122 - A Resilient Modeling Strategy
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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.
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
Feature Based Models are Editable But…

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
The Downside of Parent-Child Relationships

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
An Obsession with the Feature Tree

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
The Resilient Modeling Strategy (RMS)
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
Seeing is Believing

Same result, but…

Two different feature trees

Brittle

Resilient
Think About the Model You Just Saw

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
How are Your Feature Trees Organized?

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
Robust Models
The Big Picture

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

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

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
2-Construction Group

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
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
4-Detail Group

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
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
6-Quarantine Group

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)
Obvious Models
Obvious Models Don’t Rely on Intuition

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
All it Takes is Renaming Features

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.
Obvious Models Don’t Require Playback

The feature tree reads like a recipe for the model
I Don’t Have Time to Rename Features

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 wagging 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
Reusable Models
Obvious Models Enable Reusable Models

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
Consistent File Naming

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
Implementation
Start with a “Best Practices Manual”

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”
A “Best Practices Manual” is hard to enforce…
But a checklist is a no-brainer
Competencies Learned in this class

- Model Quality
  - Editable
  - Obvious
  - Reusable
  - Manual
  - Checklist
  - Training

- Best Practices

Competencies Learned
Basic Examples

- E1-Extrusion
- E2-Arm
- E3-Shaft
- E4-Sheetmetal
- E5-Box
- E6-Tank
- E7-Tutorial
- E8-Connecting Rod
- E9 Screw
- E10-Rounds

Original
### Advanced Examples

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E11-Bar Holder</td>
<td>Sync</td>
</tr>
<tr>
<td>E12-Sanitary Tee</td>
<td>Sync</td>
</tr>
<tr>
<td>E13-Saw</td>
<td>Original</td>
</tr>
<tr>
<td>E14-Spring</td>
<td>Original</td>
</tr>
<tr>
<td>E15-Weldment</td>
<td>Original</td>
</tr>
<tr>
<td>E16-Frame</td>
<td>Original</td>
</tr>
<tr>
<td>E17-Transformer</td>
<td>Original</td>
</tr>
<tr>
<td>E18-Casting</td>
<td>Original</td>
</tr>
<tr>
<td>E19 Tutorial</td>
<td>Original</td>
</tr>
<tr>
<td>E20-Compressor</td>
<td>Original</td>
</tr>
</tbody>
</table>
That’s All Folks

Thank You !!!

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Start = Ctrl-F

USS Montana
Best Wave Ever
Candle Light
Good Dog
German Coast Guard
Grieving
Trunk Monkey (Anti Theft Sys)
Room Keys
Mrs. Hughes
The Knack