy Defined

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The “Resilient Modeling Strategy” manages the feature tree to achieve…

- Editable Models:
  - Robust models using a structured feature sequence
- Obvious Models:
  - Models that don’t rely on personal intuition
- Reusable Models:
  - If a model is editable and obvious, reuse will follow
  - The unfulfilled promise of solid modeling

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Seeing is Believing

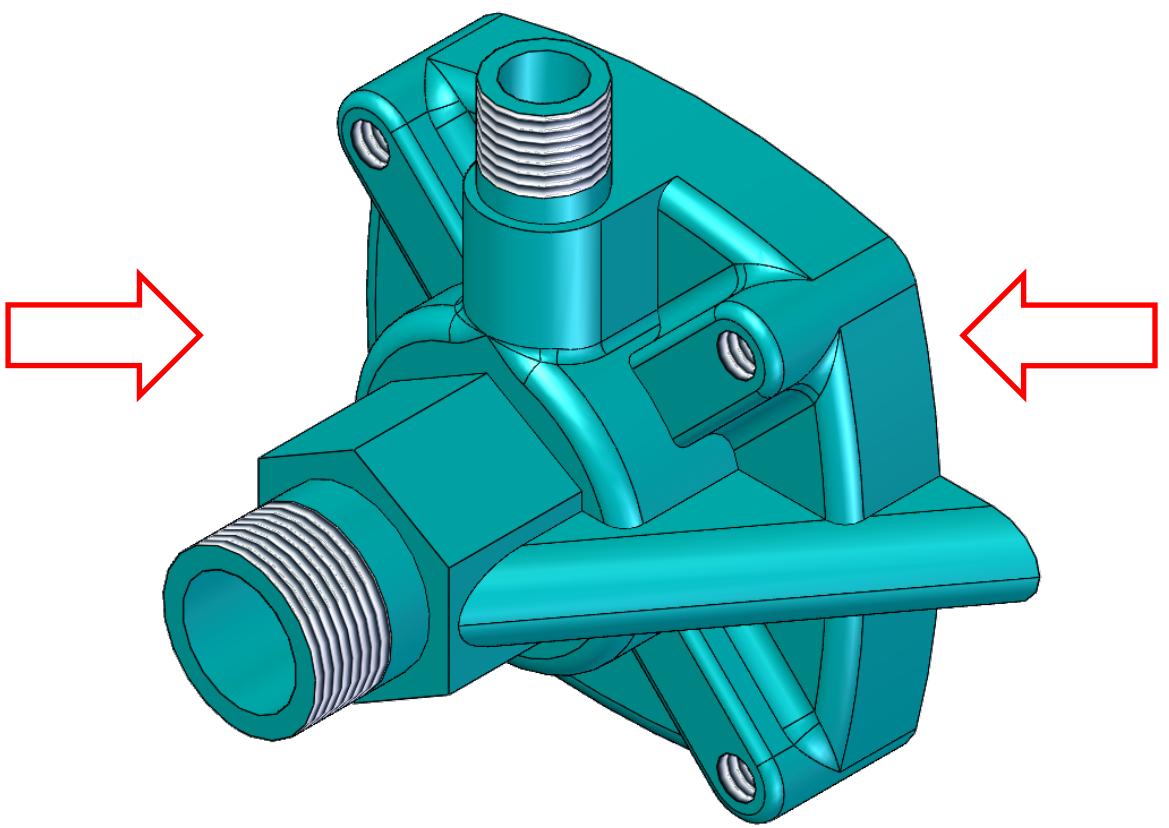
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Same result, but…

Two different feature trees

Brittle

- Ordered
  - Protrusion 1
  - Round 1
  - Round 6*
  - Protrusion 2
  - Round 2*
  - Protrusion 3
  - Protrusion 4
  - Cutout 1
  - Protrusion 5
  - Round 3
  - Round 4
  - Rib 1
  - Round 5
  - Protrusion 6
  - CircularPattern_1
  - Round 16
  - Round 17
  - Protrusion 14
  - UserDefinedPattern_1



Resilient

- Ordered
  - 1-Ref
    - Ref Body
  - 2-Construction
    - Split face surface
  - 3-Core
    - Studs 8mm x 15mm high
    - Body 10mm thick
    - Cylinder 30mm x 12mm high
    - Hex 20mm x 14mm high
    - Tombstone 12mm wide
  - 4-Detail
    - Replace Face
    - Fitting - Input 16mm dia M16
    - Fitting - Vent 10mm dia M10
    - Rib - 8mm wide
    - Extend Boss
    - Four Holes 5mm x M5 thru
  - 5-Modify
    - Pattern Boss_Hole
    - Final feature Split Face
  - 6-Quarantine
    - Thread M10
    - Thread M16
    - Round 3.99mm
    - Round 2mm
    - Round 1mm

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Think About the Model You Just Saw

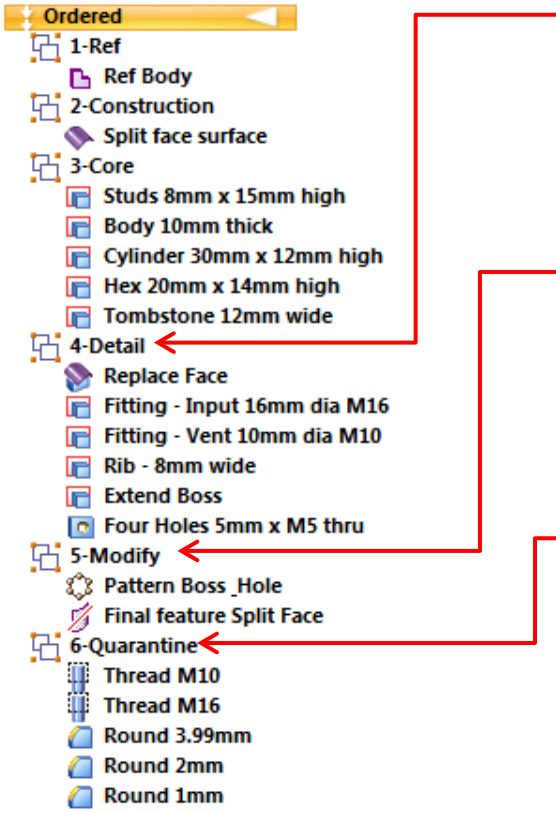
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Each feature was organized by its purpose in the model

1-Reference features:
- Requirements such as layouts, images etc.

2-Construction features:
- Key surfaces and curves that will be used alter the shape of the model

3-Core features:
- Prismatic features that capture the overall shape and orientation of the model



4-Detail Features
- Features that attach to the core of the model such as boss, slot, hole etc.

5-Modify features:
- Features that modify existing geometry such as draft, mirror, pattern etc.

6-Quarantine features:
- Cosmetic features that consume “hard” edges

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How are Your Feature Trees Organized ?

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The structure of the feature tree determines the editability of your model

Most models are created without regard to feature sequence…

On the other hand…

- "Parent-Child" relationships are very sensitive to the feature sequence

Those relationships are dormant…

- Until the first edit

Editing a feature…

- Causes the remaining features in the tree to regenerate

If the edited feature is a parent…

- Its children features can change
- This might cause them to fail

If the child feature is a parent…

- The "Domino" effect is begins

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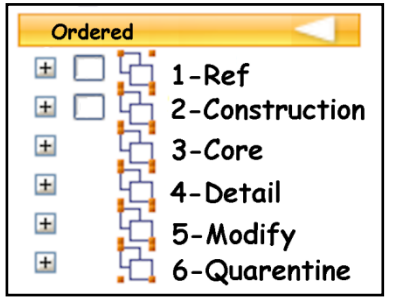
Robust Models

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The Big Picture

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The sequence of the groups, reduces the possibility of the “Domino Effect”



Group	Description	Typical Features			Notes	Links
1-Ref	All "Reference" entities are first, making them available/visible to all features	Ref Bodies Ref Planes	Layouts Coord Sys	Sketches Images	No Solids	If you can see it in the background, it is OK to link to it
2-Construction	Construction features such as Surfaces or 3D Curves that will be used to define complex solid features	Surfaces 3D Curves	Project Trim	Extend Split	No Solids	
3-Core	A “Super Base Feature” that determines the model’s shape, extents and orientation	Extrude Revolve	Sweep Loft	Thin Wall Shell	Add Material	
4-Detail	Detail features complete the shape by only linking to the Core group	Extrude Revolve	Sweep Loft	Hole Thread	Remove Material	Links to other groups are OK, but not allowed <u>within</u> the "Detail" group
5-Modify	Tilt faces and replicate features then add any "Final Features"	Draft Final Features	Pattern	Mirror		If you can see it in the background, it is OK to link to it
6-Quarantine	Volatile features that should not be parents	Chamfer	Blend	Round	Largest First	

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1-Ref Group

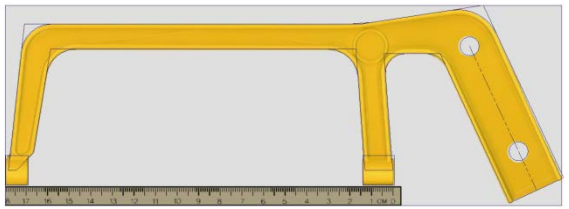
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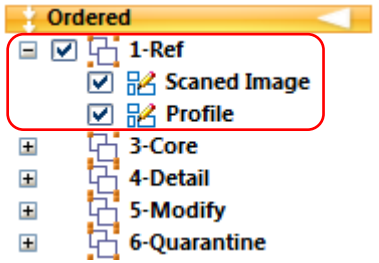
Reference entities are first in the feature tree making them visible to all features



Typical “Reference” features:

- Reference models (surface bodies) (1st)
- Ref planes, axis & coordinate systems
- Sketches
- Images





Creating Parent-Child links

- If you can see it in the background
  - It is OK to link to it

Notes:

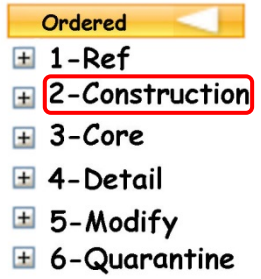
- No solid models
- Feature visibility can be toggled on-off

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2-Construction Group

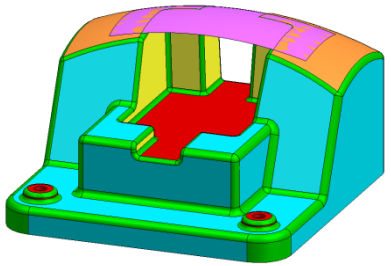
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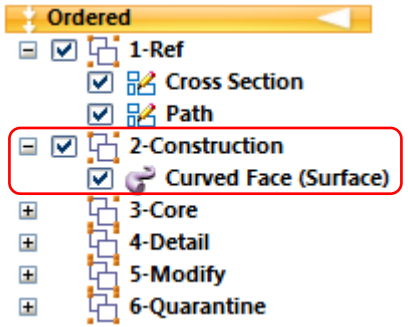
Construction entities are used to create complex solid features later



Construction features:

- 3D Curves (1st)
- Surfaces
- Projected Curves
- Features that edit a face
  - Extend, trim, split etc.





Creating Parent-Child links

- If you can see it in the background
  - It is OK to link to it

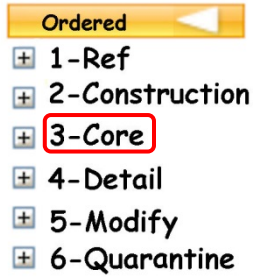
Notes:

- No solid models
- Feature visibility can be toggled on-off

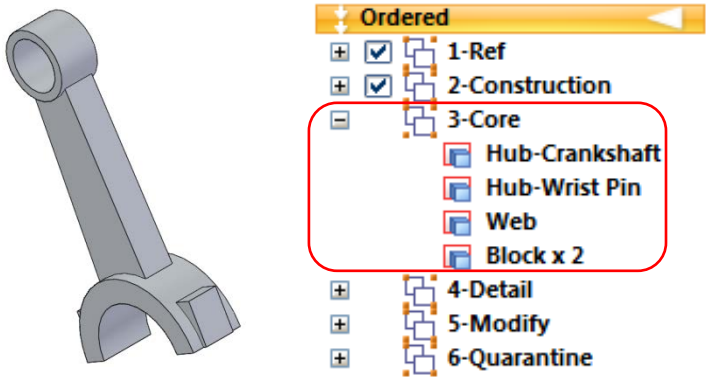
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3-Core Group

A “Super Base Feature” that defines the model’s shape, extents and orientation



The “Core Group” features are edited to make large changes to the basic shape of the model



Creating Parent-Child links

- If you can see it in the background
  - It is OK to link to it

Notes:

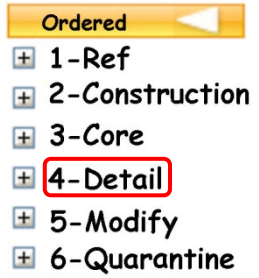
- Add material with features such as:
  - Extrude, Loft, Sweep etc.
  - Thin wall is the last feature
- Provides parent faces & key points for detail features

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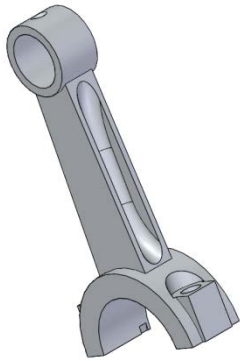
4-Detail Group

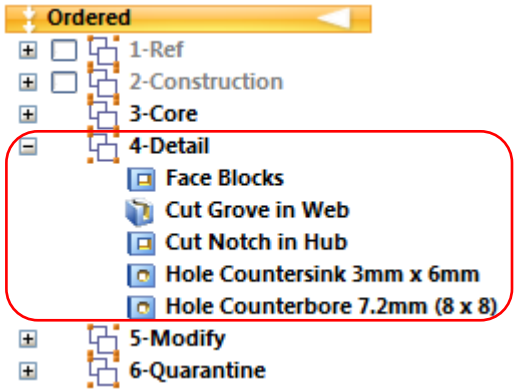
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Adds Resilient design details to the model by linking to the Ref and Core group



The “Detail Group” features are edited to make small changes to the model





Creating Parent-Child links:

- Suppress all previous Detail features
  - If you can still see it in the background, it is OK to link to it

Internal Links:

- If several features must be linked within the “Detail” group
  - Example: Boss & its hole
  - Make them adjacent & create a subgroup

Notes:

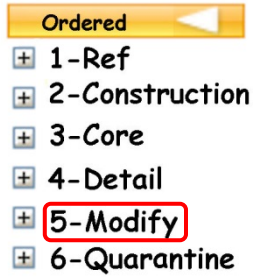
- Usually features that remove material

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5-Modify Group

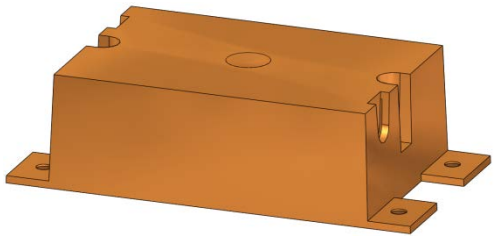
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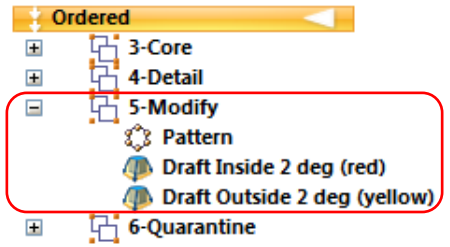
Features that transform faces or replicate features



Typical “Modify” features:

- Transform: Draft etc.
- Replicate: Mirror, Pattern etc.
- Final Features:
  - Features that modify the transformed or replicated model





Creating Parent-Child links

- **Unsuppress all Previous features**
  - If you can see it in the background, it is OK to link to it

Notes:

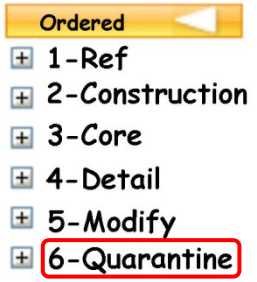
- Save suppressed to reduce file size

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6-Quarantine Group

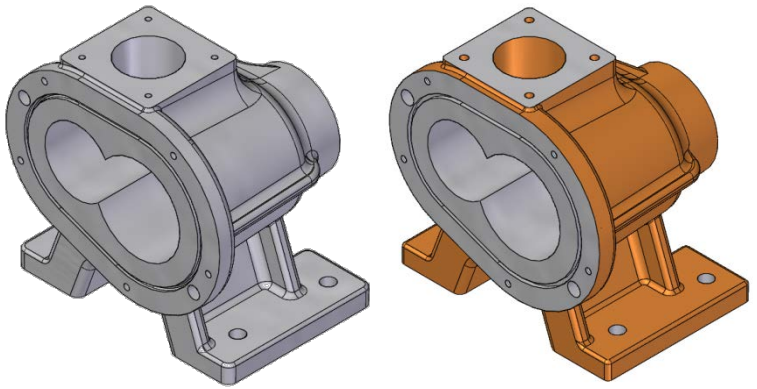
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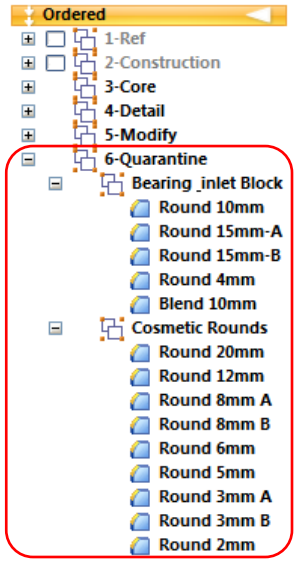
Isolates volatile features at the end of the tree



Typical “Quarantine” features:

- Chamfers
- Blends
- Rounds (Last)





Creating Parent-Child links

- **Unsuppress all Previous features**
- If you can see it in the background
  - It is OK to link to it

Notes:

- Rounds:
  - Place the largest round first
  - Rounds should never consume their defining surfaces (shared seams)

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Obvious Models

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Obvious Models Don't Rely on Intuition

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If the models structure and organization isn't ***obvious***, intuition is unleashed

Intuitive defined…

- A thing that one knows or considers likely from instinctive feeling rather than conscious reasoning

Intuitive models…

- Reflect the authors assumption of what is obvious
  - The reader fills in the blanks using intuition

But…

- The readers background isn't the same as the author
  - He will interpret the details differently

Ironic…

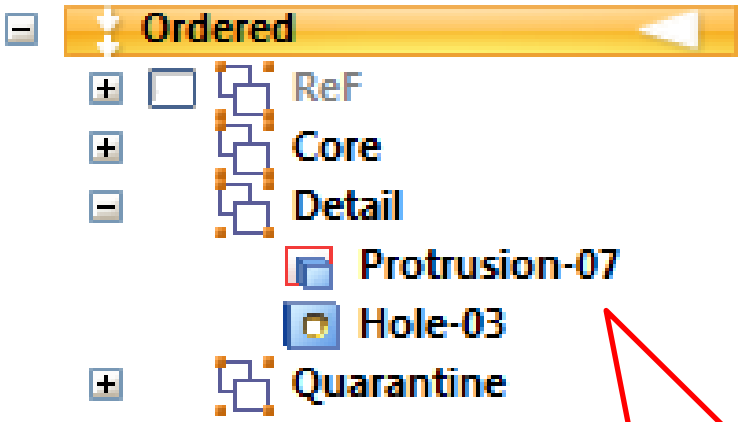
- The more experienced the author is…
  - The more vague the model is

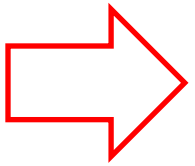
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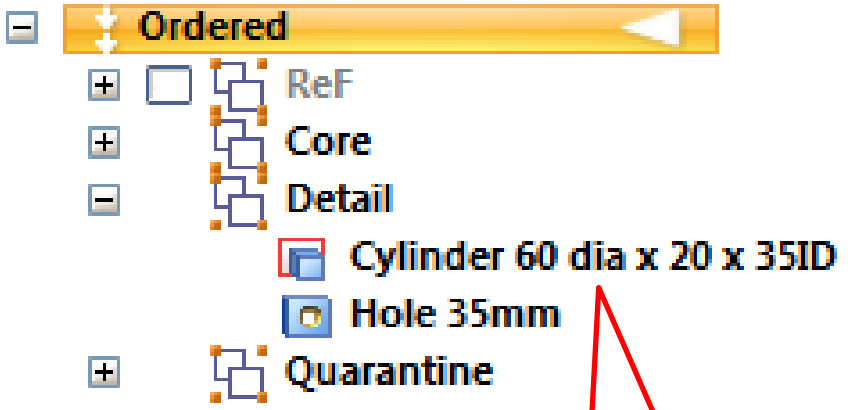
All it Takes is Renaming Features

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Communicate your design intent by renaming features !!!!







Feature icons tell you the feature type. Therefore, the default name is redundant.

Rename all features with design intent & value

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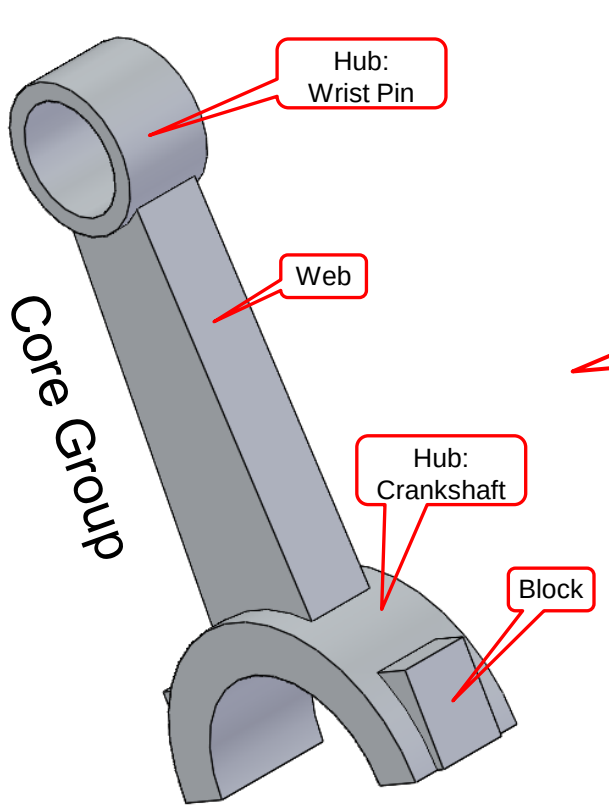
Obvious Models Don’t Require Playback

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The feature tree reads like a recipe for the model

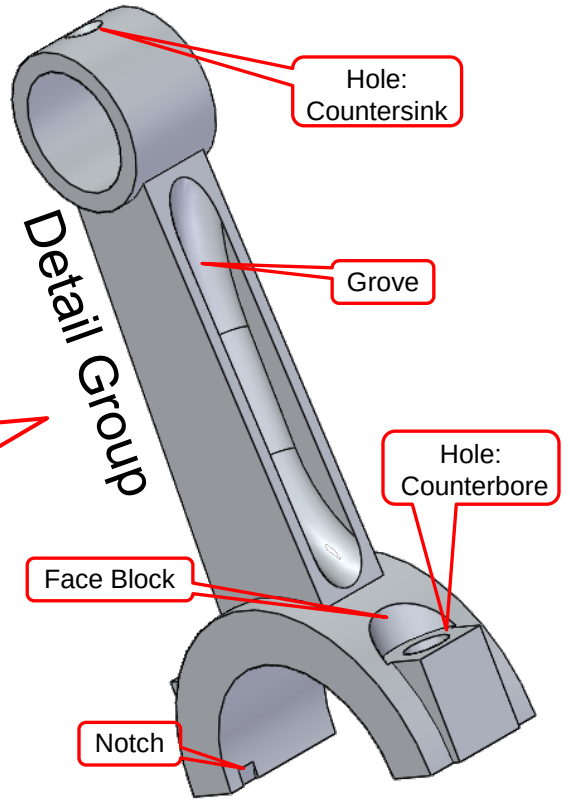
Original Tree

- Ordered
  - Protrusion 1
  - Mirror 1
  - Protrusion 3
  - Protrusion 4
  - Mirror 2
  - Protrusion 7
  - Round 1
  - Cutout 1
  - Mirror 3
  - Chamfer 1
  - Cutout 1
  - Round 2
  - Cutout 2
  - Cutout 1
  - Mirror 4
  - Cutout 3
  - Chamfer 2
  - Cutout 3
  - Chamfer 3
  - Cutout 4
  - UserDefinedPattern_1
  - Cutout 7
  - Mirror 6
  - Cutout 9
  - Mirror 7
  - Round 3
  - Round 4



Obvious Tree

- Ordered
  - 1-Ref
    - Ref Model
    - Layout
    - Grove Path
    - Grove Profile
  - 3-Core
    - Hub-Crankshaft
    - Hub-Wrist Pin
    - Web
    - Block x 2
  - 4-Detail
    - Face Blocks
    - Cut Grove in Web
    - Cut Notch in Hub
    - Hole Countersink 3mm x 6mm
    - Hole Counterbore 7.2mm (8 x 8)
  - 5-Modify
    - Mirror Grove
    - Mirror Notch
    - Cut Fillet 9mm
  - 6-Quarantine
    - Chamfer 2mm
    - Chamfer .5mm
    - Round 20mm
    - Round 10mm
    - Round 1mm



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I Don’t Have Time to Rename Features

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Do you expect models to be editable ?

- If the answer is “NO”, why are you here ?
- If the answer is “yes”…
  - Does someone design parts for you that can’t be edited ?
    - Is the “tail waging the dog” ?
- If the answer is “my job is to create parts fast”…
  - If you make at least one edit, you are no longer fast
  - Make sure model editability isn’t a priority of your boss
    - If it is, you are the cause of his problem

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Reusable Models

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Obvious Models Enable Reusable Models

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The unfulfilled promise of solid modeling

Instead of “family of parts”…

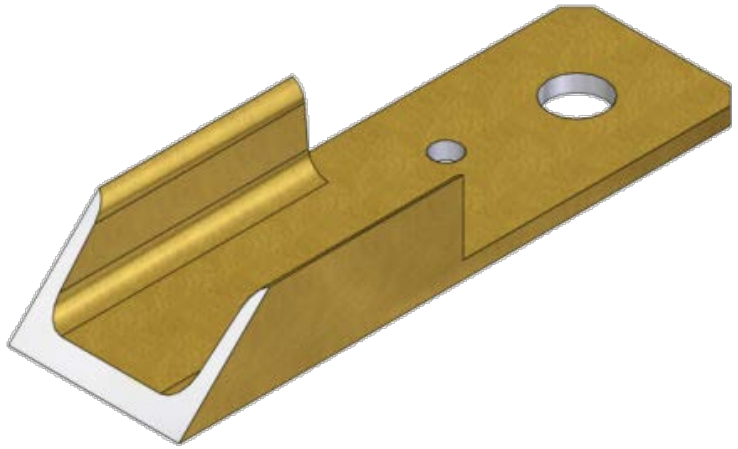
- Create a master part
- For instances, copy & chg values

Don’t reinvent the wheel…

- Copy then edit similar parts

One model, all Revisions…

- Direct Edit Features at the end of the tree



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Consistent File Naming

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An intelligent file name will enable an easy sanity check on the BOM

- All parts:
  - Category – Number – Variant – Rev
    - Note: Consider PDM before including revision in the file name
- Fasteners:
  - Head Style – Thread – Length - Variant
- Standard parts & features:
  - Shape – Variant

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Implementation

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Start with a “Best Practices Manual”

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The “Holy Grail” of Solid Modeling

- Document your minimum requirements for solids models
  - Don’t leave anything to “Tribal Knowledge”
  - Avoid nit picking (trivial requirements like colors & fonts)
- Create the “Best Practices Manual” in a training format
  - A PDF of a PowerPoint with linked example models
  - It must be “under revision control”
- Assure compliance by using a “Pre-Release Checklist”

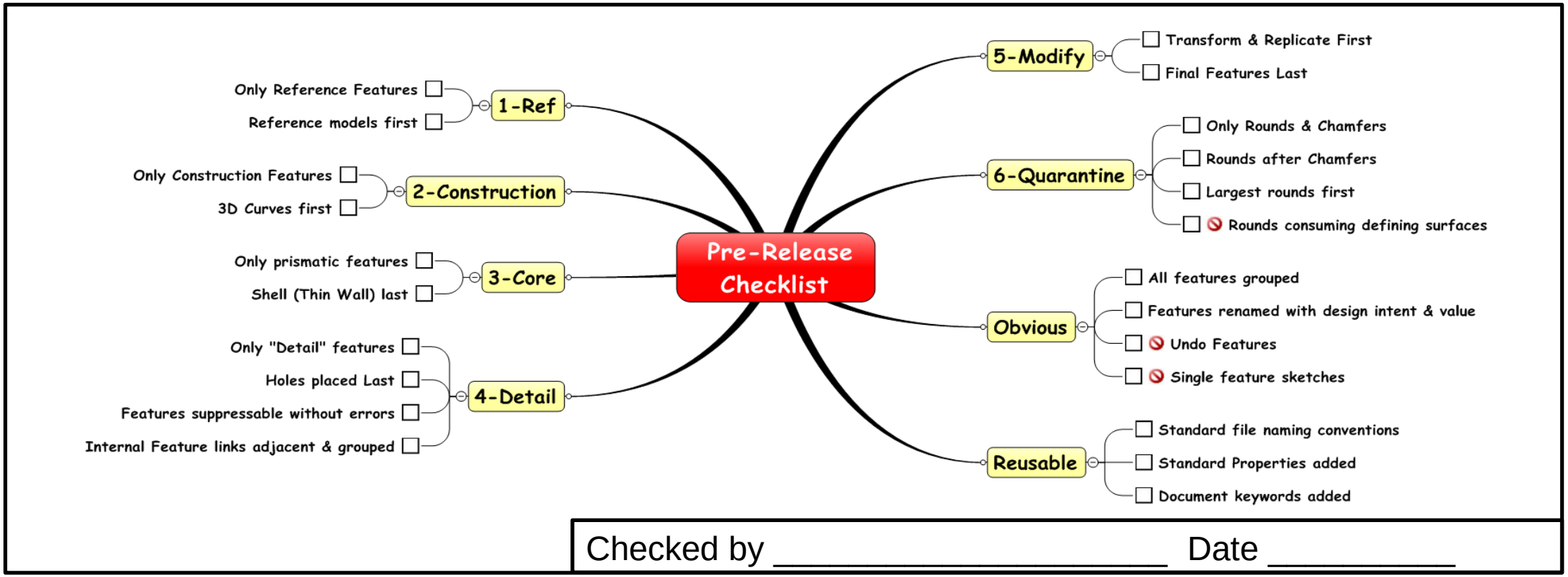
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A Typical “Pre-Release” Checklist

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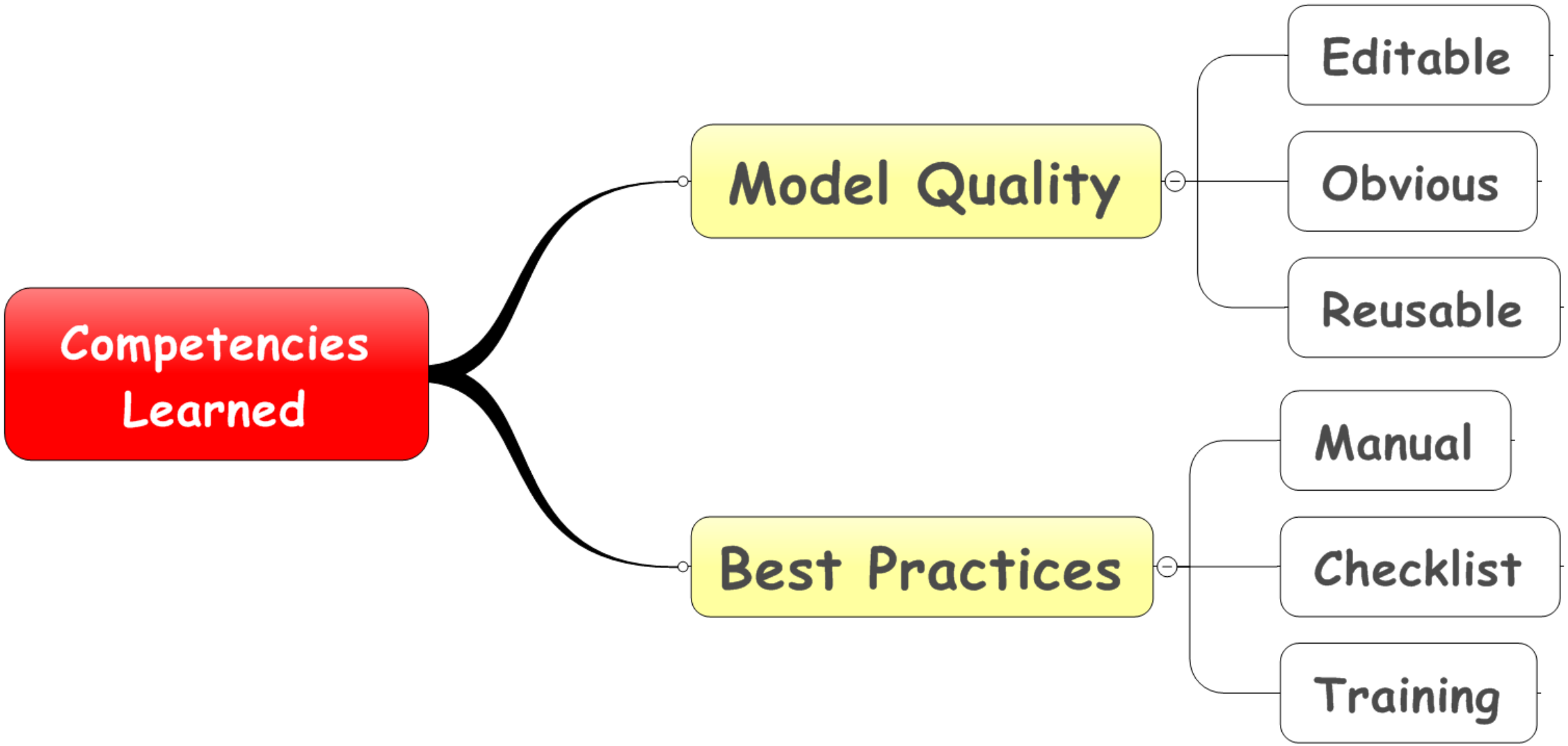
A “Best Practices Manual” is hard to enforce…

But a checklist is a no-brainer



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Competencies Learned in this class

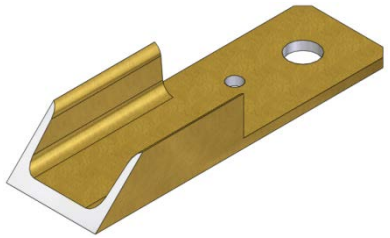


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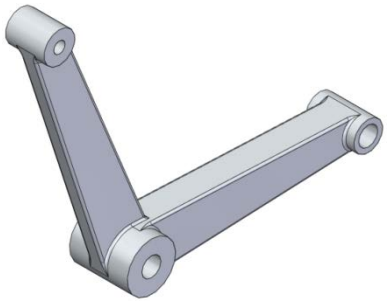
Basic Examples

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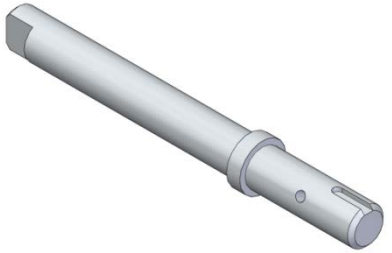
E1-Extrusion



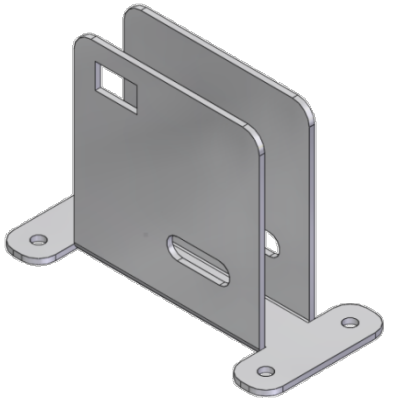
E2-Arm



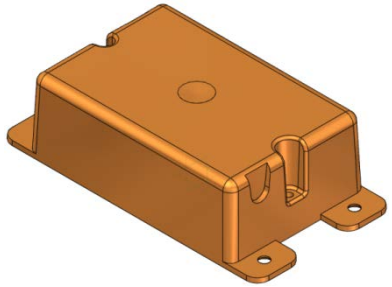
E3-Shaft



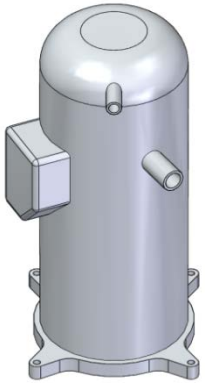
E4-Sheetmetal



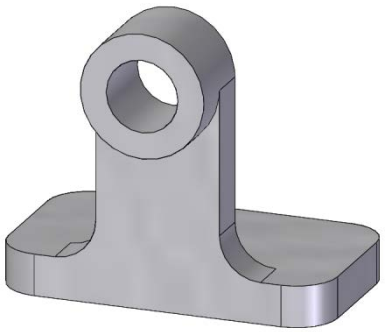
E5-Box



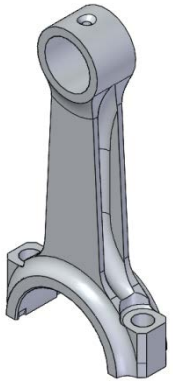
E6-Tank



E7-Tutorial



E8-Connecting Rod

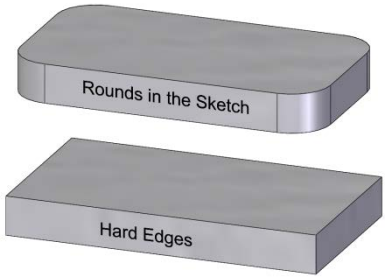


Original

E9 Screw



E10-Rounds

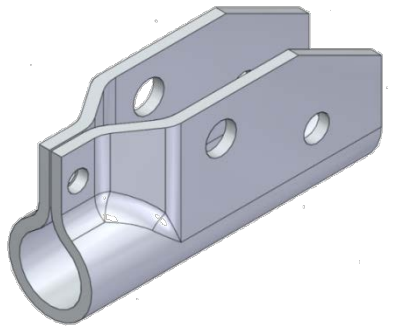


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Advanced Examples

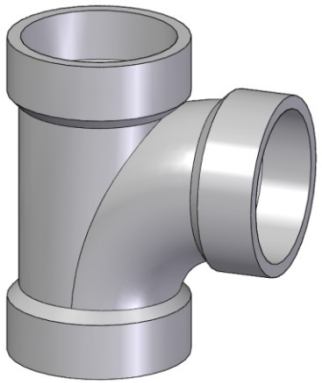
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E11-Bar Holder

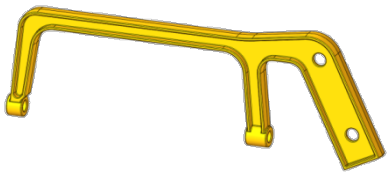


Sync

E12-Sanitary Tee

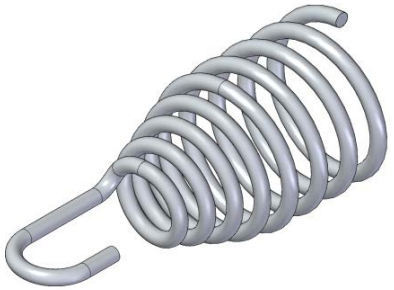


E13-Saw



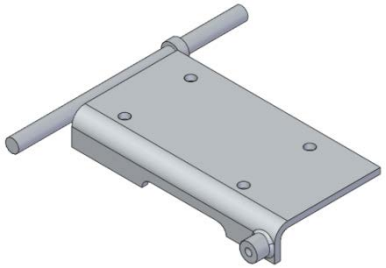
Sync

E14-Spring

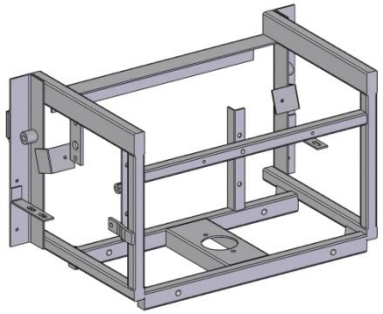


Sync

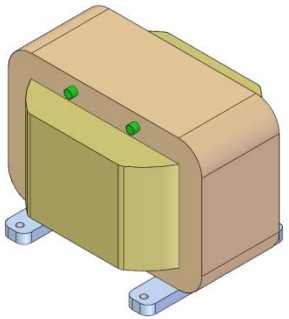
E15-Weldment



E16-Frame

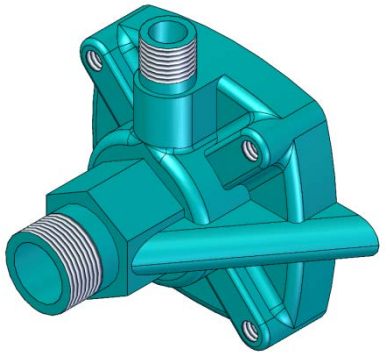


E17-Transformer



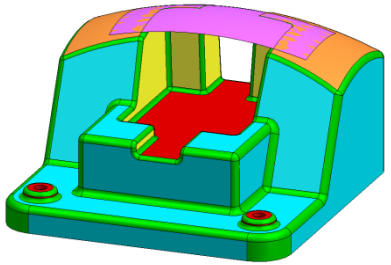
Original

E18-Casting



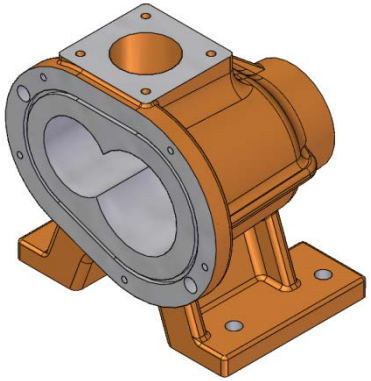
Original

E19 Tutorial



Original

E20-Compressor



Original

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That's All Folks



Thank You !!!

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Me

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  - Don’t even think about calling if the Suns are playing

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