Knowledge Encapsulation and Application in MoldWizard

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Agenda

- Why Knowledge Driven Automation?
- What is MoldWizard™?
- Four Modules of MoldWizard™
  - Cooling Channels
  - Gate and Runner
  - Sub-Insert
  - Electrode
- Discussion on Knowledge Encapsulation and Application
- Conclusion
Why Knowledge Driven Automation?

- Parametric feature based solid modeling becomes commodities
- Smart design tools are differentiators
- Easily customizable and automated systems are highly demanded
- The winner has To do The job in shorter time
- Data interoperability is The bottleneck
- Design intent has To be implemented systematically
- Late changes are inevitable
What is MoldWizard™

- A wizard is a set of sequenced UI interfaces to guide the users to complete certain interactions with computer systems.
- Extended wizard by building in engineering process knowledge in the form of CAD/CAM operation sequences and software tools
- A special process based wizard for plastic injection mold design
MoldWizard General Introduction

- 12 Main modules
- 5 main modules developed by Gintic

Moldwizard V2.0 interface
Four Modules of MoldWizard™

- Cooling Channels, Gates and Runners, Sub-Insert and Electrode
- Gintic Institute of Manufacturing Institute was engaged
- Technological/Technical Support from UGS, Cypress
- Four Modules were developed in four months time
- Valuable experiences in methodology and quality
- More challenges ahead
Cooling Channels - Why Not Holes

- Time-consuming and repeated manual tasks
- Long design time and low productivity
- To plot cooling circuit drawings without cavity or core block, mold plates, etc
- Repositioning
- Self-Identification (by color, attributes, etc)
- Association among circuit members
Cooling Channels - Definition

- A simple blind hole

Inlet vector or hole direction or sweep guide

Inlet face

Hole base point

Hole tip point

Insert

Blind hole
Cooling Channel Module Requirements

Creation of straight cooling channels.
Modification of cooling channel length, tip angle and diameter.
Creation of U-shaped cooling channel patterns.
Creation of baffle patterns.
Transformation of cooling channels.
Cooling Channels - Smart Points

- Extended guiding line
- Indicated vector and length

Extension of the input line
Cooling Channels - Smart Points

Initial inlet point arising from the initial planar face

Final inlet point arising from the channel selection. Note that only the X position of the inlet point is changed. Y position of the inlet point remains unchanged

Alteration of Inlet Position via Cooling Hole Selection
Cooling Channels - Smart Points

Possible final cooling hole inlet vector depending on whether the left or right hole is selected

Alteration of Inlet Vector via Cooling Hole Selection
Cooling Channels - Parts and Solids

- Create a Cooling Line (CL) part under the top assembly
- Balanced structure --- cooling channels are created under the product part, related waved guide paths and solids are created in CL part
- Unbalanced structure -- when user selects a face in core/cavity, a waved face will be created in the CL part, and smart objects, guide paths and cooling solids will be created in the same part
- Cooling solids are associative to the corresponding penetrating faces
Cooling guide path

- Guide path of a cooling circuit can be designed continuously
- The lengths and positions of cooling holes can be dynamically edited
Cooling Solids

- Parameters of holes can be easily edited
- Types of cooling holes can be modified during this stage
- Guide path can be edited before or after cooling channel creation
• Multiple cavities
• Substantial number of interactive operations
• Parametric and re-usable typical gates
• Need consistent gate design in the practice

The creation of the runner system
Modeling the primary runner, branch runners and cold slug wells

Substantial number of interactive operations
Creation of guide strings (curves), cross-sectional curves and a host of other features.

Gates and Runners - Requirements
## Gates and Runners - Requirements

<table>
<thead>
<tr>
<th>Requirement Description</th>
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<tbody>
<tr>
<td>A library of commonly-used, parametric gate models.</td>
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<tr>
<td>Modification gate parameters via a user-friendly UI dialog.</td>
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<tr>
<td>Creation of gates for multiple cavities with or without associativity.</td>
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<tr>
<td>Positioning of gates via a user-friendly UI dialog.</td>
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<tr>
<td>Creation of H-shaped, O-shaped or S-shaped guide string patterns for runner creation.</td>
</tr>
<tr>
<td>Creation of runner channels and cold slug wells.</td>
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<tr>
<td>Modification of runner channels.</td>
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How to Organize Gates - Representation

- Option 1 -- all gate solids and are accommodated in a single gate/runner component under the top assembly.
- Gates can be retrieved with three steps, i.e. detecting the layout, calculating the matrix and importing the gate part from library several times according to indicated position and the matrix.
- Simple assembly tree
- Disadvantages:
  » not able to associate with any smart objects because of UF: reference point is fixed values rather than an object pointer.
  » Cannot update group gates in one go with native UG functions out of the module
  » Gates does not follow the layout changes
  » Gates does not follow each other for re-positioning in native UG
How to Organize Gates - Representation

• Option 2

Assembly structure of option 2
How to Organize Gates - Representation

- Option 3 (Selected)

Assembly structure of option 3
Parametric Gates Types

- Rectangular gate
- Submarine gate
- Fan gate
- Pin gate
- Step pin gate
- Film gate
Select a gate

Gate Main Menu

Select a gate

Gate Design

Parameter Selection

H = 1.0
B = 2.0
D = 5.0
L = 20.0
L1 = 10.0

Balance

Unbalance

* If user choose Balance, all gates in every cavities will be automatically created at one time

Same as Standard Part Module

Fan Gate
Film Gate
Pin Gate
Rectangular Gate
Step Pin Gate
Submarine Gate

Gate Positioning

Position Method

Reposition
Associative Copy
Non Associative Copy

Component Name: film_gate
Layer: Work

OK | Apply | Cancel

MoldWizard Reposition Dialog
Runners Patterns

H-shaped  O-shaped  S-shaped

C -- Circular,
P -- Parabolic,
T -- Trapezoidal,
H -- Hexagonal, and
S -- Semi-circular.
Implemented Runners Patterns
Runner

- projection
- 5 types
- Cool well can be auto-attached
- Parameters
The user can select the existing curves as guide strings.
project the planar guide strings onto parting surface when the parting surface is not planar.
Electrode - Requirements

- Creating an inverse shape of a portion or the whole of a mold impression component (i.e. core insert, integer core, cavity insert, integer cavity and sub-inserts, including certain types of gates)
- Adding a base to the inverse shape (in practice, the base is tightened to a holder and the latter is fixed to the CNC machine when machining the electrode as well as the EDM machine when use it to make the core/cavity)
- Adding a reference coordinate system to the electrode for machining purposes
- Adding other reference features, such as chamfers, to the base to indicate the front side so that the electrode is positioned correctly during the EDM process.
Electrode - Definition

Front face of electrode base

Inverse shape of electrode block

Face on inverse shape to be offset to base
Electrode - Definition

Inverse shape

Coordinate system

Base
Electrode - Definition

Midpoint of bounding box for electrode block

Input planar face
Electrode - Assembly Structure

Wave linked part created from the working part

Part for electrode

Working part
Electrode (Head/Foot)

- Box can be trimmed by parting face/sheet face
- Box can be created by boolean operation with other solid
- There is an association between foot and head
- Sizes of foot can be easily adjusted
Sub-Insert - Requirements

The process of creating the entire sub-insert can be divided into the following tasks:

- creation of sub-insert head
- creation of sub-insert body
- creation of positioning and orientation features
- creation of fastening features

A sub-insert usually has a body to hold the head. In some cases, however, sub-insert bodies are not created and the sub-insert head is directly mounted onto a mold plate.
Discussion on Knowledge Encapsulation and Application

- What is knowledge in CAD context?
- Format to represent knowledge, e.g. databases, algorithms, sketches, pre-defined geometry, libraries
- Generic algorithms?
- Objects?
- Neutral language and data exchange standard?
- Rules?
- CAD -> KDA->KBE
- KBE->KDA->CAD
- Solutions?
Conclusion

- KDA has great potential
- More research and development is required
- KDA based solutions are highly demanded
- KDA will change the business nature
- KDA globalization
- Knowledge distribution and APS model