An injection moulding strategist in an information model environment

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Additional Information:

- This Thesis is in two volumes.

Metadata Record: [https://dspace.lboro.ac.uk/2134/32119](https://dspace.lboro.ac.uk/2134/32119)

Version: Not specified

Publisher: © R.J.V. Lee

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Appendix 1.

IDEFO representation of support for concurrent product and mould design.
Figure A1.1 - IDEF0 model from A1 down. Support for concurrent design for function and manufacture.

Figure A1.2 - IDEF0 model from A2 down. Support for concurrent design for function and manufacture.
Figure A1.3 - IDEFO model from A23 down. Support for concurrent design for function and manufacture.

Figure A1.4 - IDEFO model from PD2 down. Support concurrent mould design
Product functional knowledge
Injection moulding knowledge

Design and manufacture data
Design decisions

Support concurrent product and mould design.

Support Tools

Update Product model.

NODE: PD
TITLE: Support concurrent product and mould design.
NUMBER:
Product functional knowledge | Injection moulding knowledge

Design and manufacture data
Design decisions

Support concurrent functional and mouldability design.

Update Product model.

Support concurrent mould design.

modify product representation due to feedback advice

Support Tools

Product functional knowledge | Injection moulding knowledge

Design and manufacture data
Design decisions

Support concurrent functional and mouldability design.

Update Product model.

modify product representation due to feedback advice

Support Tools

NODE: PD
TITLE: Support concurrent product and mould design.

NODE: PD1
TITLE: Support concurrent functional and mouldability design.

A1/5
Product functional knowledge \[\rightarrow\] Injection moulding knowledge

Design and manufacture data \[\rightarrow\] Design decisions

Identify product representation \[\rightarrow\] Functional representation,

Manufacturing representation,

Update Product model, Modify product representation due to feedback advice.

Support tools

NODE: P11 TITLE: Support concurrent functional and mouldability design. NUMBER:

Product functional knowledge \[\rightarrow\] Injection moulding knowledge

Design decisions

Design and manufacture data

Associate function and form \[\rightarrow\] Functional representation,

Injection moulding knowledge

Injection moulding features data

Manufacturing representation

Modify product representation due to feedback advice.

Support tools

NODE: A1 TITLE: Identify product representation. NUMBER:
Product functional knowledge:

- Functional requirements data
  - Form/function data
    - Design data
    - Design decisions

Create functional specification, A111

Functional specification

- Functional representation
  - Support tools
  - Provide form/function decisions, A112

Modify product representation due to feedback advice

Functional requirements data

Design data

Design decisions

Support tools

---

**NODE: A11**
**TITLE:** Associate function and form.
**NUMBER:**

---

**NODE: A12**
**TITLE:** Translate into manufacturing representation.
**NUMBER:**

**PROJECT:** Injection moulding strategist
**NODE: A111**

**TITLE:** Create functional specification.

1. **Design decisions**
   - Identify product function

2. **Design data**
   - Functions to be addressed
   - Choice of product function
   - Product functional requirements

3. **Support tools**
   - Performance targets
   - Form/function data
   - Functions associated with the product

**NODE: A112**

**TITLE:** Provide form/function choices.

1. **Obtain choice of product function**
   - Function choice
   - Form choice and parameters
   - Obtain associated form
   - Modify product representation due to feedback advice

2. **Support tools**
   - Form/function data
   - Functions associated with the product
   - Design decisions
Injection moulding features data

Functional representation

Extract function form combination

Processing instructions

Product function and form

Associate with mouldability

Support tools

Possible mouldability equivalents

Existing product representation

Feature associations

New feature identity

New feature parameters and possible types

Surrounding geometry parameters

Processing instructions

Identity new feature, identity and type

New and surrounding feature identity

Compare surrounding geometry parameters with new feature

Identity and type surrounding geometry

Identify additional mouldability forms

Support tools

Features to create and associate

NODE: A122
TITLE: Analyse surrounding geometry.
NUMBER:
**NODE: A123**  \( \text{TITLE: Create manufacturing representation.} \)  \( \text{NUMBER:} \)

**NODE: A2**  \( \text{TITLE: Functional and manufacturability assessment.} \)  \( \text{NUMBER:} \)

**FUNCTIONAL KNOWLEDGE**

- Product functional knowledge
- Injection moulding knowledge

**FUNCTIONALITY ASSESSMENT**

- Assess functionality
- Assess manufacturability

**MANUFACTURING REPRESENTATION**

- Design and manufacture data
- Manufacture data
- Provide feedback

**FUNCTIONAL CONSTRAINTS DATA**

- Injection moulding constraints data
- Functional constraints data

**DESIGN DECISIONS**

- Design and manufacture data
- Manufacture data

**UPDATE PRODUCT MODEL**

- Modify product representation due to feedback advice

**FUNCTIONALITY ASSESSMENT**

- Update Product model
- Provide feedback

**DOCUMENTATION**

- R. J. V. Lee
- Date: 17/06/94
- Notes: 1 2 3 4 5 6 7 8 9 10
Functional constraint data

Identify functional feature constraints A211

Constraint data required from Product model

Interpret constraint data A212

How to analyse features

Carry out conformance analysis A213

Functionality assessment

Support tools

Design data

NODE: A21 TITLE: Assess functionality.

Injection moulding constraint data

Identify manufacturing feature constraints A221

Constraint data required from Manufacturing model

Interpret constraint data A222

How to analyse features

Carry out conformance analysis A223

Manufacturability assessment

Support tools

Manufacture data

NODE: A22 TITLE: Assess manufacturability.

A1/11
**Functional constraint data**

1. **Constraint data required from Product model**
   - **Interpret rule**
     - **A2121**
     - Which parameter values must be defined
2. **Define calculations required**
   - **A2122**
3. **How to analyse features**

**Support tools**

**NODE: A212**  **TITLE: Interpret constraint data.**  **NUMBER:**

---

**How to analyse features**

1. **Calculate desired parameter values or limits**
   - **A2131**

2. **Desired parameter values**

3. **Compare feature parameters with desired values**
   - **A2132**
   - **Results of comparison**
   - **Identify conformance condition**
   - **Functionality assessment**

**Support tools**

**NODE: A213**  **TITLE: Carry out conformance analysis.**  **NUMBER:**
**NODE: A221**

**TITLE:** Identify manufacturing feature constraints.

**NODE: A222**

**TITLE:** Interpret constraint data.
How to analyse injection moulding constraint data:

1. Calculate desired parameter values or limits (A2231)
2. Compare feature parameters with desired values (A2232)
3. Identify conformance condition (A2233)

Support tools

---

Functional constraint data

1. Identify required constraint advice data (A2311)
2. Extract advice data from constraint (A2312)
3. Functional decision support data

Support tools
PROJECT: Injection moulding

NODE: A232
TITLE: Match manufacturing assessment to advice data.

NODE: A233
TITLE: Calculate ideal parameter values.
**Project: Injection Moulding Strategist**

**Title:** Establish Parting Line

1. Identify widest part of product

2. Identify position of parting line

3. Generate parting line

**Title:** Generate Main Cavity Geometry

4. Identify next parting line position

5. Compare cavity volume parameters

6. Establish main cavity geometry

7. Complete cavity mold blend

8. Generate cavity tapers

**Notes:**
- Modify product representation due to feedback advice
- Further volume
- Further cavity volume
- Further position from parting line
- Further position from parting line
- Establish main cavity geometry
- Complete cavity mold blend
Feeding system design knowledge

Gas type, position, geometry
Runner system configuration
Design and manufacture data
Cavity/core geometry
Design decisions
Support tools

NODE B23
TITLE: Generate main feeding sprue.
NUMBER:

Identify main feeding sprue position B231

Identify main feeding sprue geometry B232

Mould design knowledge

Cooling system design knowledge

Design and manufacture data
Cavity/core geometry
Design decisions
Support tools

NODE B3
TITLE: Generate cooling system.
NUMBER:

Identify cooling system configuration B31

Identify maximum cooling effect B32

Generate cooling system geometry B33

Support tools
<table>
<thead>
<tr>
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<td>Design and Manufacture data -</td>
<td>Design decisions -</td>
<td>Design data -</td>
<td>Design decisions -</td>
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<td>Functional representation.</td>
<td>Change feature parameters.</td>
<td>Manufacturing representation.</td>
<td>Combination(s) of function(s) and form(s) plus product functional specification.</td>
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<td>Functional representation.</td>
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<td>Manufacturing representation.</td>
<td>Details of new features to be added to the product representation.</td>
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<td>Manufacturing representation.</td>
<td>Knowledge on how to create an equivalent representation of the product from the viewpoint of design for injection moulding.</td>
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<td>Knowledge on how to create an equivalent representation of the product from the viewpoint of design for injection moulding.</td>
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</table>
### Constraints.

**Functional requirements data.**
- Product types in the Product model and their functional objectives.

**Outputs.**
- Functional specification.
  - Details of individual product functional objectives and their quantification.

### Drawing A.1.1.2.

**Inputs.**
- Design decisions.
  - Which product function to be associated with form, form choice and parameters.
- Modification of product representation due to feedback advice.
  - Change feature parameters.

**Constraints.**
- Functional specification.
  - Details of individual product functional objectives and their quantification.
- Form/function data.
  - Which form(s) can be used to achieve which function(s) for the given product type.

**Outputs.**
- Form/function decisions.
  - Details of functional objective(s), associated form and parameters.

### Drawing A.1.2.1.

**Inputs.**
- Functional representation.
  - Combination(s) of function(s) and form(s) plus product functional specification.

**Constraints.**
- Injection moulding features data.
  - Processing instructions on associating product type and function with mouldability feature types.

**Outputs.**
- Possible mouldability equivalents.
  - The equivalent mouldability feature(s) for the form/function combination. There may be more than one.

### Drawing A.1.2.2.

**Inputs.**
- Possible mouldability equivalents.
  - The equivalent mouldability feature(s) for the form/function combination. There may be more than one.

### Existing product representation.

**Constraints.**
- Injection moulding features data.
  - How to identify new mouldability feature types.

**Outputs.**
- Features to create and associate.
  - New mouldability features to create and which existing or new features to create associations with.

### Drawing A.1.2.3.

**Inputs.**
- Features to create and associate.
  - New mouldability features to create and which existing or new features to create associations with.

**Constraints.**
- Design decisions.
  - Parameters of blends and tapers.

**Outputs.**
- Manufacturing representation.
  - How to create new mouldability features.

**Details of existing surrounding geometry.**

### Drawing A.1.1.1.1.

**Inputs.**
- Design decisions.
  - Which product type to develop, eg pot type, TP1 etc.

**Constraints.**
- Injection moulding features data.
  - How to create new mouldability features.

**Outputs.**
- Choice of product type.
  - Product type that is to be developed.

### Drawing A.1.1.1.2.

**Inputs.**
- Choice of product type.
  - Product type that is to be developed.

**Performance targets.**
- Quantifying individual product functional objectives eg function 'load bearing' = 70kg.
Design data.

Constraints.

Product functional requirements.

Outputs.

Functional specification.

Drawing A.1.1.2.1.

Inputs.

Design decisions.

Constraints.

Functions associated with the product.

Outputs.

Function choice.

Drawing A.1.1.2.2.

Inputs.

Function choice.

Form choice and parameters.

Modify product representation due to feedback advice.

Constraints.

Form/function data.

Outputs.

Form/function decisions.

Drawing A.1.2.1.1.

Inputs.

Functional representation.

Constraints.

Processing instructions.

Outputs.

Product function and form.

Drawing A.1.2.1.2.

Inputs.

Product type and function.

Constraints.

Processing instructions.

Outputs.

Possible mouldability equivalents.

Drawing A.1.2.2.1.

Inputs.

Feature associations.

New feature identity.

Constraints.

Product type context.

Outputs.

Identity new feature, identity and type surrounding geometry.

Drawing A.1.2.2.2.

Inputs.

New and surrounding features identity.

Identity of new feature and those associated so parameters can be extracted from the Product model.
New feature parameters and possible types.

Surrounding geometry parameters.

Constraints.

Injection moulding features data.

Outputs.

New feature identity, mouldability type and parameters.

Drawing A.1.2.2.3.

Inputs.

New feature identity, mouldability type and parameters.

Identity and type of surrounding geometry.

Constraints.

Injection moulding features data.

Outputs.

Tapers and blends.

Drawing A.1.2.3.1.

Inputs.

New feature identity, mouldability type and parameters.

Details of new mouldability feature to create.

Constraints.

Injection moulding features data.

Outputs.

New mouldability feature.

Drawing A.1.2.3.4.

Inputs.

A feature has been created to which a blend may be attached.

Blend type.

Design decisions.

Constraints.

Processing instructions.

Outputs.

Blend created.

Details of newly created blend feature.

A blend has been attached to the new feature and a taper can be applied.

Type of taper to create.

Parameters of the new taper.

How to get taper parameters from the designer.

How to create the blend type given and associate it with other features.

Details of newly created blend feature.

A blend has been attached to the new feature and a taper can be applied.

New feature identity, mouldability type and parameters.

Parameters of the new feature, what it could be in terms of mouldability.

Parameters of existing features adjacent to the new feature.

What the relative parameters of the new and adjacent old geometry mean in terms of mouldability equivalent.

New feature identity, mouldability type and parameters.

Identity and type of surrounding geometry.

What the combination of new and old features requires in terms of type of blend(s).

Tapers on new features and blends between old and new.

Identity of the new feature to which the blend is to be attached.

Identity of the surrounding geometry to which the blend is to be attached.

How to create the blend type given and associate it with other features.

How to create the blend type given and associate it with other features.

Parameters of the blend.

Parameters of the blend.
Outputs.
Taper parameters.

Drawing A.1.2.3.5.
Inputs.
Taper parameters.
New feature identity.
Constraints.
Processing instructions.
Outputs.
Taper.

Drawing A.2.
Inputs.
Functional representation.
Manufacturing representation.
Design and manufacture data.
Design decisions.
Constraints.
Product functional knowledge.
Injection moulding knowledge.
Outputs.
Update Product model.
Modify product representation due to feedback advice.

Parameters of the new taper to be created.

Identity of new feature to which taper is to be attached.

How to create a new taper of the given type.

Details of newly created taper feature.

Combination(s) of function(s) and form(s) plus product specification.

Details of new mouldability features and their association with form.

Existing product representation, materials data, manufacturing process data.

Designers response to advice.

Functional constraint data.
Injection moulding constraint data.
Design and manufacture data.
Manufacturing representation.
Design data.
Outputs.

Functionality assessment.

Functionality assessment.

Design decisions.
Constraints.
Functional constraint data.
Injection moulding constraint data.

Combination(s) of function(s) and form(s) plus product specification.

Materials performance, choice, price etc.

Constraint data location, processing instructions.

Conformance condition of new feature parameter(s) to be associated with a response.

Details of new mouldability features and their association with form.

Manufacturing process capabilities and performance, existing mouldability features.

Constraint data location, processing instructions.

Conformance condition of new feature parameter(s) to be associated with a response.

Existing product representation, materials data, manufacturing process data.

Conformance condition of new feature parameter(s) to be associated with a response.

Designers response to advice.

Advice data, processing instructions.

Advice data, processing instructions.
Outputs.
Update Product model.
Modify product representation due to feedback advice.
Drawing A.2.1.1.

Inputs.
Functional representation.
Constraints.
Constraint data location.
Outputs.
Constraint data required from the Product model.

Drawing A.2.1.2.

Inputs.
Constraint data required from the Product model.
Constraints.
Functional constraint data.
Outputs.
How to analyse features.

Drawing A.2.1.3.

Inputs.
How to analyse features.
Design data.
Functional representation.

Outputs.
Details of new features to be added to the product representation.
Change feature parameters.

Constraints.
Functional constraint data.

Outputs.
Functionality assessment.
Conformance condition of new feature parameter(s) to be associated with a response.

Drawing A.2.2.1.

Inputs.
Manufacturing representation.
Constraints.
Constraint data location.
Outputs.
Constraint data required from the Manufacturing model.

Drawing A.2.2.2.

Inputs.
Constraint data required from the Manufacturing model.
Constraints.
Injection moulding constraint data.
Outputs.
How to analyse features.

Expressions to be solved and to which feature parameter values the results must be compared.

Drawing A.2.2.3.

Inputs.
How to analyse features.
Manufacture data.

Expressions to be solved and to which feature parameter values the results must be compared.

Materials performance, choice, price etc.
Combination(s) of function(s) and form(s) plus product specification.
Processing instructions on how to carry out conformance analysis.
Processing instructions on how to interpret constraint data.

Details of new mouldability features and their association with form
Knowledge of the location of manufacturing constraints in the Manufacturing model.
The identity of the rules for conformance to constraints.
Expressions to be solved and to which feature parameter values the results must be compared.
Manufacturing process performance, capabilities,
<table>
<thead>
<tr>
<th>Drawing</th>
<th>Sections</th>
<th>Inputs</th>
<th>Outputs</th>
<th>Constraints</th>
<th>Functional constraint data</th>
<th>Injection moulding constraint data</th>
<th>Manufacturing decision support data</th>
<th>Design decisions</th>
<th>Ideal parameter values</th>
<th>Textual advice</th>
<th>Processing instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.2.3.1</td>
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<td></td>
<td></td>
<td></td>
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<td>Injection moulding constraint data</td>
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<td>Injection moulding constraint data</td>
<td>Functional constraint data</td>
<td>Instruction on how to calculate ideal parameter values.</td>
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<tr>
<td>A.2.3.2</td>
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<td>A.2.3.3</td>
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<tr>
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<td>Injection moulding constraint data</td>
<td>Functional constraint data</td>
<td>Instruction on how to calculate ideal parameter values.</td>
</tr>
</tbody>
</table>

Details of recommended values that must be calculated and in relation to which new feature parameters.

Details of textual advice to be given.

Textual advice ready to be given to the designer.

Processing instructions on how to obtain designer response.
Injection moulding constraint data.

Outputs.
Update Product model.
Modify product representation due to feedback advice.

Inputs.
Functional representation.
Constraint data location.

Outputs.
Feature type, location of constraint data in the Product model.

Drawing A.2.1.1.1.

1.1.
Inputs.
Functional representation.
Constraint data location.

Outputs.
Feature type, location of constraint data in the Product model.

Drawing A.2.1.1.2.

1.2.
Inputs.
Constraint data required from the product model.

Outputs.
Constraint data required from the product model.

Drawing A.2.1.2.1.

1.3.
Inputs.
Constraint data required from the product model.

Outputs.
Constraint data required from the product model.

Drawing A.2.1.3.2.

1.4.
Inputs.
Desired parameter values.

Outputs.
Desired parameter values.

Constraints.
Processing instructions.
Outputs.
Which parameter values must be defined.

Drawing A.2.1.2.2.

Inputs.
Which parameter values must be defined.

Outputs.
How to analyse features.

Constraints.
Processing instructions.
Outputs.
How to define required calculations.

Drawing A.2.1.3.1.

Inputs.
How to analyse features.

Outputs.
How to carry out calculation of parameter values or limits.

Design data.

Structural representation.

Outputs.
Which parameters of the feature are to be examined for conformance to the constraint(s).

Materials performance, choice, price etc.

Expressions to be solved, and to which feature parameter values they must be compared.

Values to be compared with feature parameters, and which feature parameters.

Combination(s) of function(s) and form(s).
Constraints.
Processing instructions.-- How to compare feature parameters with desired values.
Outputs.
Results of comparison.-- Whether feature parameters are the same/within limits, too high, too low etc.
Drawing A.2.1.3.3.
Inputs.
Results of comparison.-- Whether feature parameters are the same/within limits, too high, too low etc.
Constraints.
Processing Instructions.-- How to identify conformance condition.
Outputs.
Functionality assessment.-- Conformance condition of new feature parameter(s) to be associated with a response.

Drawing A.2.2.1.1.
Inputs.
Manufacturing representation.-- Details of new mouldability features and their association with form.
Constraints.
Constraint data location.-- Knowledge of the location of the manufacturing constraints in the Manufacturing model.
Outputs.
Feature type, location of constraint data in the Manufacturing model.-- Type of feature, where to search for manufacturing constraint data.

Drawing A.2.2.1.2.
Inputs.
Feature type, location of constraint data in the Manufacturing model.-- Type of feature, where to search for manufacturing constraint data.
Constraints.
Constraint data location.-- Knowledge of the location of the manufacturing constraints in the Manufacturing model.
Outputs.
Constraint data required from the Manufacturing model.-- The identity of rules for conformance to constraints.
Drawing A.2.2.2.1.
Inputs.
Constraint data required from the Manufacturing model.-- The identity of rules for conformance to constraints.
Constraints.
Processing instructions.-- How to read and understand the rule(s).
Outputs.
Which parameter values must be defined.-- Which parameters of the feature are to be examined for conformance to the constraint(s).

Drawing A.2.2.2.
Inputs.
Which parameter values must be defined.-- Which parameters of the feature are to be examined for conformance to the constraint(s).
Constraints.
Processing instructions.-- How to define required calculations.
Outputs.
How to analyse features.-- Expressions to be solved, and to which feature parameters they must be compared.

Drawing A.2.2.3.1.
Inputs.
How to analyse features.-- Expressions to be solved, and to which feature parameter values they must be compared.
Constraints.
Manufacturing data.-- Manufacturing process capabilities, performance, existing mouldability features.
Outputs.
Processing instructions.-- How to carry out calculation of parameter values or limits.
Outputs.
Desired parameter values.— Values to be compared with feature parameters, and which feature parameters.

Drawing A.2.2.3.2.

Inputs.
Desired parameter values.— Values to be compared with feature parameters, and which feature parameters.
Manufacturing representation.— Details of new mouldability features and their association with form.
Constraints.
Processing instructions.— How to compare feature parameters with desired values.
Outputs.
Results of comparison.— Whether feature parameters are the same/within limits, too high, too low etc.

Drawing A.2.2.3.3.

Inputs.
Results of comparison.— Whether feature parameters are the same/within limits, too high, too low etc.
Constraints.
Processing instructions.— How to identify conformance condition.
Outputs.
Manufacturability assessment.— Conformance condition of new feature parameter(s) to be associated with a response

Drawing A.2.3.1.1.

Inputs.
Functionality assessment.— Conformance condition of new feature parameter(s) to be associated with a response.
Constraints.
Functional constraint data.— A knowledge of the location of functional constraints data.
Outputs.
Constraint data location in Manufacturing model.— Location of constraint advice data.

Drawing A.2.3.1.2.

Inputs.
Constraint data location in Product model.— Location of constraint advice data.
Constraints.
Advice data.— Details of remedial advice contained in functional constraints
Outputs.
Functional decision support data.— Textual advice, details of recommended values that must be calculated, and in relation to which feature parameters.

Drawing A.2.3.2.1.

Inputs.
Manufacturability assessment.— Conformance condition of new feature parameter(s) to be associated with a response.
Constraints.
Injection moulding constraint data.— A knowledge of the location of manufacturing constraints data.
Outputs.
Constraint data location in Manufacturing model.— Location of constraint advice data.

Drawing A.2.3.2.2.

Inputs.
Constraint data location in Manufacturing model.— Location of constraint advice data.
Constraints.
Advice data.— Details of remedial advice contained in manufacturing constraints
Outputs.
Manufacturing decision support data.— Textual advice, details of recommended values that must be calculated, and in relation to which feature parameters.
Drawing A.2.3.3.1.

Inputs.
Manufacturing decision support data.—
Need calculation of recommended values.—
Details of recommended values that must be calculated

Functional decision support data.—
Need calculation of recommended values.—
Details of recommended values that must be calculated

Constraints.
Functional constraint data.—
Processing instructions.—
Injection moulding constraint data.—
Processing instructions.—

Outputs.
Calculations required.—
Expressions to be solved.

Drawing A.2.3.3.2.

Inputs.
Calculations required.—
Expressions to be solved.
Design and manufacture data.—

Constraints.
Functional constraint data.—
Processing instructions.—
Injection moulding constraint data.—
Processing instructions.—

Outputs.
Ideal parameter values.—
Those values ideal for functionality and manufacturability.

Drawing A.2.3.4.1.

Inputs.
Functional decision support data.—
Advice data.—
Details of textual advice to be given.

Constraints.
Functional constraint data.—
Injection moulding constraint data.—

Outputs.
Advice text in required form.—
Advice text data ready for calculated values to be added.

Drawing A.2.3.4.2.

Inputs.
Advice text in required form.—
Advice text data ready for calculated values to be added.

Ideal parameter values.—
Those values ideal for functionality or manufacturability.

Constraints.
Functional constraint data.—
Injection moulding constraint data.—

Outputs.
Complete decision support data.—
Textual advice ready to be given to the designer.

Drawing A.2.3.5.1.

Inputs.
Complete decision support data.—
Textual advice ready to be given to the designer.

Design decisions.—
Whether to act upon or ignore advice from the strategist—Whether to accept recommended values or put in new parameters/indicate to keep existing parameters.

Constraints.
Functional constraint data.—
Injection moulding constraint data.—

Outputs.
How to display decision support data and obtain designer response.
Outputs.
Designer response to advice.
- Confirmation to continue by the designer if functionality and manufacturability okay, or if advice given is to be ignored. Else a desire to change feature parameters.

Drawing A.2.3.5.2.

Inputs.
Designer response to advice.
- Functionality and manufacturability okay; designer ignores advice.

Constraints.
- Functional constraint data.
- Injection moulding constraint data.

Outputs.
Update Product model.
- Details of new features to be added to the product representation.

Drawing A.2.3.5.3.

Inputs.
Designer response to advice.
- Request to change given parameters.

Constraints.
- Functional constraint data.
- Injection moulding constraint data.

Outputs.
Modify product representation due to feedback advice.
- Change feature parameters.

Drawing PD2.

Inputs.
Product representation.
- Design and Manufacture data.

Constraints.
- Mould design knowledge.

Outputs.
Update Product model.
- Modify product representation due to feedback advice.

Drawing B.1.

Inputs.
Product representation.
- Design and Manufacture data.

Constraints.
- Mould design knowledge.

Outputs.
Cavity/core geometry.
- Modify product representation due to feedback advice.
Drawing B.!.!.

Constraints.

Inputs.

Cavily/core design knowledge-

Knowledgeon how 10 create a c8vilY/corc
representation, c8vity/core design consU'ainlS data.

Product representation-

Product geometry.

Design and Manufacture data-

Manufacturing process performance, capabilities,
plastic materials data.

Outputs.

Main core geometry -

Details of main core features to be added to
the Product model representation.

Constraints.

Modify product representation

Cavily/core design knowledge-

Knowledge on how to create a cavity/core
representation, cavity/core design consltaints data.

due to feedback advice-

Change feature parameters on product due to
core design considerations.

Outputs.

Drawing B.l.4.
Parting line-

Details of parting line.
Inputs.

Drawing B.1.2.

Parting line-

Details of parting line.

Inputs.

Product representation-

Productgeomc1ry and mouldability representation.

Product representation-

Product geometry and mouldability representation.

Design and Manufacture data-

Manufacturing process performance. capabilities,
plastic materials data.

Design and Manufacture data-

Manufacturing process performance, capabil ities,
plastic materials data.

Ocsign decisions.-

Decisions on mould cavity/corc design.

Decisions on mould cavity design.

Main cavity geometry-

Details of main cavity features to be added 10
the Product model representation.

Main core geometry-

Details of main core features to be added [0
the Product model representation.

Design dccisions.Constraints.

Cavity/core design knowledge-

Knowledge on how to create a cavity/core
representation, cavity/core design constraints data.
Constraints.

Injection moulding machine
lcnowJedge-

Knowledge of machine constraints.

Cavity/core design knowledge-

Knowledge on how to create a cavity/core
representation, cavity/core design constraints data.

Outputs.
Outputs.
Main cavity geometry-

Modify product representation
due to feedback advice-

Details of main cavity features to be added to
the Product model representation.

Local

Change feature parameters on product due to
cavity design considerations.

Modify product representation
due to feedback advice-

insen geometry-

Details of local insert features to be added to
the Product model representation.
Change feature parameters on product due to
cavily/core design considerations.

Drawing B.1.3.
Drawing B.1.5.
Inputs.
Inputs.
Produc~ representation-

Product geometry and mouldability representation.

Design and Manufacture data-

Manufacturing process performance. capabilities.
plastic materials data.

Design decisions.-

Decisions on mould core design.

Design and Manufacture data-

Manufactwing process performance, capabilities.
plastic malerials data.

Main cavity geometry-

Details of main cavity features to be added 10
the Product model representation.

Main core geometry-

Details of main core features to be added to
the Product model representation.


<table>
<thead>
<tr>
<th>Requirement</th>
<th>Constraints</th>
<th>Outputs</th>
<th>Details of vertical split line.</th>
<th>Product representation</th>
<th>Design and Manufacture data</th>
<th>Cavity/core design knowledge -</th>
<th>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</th>
<th>Details of parting line.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Require split mould due to configuration of main cavity/core geometry or local inserts.</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Details of vertical split line.</td>
<td>Vertical split line.</td>
<td>Product geometry.</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Cavity/core design knowledge -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Details of parting line.</td>
</tr>
<tr>
<td>Drawing B.1.1.1.</td>
<td>Inputs.</td>
<td>Outputs.</td>
<td>Cavity/core design knowledge -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Details of vertical split line.</td>
<td>Product representation</td>
<td>Design and Manufacture data</td>
<td>Cavity volume parameters -</td>
</tr>
<tr>
<td>Widest part of product -</td>
<td>Details of appropriate place(s) for parting line on the product.</td>
<td>Product geometry and mouldability representation.</td>
<td>Design and Manufacture data -</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Change cavity volume parameters due to cavity design decisions.</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Drawing B.1.1.2.</td>
<td>Inputs.</td>
<td>Outputs.</td>
<td>Cavity volume parameters -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Widest part of product -</td>
<td>Details of appropriate place(s) for parting line on the product.</td>
<td>Product geometry and mouldability representation.</td>
<td>Design and Manufacture data -</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Drawing B.1.1.3.</td>
<td>Inputs.</td>
<td>Outputs.</td>
<td>Cavity volumes and parameters -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Parting line position -</td>
<td>Chosen position of parting line.</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Design and Manufacture data -</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Drawing B.1.2.1.</td>
<td>Inputs.</td>
<td>Outputs.</td>
<td>Cavity volumes and parameters -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
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<td>Chosen position of parting line.</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Design and Manufacture data -</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Drawing B.1.2.2.</td>
<td>Inputs.</td>
<td>Outputs.</td>
<td>Cavity volumes and parameters -</td>
<td>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
<tr>
<td>Parting line position -</td>
<td>Chosen position of parting line.</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Design and Manufacture data -</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
<td>Knowledge of machine constraints.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
<td>Details of parting line.</td>
<td>Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.</td>
</tr>
</tbody>
</table>
Outputs.

Furthest volume parameters - Identity and parameters of volume currently being considered as furthest from parting line.

Drawing B.1.2.3.

Inputs.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.
Parting line - Details of parting line.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Next furthest - Identity and parameters of volume currently being considered as next furthest from parting line.

Drawing B.1.2.4.

Inputs.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.
Next furthest - Identity and parameters of volume currently being considered as next furthest from parting line.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Design decisions - Decisions on mould cavity volume parameters.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Cavity volume parameters - Parameters of cavity volumes after cavity design considerations.

Modify product representation due to feedback advice - Change feature parameters on product due to cavity design considerations.

Drawing B.1.2.5.

Inputs.

Cavity volume parameters - Parameters of cavity volumes after cavity design considerations.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Design decisions - Decisions on mould cavity blend parameters.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Cavity blends - Parameters and identity of cavity blends after cavity design considerations.

Modify product representation due to feedback advice - Change feature parameters on product due to cavity design considerations.

Drawing B.1.2.6.

Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Design decisions - Decisions on mould cavity taper parameters.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Cavity tapers - Parameters and identity of cavity tapers after cavity design considerations.
Modify product representation due to feedback advice.

Drawing B.1.3.1.

Inputs.

Product representation - Change feature parameters on product due to cavity design considerations.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Core volume parameters - Change core volume parameters due to core design decisions.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Injection moulding machine knowledge - Knowledge of machine constraints.

Outputs.

Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.

Drawing B.1.3.2.

Inputs.

Parting line - Details of parting line.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.

Evaluate as furthest next - Replace furthest volume from parting line with next furthest (Repeat until no more volumes).

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.

Drawing B.1.3.3.

Inputs.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.

Parting line - Details of parting line.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Next furthest - Identity and parameters of volume currently being considered as next furthest from parting line.

Drawing B.1.3.4.

Inputs.

Furthest volume - Identity and parameters of volume currently being considered as furthest from parting line.

Next furthest - Identity and parameters of volume currently being considered as next furthest from parting line.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.

Design decisions -

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Core volume parameters - Parameters of core volumes after core design considerations.

Furthest volume - Modify product representation due to feedback advice.

Modify product representation due to feedback advice.

Modify product representation due to feedback advice.
Drawing B.1.3.5.

Inputs.
Core volume parameters - Parameters of core volumes after core design considerations.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.
Design decisions - Decisions on mould core blend parameters.

Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.
Core blends - Parameters and identity of core blends after core design considerations.
Modify product representation due to feedback advice - Change feature parameters on product due to core design considerations.

Drawing B.1.3.6.

Inputs.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Core volumes and parameters - Details of translation from mouldability to core features prior to consideration of core design constraints.
Design decisions - Decisions on mould core taper parameters.

Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.
Core tapers - Parameters and identity of core tapers after core design considerations.
Modify product representation due to feedback advice - Change feature parameters on product due to core design considerations.

Drawing B.1.4.1.

Inputs.
Product representation - Product geometry and mouldability representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.
Protrusion features type, parameters - Identity of protrusions to be converted into local inserts and their parameters.

Drawing B.1.4.2.

Inputs.
Product representation - Product geometry and mouldability representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.
Hole features type, parameters - Identity of holes to be converted into local inserts and their parameters.

Drawing B.1.4.3.

Inputs.
Protrusion features type, parameters - Identity of protrusions to be converted into local inserts and their parameters.
Hole features type, parameters - Identity of holes to be converted into local inserts and their parameters.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Main cavity geometry - Details of main cavity features to be added to the Product model representation.
Main core geometry - Details of main core features to be added to the Product model representation.
### Drawing B.1.4.4.

**Inputs.**
- Design decisions
- Design and Manufacture data
- Constraints

**Outputs.**
- Cavity local inserts type, configuration
- Modify product representation due to feedback advice

**Constraints.**
- Cavity/core design knowledge

**Outputs.**
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

**Modifications.**
- Modify product representation due to feedback advice
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

### Drawing B.1.4.5.

**Inputs.**
- Design decisions
- Design and Manufacture data
- Which cavity features to create

**Outputs.**
- Cavity local inserts type, configuration
- Modify product representation due to feedback advice

**Constraints.**
- Cavity/core design knowledge

**Outputs.**
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

### Drawing B.1.5.1.

**Inputs.**
- Require split mould
- Design and Manufacture data
- Constraints

**Outputs.**
- Widest part of product

**Modifications.**
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

### Drawing B.1.5.2.

**Inputs.**
- Widest part of product

**Constraints.**
- Cavity/core design knowledge

**Outputs.**
- Vertical split line

**Modifications.**
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

### Drawing B.2.

**Inputs.**
- Product representation

**Outputs.**
- Core local inserts type, configuration

**Modifications.**
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Constraints.
Mould design knowledge – Knowledge on how to create a mould representation, mould design constraints data.

Outputs.
Feeding system geometry – Details of feeding system features to be added to the Product model representation.
Modify product representation due to feedback advice – Change feature parameters on product due to feeding system design considerations.

Drawing B.2.1.
Inputs.
Product representation. – Product geometry and mouldability representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.
Design decisions – Decisions on mould gating system design.
Cavity/core geometry – Details of cavity/core features to be added to the Product model representation.

Constraints.
Feeding system design knowledge – Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.
Gate type, position, geometry – Details of gating system features to be added to the Product model representation.
Modify product representation due to feedback advice – Change feature parameters on product due to gating system design considerations.

Drawing B.2.2.
Inputs.
Gate type, position, geometry – Details of gating system features to be added to the Product model representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.
Design decisions – Decisions on mould gating system design.
Cavity/core geometry – Details of cavity/core features to be added to the Product model representation.

Product representation. – Product geometry and mouldability representation.

Constraints.
Feeding system design knowledge – Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.
Runner type, position, geometry – Details of runner system features to be added to the Product model representation.

Drawing B.2.3.
Inputs.
Gate type, position, geometry – Details of gating system features to be added to the Product model representation.
Runner type, position, geometry – Details of runner system features to be added to the Product model representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.
Design decisions – Decisions on mould gating system design.
Cavity/core geometry – Details of cavity/core features to be added to the Product model representation.

Constraints.
Feeding system design knowledge – Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.
Main sprue configuration – Details of main sprue features to be added to the Product model representation.

Drawing B.2.1.1.
Inputs.
Product representation. – Product geometry and mouldability representation.

Constraints.
Feeding system design knowledge – Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.
Gate type – Type of gating system features to be added to the Product model representation.
Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Design decisions - Decisions on mould gating system design.

Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.

Constraints.

Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.

Gate position - Position of gating system features to be added to the Product model representation.

Drawing B.2.1.2.

Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Design decisions - Decisions on mould gating system design.

Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.

Constraints.

Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.

Gate position - Position of gating system features to be added to the Product model representation.

Drawing B.2.2.1.

Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Gate type, position, geometry - Details of gating system features to be added to the Product model representation.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Constraints.

Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.

Gate position - Position of gating system features to be added to the Product model representation.

Drawing B.2.2.2.

Inputs.

Gate type, position, geometry - Details of gating system features to be added to the Product model representation.

Runner type - Type of runner system features to be added to the Product model representation.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.

Constraints.

Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.

Outputs.

Runner position - Position of runner system features to be added to the Product model representation.

Drawing B.2.2.3.

Inputs.

Runner type - Type of runner system features to be added to the Product model representation.

Runner position - Position of runner system features to be added to the Product model representation.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Design decisions - Decisions on mould gating system design.

Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.

Product representation - Product geometry and mouldability representation.

Constraints.

Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.
Inputs.
Gate type, position, geometry - Details of gating system features to be added to the Product model representation.
Runner system configuration - Details of runner system features to be added to the Product model representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Constraints.
Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.
Outputs.
Main sprue position - Position of main sprue features to be added to the Product model representation.

Drawing B.2.3.2.
Inputs.
Main sprue position - Position of main sprue features to be added to the Product model representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Design decisions - Decisions on mould gating system design.
Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.
Constraints.
Feeding system design knowledge - Knowledge on how to create a feeding system representation, feeding system constraints data.
Outputs.
Main sprue geometry - Geometry of main sprue features to be added to the Product model representation.

Drawing B.3.
Inputs.
Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.
Feeding system geometry - Details of feeding system features to be added to the Product model representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Design decisions - Decisions on mould cooling system design.
Constraints.
Cooling system design knowledge - Knowledge on how to create a cooling system representation, cooling system constraints data.
Outputs.
Cooling system configuration - Configuration of cooling system to be added to the Product model representation.

Drawing B.3.1.
Inputs.
Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.
Feeding system geometry - Details of feeding system features to be added to the Product model representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Design decisions - Decisions on mould cooling system design.
Constraints.
Cooling system design knowledge - Knowledge on how to create a cooling system representation, cooling system constraints data.
Outputs.
Cooling system configuration - Configuration of cooling system to be added to the Product model representation.

Drawing B.3.2.
Inputs.
Cooling system configuration - Configuration of cooling system to be added to the Product model representation.
Cavity/core geometry - Details of cavity/core features to be added to the Product model representation.
<table>
<thead>
<tr>
<th>Feeding system geometry</th>
<th>Details of feeding system features to be added to the Product model representation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Manufacture data</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
</tr>
<tr>
<td>Design decisions</td>
<td>Decisions on mould cooling system design.</td>
</tr>
<tr>
<td>Constraints</td>
<td></td>
</tr>
<tr>
<td>Cooling system design knowledge</td>
<td>Knowledge on how to create a cooling system representation, cooling system constraints data.</td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
</tr>
<tr>
<td>Maximum cooling effect</td>
<td>Position and orientation of cooling system features to provide maximum, non-directional cooling.</td>
</tr>
</tbody>
</table>

**Drawing B.3.3.**

**Inputs.**

<table>
<thead>
<tr>
<th>Cooling system configuration</th>
<th>Configuration of cooling system to be added to the Product model representation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum cooling effect</td>
<td>Position and orientation of cooling system features to provide maximum, non-directional cooling.</td>
</tr>
<tr>
<td>Cavity/core geometry</td>
<td>Details of cavity/core features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Feeding system geometry</td>
<td>Details of feeding system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Design and Manufacture data</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
</tr>
<tr>
<td>Constraints</td>
<td></td>
</tr>
<tr>
<td>Cooling system design knowledge</td>
<td>Knowledge on how to create a cooling system representation, cooling system constraints data.</td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
</tr>
<tr>
<td>Cooling system geometry</td>
<td>Details of cooling system features to be added to the Product model representation.</td>
</tr>
</tbody>
</table>

**Drawing B.4.**

**Inputs.**

<table>
<thead>
<tr>
<th>Cavity/core geometry</th>
<th>Details of cavity/core features to be added to the Product model representation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding system geometry</td>
<td>Details of feeding system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Design and Manufacture data</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
</tr>
<tr>
<td>Constraints</td>
<td></td>
</tr>
<tr>
<td>Ejection system design knowledge</td>
<td>Knowledge on how to create an ejection system representation, ejection system constraints data.</td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
</tr>
<tr>
<td>Ejection positions</td>
<td>Position of ejection system features to be added to the Product model representation.</td>
</tr>
</tbody>
</table>

**Drawing B.4.1.**

**Inputs.**

<table>
<thead>
<tr>
<th>Cavity/core geometry</th>
<th>Details of cavity/core features to be added to the Product model representation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding system geometry</td>
<td>Details of feeding system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Design and Manufacture data</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
</tr>
<tr>
<td>Constraints</td>
<td></td>
</tr>
<tr>
<td>Ejection system design knowledge</td>
<td>Knowledge on how to create an ejection system representation, ejection system constraints data.</td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
</tr>
<tr>
<td>Ejection positions</td>
<td>Position of ejection system features to be added to the Product model representation.</td>
</tr>
</tbody>
</table>

**Drawing B.4.2.**

**Inputs.**

<table>
<thead>
<tr>
<th>Ejection positions</th>
<th>Position of ejection system features to be added to the Product model representation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Manufacture data</td>
<td>Manufacturing process performance, capabilities, plastic materials data.</td>
</tr>
<tr>
<td>Product representation</td>
<td></td>
</tr>
<tr>
<td>Design decisions</td>
<td>Decisions on mould ejection system design.</td>
</tr>
<tr>
<td>Inputs</td>
<td>Outputs</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Ejection system type</td>
<td>Knowledge on how to create an ejection system representation, ejection system constraints data.</td>
</tr>
<tr>
<td>Cavity/core geometry</td>
<td>Type of ejection system to be added to the Product model representation.</td>
</tr>
<tr>
<td>Feeding system geometry</td>
<td>Details of cavity/core features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Cooling system geometry</td>
<td>Details of feeding system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Design and Manufacture data</td>
<td>Details of cooling system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Constraints</td>
<td>Knowledge on how to create an ejection system representation, ejection system constraints data.</td>
</tr>
<tr>
<td>Ejection system design knowledge</td>
<td>Configuration of ejection system to be added to the Product model representation.</td>
</tr>
<tr>
<td>Ejection system configuration</td>
<td>Details of cavity/core features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Cavity/core geometry</td>
<td>Details of cavity/core features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Feeding system geometry</td>
<td>Details of feeding system features to be added to the Product model representation.</td>
</tr>
<tr>
<td>Cooling system geometry</td>
<td>Details of cooling system features to be added to the Product model representation.</td>
</tr>
</tbody>
</table>

**Drawing B.4.3.**

**Inputs.**
- Ejection system type
- Cavity/core geometry
- Feeding system geometry
- Cooling system geometry
- Design and Manufacture data
- Design decisions
- Constraints: Ejection system design knowledge

**Outputs.**
- Ejection system configuration

**Drawing B.5.**

**Inputs.**
- Cavity/core geometry
- Feeding system geometry
- Cooling system geometry
- Ejection system geometry
- Design and Manufacture data

**Constraints.**
- Ejection system design knowledge

**Outputs.**
- Ejection system configuration

**Drawing B.5.1.**

**Inputs.**
- Cavity/core geometry
- Feeding system geometry
- Design and Manufacture data

**Constraints.**
- Mould plate design knowledge

**Outputs.**
- Mould plate geometry

**Drawing B.5.2.**

**Inputs.**
- Inner land dimensions
- Design and Manufacture data

**Constraints.**
- Mould plate design knowledge

**Outputs.**
- Peripheral lands size and location
Inputs.
Inner land dimensions – Details of inner land features to be added to the Product model representation.
Peripheral lands size and location – Details of peripheral land features to be added to the Product model representation.
Cavity/core geometry – Details of cavity/core features to be added to the Product model representation.
Cooling system geometry – Details of cooling system features to be added to the Product model representation.
Ejection system geometry – Details of ejection system features to be added to the Product model representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.
Design decisions – Decisions on mould plate geometry.

Constraints.
Mould plate design knowledge – Knowledge on how to create a mould plate representation, mould plate constraints data.

Outputs.
Mould block size, shape – Details of mould block geometry to be added to the Product model representation.

Drawing B.5.4.

Inputs.
Mould block size, shape – Details of mould block geometry to be added to the Product model representation.
Cavity/core geometry – Details of cavity/core features to be added to the Product model representation.
Feeding system geometry – Details of feeding system features to be added to the Product model representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Constraints.
Mould plate design knowledge – Knowledge on how to create a mould plate representation, mould plate constraints data.

Outputs.
Back up plate size, shape – Details of backing plate geometry to be added to the Product model representation.

Drawing B.5.5.

Inputs.
Mould block size, shape – Details of mould block geometry to be added to the Product model representation.
Feeding system geometry – Details of feeding system features to be added to the Product model representation.
Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Constraints.
Mould plate design knowledge – Knowledge on how to create a mould plate representation, mould plate constraints data.

Outputs.
Nozzle recess size, shape – Details of nozzle recess geometry to be added to the Product model representation.
Appendix 2.

Modifications to IDEF0 representation due to translation requirements of concurrency.
Figure A2.1 – IDEF0 model from PD2 down. Support concurrent mould design
**NODE: B11**  
**TITLE: Establish parting line.**

- Identify widest part of product
- Identify position of parting line
- Generate parting line
- Support tools

**NODE: B12**  
**TITLE: Generate main cavity geometry.**

- Design and mould data
- Identify cavity volume
- Identify next feature
- Identify next feature
- Identify next feature
- Analyze cavity volume
- Generate cavity volume
- Generate cavity volume
- Add feature if not pre-existing
NOTE: 1234567890

NODE: B13
TITLE: Generate main core geometry.
NUMBER: A2/5

NODE: B14
TITLE: Generate group volumes.
NUMBER: A2/5
NODE: B15  TITLE: Create local inserts.

NODE: B16  TITLE: Generate vertical split line.
Main core geometry - Details of main core features to be added to the Product model representation.
Modify product representation due to feedback advice - Change feature parameters on product due to core design considerations.

Drawing B.1.4.
Inputs.
Main cavity geometry - Details of main cavity features to be added to the Product model representation.
Main core geometry - Details of main core features to be added to the Product model representation.
Product representation - Product geometry and mouldability representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Design decisions - Decisions on mould core design.
Parting line - Details of parting line.
Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Outputs.
Group volumes geometry/config. - Details of group volume features to be added to the Product model representation.
Modify product representation due to feedback advice - Change feature parameters on product due to cavity/core design considerations.

Drawing B.1.5.
Inputs.
Parting line - Details of parting line.
Product representation - Product geometry and mouldability representation.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Design decisions - Decisions on mould cavity/core design.
Main cavity geometry - Details of main cavity features to be added to the Product model representation.
Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Outputs.
Local insert geometry/config. - Details of local insert features to be added to the Product model representation.
Modify product representation due to feedback advice - Change feature parameters on product due to cavity/core design considerations.

Drawing B.1.6.
Inputs.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Main cavity geometry - Details of main cavity features to be added to the Product model representation.
Main core geometry - Details of main core features to be added to the Product model representation.
Require split mould - Require split mould due to configuration of main cavity/core geometry or local inserts.
Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Outputs.
Vertical split line - Details of vertical split line.

Drawing B.1.1.1.
Inputs.
Product representation - Product geometry.
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Constraints.
Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Outputs.
Widest part of product - Details of appropriate place(s) for parting line on the Product model representation.
<table>
<thead>
<tr>
<th>Drawing B.1.1.2.</th>
<th>Drawing B.1.2.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs.</strong></td>
<td><strong>Inputs.</strong></td>
</tr>
<tr>
<td>Widest part of product –</td>
<td>Design and Manufacture data –</td>
</tr>
<tr>
<td>Design and Manufacture data –</td>
<td>Cavity volumes and parameters –</td>
</tr>
<tr>
<td><strong>Constraints.</strong></td>
<td><strong>Constraints.</strong></td>
</tr>
<tr>
<td>Cavity/core design knowledge –</td>
<td>Cavity design knowledge –</td>
</tr>
<tr>
<td><strong>Outputs.</strong></td>
<td><strong>Outputs.</strong></td>
</tr>
<tr>
<td>Parting line position–</td>
<td>Parting line –</td>
</tr>
<tr>
<td>**Drawing B.1.1.3.</td>
<td><strong>Drawing B.1.2.3.</strong></td>
</tr>
<tr>
<td><strong>Inputs.</strong></td>
<td><strong>Inputs.</strong></td>
</tr>
<tr>
<td>Parting line position–</td>
<td>Furthest volume –</td>
</tr>
<tr>
<td>Design and Manufacture data –</td>
<td>Design and Manufacture data –</td>
</tr>
<tr>
<td><strong>Constraints.</strong></td>
<td><strong>Constraints.</strong></td>
</tr>
<tr>
<td>Cavity/core design knowledge –</td>
<td>Cavity design knowledge –</td>
</tr>
<tr>
<td><strong>Outputs.</strong></td>
<td><strong>Outputs.</strong></td>
</tr>
<tr>
<td>Parting line –</td>
<td>Parting line –</td>
</tr>
<tr>
<td><strong>Drawing B.1.2.1.</strong></td>
<td><strong>Drawing B.1.2.3.</strong></td>
</tr>
<tr>
<td><strong>Inputs.</strong></td>
<td><strong>Inputs.</strong></td>
</tr>
<tr>
<td>Product representation –</td>
<td>Furthest volume –</td>
</tr>
<tr>
<td>Design and Manufacture data –</td>
<td>Cavity volumes and parameters –</td>
</tr>
<tr>
<td>Parting line –</td>
<td>Parting line –</td>
</tr>
<tr>
<td><strong>Constraints.</strong></td>
<td><strong>Constraints.</strong></td>
</tr>
<tr>
<td>Cavity design knowledge –</td>
<td>Cavity design knowledge –</td>
</tr>
<tr>
<td><strong>Outputs.</strong></td>
<td><strong>Outputs.</strong></td>
</tr>
<tr>
<td>Cavity volumes and parameters –</td>
<td>Next furthest –</td>
</tr>
</tbody>
</table>

Data 5

Data 6
Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Product representation - Product geometry and mouldability representation.

Constraints.

Cavity design knowledge - Knowledge on how to create a cavity representation, cavity design constraints data.

Outputs.

Blender parameters or non existence - Parameters of blend associated with mouldability equivalent of cavity volumes or no blend exists.

Drawing B.1.2.5.

Inputs.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Product representation - Product geometry and mouldability representation.

Outputs.

Blender parameters or non existence - Parameters of blend associated with mouldability equivalent of cavity volumes or no blend exists.

Drawing B.1.2.6.

Inputs.

Taper parameters or non existence - Parameters of taper associated with mouldability equivalent of cavity volume or no taper exists.
Blender parameters or non existence - Parameters of blend associated with mouldability equivalent of cavity volumes or no blend exists.
Furthest volume - Identity and parameters of volume currently being considered as next furthest from parting line.

Next furthest -

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.
Cavity volumes and parameters - Details of translation from mouldability to cavity features prior to consideration of cavity design constraints.
Constraints.

Cavity design knowledge - Knowledge on how to create a cavity representation, cavity design constraints data.

Outputs.

Updated cavity volume parameters -

Drawing B.1.2.7.

Inputs.

Updated cavity volume parameters -
Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Outputs.

Cavity blends and parameters -

Identity of new cavity blend and parameters.

Data 8
Cavity design knowledge – Knowledge on how to create a cavity representation, cavity design constraints data.

Outputs.

Cavity tapers and parameters – Identity of new cavity taper and parameters.

Drawing B.1.3.1.

Inputs.

Product representation – Product geometry and mouldability representation.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Parting line – Details of parting line.

Constraints.

Core design knowledge – Knowledge on how to create a core representation, core design constraints data.

Outputs.

Cavity volumes and parameters – Details of translation from mouldability to core features prior to consideration of core design constraints.

Drawing B.1.3.2.

Inputs.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters – Details of translation from mouldability to core features prior to consideration of core design constraints.

Evaluate as furthest next – Replace furthest volume from parting line with next furthest (Repeat until no more volumes).

Parting line – Details of parting line.

Constraints.

Core design knowledge – Knowledge on how to create a core representation, core design constraints data.

Outputs.

Furthest volume – Identity and parameters of volume currently being considered as furthest from parting line.

Inputs.

Furthest volume – Identity and parameters of volume currently being considered as furthest from parting line.

Parting line – Details of parting line.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters – Details of translation from mouldability to core features prior to consideration of core design constraints.

Outputs.

Next furthest – Knowledge on how to create a core representation, core design constraints data.

Drawing B.1.3.4.

Inputs.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters – Details of translation from mouldability to core features prior to consideration of core design constraints.

Product representation – Product geometry and mouldability representation.

Constraints.

Core design knowledge – Knowledge on how to create a core representation, core design constraints data.

Outputs.

Taper parameters or non existence – Parameters of taper associated with mouldability equivalent of core volume or no taper exists.

Drawing B.1.3.5.

Inputs.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Core volumes and parameters – Details of translation from mouldability to core features prior to consideration of core design constraints.
<table>
<thead>
<tr>
<th>Drawing</th>
<th>Inputs</th>
<th>Outputs</th>
<th>Constraints</th>
<th>Core design knowledge</th>
<th>Knowledge on how to create a cavity/core representation, cavity/core design constraints data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1.3.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>B.1.3.7</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.1.4.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Inputs**
- Updated core volume parameters—after
- Main cavity geometry
- Main core geometry
- Updated core volume parameters—after
- Design and Manufacture data

**Outputs**
- Parameters of volume and associated blend and taper core design considerations
- Core blends and parameters—
- Core tapers and parameters—
- Gap position and size

**Constraints**
- Core design knowledge—
- Core design knowledge—
- Product representation—
- Design and Manufacture data—

**Knowledge on how to create a core representation, core design constraints data.**
Inputs.
- Gap position and size
- Product representation
- Design and Manufacture data

Constraints.
- Cavity/core design knowledge

Outputs.
- Identity of protrusion features
- Drawing B.1.4.3.

Inputs.
- Identity of protrusion features
- Product representation
- Design and Manufacture data

Constraints.
- Cavity/core design knowledge

Outputs.
- Dimensions for group volume

Drawing B.1.4.4.

Inputs.
- Dimensions for group volume
- Design and Manufacture data
- Design decisions
- Modify cavity representation due to feedback advice

Outputs.
- Core group volume parameters, stripping/collapsing core required/not required

Drawing B.1.5.1.

Inputs.
- Product representation
- Design and Manufacture data

Constraints.
- Cavity/core design knowledge

Outputs.
- Knowledge on how to create a cavity/core representation, cavity/core design constraints data.
Protrusion features type, parameters - Identity of protrusions to be converted into local inserts and their parameters.

Drawing B.1.5.2.

Inputs.

Product representation - Product geometry and mouldability representation.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Hole features type, parameters - Identity of holes to be converted into local inserts and their parameters.

Drawing B.1.5.3.

Inputs.

Protrusion features type, parameters - Identity of protrusions to be converted into local inserts and their parameters.

Hole features type, parameters - Identity of holes to be converted into local inserts and their parameters.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Main cavity geometry - Details of main cavity features to be added to the Product model representation.

Main core geometry - Details of main core features to be added to the Product model representation.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Which cavity or core features to create - Translation to cavity or core and type of cavity or core feature to create.

Drawing B.1.5.4.

Inputs.

Design decisions - Decisions on local insert parameters.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Which cavity features to create - Type of cavity local inserts to create.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Cavity local inserts type, configuration - Cavity local insert(s) type and parameters to be added to the Product model.

Modify product representation due to feedback advice - Change feature parameters on product due to local insert design considerations.

Drawing B.1.5.5.

Inputs.

Design decisions - Decisions on local insert parameters.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Which cavity features to create - Type of core local inserts to create.

Constraints.

Cavity/core design knowledge - Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Core local inserts type, configuration - Core local insert(s) type and parameters to be added to the Product model.

Modify product representation due to feedback advice - Change feature parameters on product due to local insert design considerations.

Drawing B.1.6.1.

Inputs.

Require split mould - Require split mould due to configuration of main cavity/core geometry or local inserts.

Design and Manufacture data - Manufacturing process performance, capabilities, plastic materials data.

Product representation - Product geometry and mouldability representation.

Constraints.
Outputs.

Widest part of product – Position where parting line should be created.

Drawing B.1.6.2.

Inputs.

Widest part of product – Position where parting line should be created.

Require split mould - Require split mould due to configuration of main cavity/core geometry or local inserts.

Design and Manufacture data – Manufacturing process performance, capabilities, plastic materials data.

Constraints.

Cavity/core design knowledge – Knowledge on how to create a cavity/core representation, cavity/core design constraints data.

Outputs.

Vertical split line – Details of vertical split line to be added to Product model representation.
Appendix 3.

Booch representation of Manufacturing model
Class Diagram: Blend_constraints

Project: ron
Title: Class Diagram: Blend_constraints
Printed on: Tuesday, October 10, 1995
Printed by: archy

Class Diagram: Gate_constraints

Project: ron
Title: Class Diagram: Gate_constraints
Printed on: Tuesday, August 15, 1995
Printed by: archy
Class Diagram: Integer_cavity_blend

Integer_cavity_blend

has

Integer_cavity_blend_parameters

has

Integer_cavity_blend_constraints

is_a

Cavity_blend_radius

Class Diagram: Integer_cavity_taper

Integer_cavity_taper

has

Integer_cavity_taper_parameters

has

Integer_cavity_taper_constraints

is_a

Cavity_taper_angle
Clan Diagram: Integer_core_shallow_cooling

Monday, August 21, 1995

Integer_core_shallow_cooling

has

Integer_core_shallow_cooling_constraints

is_a

is_a

Shallow_core_optimum_cooling_formation

Shallow_core_cooling_system_configuration

Shallow_core_cooling_maximum_cooling_capacity

Clan Diagram: Integer_core_deep_cooling

Monday, August 21, 1995

Integer_core_deep_cooling

has

Integer_core_deep_cooling_constraints

is_a

is_a

Type_of_deep_cooling

Deep_core_optimum_cooling_formation

Deep_core_maximum_cooling_capacity
Class Diagram: Manufacturing_constraint

- Manufacturing_constraint
  - has
  - has

- Expression
  - uses

- Parameter_evaluation_function

- Response
  - uses

- Response_function

- result_in
Appendix 4.

EXPRESS representation of the Manufacturing Model.
SCHEMA Manufacturing_model

TYPE dimension = REAL;
WHERE
non_negative : SELF >= 0.0;
END_TYPE;

TYPE integer = INTEGER;
WHERE
non-negative : SELF >= 0;
END_TYPE;

//MOULDABILITY FEATURES

ENTITY Mouldability_features
ABSTRACT SUPERTYPE OF (ONE OF (Primary_mouldability_features,
Secondary_mouldability_features));
END_ENTITY;

ENTITY Primary_mouldability_features
SUBTYPE OF (Mouldability_features);
ABSTRACT SUPERTYPE OF (ONE OF (Hole, Reinforcement, Wall));
END_ENTITY;

ENTITY Wall
SUBTYPE OF (Primary_mouldability_features);
Feature_name : STRING;
Feature_type : STRING;
Associated_form_name : STRING;
Associated_form_type : STRING;
thickness : dimension;
length : dimension;
height : dimension;
position : POINT3D;
orientation : POINT3D;
gated : STRING;
connect_wall : wall;
WHERE
max_thickness : thickness <= 5.0;
DERIVE
thickness_difference : BOOLEAN := (thickness.NE.connect_wall.thickness);
RULE wall_thickness FOR (Wall);
IF thickness>max_thickness THEN
Possible shrinkage marks and component warpage. Advise reduction in wall thickness
to a maximum of max_thickness.
END_RULE;
RULE Use_rib FOR (Wall);
IF thickness>max_thickness THEN
Advise the use of ribs to allow a reduction in wall thickness.
END_RULE;
RULE Wall_taper FOR (Wall, untapered);
IF wall has no taper THEN
Problems with removal of part from mould. Request that a Taper be created.
END_RULE;
RULE Relative thickness FOR (Wall, against adjacent wall);
IF thickness difference THEN
Possible feeding problems, component warpage or surface finish problems,
stress concentrations in the component.
Advise change of thickness to
connect_wall.thickness.
END_RULE;
RULE Wall_blend FOR (Wall, against adjacent wall or reinforcement);
IF wall has no blend THEN
Stress concentrations in the component,
possible surface defects. Request that a
Blend be created.
IF adjacent mouldability type == Wall THEN
Blend type = corner.
IF adjacent mouldability type == Solid_boss OR Rib OR Hollow_boss THEN
Blend type = protrusion.
END_RULE;
RULE Wall_gating FOR (Wall, ungated);
IF wall has no gate THEN
Ask if a gate is to be created
on the wall.
END_RULE;
END_ENTITY;

ENTITY Reinforcement
SUBTYPE OF (Primary_mouldability_features);
ABSTRACT SUPERTYPE OF (ONE OF( Rib, Solid_boss, Hollow_boss));
Feature_name : STRING;
Feature_type : STRING;
Associated_form_name : STRING;
Associated_form_type : STRING;
width : dimension;
height : dimension;
orientation : dimension;
position : dimension;
connect_wall : wall;
WHERE
max_height : height <= 3.0*connect_wall.thickness + 0.85;
max_width : width <= (2.0/3.0)*connect_wall.thickness;
machine_axis : = (0.0,0.0 , 1.0);
DERIVE
correct_orientation : BOOLEAN := (orientation == machine_axis);
RULE Reinforcement_orientation FOR (Reinforcement);
IF !correct_orientation THEN
Ejection problems, maybe moving
cores required and/or complex parting
line. Request re-orientation.
END_RULE;
RULE Reinforcement_taper FOR (Reinforcement, untapered);
IF Reinforcement has no taper THEN
Problems with removal of part from
mould. Request that a Taper be created.
END_RULE;
RULE Reinforcement_height FOR (Reinforcement, against adjacent wall);
IF height>max_height THEN
Possible sink marks opposite the
reinforcement and/or component warpage.
Advise height reduction to a maximum
of max_height.
END_RULE;
RULE Reinforcement_width FOR (Reinforcement, against adjacent wall);
IF width>max_width THEN
Possible sink marks opposite the
reinforcement and/or component warpage.
Advise width reduction to a maximum
of max_width.
END_RULE;
RULE Reinforcement_blend FOR (Reinforcement, against adjacent wall);
IF Reinforcement has no blend THEN
Stress concentrations in the component, possible surface defects. Request that a Blend be created.
END_RULE;
END_ENTITY;

ENTITY Rib
SUBTYPE OF (Reinforcement);
length : dimension;
END_ENTITY;

ENTITY Solid_boss
SUBTYPE OF (Reinforcement);
END_ENTITY;

ENTITY Hollow_boss
SUBTYPE OF (reinforcement);
ing internal : dimension;
END_ENTITY;

ENTITY Hole
SUBTYPE OF (Primary_mouldability_features);
Feature_name : STRING;
Feature_type : STRING;
Name of associated form : STRING;
Type of associated form : STRING;
diameter : dimension;
depth : dimension;
orientation : POINT3D;
positon : POINT3D;
connect_wall : wall;
WHERE
min_distance_wall : distance_hole_wall >= diameter;
min_distance_hole : distance_hole_hole >= diameter;
max_blind_depth : depth <= 2.0*diameter;
min_blind_depth : depth >= diameter;
machine_axis : = (0.0, 0.0, 1.0);
DERIVE
correct_orientation : BOOLEAN := (orientation = machine_axis);
blind_hole : BOOLEAN := (depth < connect_wall.thickness);
RULE Hole_orientation FOR (Hole);
IF !correct_orientation THEN
Ejection problems, maybe moving cores required and/or complex parting line. Request re-orientation.
END_RULE;
RULE Hole_taper FOR (Hole, untapered);
IF Hole has no taper THEN
Problems with removal of part from mould. Request that a Taper be created.
END_RULE;
RULE Distance_hole_wall FOR (Hole, near to wall);
IF distance_hole_wall < min_distance_wall THEN
Possible weld line between hole and wall. Area between hole and wall highly stressed. Advise either move hole or reduce diameter.
END_RULE;
RULE Distance_hole_hole FOR (Hole, near to hole);
IF distance_hole_hole<min_distance_hole THEN
Possible weld line between the holes. Area between holes highly stressed. Advise either move hole, reduce diameter or reduce number of holes.
END_RULE;
RULE Prefer_through_hole FOR (Hole, blind);
IF blind_hole THEN
Advise that a through hole is preferred so that the core pin can be supported at both ends. Request change to through hole.
END_RULE;
RULE Maximum_depth FOR (Hole, blind);
IF depth>max_blind_depth THEN
Possible poor dimensional location of hole and/or bending or breaking of the core pin. Advise decrease in depth to a maximum of max_blind_depth.
END_RULE;
RULE Minimum_depth FOR (Hole, blind);
IF depth<min_blind_depth THEN
Minimum practical depth for a core pin in the mould is min_blind_depth. Advise increase in depth to a minimum of min_blind_depth.
END_RULE;
END_ENTITY;
ENTITY Taper
SUBTYPE OF (Secondary_mouldability_features);
Name of associated_form : STRING;
Type_of_associated_form : STRING;
angle : dimension;
WHERE
min_angle_wall : angle >=0.8;
min_angle_reinforcement : angle >=5.0;
min_angle_hole : angle >=5.0;
RULE Wall_draft_angle FOR (Taper, on wall);
IF angle<min_angle_wall THEN
Difficulty in removing the component from the mould. Request an increase in taper_angle to a minimum of min_angle_wall.
END_RULE;
RULE Reinforcement_draft_angle FOR (Taper, on reinforcement);
IF angle<min_angle_reinforcement THEN
Difficulty in removing the component from the mould. Request an increase in taper_angle to a minimum of min_angle_reinforcement.
END_RULE;
RULE Hole_draft_angle FOR (Taper, on hole);
IF angle<min_angle_hole THEN
Difficulty in removing the component from the mould. Request an increase in taper_angle to a minimum of min_angle_hole.
END_RULE;
END_ENTITY;
ENTITY Blend
SUBTYPE OF (Secondary_mouldability_features);
ABSTRACT SUPERTYPE OF (ONE OF( Corner_blend, Protrusion_blend));
Name of associated_form : STRING;
Type_of_associated_form : STRING;
ENTITY Corner_blend
SUBTYPE OF (Blend);
inside_radius : dimension;
outside_radius : dimension;
connect_wall : wall;
WHERE
fixed_min : inside_radius >= 0.5;
DERIVE
best_inner : BOOLEAN := (0.4*connect_wall.thickness<=inside_radius<=0.6*connect_wall.thickness);
between : BOOLEAN := (outside_radius == inside_radius + connect_wall.thickness);
RULE Corner_blend_minimum_radius FOR (Corner_blend);
IF inside_radius < fixed_min THEN
Possible stress concentrations in the component and surface defects.
Advise increase in inside_radius to a minimum of fixed_min.
END_RULE;
RULE Corner_blend_inner_radius FOR (Corner_blend, on a wall intersection);
IF !best_inner THEN
Possible stress concentrations in the component and surface defects.
Advise inside_radius change to within best_inner, subject to fixed_min.
END_RULE;
RULE Corner_blend_outer_radius FOR (Corner_blend, on a wall intersection);
IF !best_outer THEN
IF outside_radius < best_outer THEN
Thickening corner section – leading to possible shrinkage marks/surface depression, widening of corner angle and curvature of wall sections either side of the corner. Advise increase in outside_radius to best_outer.
IF outside_radius > best_outer THEN
Thinning corner section – leading to feeding problems around the corner, weak corner section. Advise decrease in outside_radius to best_outer.
END_RULE;
END_ENTITY;

ENTITY Protrusion_blend
SUBTYPE OF (Blend);
radius : dimension;
WHERE
fixed_min : radius >= 0.5;
RULE Reinforcement_wall_blend FOR (Protrusion_blend)
IF radius < fixed_min THEN
Possible stress concentrations in the component and surface defects.
Advise increase in radius to a minimum of fixed_min.
END_RULE;
END_ENTITY;

ENTITY Gate
SUBTYPE OF (Secondary_mouldability_features);
Name of associated_form : STRING;
Type_of_associated_form : STRING;
location : STRING;
position : POINT3D_ARRAY;
gate_type : STRING;
gate_no : integer;
WHERE

min_gates : gate_no>=Ceiling(feeding_distance/800);
DERIVE
extra_gate_required : BOOLEAN := (Feeding_distance > 800);
RULE Max_flow_length FOR (Gate, on wall);
IF extra_gate_required THEN
Material will not reach the mould extremities. Recommend a minimum of min_gates and/or relocation of gate position.
END_RULE;
RULE Gate_type FOR (Gate, on wall);
IF part.geometry = thin_rot THEN
IF gate_no=1 THEN
Advise possible gate types : rectangular_edge_gate, pin_gate, sprue_gate. Advise pin_gate requires three plate mould.
IF gate_no>1 THEN
Advise possible gate types : rectangular_edge_gate, pin_gate. Advise pin gate requires three plate mould, rectangular_edge_gate requires multi nozzle manifold.
IF part.geometry = thick_rot THEN
Advise possible gate types : rectangular_edge_gate, sub_surface_gate, round_edge_gate.
IF gate_no=1 THEN
Advise multi nozzle manifold required for all above types.
IF part.geometry = tubular THEN
IF gate_no=1 THEN
Advise possible gate types: rectangular_edge_gate, pin_gate, diaphragm_gate, ring_gate. Advise pin_gate requires three plate mould.
IF gate_no>1 THEN
Advise possible gate types: rectangular_edge_gate, pin_gate. Advise pin gate requires three plate mould, rectangular_edge_gate requires multi nozzle manifold.
IF part.geometry = non_rotn_thin THEN
Advise possible gate types : fan_gate, film_gate.
IF gate_no>1 THEN
Advise multi nozzle manifold required for all above types.
IF part.geometry = non_rotn_thick THEN
Advise possible gate types : sub_surface_gate.
IF gate_no>1 THEN
Advise multi nozzle manifold required for all above types.
IF part.geometry = solid_block THEN
Advise possible gate types : overlap_gate, tab_gate.
IF gate_no>1 THEN
Advise multi nozzle manifold required for overlap_gate and may be required for tab_gate.
IF part.geometry = large_area THEN
Advise possible gate types: fan_gate.
END_RULE;
END_ENTITY;
//MOULD SYSTEM ELEMENTS

ENTITY Injection_mould_elements
  has_cavity: Cavity;
  has_core: Core;
  has_feeding: Feeding_system;
  has_cooling: Cooling_system;
  has_ejection: Ejection_system;
  has_guidance: Guide_system;
END_ENTITY;

ENTITY Cavity
  ASTRACT SUPERTYPE OF (ONE OF (Integer_cavity, Insert_cavity));
END_ENTITY;

ENTITY Integer_cavity
  SUBTYPE OF (Cavity);
  has_volume: Integer_cavity_volume;
  has_group_volume: Integer_cavity_group_volume;
  has_gate_position: Integer_cavity_gate_position;
  has_rim: Integer_cavity_rim;
  has_boss: Integer_cavity_boss;
  has_hole: Integer_cavity_hole;
  has_slot: Integer_cavity_slot;
  has_taper: Integer_cavity_taper;
  has_blend: Integer_cavity_blend;
  has_block: Integer_cavity_block;
  has_inner_land: Integer_cavity_inner_land;
  has_perif_land: Integer_cavity_perif_land;
  has_parting: Integer_cavity_parting_line;
  has_backing: Integer_cavity_backing_plate;
  has_recess: Integer_cavity_nozzle_recess;
END_ENTITY;

ENTITY Integer_cavity_volume
  mouldability_feat: STRING;
  mouldability_type: STRING;
  position: POINT3D;
  diameter: dimension;
  height: dimension;
  orientation: POINT3D;
  connect_volume_above: Integer_cavity_volume;
  connect_taper: Integer_cavity_taper;
  connect_blend: Integer_cavity_blend;
WHERE
  small_angle_radians := (connect_taper.angle/360)*2.0*3.1416;
  remaining_angle := 90 - connect_taper.angle;
  larger_angle_radians := (remaining_angle/360)*2.0*3.1416;
  taper_allowance := (height*SINE(small_angle_radians))/
  SINE(large_angle_radians);
DERIVE
  IF connect_taper.angle == 0.0 THEN
    overhang_exists : BOOLEAN := (diameter > connect_volume_above.diameter);
  IF connect_taper.angle != 0.0 THEN
    overhang_exists : BOOLEAN := (diameter+2.0*taper_allowance >
    connect_volume_above.diameter);
  contact_exists : BOOLEAN := (position[3] + diameter >= connect_volume_above.diameter);
RULE Cavity_volume_overhang FOR (Integer_cavity_volume, in cavity);
  IF overhang_exists THEN
    Require split mould. If a rim
    exists on the part - non
mouldable. Advise diameter reduction to a maximum of connect_volume_above.diameter.
If no adjustment -- Create vertical split line.
END_RULE;
RULE Cavity_volume_taper FOR (Integer_cavity_volume, in cavity);
IF Taper exists on mouldability wall equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability wall equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
RULE Cavity_volume_blend FOR (Integer_cavity_volume, in cavity);
IF !contact_exists THEN
No blend required.
IF contact_exists THEN
IF Corner_blend does not exist on mouldability wall equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Corner_blend is created on mouldability_feat.
IF external product geometry at intersection == convex THEN
connect_blend.radius == outside_radius of Corner_blend.
IF external product geometry at intersection == concave THEN
connect_blend.radius == inside_radius of Corner_blend.
IF Corner_blend exists on mouldability wall equivalent (mouldability_feat) THEN
IF external product geometry at intersection == convex THEN
connect_blend.radius == outside_radius of Corner_blend.
IF external product geometry at intersection == concave THEN
connect_blend.radius == inside_radius of Corner_blend.
END_RULE;
END_ENTITY;
ENTITY Integer_cavity_group_volume
mouldability_feat : STRING_ARRAY;
mouldability_type : STRING;
position : POINT3D;
diameter : dimension;
height : dimension;
orientation : POINT3D;
group_number : integer,
connect_volume_above : Integer_cavity_volume;
connect_volume_below : Integer_cavity_volume;
connect_taper_on_volume_below : Integer_cavity_taper
WHERE
small_angle_radians : = (connect_taper_on_volume_below.angle/360)*2.0*3.1416;
remaining_angle : = 90 - connect_taper_on_volume_below.angle;
larger_angle_radians : = (remaining_angle/360)*2.0*3.1416;
taper_allowance : = (connect_volume_below.height*SINE(small_angle_radians))/
                   SINE(larger_angle_radians);
DERIVE
overhang_exists_above : BOOLEAN := (diameter>connect_volume_above.diameter);
IF connect_taper_on_volume_below.angle == 0.0 THEN
overhang_exists_below : BOOLEAN := (diameter < connect_volume_below.diameter);
IF connect_taper_on_volume_below_angle !=0.0 THEN
overhang_exists_below : BOOLEAN := (diameter < 2.0*taper_allowance +
connect_volume_below.diameter);
RULE Cavity_group_volume_overhang_above FOR(Integer_cavity_group_volume, in cavity);
IF overhang_exists_above THEN
Require split mould. If a rim exists on the part – non mouldable. Advise diameter reduction to a maximum of connect_volume_above.diameter. If no adjustment – Create vertical split line.

END_RULE;

RULE Cavity_group_volume_overhang_below FOR (Integer_cavity_group_volume, in cavity);
IF overhang_exists_below THEN
Require split mould. If a rim exists on the part – non mouldable.
IF connect_taper_on_volume_below.angle == 0.0 THEN
Advise diameter increase to a minimum of connect_volume_below.diameter.
IF connect_taper_on_volume_below.angle != 0.0 THEN
Advise diameter increase to a minimum of connect_volume_below.diameter + 2.0*taper_allowance.
If no adjustment – Create vertical split line.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_rim
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
inner_dia : dimension;
outer_dia : dimension;
height : dimension;
orientation : POINT3D;
connect_volume_above : Integer_cavity_volume;
connect_taper : Integer_cavity_taper;
connect_blend : Integer_cavity_blend;
WHERE
small_angle_radians: = (connect_taper.angle/360)*2.0*3.1416;
remaining_angle : = 90 – connect_taper.angle;
larger_angle_radians: = (remaining_angle/360)*2.0*3.1416;
taper_allowance: = (height*SINE(small_angle_radians))/SINE(larger_angle_radians);
DERIVE
IF connect_taper.angle ==0.0 THEN
overhang_exists: BOOLEAN := (outer_dia > connect_volume_above.diameter);
IF connect_taper.angle !=0.0 THEN
overhang_exists: BOOLEAN := (outer_dia+ 2.0*taper_allowance > connect_volume_above.diameter);
contact_exists: BOOLEAN := (position[3] + diameter >= connect_volume_above.diameter);
RULE Cavity_rim_overhang FOR (Integer_cavity_rim, in cavity, mouldability_type==wall);
IF overhang_exists THEN
Require split mould. If a rim exists on the part – non mouldable. Advise outer_dia reduction to a maximum of connect_volume_above.diameter. If no adjustment – Create vertical split line.
END_RULE;
RULE Cavity_rim_blend FOR (Integer_cavity_rim, in cavity, mouldability_type==wall);
IF !contact_exists THEN
No blend required.
IF contact_exists THEN
IF Corner_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners.

in mould. Corners wear during mould operation. Request Corner_blend is created on mouldability_feat.
connect_blend.radius == inside_radius of Corner_blend.
IF Corner_blend exists on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == inside_radius of Corner_blend.
END_RULE;
RULE Cavity_rim_blend FOR (Integer_cavity, in cavity, mouldability_type==hollow_boss);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.
connect_blend.radius == radius of Protrusion_blend.
IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == radius of Protrusion_blend.
END_RULE;
RULE Cavity_rim_taper FOR (Integer_cavity_rim, in cavity);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_boss
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
diameter : dimension;
height : dimension;
connect_taper : Integer_cavity_taper;
RULE Cavity_boss_taper FOR (Integer_cavity_boss, in cavity);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_slot
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
feature_orientation : POINT3D;
width : dimension;
length : dimension;
height : dimension;
connect_taper : Integer_cavity_taper;
connect_blend : Integer_cavity_blend;
RULE Cavity_slot_blend FOR (Integer_cavity_slot, in cavity);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.

connect_blend.radius = radius of Protrusion_blend.

IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius = radius of Protrusion_blend.
END_RULE;

RULE Cavity_slot_taper FOR (Integer_cavity_slot, in cavity);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;

RULE Cavity-hole_blend FOR (Integer_cavity_hole, in cavity);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.
connect_blend.radius = radius of Protrusion_blend.
IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius = radius of Protrusion_blend.
END_RULE;

RULE Cavity_slot_taper FOR (Integer_cavity_slot, in cavity);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;

RULE Cavity_hole_taper FOR (Integer_cavity_hole, in cavity);
angle = connect_taper.angle identified by
cavity_entity: Integer_cavity_volume OR Integer_cavity_rim OR Integer_cavity_slot OR
Integer_cavity_hole OR Integer_cavity_boss;
RULE Cavity_volume_taper angle FOR (Integer_cavity_taper, in cavity)
angle = connect_taper.angle identified by
connect_cavity_entity: Integer_cavity_volume OR Integer_cavity_rim OR Integer_cavity_slot OR
Integer_cavity_hole OR Integer_cavity_boss;
connect_cavity_entity: RULE Cavity_rim_taper OR
connect_cavity_entity: RULE Cavity_slot_taper OR
connect_cavity_entity: RULE Cavity_hole_taper OR
connect_cavity_entity: RULE Cavity_boss_taper OR
Advise taper angle.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_blend
prim_volume_name : STRING;
prim_volume_type : STRING;
join_volume_name : STRING;
join_volume_type : STRING;
Mould_equiv : STRING;
radius : dimension;
connect_blend : Blend;
connect_cavity_entity : Integer_cavity_volume OR Integer_cavity_rim OR Integer_cavity_hole OR Integer_cavity_slot;
RULE Cavity_blend_radius FOR (Integer_cavity_blend, in cavity);
IF connect_blend == Protrusion_blend THEN
radius = connect_blend.radius identified by
connect_cavity_entity:RULE Cavity_rim_blend OR
connect_cavity_entity:RULE Cavity_slot_blend. OR
connect_cavity_entity:RULE Cavity_hole_blend.
Advise blend radius.
IF connect_blend == Corner_blend THEN
radius = connect_blend.radius identified by
connect_cavity_entity:RULE Cavity_volume_blend OR
connect_cavity_entity:RULE Cavity_rim_blend.
Advise blend radius
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_rect_block
position : POINT3D;
length : dimension;
width : dimension;
depth : dimension;
guide_pin_dia : dimension;
connect_cooling : Standard_flow_way;
connect_sprue : Main_feeding_sprue;
connect_parting : Integer_cavity_parting_line;
connect_volume_lowest : Integer_cavity_volume; (furthest from parting line)
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_land : Integer_cavity_circ_land OR Integer_cavity_rect_land;
WHERE
depth_of_cavity = connect_parting.position − connect_volume_lowest.position[2];
depth_of_land = connect_land.depth;
min_land_width = 5.0;
max_land_width = 25.0;
directional_cooling_distance = 16.0;
minimum_cooling_space = connect_cooling.diameter + 2.0*directional_cooling_distance;
min_metal_condition: IF connect_volume_highest.diameter <= 25.0 THEN
min_metal_under_cavity = 6.0;
IF connect_volume_highest.diameter <= 38.0 THEN
min_metal_under_cavity = 10.0;
IF connect_volume_highest.diameter <= 44.0 THEN
min_metal_under_cavity = 14.0;
IF connect_volume_highest.diameter <= 50.0 THEN
min_metal_under_cavity = 16.0;
IF connect_volume_highest.diameter <= 56.0 THEN
min_metal_under_cavity = 18.0;
IF \( \text{connect\_volume\_highest\_diameter} \leq 62.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 22.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 68.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 25.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 74.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 29.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 80.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 33.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 86.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 36.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 92.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 40.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 98.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 44.0; \)
IF \( \text{connect\_volume\_highest\_diameter} \leq 104.0 \) THEN
\( \text{min\_metal\_under\_cavity} = 49.0; \)

\text{land\_size\_x:} \text{IF gate type == rectangular\_edge OR round\_edge OR film OR fan OR overlap OR sub\_surface OR tab THEN}
IF \( \text{connect\_sprue\_position}[2] < 0.0 \) THEN
\( \text{land\_size\_x} = 2.0\times(\text{connect\_volume\_highest\_position}[0] - \text{connect\_sprue\_position}[0]) + \text{min\_land\_width}; \)
IF \( \text{connect\_sprue\_position}[2] > 0.0 \) THEN
\( \text{land\_size\_x} = 2.0\times(\text{connect\_volume\_highest\_position}[0] + \text{min\_land\_width}); \)
IF \( \text{gate type == diaphragm OR pin OR ring OR sprue THEN}
\( \text{land\_size\_x} = \text{connect\_volume\_highest\_diameter} + 2.0\times\text{min\_land\_width}; \)
\( \text{min\_land\_size\_y:} \text{IF gate type == rectangular\_edge OR round\_edge OR film OR fan OR overlap OR sub\_surface OR tab THEN}
\( \text{land\_size\_y} = \text{connect\_volume\_highest\_diameter} + 2.0\times\text{minimum\_cooling\_space}; \)
\( \text{land\_size\_y:} \text{IF gate type == diaphragm OR pin OR ring OR sprue THEN}
\( \text{land\_size\_y} = \text{connect\_volume\_highest\_diameter} + 2.0\times\text{min\_land\_width}; \)
\( \text{IF land\_size\_y < min\_land\_size\_y THEN}
\( \text{land\_size\_y} = \text{min\_land\_size\_y}; \)
\( \text{area\_of\_land:} 3.1416 \times \text{SQ}((\text{connect\_volume\_highest\_diameter}/2.0 + \text{min\_land\_width}) - \text{max\_area\_of\_land:} 3.1416 \times \text{SQ}((\text{connect\_volume\_highest\_diameter}/2.0 + \text{max\_land\_width}) - \text{perif\_land\_area:} (\text{max\_area\_of\_land} - \text{area\_of\_land})/4.0; \)
\( \text{perif\_land\_diam:} \text{SQRT}(\text{perif\_land\_area}/3.1416); \)
\text{RULE Cavity\_block\_position FOR (Integer\_cavity\_block, enclosing mould system elements);}
x position = centre of cavity base in x axis.
y position = centre of cavity base in y axis.
\( \text{IF gate type == rectangular\_edge OR round\_edge OR film OR fan OR overlap OR sub\_surface OR tab THEN}
\text{IF no nozzle\_recess is required THEN}
z position = \text{connect\_sprue\_position}[2] - \text{connect\_sprue\_sprue\_length}. \)
\text{IF nozzle\_recess is required THEN}
\text{IF (depth\_of\_cavity + min\_metal\_condition) \geq minimum\_cooling\_space THEN}
z position = \text{connect\_volume\_lowest\_position}[2] - \text{min\_metal\_condition}. \)
\text{IF (depth\_of\_cavity + min\_metal\_condition) < minimum\_cooling\_space THEN}
z position = \text{connect\_parting\_position} - \text{minimum\_cooling\_space}. \)
\text{IF gate type == diaphragm OR pin OR ring OR sprue THEN}
\text{IF (depth\_of\_cavity + min\_metal\_condition) \geq minimum\_cooling\_space THEN}
z position = \text{connect\_volume\_lowest\_position}[2] - \text{min\_metal\_condition}. \)
\text{IF (depth\_of\_cavity + min\_metal\_condition) < minimum\_cooling\_space THEN}
z position = \text{connect\_parting\_position} - \text{minimum\_cooling\_space}. \)
\text{END\_RULE;}
RULE Guide_system_parameters FOR (Integer_cavity_block, enclosing mould system elements);
  Advise use minimum suitable diameter to minimise mould size.
  IF gate type == rectangular_edge OR round_edge OR film OR fan OR overlap OR sub_surface OR tab
  THEN area in guide system = land_size_x*land_size_y.
  IF gate type == diaphragm OR pin OR ring OR sprue THEN
  area in guide system = (land_size_x + 2.0*perif_land_diam)*
  (land_size_y + 2.0*perif_land_diam).
  IF area in guide system < 10000 THEN
  Advise recommended guide pin diameter == 10.0.
  IF area in guide system < 15000 THEN
  Advise recommended guide pin diameter == 13.0.
  IF area in guide system < 30000 THEN
  Advise recommended guide pin diameter == 16.0.
  IF area in guide system < 50000 THEN
  Advise recommended guide pin diameter == 19.0.
  IF area in guide system < 75000 THEN
  Advise recommended guide pin diameter == 22.0.
  IF area in guide system < 120000 THEN
  Advise recommended guide pin diameter == 25.0.
  IF area in guide system < 240000 THEN
  Advise recommended guide pin diameter == 32.0.
  IF area in guide system < 420000 THEN
  Advise recommended guide pin diameter == 38.0.
  IF gate type == rectangular_edge OR round_edge OR film OR fan OR overlap OR sub_surface OR tab AND
  number of gates == 1 THEN
  Unbalanced forces in mould tending to open the mould on one side. Possible larger wall thickness on one side than the other. Advise use next size up than recommended to ensure alignment.
END_RULE;
RULE Cavity_block_width FOR (Integer_cavity_block, enclosing mould system elements);
  IF gate type == rectangular_edge OR round_edge OR film OR fan OR overlap OR sub_surface OR tab
  THEN width = land_size_y + 4.0*guide pin diameter.
  IF gate type == diaphragm OR pin OR ring OR sprue THEN
  width = (land_size_y + 2.0*perif_land_diam) + 4.0*guide pin diameter.
END_RULE;
RULE Cavity_block_length FOR (Integer_cavity_block, enclosing mould system elements);
  IF gate type == rectangular_edge OR round_edge OR film OR fan OR overlap OR sub_surface OR tab
  THEN length = land_size_x + 4.0*guide pin diameter.
  IF gate type == diaphragm OR pin OR ring OR sprue THEN
  length = (land_size_x + 2.0*perif_land_diam) + 4.0*guide pin diameter.
END_RULE;
END_ENTITY;
ENTITY Integer_cavity_inner_land
  ABSTRACT SUPERTYPE OF (ONE OF (Integer_cavity_rect_land, Integer_cavity_circ_land));
END_ENTITY;
ENTITY Integer_cavity_rect_land
  SUBTYPE OF (Integer_cavity_inner_land);
  position : POINT3D;
  length : dimension;
  width : dimension;
  depth : dimension;
  connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
  connect_parting : Integer_cavity_parting_line;
  connect_taper : Integer_cavity_taper; (taper on connect_volume)
connect_sprue : Main_feeding_sprue;
WHERE
min_land_width = 5.0;
small_angle_radians = (connect_taper.angle/360)*2.0*3.1416;
remaining_angle = 90 - connect_taper.angle;
larger_angle_radians = (remaining_angle/360)*2.0*3.1416;
taper_allowance = (connect_volume.height*SINE(small_angle_radians))/
SINE(large_angle_radians);
small_angle_sprue = (connect_sprue.angle/360)*2.0*3.1416;
remaining_angle_sprue = 90 - connect_sprue.angle;
larger_angle_sprue = (remaining_angle_sprue/360)*2.0*3.1416;
sprue_taper_allowance = ((connect_sprue.length - 5.0)*SINE(small_angle_sprue))/
SINE(large_angle_sprue);
RULE Cavity_rect_land_depth FOR (Integer_cavity_rect_land, around cavity);
depth = 2.4.
END_RULE;
RULE Cavity_rect_land_position FOR (Integer_cavity_rect_land, around cavity);
x position = connect_volume.position[0];
y position = connect_volume.position[1];
z position = connect_parting.position - depth;
END_RULE;
RULE Cavity_rect_land_length FOR (Integer_cavity_rect_land, around cavity);
IF connect_sprue.position[0] < 0.0 THEN
length = 2.0*(connect_volume_highest.position[0] -
connect_sprue.position[0] + min_land_width + (connect_sprue.diameter + sprue_taper_allowance/2.0));
ELSE
length = 2.0*(connect_sprue.position[0] -
connect_sprue.position[0] + min_land_width + (connect_sprue.diameter + sprue_taper_allowance/2.0));
ENDIF
ENDIF
RULE Cavity_rect_land_width FOR (Integer_cavity_rect_land, around cavity);
width = connect_volume_highest.diameter + 2.0*min_land_width;
ELSE
width = width + (2.0*taper_allowance);
ENDIF
END_RULE;
RULE Cavity_rect_land_diameter FOR (Integer_cavity_rect_land, around cavity);
width = width + (2.0*taper_allowance);
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_circ_land
SUBTYPE OF (Integer_cavity_inner_land);
position : POINT3D;
diameter : dimension;
depth : dimension;
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_parting : Integer_cavity_parting_line;
connect_taper : Integer_cavity_taper; (taper on connect_volume)
WHERE
min_land_width = 5.0;
small_angle_radians = (connect_taper.angle/360)*2.0*3.1416;
remaining_angle = 90 - connect_taper.angle;
larger_angle_radians = (remaining_angle/360)*2.0*3.1416;
taper_allowance = (connect_volume.height*SINE(small_angle_radians))/
SINE(large_angle_radians);
RULE Cavity_circ_land_depth FOR (Integer_cavity_circ_land, around cavity);
depth = 2.4.
END_RULE;
RULE Cavity_circ_land_position FOR (Integer_cavity_circ_land, around cavity);
x position = connect_volume.position[0];
y position = connect_volume.position[1];
z position = connect_parting.position - depth;
END_RULE;
RULE Cavity_circ_land_diameter FOR (Integer_cavity_circ_land, around cavity);
diameter = connect_volume_highest.diameter + 2.0*min_land_width;
IF connect_taper.angle !=0.0 THEN
diameter = diameter + (2.0*taper_allowance).
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_perif_land
position : POINT3D;
diameter : dimension;
depth : dimension;
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_parting : Integer_cavity_parting_line;
WHERE
min_land_width : = 5.0;
max_land_width : = 25.0;
area_of_land: 3.1416 * SQ(connect_volume_highest.diameter/2.0 + min_land_width) -
3.1416 * SQ(connect_volume_highest.diameter/2.0);
max_area_of_land: 3.1416 * SQ(connect_volume_highest.diameter/2.0 + max_land_width) -
3.1416 * SQ(connect_volume_highest.diameter/2.0);
perif_land_area: (max_area_of_land - area_of_land)/4.0;
RULE Cavity_peripheral_land_depth FOR (Integer_cavity_perif_land, around cavity);
depth = 2.4.
END_RULE;
RULE Cavity_peripheral_land_diameter FOR (Integer_cavity_perif_land, around cavity);
diameter = SQRT (perif_land_area/3.1416).
END_RULE;
RULE Cavity_peripheral_land_position FOR (Integer_cavity_perif_land, around cavity);
z position = connect_parting.position - depth.
IF first_peripheral_land of four THEN
x position = connect_volume.position[0] + (connect_volume.diameter/2.0 + min_land_width + diameter).
y position = connect_volume.position[1] + (connect_volume.diameter/2.0 + min_land_width + diameter).
IF second Peripheral land of four THEN
x position = connect_volume.position[0] - (connect_volume.diameter/2.0 + min_land_width + diameter).
y position = connect_volume.position[1] + (connect_volume.diameter/2.0 + min_land_width + diameter).
IF third Peripheral land of four THEN
x position = connect_volume.position[0] + connect_volume.diameter/2.0 + min_land_width + diameter.
y position = connect_volume.position[1] - (connect_volume.diameter/2.0 + min_land_width + diameter).
IF fourth Peripheral land of four THEN
x position = connect_volume.position[0] - (connect_volume.diameter/2.0 + min_land_width + diameter).
y position = connect_volume.position[1] - (connect_volume.diameter/2.0 + min_land_width + diameter).
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_nozzle_recess
position : POINT3D;
diameter : dimension;
depth : dimension;
connect_sprue : Main_feeding_sprue;
connect_block : Integer_cavity_rect_block;
WHERE
min_all_round_nozzle_clearance : = 7.0;
machine_nozzle_outer_diameter : = 12.7;
RULE Nozzle_recess_position FOR (Nozzle_recess, in block);
x position = connect_sprue.position[0].
y position = connect_sprue.position[1].
z position = connect_block.position[2].
END_RULE;
RULE Nozzle_recess_depth FOR (Nozzle_recess, in block);
depth = (connect_sprue.position[2]-connect_sprue.sprue_length) - connect_block.position[2].
END_RULE;
RULE Nozzle_recess_diameter FOR (Nozzle_recess, in block);
diameter = machine_nozzle_outer_diameter + 2.0*min_all_round_nozzle_clearance.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_backing_plate
position : POINT3D;
width : dimension;
length : dimension;
depth : dimension;
connect_block : Integer_cavity_rect_block;
connect_sprue : Main_feeding_sprue;
connect_runner : Trapezoidal_runner;
RULE Backing_plate_position FOR (Integer_cavity_backing_plate, on cavity block);
x position = connect_block.position[0].
y position = connect_block.position[1].
END_RULE;
RULE Backing_plate_depth FOR (Integer_cavity_backing_plate, on cavity block);
depth = connect_sprue.length + connect_runner.width.
END_RULE;
RULE Backing_plate_length FOR (Integer_cavity_backing_plate, on cavity block);
length = connect_block.length.
END_RULE;
RULE Backing_plate_width FOR (Integer_cavity_backing_plate, on cavity block);
width = connect_block.width.
END_RULE;
END_ENTITY;

ENTITY Integer_cavity_parting_line
position : POINT3D;
type : STRING;
on_entity : STRING;
connect_volume_widest : Integer_cavity_volume OR Integer_cavity_rim (on parting_line)
RULE Cavity_parting_line_position FOR (Integer_cavity_parting_line, on cavity);
IF type == block THEN
IF type == split THEN
position = connect_volume_widest.position[0].
END_RULE;

ENTITY Core
ABSTRACT SUPERTYPE OF (ONE OF (Integer_core, Insert_core));
END_ENTITY;

ENTITY Integer_core
SUBTYPE OF (Core);

has_volume : Integer_core_volume;
has_group_volume : Integer_core_group_volume;
has_gate_position : Integer_core_gate_position;
has_rim : Integer_core_rim;
has_boss : Integer_core_boss;
has_slot : Integer_core_slot;
has_taper : Integer_core_taper;
has_blend : Integer_core_blend;
has_block : Integer_core_block;
has_inner_land : Integer_core_inner_land;
has_peri_land : Integer_core_peri_land;
has_parting : Integer_core_parting_line;
END_ENTITY;
ENTITY Integer_core_volume
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
diameter : dimension;
height : dimension;
orientation : POINT3D;
origin : dimension;
origin_d : dimension;
connect_volume_above : Integer_core_volume;
connect_taper : Integer_core_taper;
connect_blend : Integer_core_blend;
WHERE
small_angle_radians = (connect_taper.angle/360)*2.0*3.1416;
remaining_angle = 90 - connect_taper.angle;
larger_angle_radians = (remaining_angle/360)*2.0*3.1416;
taper_allowance = (height*SINE(small_angle_radians))/
                  SINE(larger_angle_radians);
DERIVE
IF connect_taper.angle == 0.0 THEN
  overhang_exists : BOOLEAN := (diameter > connect_volume_above.diameter);
IF connect_taper.angle !=0.0 THEN
  overhang_exists : BOOLEAN := (diameter+ 2.0*taper_allowance >
                              connect_volume_above.diameter);
contact_exists : BOOLEAN := (position[3] + diameter >= connect_volume_above.diameter);
RULE Core_volume_overhang FOR (Integer_core_volume, in core);
  IF overhang_exists THEN
    IF overhang < 1.5 THEN
      Stripping of component from the core
      is required for removal.
    IF overhang > 1.5 THEN
      Collapsible core required for
      component removal.
    Advise diameter reduction to a maximum of
    connect_volume_above.diameter.
  END_RULE;
RULE Core_volume_taper FOR (Integer_core_volume, in core);
  IF Taper exists on mouldability wall equivalent (mouldability_feat) THEN
    connect_taper.angle == angle of mouldability taper.
  IF Taper does not exist on mouldability wall equivalent (mouldability_feat) THEN
    Difficulty in removing the product
    from the mould. Request Taper is
    created on mouldability_feat.
    connect_taper.angle == angle of mouldability taper.
  END_RULE;
RULE Core_volume_blend FOR (Integer_core_volume, in core);
  IF contact_exists THEN
    No blend required.
  IF contact_exists THEN
    IF Corner_blend does not exist on mouldability wall equivalent (mouldability_feat) THEN
      Difficult to produce sharp corners
      in mould. Corners wear during
      mould operation. Request Corner_blend
      is created on mouldability_feat.
      IF internal product geometry at intersection == convex THEN
        connect_blend.radius == inside_radius of Corner_blend.
      IF internal product geometry at intersection == concave THEN
        connect_blend.radius == outside_radius of Corner_blend.
      IF Corner_blend exists on mouldability wall equivalent (mouldability_feat) THEN
        IF internal product geometry at intersection == convex THEN
          connect_blend.radius == inside_radius of Corner_blend.
IF internal product geometry at intersection == concave THEN
  connect_blend.radius == outside_radius of Corner_blend.
END_RULE;
END_ENTITY;

ENTITY Integer_core_group_volume
  mouldability_feat : STRING_ARRAY;
  mouldability_type : STRING;
  position : POINT3D;
  diameter : dimension;
  height : dimension;
  orientation : POINT3D;
  group_number : integer;
  connect_volume_above : Integer_core_volume;
  connect_volume_below : Integer_core_volume;
  connect_taper_on_volume_below : Integer_core_taper
WHERE
  small_angle_radians := (connect_taper_on_volume_below.angle(360)*2.0*3.1416;
  remaining_angle := 90 - connect_taper_on_volume_below.angle;
  larger_angle_radians := (remaining_angle/360)*2.0*3.1416;
  taper_allowance := (connect_volume_below.height*SINE(small_angle_radians))/
                   SINE(large_angle_radians);
DERIVE
  overhang_exists_above : BOOLEAN := (diameter > connect_volume_above.diameter);
  IF connect_taper_on_volume_below.angle == 0.0 THEN
    overhang_exists_below : BOOLEAN := (diameter < connect_volume_below.diameter);
  IF connect_taper_on_volume_below.angle != 0.0 THEN
    overhang_exists_below : BOOLEAN := (diameter < 2.0*taper_allowance +
                                           connect_volume_below.diameter);
RULE Core_group_volume_overhang_above FOR(Integer_core_group_volume, in core);
  IF overhang_exists_above THEN
    IF overhang < 1.5 THEN
      Stripping of component from the core
      is required for removal.
    IF overhang > 1.5 THEN
      Collapsible core required for
      component removal.
      Advise diameter reduction to a maximum of
      connect_volume_above.diameter.
    END_RULE;
  RULE Core_group_volume_overhang_below FOR (Integer_core_group_volume, in core);
  IF overhang_exists_below THEN
    IF overhang < 1.5 THEN
      Stripping of component from the core
      is required for removal.
    IF overhang > 1.5 THEN
      Collapsible core required for
      component removal.
      IF connect_taper_on_volume_below.angle == 0.0 THEN
        Advise diameter increase to a minimum of
        connect_volume_below.diameter.
      IF connect_taper_on_volume_below.angle == 0.0 THEN
        Advise diameter reduction to a minimum of
        connect_volume_below.diameter + 2.0*taper_allowance.
    END_RULE;
  END_RULE;
END_ENTITY;

ENTITY Integer_core_rim
  mouldability_feat : STRING;
  mouldability_type : STRING;
position : POINT3D;
inner_dia : dimension;
outer_dia : dimension;
height : dimension;
orientation : POINT3D;
connect_volume_above : Integer_core_volume;
connect_taper : Integer_core_taper;
connect_blend : Integer_core_blend;
RULE Core_rim_blend FOR (Integer_core_rim, in core);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners
in mould. Corners wear during
mould operation. Request Protrusion_blend
is created on mouldability_feat.
connect_blend.radius == radius of
Protrusion_blend.
IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == radius of Protrusion_blend.
END_RULE;
RULE Core_rim_taper FOR (Integer_core_rim, in core);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product
from the mould. Request Taper is
created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
END_ENTITY;

ENTITY Integer_core_boss
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
diameter : dimension;
height : dimension;
connect_taper : Integer_core_taper;
RULE Core_boss_taper FOR (Integer_core_boss, in core);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product
from the mould. Request Taper is
created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
END_ENTITY;

ENTITY Integer_core_slot
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
feature_orientation : POINT3D;
width : dimension;
length : dimension;
height : dimension;
connect_taper : Integer_core_taper;
connect_blend : Integer_core_blend;
RULE Core_slot_blend FOR (Integer_core_slot, in core);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.

connect_blend.radius == radius of Protrusion_blend.

IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == radius of Protrusion_blend.
END_RULE;
RULE Core_slot_taper FOR (Integer_core_slot, in core);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
RULE Core_hole_blend FOR (Integer_core_hole, in core);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.
connect_blend.radius == radius of Protrusion_blend.
IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == radius of Protrusion_blend.
END_RULE;
RULE Core_hole_taper FOR (Integer_core_hole, in core);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
RULE Core_taper_angle FOR (Integer_core_taper, in core)
angle = connect_taper.angle identified by
connect_core_entity.RULE Core_volume_taper OR

ENTITY Integer_core_hole
mouldability_feat : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
diameter : dimension;
depth : dimension;
connect_taper : Integer_core_taper;
connect_blend : Integer_core_blend;
RULE Core_hole_blend FOR (Integer_core_hole, in core);
IF Protrusion_blend does not exist on mouldability equivalent (mouldability_feat) THEN
Difficult to produce sharp corners in mould. Corners wear during mould operation. Request Protrusion_blend is created on mouldability_feat.
connect_blend.radius == radius of Protrusion_blend.
IF Protrusion_blend does exist on mouldability equivalent (mouldability_feat) THEN
connect_blend.radius == radius of Protrusion_blend.
END_RULE;
RULE Core_hole_taper FOR (Integer_core_hole, in core);
IF Taper exists on mouldability equivalent (mouldability_feat) THEN
connect_taper.angle == angle of mouldability taper.
IF Taper does not exist on mouldability equivalent (mouldability_feat) THEN
Difficulty in removing the product from the mould. Request Taper is created on mouldability_feat.
connect_taper.angle == angle of mouldability taper.
END_RULE;
RULE Core_taper_angle FOR (Integer_core_taper, in core)
angle = connect_taper.angle identified by
connect_core_entity.RULE Core_volume_taper OR

ENTITY Integer_core_taper
core_vol_name : STRING;
core_vol_type : STRING;
Mould_equiv : STRING;
angle : dimension;
connect_taper : Taper;
connect_core_entity: Integer_core_volume OR Integer_core_rim OR Integer_core_slot OR Integer_core_hole OR Integer_core_boss;
RULE Core_taper_angle FOR (Integer_core_taper, in core)
angle = connect_taper.angle identified by
connect_core_entity.RULE Core_volume_taper OR
connect_core_entity.RULE Core_rim_taper OR
connect_core_entity.RULE Core_slot_taper OR
connect_core_entity.RULE Core_hole_taper OR
connect_core_entity.RULE Core_boss_taper OR
Advise taper angle.
END_RULE;
END_ENTITY;

ENTITY Integer_core_blend
prim_volume_name : STRING;
prim_volume_type : STRING;
join_volume_name : STRING;
join_volume_type : STRING;
Mould_equiv : STRING;
radius : dimension;
connect_blend : Blend;
connect_core_entity : Integer_core_volume OR Integer_core_rim OR Integer_core_slot OR Integer_core_hole;
RULE Core_blend_radius FOR (Integer_core_blend, in core);
IF connect_blend = Protrusion_blend THEN
radius = connect_blend.radius identified by
connect_core_entity.RULE Core_rim_blend OR
connect_core_entity.RULE Core_slot_blend OR
connect_core_entity.RULE Core_hole_blend.
Advise blend radius.
IF connect_blend = Corner_blend THEN
radius = connect_blend.radius identified by
connect_core_entity.RULE Core_volume_blend.
Advise blend radius
END_RULE;
END_ENTITY;

ENTITY Integer_core_rect_block
position : POINT3D;
length : dimension;
width : dimension;
depth : dimension;
guide_pin_dia : dimension;
connect_cooling : Standard_flow_way;
connect_parting : Integer_core_parting_line;
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_land : Integer_core_circ_land OR Integer_core_rect_land;
connect_block : Integer_cavity_rect_block;
WHERE
directional_cooling_distance = 16.0;
minimum_cooling_space = connect_cooling.diameter + 2.0*directional_cooling_distance;
min_metal_condition: IF connect_volume_highest.diameter <= 25.0 THEN
min_metal_over_cavity = 6.0;
IF connect_volume_highest.diameter <= 38.0 THEN
min_metal_over_cavity = 10.0;
IF connect_volume_highest.diameter <= 44.0 THEN
min_metal_over_cavity = 14.0;
IF connect_volume_highest.diameter <= 50.0 THEN
min_metal_over_cavity = 16.0;
IF connect_volume_highest.diameter <= 56.0 THEN
min_metal_over_cavity = 18.0;
IF connect_volume_highest.diameter <= 62.0 THEN
min_metal_over_cavity = 20.0;
IF connect_volume_highest.diameter <= 68.0 THEN
min_metal_over_cavity = 22.0;
IF connect_volume_highest.diameter <= 74.0 THEN
min_metal_over_cavity = 25.0;
IF connect_volume_highest.diameter <= 80.0 THEN
min_metal_over_cavity = 29.0;
IF conneccvolume_highest.diameter <= 80.0 THEN
min_metal_over_cavity = 33.0;
IF conneccvolume_highest.diameter <= 86.0 THEN
min_metal_over_cavity = 36.0;
IF conneccvolume_highest.diameter <= 92.0 THEN
min_metal_over_cavity = 40.0;
IF conneccvolume_highest.diameter <= 98.0 THEN
min_metal_over_cavity = 44.0;
IF conneccvolume_highest.diameter <= 104.0 THEN
min_metal_over_cavity = 49.0;
RULE Core_block_position FOR (Integer_core_block, enclosing mould system elements);
  x position = x position of cavity block.
y position = y position of cavity block.
z position = connect_parting.position + connect_land.depth.
END_RULE;
RULE Core_block_depth FOR (Integer_core_block, enclosing mould system elements);
  IF min_metal_condition > minimum_cooling_space THEN
    depth = min_metal_condition.
  IF min_metal_condition < minimum_cooling_space THEN
    depth = minimum_cooling_space.
END_RULE;
RULE Core_block_width FOR (Integer_core_block, enclosing mould system elements);
  width = connect_block.width.
END_RULE;
RULE Core_block_length FOR (Integer_core_block, enclosing mould system elements);
  length = connect_block.length.
END_RULE;
END_ENTITY;
ENTITY Integer_core_inner_land
  ABSTRACT SUPERTYPE OF (ONE OF (Integer_core_rect_land, Integer_core_circ_land));
END_ENTITY;
ENTITY Integer_core_rect_land
  SUBTYPE OF (Integer_core_inner_land);
  position : POINT3D;
  length : dimension;
  width : dimension;
  depth : dimension;
  connect_parting : Integer_core_parting_line;
  connect_land : Integer_cavity_rect_land;
RULE Core_rect_land_depth FOR (Integer_core_rect_land, around core);
  depth = 2.4.
END_RULE;
RULE Core_rect_land_position FOR (Integer_core_rect_land, around core);
  x position = connect_land.position[0].
y position = connect_land.position[1].
z position = connect_parting.position.
END_RULE;
RULE Core_rect_land_length FOR (Integer_core_rect_land, around core);
  length = connect_land.length.
END_RULE;
RULE Core_rect_land_width FOR (Integer_core_rect_land, around core);
  width = connect_land.width.
END_RULE;
END_ENTITY;
ENTITY Integer_core_circ_land
  SUBTYPE OF (Integer_core_inner_land);
position: POINT3D;
diameter: dimension;
depth: dimension;
connect_parting: Integer_core_parting_line;
connect_land: Integer_cavity_land;
RULE Core_circ_land_depth FOR (Integer_core_circ_land, around core);
depth = 2.4.
END_RULE;
RULE Core_circ_land_position FOR (Integer_core_circ_land, around core);
x position = connect_land.position[0].
y position = connect_land.position[1].
z position = connect_parting.position.
END_RULE;
RULE Core_circ_land_diameter FOR (Integer_core_circ_land, around core);
diameter = connect_land.diameter.
END_RULE;
RULE Core_peripheral_land_depth FOR (Integer_core_perif_land, around core);
depth = 2.4.
END_RULE;
RULE Core_peripheral_land_diameter FOR (Integer_core_perif_land, around core);
diameter = connect_land.diameter.
END_RULE;
RULE Core_peripheral_land_position FOR (Integer_core_perif_land, around core);
z position = connect_parting.position.
x position = connect_land.position[0].
y position = connect_land.position[1].
END_RULE;
END_ENTITY;
ENTITY Integer_core_perif_land
position: POINT3D;
diameter: dimension;
depth: dimension;
connect_land: Integer_cavity_perif_land;
connect_parting: Integer_core_parting_line;
RULE Core_peripheral_land_depth FOR (Integer_core_perif_land, around core);
depth = 2.4.
END_RULE;
RULE Core_peripheral_land_diameter FOR (Integer_core_perif_land, around core);
diameter = connect_land.diameter.
END_RULE;
RULE Core_peripheral_land_position FOR (Integer_core_perif_land, around core);
z position = connect_parting.position.
x position = connect_land.position[0].
y position = connect_land.position[1].
END_RULE;
END_ENTITY;
ENTITY Integer_core_parting_line
position: POINT3D;
type: STRING;
on_entity: STRING;
connect_parting: Integer_cavity_parting_line;
RULE Core_parting_line_position FOR (Integer_core_parting_line, on core);
position = connect_parting.position.
END_RULE;
ENTITY Feeding_system
has_pin_gate: Pin_gate;
has_sprue_gate: Sprue_gate;
has_rect_edge: Rectangular_edge_gate;
has_circ: Circular_runner;
has_trap: Trapezoidal_runner;
has_main: Main_feeding_sprue;
END_ENTITY;
ENTITY Rectangular_edge_gate
mouldability_feat: STRING;
position: POINT3D;
land_length: dimension;
depth: dimension;
width: dimension;
connect_gate : Gate;
connect_gated_wall : Wall; (wall upon which the gate has been placed)
connect_parting : Integer_cavity_parting_line;
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_taper_on_volume_highest : Integer_cavity_taper;
connect_volume_lowest : Integer_cavity_volume (furthest from parting line);
WHERE
small_angle_radians := (connect_taper_on_volume_highest.angle/360)*2.0*3.1416;
remaining_angle := 90 - connect_taper_on_volume_highest.angle;
larger_angle_radians := (remaining_angle/360)*2.0*3.1416;
taper_allowance := (connect_volume_highest.height*SINE(small_angle_radians)) /
SINE(larger_angle_radians);
average_cavity_dia := ((connect_volume_highest.diameter +
connect_volume_lowest.diameter)/2.0);
cavity_height := connect_parting.position - connect_volume_lowest.position[2];
cavity_area := (3.1416*average_cavity_dia*cavity_height) +
(3.1416*SQ(average_cavity_dia/2.0));
min_land_length := 0.5;
max_land_length := 0.75;
RULE Rect_edge_gate_position FOR (Rectangular_edge_gate, into cavity);
IF connect_gate.position is not on edge of cavity THEN
  IF connect_gate.position is inside cavity edge THEN
    Reduced land length – weakness in mould construction can lead to
    wear or failure. Advise move gate position to edge of cavity.
  IF connect_gate.position is outside cavity edge THEN
    Gate not attached to component – No feeding. Advise move gate
    position to edge of cavity.
ENDIF
ENDIF
IF connect_gate.position is not on parting line THEN
  Gate and runner system cannot be ejected – component
  non-mouldable. Gate and runner system cannot be
  machined into mould block – mould non-manufacturable.
  Advise move gate position to parting line.
z position = connect_parting.position
ENDIF
END_RULE;
RULE Rect_edge_gate_land_length FOR (Rectangular_edge_gate, into cavity);
IF land_length < min_land_length THEN
  Weakness in mould construction can lead to wear or failure. Advise increase in land
  length to a minimum of min_land_length.
ENDIF
IF land_length > max_land_length THEN
  Excessive pressure drop across gate – inadequate filling of mould cavity.
  Advise decrease in land length to a maximum of max_land_length.
ENDIF
END_RULE;
RULE Rect_edge_gate_depth FOR (Rectangular_edge_gate, into cavity);
depth = 0.7*connect_gated_wall.thickness.
END_RULE;
RULE Rect_edge_gate_width FOR (Rectangular_edge_gate, into cavity);
width = 0.7*SQRT(cavity_area)/30;
END_RULE;
END_ENTITY;
ENTITY Sprue_gate
mouldability_features: STRING;
position: POINT3D;
lower_diameter: dimension;
sprue_length: dimension;
taper_angle: dimension;
connect_gate: Gate;
connect_parting: Integer_cavity_parting_line;
connect_volume_highest: Integer_cavity_volume OR Integer_cavity_rim (on parting line);
connect_volume_lowest: Integer_cavity_volume (furthest from parting line);
connect_cooling: Standard_flow_way;
WHERE
machine_nozzle_inner_diameter = 3.0;
directional_cooling_distance = 16.0;
minimum_cooling_space = connect_cooling.diameter + 2.0*directional_cooling_distance;
cavity_height = connect_parting.position - connect_volume_lowest.position(2);
min_meta_condition: IF connect_volume_highest.diameter <= 25.0 THEN
  min_meta_over_cavity = 6.0;
  IF connect_volume_highest.diameter <= 38.0 THEN
    min_meta_over_cavity = 10.0;
  IF connect_volume_highest.diameter <= 44.0 THEN
    min_meta_over_cavity = 14.0;
  IF connect_volume_highest.diameter <= 50.0 THEN
    min_meta_over_cavity = 16.0;
  IF connect_volume_highest.diameter <= 56.0 THEN
    min_meta_over_cavity = 18.0;
  IF connect_volume_highest.diameter <= 62.0 THEN
    min_meta_over_cavity = 22.0;
  IF connect_volume_highest.diameter <= 68.0 THEN
    min_meta_over_cavity = 25.0;
  IF connect_volume_highest.diameter <= 74.0 THEN
    min_meta_over_cavity = 29.0;
  IF connect_volume_highest.diameter <= 80.0 THEN
    min_meta_over_cavity = 33.0;
  IF connect_volume_highest.diameter <= 86.0 THEN
    min_meta_over_cavity = 36.0;
  IF connect_volume_highest.diameter <= 92.0 THEN
    min_meta_over_cavity = 40.0;
  IF connect_volume_highest.diameter <= 98.0 THEN
    min_meta_over_cavity = 44.0;
  IF connect_volume_highest.diameter <= 104.0 THEN
    min_meta_over_cavity = 49.0;
END_RULE;
RULE Sprue_gate_position FOR (Sprue_gate, into cavity);
IF connect_gate.position is not in centre of part base THEN
  Unbalanced gating of component can produce uneven section thickness in the component.
  Advise move gate to centre of base.
  x position = connect_volume_lowest.position[0].
  y position = connect_volume_lowest.position[1].
IF connect_gate.position is not on base of component THEN
  IF connect_gate.position is above component base THEN
    Reduced sprue length below cavity means a weakened mould block - can lead to distortion
    of mould due to injection pressure. Advise move gate down to base level.
  IF connect_gate.position is below component base THEN
    Gate not attached to component - No feeding.
    Advise move gate up to base level.
  z position = connect_volume_lowest.position[2].
END_RULE;
RULE Sprue_gate_lower_diameter FOR (Sprue_gate, into cavity);
lower_diameter = machine_nozzle_inner_diameter + 0.1;
END_RULE;
RULE Sprue_gate_sprue_length FOR (Sprue_gate, into cavity);
IF (min_metaCcondition + cavity_height) >= minimum_coolinLspace THEN
sprue_length = min_metaCcondition.
IF (min_metaCcondition + cavity_height) < minimum_coolinLspace THEN
sprue_length = minimum_coolinLspace - cavity_height.
END_RULE;
RULE Sprue_gate_taper_angle FOR (Sprue_gate, into cavity);
IF taper_angle < 4.0 THEN
Difficulty removing part and gate from mould. Advise increase taper angle to a minimum of 4.0.
END_RULE;
END_ENTITY;
ENTITY Pin_gate mouldability_fea: STRING;
position : POINT3D;
land_length : dimension;
diameter : dimension;
secondary_sprue_length : dimension;
taper_angle : dimension;
connect_gate : Gate;
connect_gated_wall : Wall; (wall upon which the gate has been placed)
connect_parter : Integer_cavity_parting_line;
connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_volume_on_volume_lowest : Integer_cavity_taper;
connect_volume_lowest : Integer_cavity_volume (furthest from parting line);
connect_cooling : Standard_flow_way;
WHERE
small_angle_radians : = (connect_volume_on_volume_lowest.angle(360)*2.0*3.1416;
remaining_angle : = 90 - connect_volume_on_volume_lowest.angle;
larger_angle_radians : = (remaining_angle/360)*2.0*3.1416;
taper_allowance : = (connect_volume_on_volume_lowest.height*SINE(small_angle_radians))/
SINE(large_angle_radians);
min_land_length : = 0.5;
max_land_length : = 0.75;
wall_thickness_constant : = IF connect_gated_wall.thickness <= 0.75 THEN
Constant = 0.178;
IF connect_gated_wall.thickness <= 1.0 THEN
Constant = 0.206;
IF connect_gated_wall.thickness <= 1.25 THEN
Constant = 0.230;
IF connect_gated_wall.thickness <= 1.5 THEN
Constant = 0.242;
IF connect_gated_wall.thickness <= 1.75 THEN
Constant = 0.272;
IF connect_gated_wall.thickness <= 2.0 THEN
Constant = 0.294;
IF connect_gated_wall.thickness <= 2.25 THEN
Constant = 0.309;
IF connect_gated_wall.thickness > 2.25 THEN
Constant = 0.326;
average_cavity_dia : = ((connect_volume_highest.diameter +
connect_volume_lowest.diameter)/2.0);
cavity_height : = connect_partering.position - connect_volume_lowest.position(2);
cavity_area : = (3.1416*average_cavity_dia*cavity_height) +
(3.1416*SQ(average_cavity_dia/2.0));
directional_cooling_distance ; = 16.0;
minimum_cooling_space: = connect_cooling.diameter + 2.0*directional_cooling_distance;
min_metal_condition: IF connect_volume_highest.diameter <= 25.0 THEN
min_metal_under_cavity = 6.0;
IF connect_volume_highest.diameter <= 38.0 THEN
  min_metal_under_cavity = 10.0;
IF connect_volume_highest.diameter <= 44.0 THEN
  min_metal_under_cavity = 14.0;
IF connect_volume_highest.diameter <= 50.0 THEN
  min_metal_under_cavity = 16.0;
IF connect_volume_highest.diameter <= 56.0 THEN
  min_metal_under_cavity = 18.0;
IF connect_volume_highest.diameter <= 62.0 THEN
  min_metal_under_cavity = 22.0;
IF connect_volume_highest.diameter <= 68.0 THEN
  min_metal_under_cavity = 25.0;
IF connect_volume_highest.diameter <= 74.0 THEN
  min_metal_under_cavity = 29.0;
IF connect_volume_highest.diameter <= 80.0 THEN
  min_metal_under_cavity = 33.0;
IF connect_volume_highest.diameter <= 86.0 THEN
  min_metal_under_cavity = 36.0;
IF connect_volume_highest.diameter <= 92.0 THEN
  min_metal_under_cavity = 40.0;
IF connect_volume_highest.diameter <= 98.0 THEN
  min_metal_under_cavity = 44.0;
IF connect_volume_highest.diameter <= 104.0 THEN
  min_metal_under_cavity = 49.0;
RULE Pin_gate_position FOR (Pin_gate, into cavity);
IF connect_volume_lowest == closing off geometry THEN
  IF connect_taper_on_volume_lowest.angle != 0.0 THEN
    Gate position no longer in centre of section.
    Advise adjust gate position.
    IF connect_gate.position[0] < 0.0 THEN
      x position = connect_gate.position[0] + taper_allowance.
    y position = connect_gate.position[1].
    IF connect_gate.position[0] > 0.0 THEN
      x position = connect_gate.position[0] - taper_allowance.
    y position = connect_gate.position[1].
    IF connect_gate.position is not on base of component THEN
      IF connect_gate.position is above component base THEN
        Either component attached to secondary sprue -
        cannot be ejected. OR Reduced land length
        means weakness in mould can lead to wear
        or failure. Advise move gate down to base level.
      IF connect_gate.position is below component base THEN
        Gate not attached to component - No feeding
        Advise move gate up to base level.
    z position = connect_volume_lowest.position[2].
  END_RULE;
RULE Pin_gate_land_length FOR (Pin_gate, into cavity);
IF land_length < min_land_length THEN
  Weakness in mould construction can lead
  to wear or failure. Advise increase in land
  length to a minimum of min_land_length.
IF land_length > max_land_length THEN
  Excessive pressure drop across gate -
  inadequate filling of mould cavity.
  Advise decrease in land length to a
  maximum of max_land_length.
END_RULE;
RULE Pin_gate_diameter FOR (Pin_gate, into cavity);
diameter = 0.7*wall_thickness_constant*POW(cavity_area, 0.25);
END_RULE;
RULE Pin_gate_taper_angle FOR (Pin_gate, into cavity);
IF taper_angle < 4.0 THEN
Difficulty removing part and gate
from mould. Advise increase taper
angle to a minimum of 4.0.
END_RULE;
RULE Pin..gate_secondary_sprue_length FOR (Pin..gate, into cavity);
IF (min_metaCcondition + cavity_height) >= minimum_coolinjLspace THEN
secondary_sprue_length = min_metaCcondition - land_length.
IF (min_metaCcondition + cavity_height) < minimum_coolinupace THEN
secondary_sprue_length = minimum_coolinjLspace - cavity_height - land_length.
END_RULE;
END_ENTITY;
ENTITY Circular_runner
gate_name : STRING;
gate_type : STRING;
position : POINT3D;
runner_length : dimension;
diameter : dimension;
orientation : POINT3D;
configuration : integer;
connect..gate : Fan..gate OR Sub_surface..gate OR Overlap..gate OR Rectangular..edge..gate OR Tab..gate
OR Film..gate;
connect..gate_wall : Wall; (wall upon which the gate has been placed)
connect..parting : Integer_cavity..partition_line;
connect..volume_lowest : Integer_cavity..volume; (furthest from parting line)
connect..volume_highest : Integer_cavity..volume; (on parting line)
WHERE
average_cavity_dia = ((connect..volume_highest.diameter +
connect..volume_lowest.diameter)/2.0);
cavity_height = connect..parting.position - connect..volume_lowest.position[2];
cavity_area = (3.1416*average_cavity_dia*cavity_height) +
(3.1416*SQ(average_cavity_dia/2.0));
material_density = 0.6/1000;
part_weight = cavity_area*connect..gate_wall.thickness*material.density;
directional..cooling..distance = 16.0;
maximum..sprue..diameter = 10.0;
minimum..runner..diameter = 2.0;
maximum..runner..diameter = 10.0;
RULE Circ_runner..position FOR ( Circular_runner, in mould);
z position = connect..parting.position.
IF connect..gate.position[0] > 0.0 THEN
IF connect..gate.type == Rectangular..edge OR Fan OR Overlap OR Round..edge THEN
x position = connect..gate.position[0] + connect..gate.land_length.
y position = connect..gate.position[1].
IF connect..gate.type == Film THEN
x position = connect..gate.position[0] + connect..gate.land_length + diameter/2.0.
IF first of three runners THEN
y position = connect..gate.position[1].
IF second of three runners THEN
y position = connect..gate.position[1] - (connect..gate.width/2.0 + diameter/2.0).
IF third of three runners THEN
y position = connect..gate.position[1] + (connect..gate.width/2.0 + diameter/2.0).
IF connect..gate.type == Sub..surface THEN
x position = connect..gate.position[0] + 0.7*land_length.
y position = connect..gate.position[1].
IF connect..gate.type == Tab THEN
x position = connect..gate.position[0] + diameter.
IF connect..gate.position[0] < 0.0 THEN
IF connect..gate.type == Rectangular..edge OR Fan OR Overlap OR Round..edge THEN
x position = connect..gate.position[0] - connect..gate.land_length.
y position = connect_gate.position[1].
IF connect_gate.type == Film THEN
x position = connect_gate.position[0] - connect_gate.land_length - diameter/2.0.
IF first of three runners THEN
y position = connect_gate.position[1].
IF second of three runners THEN
y position = connect_gate.position[1] - (connect_gate.width/2.0 + diameter/2.0).
IF third of three runners THEN
y position = connect_gate.position[1] + (connect_gate.width/2.0 + diameter/2.0).
IF connect_gate.type == Sub_surface THEN
x position = connect_gate.position[0] - 0.7*land_length.
y position = connect_gate.position[1].
IF connect_gate.type == Tab THEN
x position = connect_gate.position[0] - diameter.
y position = connect_gate.position[1] - diameter.
END_RULE;
RULE Circ_runner_length FOR ( Circular_runner. in mould);
IF connect_gate.type == Rectangular_edge OR Fan OR Overlap OR Round_edge THEN
runner_length = directional_cooling_distance + maximum_sprue_diameter/2.0 -
connect_gate.land_length.
IF connect_gate.type == Film THEN
IF first of three runners THEN
runner_length = directional_cooling_distance + maximum_sprue_diameter/2.0 -
connect_gate.land_length.
IF second of three runners THEN
runner_length = connect_gate.width/2.0 + diameter/2.0.
IF third of three runners THEN
runner_length = connect_gate.width/2.0 + diameter/2.0.
IF connect_gate.type == Sub_surface THEN
runner_length = directional_cooling_distance + maximum_sprue_diameter/2.0 -
0.7*connect_gate.land_length.
IF connect_gate.type == Tab THEN
part.width/2.0 - diameter + directional_cooling_distance + maximum_sprue_diameter/2.0.
END_RULE;
RULE Circ_runner_diameter FOR ( Circular_runner. in mould);
diameter = \sqrt{\text{part weight} \times \text{POW(runner_length,0.25)}}/3.7.
IF diameter < minimum_runner_diameter THEN
Runner solidifies before cavity is filled.
Increase diameter to minimum_runner_diameter.
IF diameter > maximum_runner_diameter THEN
Large runner diameter results in cycle
time controlled by runner solidification
rate. Decrease runner diameter to
maximum_runner_diameter.
END_RULE;
RULE Circ_runner_orientation FOR ( Circular_runner. in mould);
IF connect_gate.type == Rectangular_edge OR Fan OR Overlap OR Round_edge OR
Sub_surface THEN
IF connect_gate.position > 0.0 THEN
orientation = 0.0.
IF connect_gate.position < 0.0 THEN
orientation = 3.1416.
IF connect_gate.type == Film THEN
IF connect_gate.position > 0.0 THEN
IF first of three runners THEN
orientation = 0.0.
IF second of three runners THEN
orientation = 3.1416/2.0.
IF third of three runners THEN
orientation = 2.0*3.1416/3.0.
IF connect_gate.position < 0.0 THEN
IF first of three runners THEN
orientation = 3.1416.
IF second of three runners THEN orientation = 3.1416/2.0.
IF third of three runners THEN orientation = 2.0*3.1416/3.0.
IF connect_gate.type == Tab THEN orientation = 2.0*3.1416/3.0.
END_RULE;
END_ENTITY;

ENTITY Trapezoidal_runner
gate_name : STRING;
gate_type : STRING;
position : POINT3D;
runner_length : dimension;
width : dimension;
orientation : dimension;
configuration : integer;
connect_gate : Ring_gate OR Pin_gate;
connect_gated_wall : Wall; (wall upon which the gate has been placed)
connect_parting : Integer_cavity_parting_line;
connect_volume_lowest : Integer_cavity_volume; (furthest from parting line)
connect_volume_highest : Integer_cavity_volume; (on parting line)
connect_cooling : Standard_flow_way;
WHERE
average_cavity_dia : = ((connect_volume_highest.diameter +
connect_volume_lowest.diameter)/2.0);
cavity_height : = connect_parting.position - connect_volume_lowest.position[2];
cavity_area : = (3.1416*average_cavity_dia*cavity_height) +
(3.1416*SQ(average_cavity_dia/2.0));
material_density = 0.6/1000;
part_weight : = cavity_area*connect_gated_wall.thickness*material_density;
min_metal_condition: IF connect_volume_highest.diameter <= 25.0 THEN
min_metal_over_cavity = 6.0;
IF connect_volume_highest.diameter <= 38.0 THEN min_metal_over_cavity = 10.0;
IF connect_volume_highest.diameter <= 44.0 THEN min_metal_over_cavity = 14.0;
IF connect_volume_highest.diameter <= 50.0 THEN min_metal_over_cavity = 16.0;
IF connect_volume_highest.diameter <= 56.0 THEN min_metal_over_cavity = 18.0;
IF connect_volume_highest.diameter <= 62.0 THEN min_metal_over_cavity = 20.0;
IF connect_volume_highest.diameter <= 68.0 THEN min_metal_over_cavity = 22.0;
IF connect_volume_highest.diameter <= 74.0 THEN min_metal_over_cavity = 25.0;
IF connect_volume_highest.diameter <= 80.0 THEN min_metal_over_cavity = 29.0;
IF connect_volume_highest.diameter <= 86.0 THEN min_metal_over_cavity = 33.0;
IF connect_volume_highest.diameter <= 92.0 THEN min_metal_over_cavity = 36.0;
IF connect_volume_highest.diameter <= 98.0 THEN min_metal_over_cavity = 40.0;
IF connect_volume_highest.diameter <= 104.0 THEN min_metal_over_cavity = 44.0;
IF connect_volume_highest.diameter <= 104.0 THEN min_metal_over_cavity = 49.0;
directional_cooling_distance: = 16.0;
minimum_cooling_space: = connect_cooling.diameter + 2.0*directional_cooling_distance;
minimum_runner_width : = 2.0;
maximum_runner_width : = 10.0;
max_sprue_diameter = 10.0;
IF connect_gate.type == Pin THEN
  gate_angle.radians = ((connect_gate.taper_angle/2.0)/360)*2.0*3.1416;
  remaining_angle : = 90 - connect_gate.taper_angle/2.0;
  larger_angle.radians : = (remaining_angle/360)*2.0*3.1416;
  taper_allowance : = (connect_gate.secondary_sprue_length*SINE(gate_angle.radians))/
                  SINE(larger_angle.radians);
  sprue_junction_dia : = connect_gate.diameter + 2.0*taper_allowance;
RULE Trap_runner_position FOR (Trapezoidal_runner, in mould);
  IF connect_gate.type == Ring THEN
    x position = connect_volume_highest.position[0] + connect_volume_highest.diameter/2.0 +
                 connect_gate.land_length.
    y position = connect_volume_highest.position[1].
    z position = connect_parting.position.
  IF connect_gate.type == Pin THEN
    IF connect_gate.position[0] > 0.0 THEN
      x position = connect_gate.position[0] + max_sprue_diameter.
      y position = connect_gate.position[1].
    IF connect_gate.position[0] < 0.0 THEN
      x position = connect_gate.position[0] - max_sprue_diameter.
      y position = connect_gate.position[1].
    IF (min_metal_condition + cavity_height) >= minimum_cooling_space THEN
      z position = connect_parting_position - (min_metal_condition + cavity_height) .
    IF (min_metal_condition + cavity_height) < minimum_cooling_space THEN
      z position = connect_parting_position - minimum_cooling_space.
  END_RULE;
RULE Trap_runner_length FOR (Trapezoidal_runner, in mould);
  IF connect_gate.type == Ring THEN
    runner_length = directional_cooling_distance + max_sprue_diameter/2.0 + width.
  IF connect_gate.type == Pin THEN
    IF connect_gate.position[0] > 0.0 THEN
      runner_length = connect_gate.position[0] - connect_volume_lowest.position[0] +
                      max_sprue_diameter.
    IF connect_gate.position[0] < 0.0 THEN
      runner_length = connect_volume_lowest.position[0] - connect_gate.position[0] +
                      max_sprue_diameter.
  END_RULE;
RULE Trap_runner_width FOR (Trapezoidal_runner, in mould);
  width = (SQRT(part_weight)*POW(runner_length,0.25)*3.7.
  IF connect_gate.type == Pin THEN
    IF width < sprue_junction_dia THEN
      width = sprue_junction_dia.
  IF diameter < minimum_runner_diameter THEN
    Runner solidifies before cavity is filled.
    Increase diameter to minimum_runner_diameter.
  IF diameter > maximum_runner_diameter THEN
    Large runner diameter results in cycle
time controlled by runner solidification
rate. Decrease runner diameter to
maximum_runner_diameter.
  END_RULE;
RULE Trap_runner_orientation FOR (Trapezoidal_runner, in mould);
  IF connect_gate.type == Ring THEN
    orientation = 0.0.
  IF connect_gate.type == Pin THEN
    IF connect_gate.position[0] > 0.0 THEN
      orientation = 0.0.
    IF connect_gate.position[0] > 0.0 THEN
      orientation = 3.1416.
  END_RULE;
END_ENTITY;
ENTITY Main_feeding_sprue
  runner_name : STRING;
  runner_type : STRING;
  position : dimension;
  sprue_length : dimension;
  lower_diameter : dimension;
  taper_angle : dimension;
  connect_gate : Fan_gate OR Sub_surface_gate OR Overlap_gate OR Rectangular_edge_gate OR Tab_gate
    OR Film_gate OR Ring_gate OR Pin_gate;
  connect_runner : Circular_runner OR Trapezoidal_runner;
  connect_volume_highest : Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
  connect_volume_lowest : Integer_cavity_volume; (furthest from parting line)
WHERE
  cavity_height := connect_volume_highest.position - connect_volume_lowest.position[2];
  max_sprue_diameter = 10.0;
  sprue_puller_length = 5.0;
  max_sprue_dia = 10.0;
  machine_nozzle_inner_diameter = 3.0;
  min_metal_condition: IF connect_volume_highest.diameter <= 25.0 THEN
    min_metal_under_cavity = 6.0;
    IF connect_volume_highest.diameter <= 38.0 THEN
      min_metal_under_cavity = 10.0;
    IF connect_volume_highest.diameter <= 44.0 THEN
      min_metal_under_cavity = 14.0;
    IF connect_volume_highest.diameter <= 50.0 THEN
      min_metal_under_cavity = 16.0;
    IF connect_volume_highest.diameter <= 56.0 THEN
      min_metal_under_cavity = 18.0;
    IF connect_volume_highest.diameter <= 62.0 THEN
      min_metal_under_cavity = 22.0;
    IF connect_volume_highest.diameter <= 68.0 THEN
      min_metal_under_cavity = 25.0;
    IF connect_volume_highest.diameter <= 74.0 THEN
      min_metal_under_cavity = 29.0;
    IF connect_volume_highest.diameter <= 80.0 THEN
      min_metal_under_cavity = 33.0;
    IF connect_volume_highest.diameter <= 86.0 THEN
      min_metal_under_cavity = 36.0;
    IF connect_volume_highest.diameter <= 92.0 THEN
      min_metal_under_cavity = 40.0;
    IF connect_volume_highest.diameter <= 98.0 THEN
      min_metal_under_cavity = 44.0;
    IF connect_volume_highest.diameter <= 104.0 THEN
      min_metal_under_cavity = 49.0;

directional_cooling_distance = 16.0;
minimum_cooling_space = connect_cooling.diameter + 2.0*directional_cooling_distance;
sprue_top_dia : sprue_angle_radians := ((taper_angle/2.0)/360)*2.0*3.1416;
remaining_angle := 90 - taper_angle/2.0;
larger_angle_radians := (remaining_angle/360)*2.0*3.1416;
taper_allowance := (sprue_length*SINE(sprue_angle_radians))/
  SINE(larger_angle_radians);
top_dia := lower_diameter + 2.0*taper_allowance;
length_ten_top_dia := required_allowance := (max_sprue_diameter - lower_diameter)/2.0;
  required_sprue_length := required_allowance*SINE(sprue_angle_radians)
  /SINE(larger_angle_radians);
length_runner_dia := required_allowance2 := (connect_runner.diameter - lower_diameter)/2.0;
  required_sprue_length2 := required_allowance2*SINE(sprue_angle_radians)
  /SINE(larger_angle_radians);
length_with_trap_runn := required_allowance3 := (connect_runner.width - lower_diameter)/2.0;
  req_trap_length := required_allowance3*SINE(sprue_angle_radians)
  /SINE(larger_angle_radians);
RULE Main_feeding_sprue_position FOR (Main_feeding_sprue, in mould);
IF connect_runner == Circular THEN
  IF connect_gate.type == Fan OR Rectangular_edge OR Overlap OR Sub_surface OR Round_edge THEN
    IF connect_runner.position[0] > 0.0 THEN
      x position = connect_runner.position[0] + connect_runner.runner_length.
      y position = connect_runner.position[1].
    ELSE IF connect_runner.position[0] < 0.0 THEN
      x position = connect_runner.position[0] - connect_runner.runner_length.
      y position = connect_runner.position[1].
  END_IF
END_IF

IF connect_runner == First of three THEN
  IF connect_runner.position[0] > 0.0 THEN
    x position = connect_runner.position[0] + connect_runner.runner_length.
  ELSE IF connect_runner.position[0] < 0.0 THEN
    x position = connect_runner.position[0] - connect_runner.runner_length.
  END_IF
END_IF

IF connect_runner == Trapezoidal THEN
  IF connect_gate.type == Tab THEN
    x position = connect_runner.position[0].
  ELSE IF connect_gate.type == Ring THEN
    x position = connect_runner.position[0] + connect_runner.runner_length - max_sprue_dia.
    y position = connect_runner.position[1].
  ELSE IF connect_gate.type == Pin THEN
    x position = connect_runner.position[0] - max_sprue_dia.
    y position = connect_runner.position[1].
  END_IF
END_IF

END_RULE;
RULE Main_sprue_taper_angle FOR (Main_feeding_sprue, in mould);
  IF taper_angle < 4.0 THEN
    Difficulty removing part and gate from mould. Advise increase taper angle to a minimum of 4.0.
  END_RULE;
RULE Main_sprue_lower_diameter FOR (Main_feeding_sprue, in mould);
  lower_diameter = machine_nozzle_inner_diameter + 0.1;
END_RULE;
RULE Main_sprue_length FOR (Main_feeding_sprue, in mould);
  IF connect_runner == Circular THEN
    IF (min_meta_condition + cavity_height) >= minimum_cooling_space THEN
      sprue_length = min_meta_condition + cavity_height.
    ELSE IF (min_meta_condition + cavity_height) < minimum_cooling_space THEN
      sprue_length = minimum_cooling_space.
    END_IF
  ELSE IF sprue_top_dia > max_sprue_diameter THEN
    Nozzle recess required.
    sprue_length = length_ten_top_dia.
  ELSE IF sprue_top_dia < connect_runner.diameter THEN
    sprue_length = length_runner_dia.
  END_IF
  sprue_length = sprue_length + sprue_puller_length.
  IF connect_runner == Trapezoidal THEN

A4/35
IF connect_gate.type == Pin THEN
sprue_length = length_with_trap_runn.
IF sprue_length < min_metal_condition
sprue_length = min_metal_condition.
IF connect_gate.type == Ring THEN
IF (min_metal_condition + cavity_height) >= minimum_cooling_space THEN
sprue_length = min_metal_condition + cavity_height - connect_runner.width.
IF (min_metal_condition + cavity_height) < minimum_cooling_space THEN
sprue_length = minimum_cooling_space - connect_runner.width.
IF sprue_top_dia > max_sprue_diameter THEN
Nozzle recess required.
sprue_length = length_ten_top_dia.
IF sprue_top_dia < connect_runner.diameter THEN
sprue_length = length_with_trap_runn.
END_RULE;
END_ENTITY;

ENTITY Coolin&-system
has_cav_cooling: Integer_cavity_cooling_system;
has_core_cooling: Integer_core_cooling_system;
has_standard: Standard_flow_way;
has_baffle_flow: Baffle_flow_way;
has_baffle_blade: Baffle_blade;
END_ENTITY;

ENTITY Integer_cavity_cooling_system
ABSTRACT SUPERTYPE OF (ONE OF (Pair_tube_configuration, U_tube_configuration));
connect_volume_highest: Integer_cavity_volume OR Integer_cavity_rim; (on parting line)
connect_volume_lowest: Integer_cavity_volume; (furthest from parting line)
connect_gate: Sprue_gate OR Diaphragm_gate OR Ring_gate OR Pin_gate OR Fan_gate OR
Sub_surface_gate OR Overlap_gate OR Rectangular_edge_gate OR Tab_gate;
connect_tube: Standard_flow_way;
connect_sprue: Main_feeding_sprue;
WHERE
max_sprue_diameter = 10.0;
cavity_height = connect_parting.position - connect_volume_lowest.position[2];
directional_cooling_distance = 16.0;
min_cooling_tube_diameter = 7.0;
max_cooling_tube_diameter = 10.0;
number_of_flow_ways = cavity_height/(cooling_tube_diameter +
directional_cooling_distance);
relative_cooling_effect = cooling_tube_diameter*3.1416*number_of_flow_ways;
RULE Cavity_maximum_cooling_capacity FOR (Integer_cavity_cooling_system);
IF relative_cooling_effect 7.0 mm > 8.0mm THEN
Advise optimum tube diameter = 7.0mm.
IF relative_cooling_effect 7.0 mm < 8.0mm THEN
Advise optimum tube diameter = 8.0mm
IF relative_cooling_effect 8.0 mm > 9.0mm THEN
Advise optimum tube diameter = 9.0mm
IF relative_cooling_effect 9.0 mm > 10.0mm THEN
Advise optimum tube diameter = 10.0mm
END_RULE;
RULE Cavity_cooling_system_configuration FOR (Integer_cavity_cooling_system);
IF connect_gate.type == Pin_gate OR Fan_gate OR Sub_surface_gate OR Overlap_gate OR
Rectangular_edge_gate OR Tab_gate OR Film_gate THEN
IF number of gates == 1 THEN
Advise use of U_tube configuration.
Bottom of 'U' cooling gated side provides
more even mould cooling and can reduce
cycle time.
IF number of gates > 1 THEN
Advise use of paired_tube configuration
U_tube provides uneven cooling of mould —
Possible differential thickness over moulding,
differential shrinkage causing warpage.
IF connect_gate.type == Ring_gate THEN
Advis use of U_tube configuration.
Bottom of 'U' cooling gated side provides
more even mould cooling and can reduce
cycle time.
IF connect_gate.type == Diaphragm_gate OR Sprue_gate THEN
Advise use of paired_tube configuration
U_tube provides uneven cooling of mould —
Possible differential thickness over moulding,
differential shrinkage causing warpage.
END_RULE;
RULE Cavity_optimum_cooling_membership FOR (Integer_cavity_cooling_system);
IF Configuration == Paired_tube THEN
Front tube:
(connect_volume_highest.diameter/2.0 + directional_cooling_distance +
connect_tube.diameter/2.0)
connect_tube.orientation = 0.0;
Back tube:
(connect_volume_highest.diameter/2.0 + directional_cooling_distance +
connect_tube.diameter/2.0)
connect_tube.orientation = 0.0;
IF Configuration == U_tube THEN
Front tube:
(connect_volume_highest.diameter/2.0 + directional_cooling_distance +
connect_tube.diameter/2.0)
connect_tube.orientation = 0.0;
Back tube:
(connect_volume_highest.diameter/2.0 + directional_cooling_distance +
connect_tube.diameter/2.0)
connect_tube.orientation = 0.0;
Side tube:
connect_tube.position[0] = connect_sprue.position[0] + max_sprue_diameter/2.0 +
directional_cooling_distance + connect_tube.diameter/2.0.
connect_tube.orientation = 3.1416/2.0;
END_RULE;
END_ENTITY;

ENTITY Integer_core_cooling_system
ABSTRACT SUPERTYPE OF (ONE OF (Integer_core_shallow_cooling,
Integer_core_deep_cooling));
connect_parting_line : Integer_core_parting_line;
connect_volume_lowest : Integer_cavity_volume; (furthest from parting line)
connect_wall_lowest : Wall; (mouldability equivalent of connect_volume_lowest)
WHERE
   cavity_height : = connect_parting.position — connect_volume_lowest.position[2];
   core_depth : = cavity_height — connect_wall.thickness;
RULE Type_of_cooling_system FOR (Integer_core_cooling_system);
IF core_depth > 25.0 THEN
   Integer_core_deep_cooling.
IF core_depth <= 25.0 THEN
   Integer_core_shallow_cooling.
END_RULE;
END_ENTITY;

ENTITY Integer_core_deep_cooling
SUBTYPE OF (Integer_core_cooling_system);
ABSTRACT SUPERTYPE OF (ONE OF (Stepped_circuit, Angled_hole_system, Baffle_system));
connect_block : Integer_core_rect_block;
connect_volume_lowest : Integer_core_volume; (furthest from parting line)
connect_parting : Integer_core_parting_line;
connect_standard_tube : Standard_flow_way;
connect_baffle_tube : Baffle_flow_way;
WHERE
directional_cooling_distance = 16.0;
core_minimum_dia = connect_volume_lowest.diameter;
min_baffle_tube_diameter = 12.0;
max_baffle_tube_diameter = 16.0;
min_space_between_baffles = 9.0;
max_standard_tube_diameter = 10.0;
number_of_baffle_tubes = ((core_minimum_dia - (2.0 * directional_cooling_distance +
  baffle_tube_diameter)) / (baffle_tube_diameter +
  min_space_between_baffles)) + 1;
relative_cooling_effect = baffle_tube_diameter * 3.1416 * number_of_baffle_tubes;
RULE Type_of_deep_cooling FOR (Integer_core_deep_cooling_system);
Choice of deep core cooling systems:
1. Angled_hole_system - Cannot be used on deeper cores. Hard to manufacture due to angled holes (fixture required). Relatively small cooling capacity. Inadequate cooling of core base periphery.
2. Stepped_circuit_system - Holes drilled into cavity space through core, require plugging, finishing and polishing. Relatively small cooling capacity.
3. Baffled_straight_hole_system - Straight holes into core, easy to manufacture. No holes into cavity. Much larger cooling capacity than the other systems.
   - Use baffled_straight_hole_system.
END_RULE;
RULE Deep_core_maximum_cooling_capacity FOR (Integer_core_deep_cooling_system);
connect_standard_tube.diameter = max_standard_tube_diameter;
IF relative_cooling_effect 12.0 mm > 13.0 mm THEN
Advise optimum baffle tube diameter = 12.0 mm.
IF relative_cooling_effect 12.0 mm < 13.0 mm THEN
Advise optimum tube diameter = 13.0 mm
IF relative_cooling_effect 13.0 mm > 14.0 mm THEN
Advise optimum tube diameter = 14.0 mm
IF relative_cooling_effect 14.0 mm > 15.0 mm THEN
Advise optimum tube diameter = 15.0 mm
IF relative_cooling_effect 15.0 mm > 16.0 mm THEN
Advise optimum tube diameter = 16.0 mm
END_RULE;
RULE Deep_core_optimum_cooling_formation FOR (Integer_core_deep_cooling_system);
connect_baffle_tube.position[0] = (connect_volume_lowest.position[0] -
  connect_volume_lowest.diameter/2.0) +
  directional_cooling_distance +
  connect_baffle_tube.diameter/2.0.
connect_baffle_tube.length = connect_baffle_tube.position[2] -
  connect_volume_lowest.tube.position[2] -
  directional_cooling_distance,
spacing_between_tubes (in x direction) = connect_baffle_tube.diameter +
  min_space_between_baffles.
connect_standard_tube.position[0] = connect_volume_lowest.position[0] -

A4 / 38
connect_block.length/2.0.
connect_standard_tube.diameter/2.0.

END_RULE;
END_ENTITY;

ENTITY Integer_core_shallow_cooling
SUBTYPE OF (Integer_core_cooling_system);
ABSTRACT SUPERTYPE OF (ONE OF (Single_tube_configuration, Pair_tube_configuration,
U_tube_configuration, Z_tube_configuration));
connect_volume_highest: Integer_cavity_volume OR Integer_cavity_rim; (on parting_line)
connect_standard_tube: Standard_flow_way;
connect_parting: Integer_core_parting_line;
connect_block: Integer_cavity+rect_block;
WHERE
directional_cooling_distance: = 16.0;
min_baffle_tube_diameter: = 7.0;
max_baffle_tube_diameter: = 10.0;
cavity_width = connect_volume_highest.diameter + 2.0*connect_land.width;
number_of_flow_ways: = cavity_width/(cooling_tube_diameter +
    directional_cooling_distance);
relative_cooling_effect: = cooling_tube_diameter*3.1416*number_of_flow_ways;
RULE Shallow_core_maximum_cooling_capacity FOR (Integer_core_shallow_cooling);
IF relative_cooling_effect 7.0 mm > 8.0mm THEN
Advise optimum tube diameter = 7.0mm.
IF relative_cooling_effect 7.0 mm < 8.0mm THEN
Advise optimum tube diameter = 8.0mm
IF relative_cooling_effect 8.0 mm > 9.0mm THEN
Advise optimum tube diameter = 9.0mm
IF relative_cooling_effect 9.0 mm > 10.0mm THEN
Advise optimum tube diameter = 10.0mm
END_RULE;
RULE Shallow_core_cooling_system_configuration FOR (Integer_core_shallow_cooling);
IF number of tubes across core == 2.0 THEN
Choice of system configuration:
1. Paired_tube_configuration
2. U_tube_configuration
IF connect_gate.type == Pin_gate OR Fan_gate OR Sub_surface_gate OR
Overlap_gate OR Rectangular_edge_gate OR Tab_gate OR Film_gate THEN
IF number of gates == 1 THEN
Advise use of U tube configuration.
Bottom of 'U' cooling gated side provides
more even mould cooling and can reduce
cycle time.
IF number of gates > 1 THEN
Advise use paired tube configuration.
U_tube provides uneven cooling of mould
Possible differential thickness over moulding,
differential shrinkage causing warpage.
IF connect_gate.type == Ring_gate THEN
Advise use of U tube configuration.
Bottom of 'U' cooling gated side provides
more even mould cooling and can reduce
cycle time.
IF connect_gate.type == Diaphragm_gate OR Sprue_gate THEN
Advise use of paired tube configuration.
U_tube provides uneven cooling of mould
Possible differential thickness over moulding,
differential shrinkage causing warpage.
IF number of tubes across core == 3.0 THEN
Choice of system configuration:
1. Z_tube_configuration

2. Single_tube_configuration
   IF connect_gate.type == Pin_gate OR Fan_gate OR Sub_surface_gate OR Overlap_gate OR Rectangular_edge_gate OR Tab_gate OR Film_gate THEN
   IF number of gates == 1 THEN
   Advise use of Z tube configuration.
   Cooler water entering gated side provides more even mould cooling and can reduce cycle time.
   IF number of gates > 1 THEN
   Using Z tube configuration 'cooler' water entering the mould at the gated end provides uneven cooling of the moulding. Possible differential thickness over moulding, differential shrinkage causing warpage.
   Recommendation – Use single tube configuration.
   IF connect_gate.type == Ring_gate THEN
   Advise use of Z tube configuration.
   Cooler water entering gated side provides more even mould cooling and can reduce cycle time.
   IF connect_gate.type == Diaphragm_gate OR Sprue_gate THEN
   Using Z tube configuration 'cooler' water entering the mould at the gated end provides uneven cooling of the moulding. Possible differential thickness over moulding, differential shrinkage causing warpage.
   Recommendation – Use single tube configuration.
   IF number of tubes across core == 4.0 THEN
   Choice of system configuration:
   1. Balanced U_tube_configuration
   2. Balanced Paired_tube_configuration
      IF connect_gate.type == Pin_gate OR Fan_gate OR Sub_surface_gate OR Overlap_gate OR Rectangular_edge_gate OR Tab_gate OR Film_gate THEN
      IF number of gates == 1 THEN
      Advise use of balanced U tube configuration.
      Bottom of 'U' cooling gated side provides more even mould cooling and can reduce cycle time.
      IF number of gates > 1 THEN
      Advise use of paired tube configuration.
      Balanced U_tube provides uneven cooling of the mould – Possible differential thickness over moulding, differential shrinkage causing warpage.
      IF connect_gate.type == Ring_gate THEN
      Advise use of balanced U tube configuration.
      Bottom of 'U' cooling gated side provides more even mould cooling and can reduce cycle time.
      IF connect_gate.type == Diaphragm_gate OR Sprue_gate THEN
      Advise use of paired tube configuration.
      Balanced U_tube provides uneven cooling of the mould – Possible differential thickness over moulding, differential shrinkage causing warpage.
   END_RULE;

RULE Shallow_core_optimum_cooling_formation FOR (Integer_core_shallow_cooling);
Spacing_between_tubes = directional_cooling_distance + connect_standard_tube.diameter.
IF system configuration == Single_tube OR Paired_tube THEN
  x position:
connect_standard_tube.position[0] = connect_volume.highest_position[0] - connect_block_length/2.0.
IF number of tubes across core == 2.0 THEN
y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
directional_cooling_distance/2.0 -
connect_standard_tube.diameter/2.0.

IF number of tubes across core == 3.0 THEN
y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
directional_cooling_distance -
connect_standard_tube.diameter.

IF number of tubes across core == 4.0 THEN
y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
1.5*directional_cooling_distance -
1.5*connect_standard_tube.diameter.

z position:
connect_standard_tube.diameter/2.0.
connect_standard_tube.orientation = 0.0;
IF system configuration == U_tube THEN
Parallel tubes:
x position:
connect_standard_tube.position[0] = connect_volume_highest.position[0] -
connect_block.length/2.0.

IF number of tubes across core == 2.0 THEN
y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
directional_cooling_distance/2.0 -
connect_standard_tube.diameter/2.0.

IF number of tubes across core == 4.0 THEN
y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
1.5*directional_cooling_distance -
1.5*connect_standard_tube.diameter.

z position:
connect_standard_tube.diameter/2.0.
connect_standard_tube.orientation = 0.0.
Perpendicular tubes:
x position:
connect_standard_tube.position[0] = connect_volume_highest.position[0] +
connect_volume_highest.diameter/2.0 +
directional_cooling_distance.

y position:
connect_block.width/2.0.

z position:
connect_standard_tube.diameter/2.0.

orientation perpendicular tube:
connect_standard_tube.orientation = 3.1416/2.0.
IF system configuration == Z_tube THEN
Parallel tubes:
x position:
connect_standard_tube.position[0] = connect_volume_highest.position[0] -
connect_block.length/2.0.

y position front tube:
connect_standard_tube.position[1] = connect_volume_highest.position[1] -
connect_volume_highest.diameter/2.0 -
directional_cooling_distance -
connect_standard_tube.diameter/2.0.

z position:
connect_standard_tube.diameter/2.0.
connect_standard_tube.orientation = 0.0;
connect_standard_tube.length = connect_block.length/2.0 +
    connect_volume.highest.diameter/2.0 +
    directional_cooling_distance +
    connect_standard_tube.diameter.

Perpendicular tubes:
x position:
connect_standard_tube.position[0] = connect_volume.highest.position[0] -
    directional_cooling_distance -
    connect_standard_tube.diameter/2.0.

y position:
    connect_block.width/2.0.

z position:
    connect_standard_tube.diameter/2.0.

orientation parallel tubes:
connect_standard_tube.orientation = 0.0.
orientation perpendicular tubes:
connect_standard_tube.orientation = 3.1416/2.0.

ENTITY Standard_flow_way
  cav_core_name : STRING;
  configuration : STRING;
  position : POINT3D;
  diameter : dimension;
  length : dimension;
  orientation : dimension;
  connect_cooling : OR Integer.core_shallow_cooling OR
    Integer.core_deep_cooling;
  connect_block_core : Integer.core_rect_block;
  connect_block_cavity : Integer.cavity_rect_block;
  connect_volume.highest : Integer.cavity_volume OR Integer.cavity_rim; (on parting_line)
  connect_gate : Sprue_gate OR Diaphragm_gate OR Ring_gate OR Pin_gate OR Fan_gate OR
    Sub_surface_gate OR Overlap_gate OR Rectangular_edge_gate OR Tab_gate;
  connect_sprue : Main_feeding_sprue;
WHERE
  sprue_puller_length : = 5.0;
  max_sprue.diameter : = 10.0;
  directional_cooling_distance : = 16.0;
RULE Standard_flow_way_position FOR (Standard_flow_way, in a cooling system);
IF connect_cooling == Integer.core.cavity.cooling_system THEN
    IF orientation == 0.0 THEN
        Take y and z position from connect_cooling.
        position[0] = connect_volume.highest.position[0] - connect_block.cavity.length/2.0.
    ELSE
        Take x and z position from connect_cooling.
    END_IF
    IF connect_cooling == Integer.core.deep_cooling THEN
        Take position from connect_cooling.
        IF connect_gate.type == Fan_gate OR Sub_surface_gate OR Overlap_gate OR
            Rectangular_edge_gate OR Tab_gate THEN
            connect_block_core.depth = connect_block.depth + sprue_puller_length.
        END_IF
        IF connect_cooling == Integer.core.shallow_cooling THEN
            position from connect_cooling.
            IF Single_tube OR Paired_tube THEN
                Take position from connect_cooling.
                IF number of tubes == 3 THEN
                    IF connect_gate.type == Fan_gate OR Sub_surface_gate OR Overlap_gate OR
                        Rectangular_edge_gate OR Tab_gate THEN
                        connect_block_core.depth = connect_block.depth + sprue_puller_length.
                    END_IF
                END_IF
            END_IF
        END_IF
    END_IF
END_RULE;
END_ENTITY;
Rectangular_edge_gate OR Tab_gate THEN
connect_block_core_depth = connect_block_depth + sprue_pulldor_length.
IF U_tube THEN
IF number of tubes == 2.0 THEN
Take position from connect_cooling.
IF number of tubes == 4.0 THEN
IF first tube THEN
Take position from connect_cooling.
IF second tube THEN
Take position from connect_cooling.
IF Z_tube THEN
IF first parallel tube THEN
Take position from connect_cooling.
IF second parallel tube THEN
Take position from connect_cooling.
position[0] = - position[0].
IF third parallel tube THEN
Take position from connect_cooling.
position[0] = - position[0].
END_RULE;
RULE Standard_flow_way_orientation FOR (Standard_flow_way, in a cooling system);
IF connect_cooling == Integer_cavity_cooling_system THEN
Take orientation from connect_cooling.
IF connect_cooling == Integer_core_deep_cooling THEN
orientation = 0.0.
IF connect_cooling == Integer_core_shallow_cooling THEN
IF system configuration == Single_tube OR Paired_tube THEN
Take orientation from connect_cooling.
IF system configuration == U_tube THEN
Take orientation from connect_cooling.
IF second perpendicular tube THEN
orientation = orientation + 3.1416.
IF system configuration == Z_tube THEN
Take orientation from connect_cooling.
IF second parallel tube THEN
orientation = orientation + 3.1416.
IF second perpendicular tube OR third perpendicular tube THEN
orientation = orientation + 3.1416.
END_RULE;
RULE Standard_flow_way_diameter FOR (Standard_flow_way, in a cooling system);
Take diameter from connect_cooling.
END_RULE;
RULE Standard_flow_way_length FOR (Standard_flow_way, in a cooling system);
IF orientation == 0.0 THEN
IF Paired_tube THEN
length = connect_block_cavity.length.
IF U_tube THEN
IF connect_gate.type == Fan_gate OR Sub_surface_gate OR Overlap_gate OR
Rectangular_edge_gate OR Tab_gate THEN
length = connect_block_cavity.length/2.0 + (connect_sprue.position[0] -
connect_volume_highest.position[0]) + max_sprue_diameter/2.0 +
directional_cooling_distance + diameter.

IF connect_gate.type == Pin_gate OR Ring_gate OR Diaphragm_gate THEN
length = connect_block_cavity.length/2.0 + connect_volumeighest.diameter/2.0 +
directional_cooling_distance + diameter.

IF orientation != 0.0 THEN
length = connect_block_cavity.width/2.0 + connect_volumeighest.diameter/2.0 +
directional_cooling_distance + diameter.

IF connect_cooling == Integer_core_deep_cooling THEN
length = connect_block_cavity.length.
IF connect_cooling == Integer_core_shallow_cooling THEN
IF Single_tube OR Paired_tube THEN
length = connect_block_cavity.length.
IF U_tube THEN
IF orientation == 0.0 THEN
IF connect_gate.type == Fan_gate OR Sub_surface_gate OR Overlap_gate OR
Rectangular_edge_gate OR Tab_gate THEN
length = connect_block_cavity.length/2.0 + (connect_spur.position[0] -
connect_volumeighest.position[0]) + max_sprue_diameter/2.0 +
directional_cooling_distance + diameter.
IF orientation != 0.0 THEN
length = connect_block_cavity.width/2.0 - directional_cooling_distance/2.0.

END_RULE;
END_ENTITY;

ENTITY Baffle_flow_way
cav_core_name : STRING;
configuration : STRING;
position : POINT3D;
diameter : dimension;
length : dimension;
connect_cooling: Integer_core_deep_cooling;
connect_land : Integer Core_rect_land OR Integer_core_circ_land.
RULE Baffle_flow_way_position FOR (Baffle_flow_way, in a cooling system);
Take position from connect_cooling.
position[0] = position[0] + connect_land.depth.
END_RULE;
RULE Baffle_flow_way_orientation FOR (Baffle_flow_way, in a cooling system);
orientation = 0.0, 0.0, -1.0.
END_RULE;
RULE Baffle_flow_way_length FOR (Baffle_flow_way, in a cooling system);
Take length from connect_cooling.
END_RULE;
RULE Baffle_flow_way_diameter FOR (Baffle_flow_way, in a cooling system);
Take diameter from connect_cooling.
END_RULE;
END_ENTITY;

ENTITY Baffle_blade
cav_core_name : STRING;
configuration : STRING;
position : POINT3D;
width : dimension;
length : dimension;
thickness : dimension;
connect_flow_way : Baffle_flow_way;
RULE Baffle_blade_position FOR (Baffle_blade, in a cooling system);
  position = connect_flow_way.position.
END_RULE;
RULE Baffle_blade_orientation FOR (Baffle_blade, in a cooling system);
  orientation = downwards.
END_RULE;
RULE Baffle_blade_length FOR (Baffle_blade, in a cooling system);
  length = connect_flow_way.length - connect_flow_way.diameter.
END_RULE;
RULE Baffle_blade_width FOR (Baffle_blade, in a cooling system);
  width = connect_flow_way.diameter - baffle_blade_clearance.
END_RULE;
RULE Baffle_blade_thickness FOR (Baffle_blade, in a cooling system);
  thickness = 2.0.
END_RULE;
END_ENTITY;
Appendix 5.

Booch representation of Product Range Model
Class Diagram: Break_in_tension

- Break_in_tension
  - has Break_in_tension_requirements_data
  - has Break_in_tension_adjacency_data
  - has Break_in_tension_constraints
    - has Torsion_position
    - has Torsion_group_diameter
    - has Torsion_torque

Class Diagram: Locate_on_jar

- Locate_on_jar
  - has Locate_on_jar_requirements_data
  - has Locate_on_jar_adjacency_data
  - has Locate_on_jar_constraints
    - has Locate_on_jar_height
    - has Locate_on_jar_position
    - has Locate_on_jar_location
Appendix 6.

EXPRESS representation of the Product Range Model.
SCHEMA Product_model

TYPE dimension = REAL;
WHERE
  non_negative: SELF >= 0.0;
END_TYPE;

TYPE integer = INTEGER;
WHERE
  non-negative: SELF >= 0;
END_TYPE;

//PRODUCT RANGE DESIGN MODEL.

ENTITY Product_range_design_model
  has_ranges : Product_ranges;
END_ENTITY;

ENTITY Product_ranges
  ABSTRACT SUPERTYPE OF (ONE OF PTPlus, Flower_pots, Yoghurt_pots);
  has_IPD: Initial_product_definition_data;
  has_requirements: Functional_requirements;
  has_relations: Form_function_relations_data;
END_ENTITY;

ENTITY Yoghurt_pots
  SUBTYPE OF (Product_ranges);
END_ENTITY;

ENTITY Flower_pots
  SUBTYPE OF (Product_ranges);
END_ENTITY;

ENTITY PTPlus
  SUBTYPE OF (Product_ranges);
END_ENTITY;

ENTITY Functional_requirements_data
  ABSTRACT SUPERTYPE OF (ONE OF Yoghurt_pot_functional_requirements,
  Flower_pot_functional_requirements, PTPlus_functional_requirements,
  Initial_product_definition_functional_requirements);
  has_constraints: Functional_constraints;
  has_adjacent: Adjacency_data;
  has_require: Requirements_data;
END_ENTITY;

ENTITY Yoghurt_pot_functional_requirements_data
  ABSTRACT SUPERTYPE OF (ONE OF Enclose_horizontal, Enclose_below,
  Provide密封_surface, Section_destack_horizontal, Section_destack_vertical, Insert_destack);
  SUBTYPE OF (Functional_requirements_data);
END_ENTITY;

ENTITY Enclose_horizontal
  SUBTYPE OF (Yoghurt_pot_functional_requirements_data, Flower_pot_functional_requirements_data
  Initial_product_definition_functional_requirements);
  adjacent_feature_type : STRING;
  volume : dimension;
  diameter : dimension;
  connect_wall : Side_wall;
  connect_adj_wall : Base_wall;
  connect_taper_on_wall: Taper;
WHERE
small_angle_radians := (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle := 90 - connect_taper_on_wall.angle;
larger_angle_radians := (remaining_angle/360)*2.0*3.1416;
taper_allowance := (connect_wall.height*SINE(smaller_angle_radians))/
                  SINE(larger_angle_radians);
taper_effect_volume := (taper_allowance*connect_wall.height/2.0)*3.1416*
                      connect_wall.inner_dia;
volume_assessment := ((3.1416*SQ(connect_wall.inner_dia/2.0)*connect_wall.height) +
                      taper_effect_volume);
recommended_height := volume/(3.1416*SQ(connect_wall.inner_dia/2.0) +
                        SINE(smaller_angle_radians)/SINE(larger_angle_radians));
recommended_diameter := 2.0*SQRT((volume-connect_wall.height*
                               SINE(smaller_angle_radians)/SINE(larger_angle_radians))
                              /3.1416*connect_wall.height);

RULE Enclose_horizontal_requirements_data FOR (Enclose_horizontal);
  Require enclosed volume (mm^3) = volume.
  Require enclosed diameter (mm) = diameter.
END_RULE;

RULE Enclose_horizontal_adjacency_data FOR (Enclose_horizontal):
  adjacent_feature_type == Base_wall.
END_RULE;

RULE Enclose_horizontal_diameter FOR (Enclose_horizontal);
  IF connect_wall.inner_dia < diameter THEN
    Diameter less than specified for Enclose horizontal function. Enclose horizontal function not achieved.
    Advise increase connect_wall.inner_dia to diameter.
  IF connect_wall.inner_dia > diameter THEN
    Diameter greater than specified for Enclose horizontal function. Enclose horizontal function not achieved.
    Advise decrease connect_wall.inner_dia to diameter.
END_RULE;

RULE Enclose_horizontal_volume FOR (Enclose_horizontal);
  IF volume_assessment < volume THEN
    Volume enclosed less than specified. Enclose horizontal function not achieved. Advise increase connect_wall.height to recommended_height or
    increase connect_wall.inner_dia to recommended_diameter.
  IF volume_assessment > volume THEN
    Volume enclosed greater than specified. Enclose horizontal function not achieved. Advise decrease connect_wall.height to recommended_height or
    decrease connect_wall.inner_dia to recommended_diameter.
END_RULE;
END_ENTITY;

ENTITY Enclose_below
  SUBTYPE OF (Yoghurt_pot_functional_requirements_data, Flower_pot_functional_requirements_data,
               Initial_product_definition_functional_requirements);
  adjacent_feature_type : STRING;
  diameter : dimension;
  connect_wall : Base_wall;
  connect_adj_wall : Side_wall;
  connect_taper_on_wall : Taper;
  connect_horiz : Enclose_horizontal;
RULE Enclose_below_requirements_data FOR (Enclose_below);
  Require enclosed diameter (mm) = diameter.
  IF diameter < connect_horiz.diameter THEN
    Diameter specification smaller than for adjacent
    'Enclose_horizontal' function. If form matches
specification, enclosure not achieved, product functionality lost. Advise increase diameter specification to a minimum of connect_horiz. diameter.
END_RULE;
RULE Enclose_below_adjacency_data FOR (Enclose_below):
adjacent_feature_type == Side_wall.
END_RULE;
RULE Enclose_below_position FOR (Enclose_below);
END_RULE;
RULE Enclose_below_diameter FOR (Enclose_below);
IF connect_wall.diameter < diameter THEN
Diameter less than specified for Enclose below function. Enclosure not achieved, product functionality lost. Advise increase connect_wall.diameter to a minimum of diameter.
END_RULE;
RULE Enclose_below_horizontal_relation FOR (Enclose_below)
IF connect_wall.diameter > (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness) THEN
Unnecessary material and weight in the product – Significant extra cost over a production run. Unnecessary aesthetic feature. Advise decrease connect_wall.diameter to connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness.
IF connect_wall.diameter < (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness) THEN
Drastically reduced section thickness leading to excessive structural weakness. Advise increase connect_wall.diameter to connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness
END_RULE;
END_ENTITY;
ENTITY Provide_seal_surface
SUBTYPE OF (Yoghurt_pot_functional_requirements_data);
adjacent_feature_type : STRING;
min_surface_area : dimension;
additional_function : STRING;
additional_spec : dimension;
connect_wall : Flange;
connect_adj_wall : Side_wall;
connect_taper_on_wall : Taper;
connect_taper_on_adjacent_wall : Taper;
connect_vert : Section_destack_vertical;
connect_horiz : Section_destack_horizontal;
WHERE
small_angle_adjacent_rads := (connect_taper_on_adjacent_wall.angle/360)*2.0*3.1416;
remaining_angle_adjacent := 90 - connect_taper_on_adjacent_wall.angle;
larger_angle_adjacent_rads := (remaining_angle_adjacent/360)*2.0*3.1416;
SINE(large_angle_adjacent_rads);
taper_allowance_adjacent2 := ((connect_adj_wall.height*SINE(small_angle_adjacent_rads))/
SINE(large_angle_adjacent_rads);
min_width_spec := (connect_vert_height_difference*SINE(small_angle_adjacent_rads))/
SINE(large_angle_adjacent_rads);
small_angle_rads := (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle := 90 - connect_taper_on_wall.angle;
larger_angle := (remaining_angle/360)*2.0*3.1416;
taper_allowance := (connect_wall.height*SINE(small_angle_radians))/
SINE(large_angle_radians);
IF (taper_allowance == 0.0) AND (taper_allowance_adjacent != 0.0) THEN
taper_allowance_difference := ((connect_wall_adjacent.height - connect_wall.position[2]) +
SINE(small_angle_adjacent_rads))/
SINE(large_angle_adjacent_rads);
IF (taper_allowance != 0.0) OR (taper_allowance_adjacent == 0.0) THEN
taper_allowance_difference := 0.0;
sealing_area := ((3.1416*SQ(connect_wall.inner_dia/2.0 + connect_wall.thickness +
taper_allowance)) - (3.1416*SQ(connect_adj_wall.inner_dia/2.0 +
connect_adj_wall.thickness + taper_allowance_adjacent2));
min_seal_area := min_surface_area - (3.1416*SQ(connect_adj_wall.inner_dia/2.0 +
connect_adj_wall.thickness + taper_allowance_adjacent2));
min_outer_dia := SQRT(min_seal_area/PI)*2.0;
RULE Provide_seal_surface_requirements_data FOR (Provide_seal_surface);
Require minimum sealing surface area (mm²) == min_surface_area.
'Provide_seal_surface' and 'Section_destack_horizontal' functions can
be performed using the same form.
IF Use same form for 'Section_destack_horizontal' THEN
'Section_destack_vertical' function – must also be applied.
'Insert_destack' function – no longer required.
additional_function = Section_destack_horizontal.
Require step width specification (mm) == additional_spec.
Advise min step width specification = min_width_spec.
IF Do not use same form for 'Section_destack_horizontal' THEN
Using 'Insert_destack' function:
'Section_destack_horizontal' function – no longer required.
'Section_destack_vertical' function – no longer required.
additional_function = 'none'.
END_RULE;
RULE Provide_seal_surface_adjacency_data FOR (Provide_seal_surface):
adjacent_feature_type == Side_wall.
END_RULE;
RULE Sealing_position FOR (Provide_seal_surface);
connect_adj_wall.height) THEN
Top of flange is below top surface of horizontal
enclosure wall. Drastic reduction in area available
for sealing. Flange area superfluous, sealing reliant
on top surface of horizontal enclosure wall. Advise
relocate flange to be flush with top of horizontal
enclosure wall, ie connect_wall.position[2] ==
connect_adj_wall.height) THEN
Top of flange is above top surface of horizontal
enclosure wall. Drastic reduction in section thickness
leading to severe structural weakness. Drastic reduction
in area available for sealing. Advise
relocate flange to be flush with top of horizontal
enclosure wall, ie connect_wall.position[2] ==
- connect_wall.height.
END_RULE;

RULE Sealing_enclosure_relation FOR (Provide_seal_surface);
IF connect_taper_on_wall_angle != 0.0 AND connect_taper_on_adjacent_wall_angle != 0.0
AND connect_taper_on_wall_angle < connect_taper_on_adjacent_wall_angle THEN
  IF (connect_wall.inner_dia - (2.0*taper_allowance_difference - 2.0*taper_allowance) <
      (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent) ) THEN
    Flange inner diameter smaller than inner diameter
    of horizontal enclosure wall. Flange encroaching on
    'Enclose_horizontal' function. Advise Increase
    connect_wall.inner_dia to a minimum of
    (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent
     + (2.0*taper_allowance_difference - 2.0*taper_allowance ) ).
  IF connect_taper_on_wall_angle == 0.0 OR connect_taper_on_adjacent_wall_angle == 0.0
  OR connect_taper_on_wall_angle == connect_taper_on_adjacent_wall_angle THEN
    IF (connect_wall.inner_dia - 2.0*taper_allowance_difference) <
      (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent ) THEN
      Flange inner diameter smaller than inner diameter
      of horizontal enclosure wall. Flange encroaching on
      'Enclose_horizontal' function. Advise Increase
      connect_wall.inner_dia to a minimum of
      (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent
       + 2.0*taper_allowance_difference).  
  IF connect_taper_on_wall_angle > connect_taper_on_adjacent_wall_angle THEN
    IF (connect_wall.inner_dia + 2.0*taper_allowance) > (connect_wall_adjacent.inner_dia +
      2.0*connect_wall_adjacent.thickness + 2.0*taper_allowance Adjacent +
      2.0*taper allow ance difference) THEN
      Flange inner diameter larger than corresponding
      outer diameter of horizontal enclosure wall. Drastically
      reduced section thickness leading to severe structural
      weakness or flange and horizontal enclosure wall not
      in contact - Product functionality lost. Advise decrease
      connect_wall.inner_dia to a maximum of (connect_wall_adjacent.
      inner_dia + 2.0*connect_wall_adjacent.thickness +
      2.0*taper allow ance_adjacent + 2.0*taper allow ance_difference
     - 2.0 *taper_allowance).
  IF connect_taper_on_wall_angle == 0.0 OR connect_taper_on_adjacent_wall_angle == 0.0
  OR connect_taper_on_wall_angle == connect_taper_on_adjacent_wall_angle THEN
    IF connect_wall.inner_dia > (connect_wall_adjacent.inner_dia + 2.0*connect_wall Adjacent.
      thickness + 2.0*taper_allowance Adjacent - 2.0*taper allow ance_difference) THEN
      Flange inner diameter larger than corresponding
      outer diameter of horizontal enclosure wall. Drastically
      reduced section thickness leading to severe structural
      weakness or flange and horizontal enclosure wall not
      in contact - Product functionality lost. Advise decrease
      connect_wall.inner_dia to a maximum of (connect_wall_adjacent.
      inner_dia + 2.0*connect_wall_adjacent.thickness +
      2.0*taper allow ance_adjacent - 2.0*taper allow ance_difference).
END_RULE;
RULE Sealing_area FOR (Provide_seal_surface);
IF connect_horiz.additional_function == 'Provide_seal_surface' THEN
  min_sealing_area = connect_horiz.additional_spec.
IF sealing_area < min_sealing_area THEN
  Flange sealing area insufficient to achieve
  'Provide_seal_surface' function. Product
  functionality lost. Advise increase in connect_wall
  outer diameter to a minimum of min_outer_dia.
END_RULE;
END_ENTITY;

ENTITY Insert_destack
SUBTYPE OF (Yoghurt_pot_functional_requirements_data, Flower_pot_functional_requirements_data);
adjacent_feature_type : STRING;
height_difference : dimension;
additional_function : STRING;
additional_spec : dimension;
connect_insert : Spaced_ribs OR Base_feature;
connect_adj_wall : Base_wall;
connect_drain : Drainage_clearance;
RULE Insert_destack_requirements_data FOR (Insert_destack);
'Section_destack_horizontal' function – no longer required.
'Section_destack_vertical' function – no longer required.
Require protruding height of each (stacked) product (mm) == height_difference.
IF product range == Flower_pot THEN
'Insert_destack' and 'Drainage_clearance' functions can be performed using the same form.
IF Use same form for 'Drainage_clearance' THEN
For 'Drainage_clearance' feature MUST be below base wall.
additional_function = Drainage_clearance.
Require drainage clearance height (mm) == additional_spec.
IF Do not use same form for 'Drainage_clearance' THEN
additional_function = none.
END_RULE;
RULE Insert_destack_adjacency_data FOR (Insert_destack):
adjacent_feature_type == Base_wall.
END_RULE;
RULE Insert_destack_position FOR (Insert_destack);
    Top of connect_insert not in contact with base wall.
    Product functionality lost. Advise relocate
      Top of connect_insert is higher than underside of base wall. Possible loss of function if insert feature
      is contained in base wall. Advise relocate
      connect_adj_wall.thickness) THEN
          Base of connect_insert not in contact with top of base wall. Product functionality lost. Advise relocate
            Base of connect_insert is lower than topside of base wall. Possible loss of function if insert feature
            is contained in base wall. Advise relocate
          END_RULE;
RULE Insert_destack_height FOR (Insert_destack);
IF connect_drain.additional_function == 'Insert_destack' THEN
  height_difference = connect_drain.additional_spec.
  IF (connect_adj_wall.position[2] - connect_insert.position[2]) < height_difference THEN
    Connect_insert.height insufficient to achieve
    'insert_destack' function. Product functionality lost.
    IF connect_insert.height < height_difference THEN

A6/7
Advise change connect_insert.height to height_difference and relocate connect_insert.position[2] to connect_adj_wall.
IF connect_insert.height >= height_difference THEN
IF (connect_adj_wall.position[2] - connect_insert.position[2]) > height_difference THEN
Connect_insert.height higher than specified to achieve 'insert_destack' function. Destack height higher than specified, unnecessary material in the product. Advise relocate connect_insert.position[2] to connect_adj_wall.
Connect_insert height insufficient to achieve 'insert_destack' function. Product functionality lost.
IF connect_insert.height < height_difference THEN
Advise increase connect_insert.height to height_difference and relocate connect_insert.position[2] to (connect_adj_wall + connect_adj_wall.thickness).
IF connect_insert.height >= height_difference THEN
Advise relocate connect_insert.position[2] to (connect_adj_wall + connect_adj_wall.thickness) - (connect_insert.height - height_difference).
Connect_insert.height higher than specified to achieve 'insert_destack' function. Destack height higher than specified, unnecessary material in the product. Advise decrease connect_insert.height to height_difference.
END_RULE;
END_ENTITY;

ENTITY Section_destack_horizontal
SUBTYPE OF (Yoghurt_pot_functional_requirements_data, Flower_pot_functional_requirements_data);
adjacent_feature_type : STRING;
min_destack_width : dimension;
additional_function : STRING;
additional_spec : dimension;
connect_wall : Flange;
connect_adj_wall : Side_wall;
connect_taper_on_wall : Taper;
connect_taper_on_adjacent_wall : Taper;
connect_vert : Section_destack_vertical;
connect_seal : Provide_seal_surface;
WHERE
small_angle_adjacent_rads : = (connect_taper_on_adjacent_wall.angle/360)*2.0*3.1416;
remaining_angle_adjacent : = 90 - connect_taper_on_adjacent_wall.angle;
larger_angle_adjacent_rads : = (remaining_angle_adjacent/360)*2.0*3.1416;
SINE(larger_angle_adjacent_rads);
taper_allowance_adjacent2 : = (connect_adj_wall.height*SINE(small_angle_adjacent_rads))/
SINE(larger_angle_adjacent_rads);
min_width_spec : = (connect_vert.height_difference*SINE(small_angle_adjacent_rads))/
SINE(larger_angle_adjacent_rads);
small_angle_rads : = (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle : = 90 - connect_taper_on_wall.angle;
larger_angle : = (remaining_angle/360)*2.0*3.1416;
taper_allowance := (connect_wall.height*SINE(small_angle_radians))/SINE(large_angle_radians);
IF (taper_allowance == 0.0) AND (taper_allowance_adjacent != 0.0) THEN
  taper_allowance_difference := ((connect_wall_adjacent.position[2] +
  connect_wall_adjacent.height - connect_wall.position[2])*
  SINE(small_angle_adjacent_rads))/SINE(large_angle_adjacent_rads);
IF (taper_allowance != 0.0) OR (taper_allowance_adjacent == 0.0) THEN
  taper_allowance_difference := 0.0;
width_difference := (connect_wall.inner_dia/2.0 + taper_allowance) -
  (connect_adj_wall.inner_dia/2.0 + taper_allowance_adjacent);
RULE Section_destack_horizontal_requirements_data FOR (Section_destack_horizontal);
  'Section_destack_vertical' function – must also be applied.
  'Insert_destack' function – no longer required.
  Require step width specification (mm) == min_destack_width.
  Advise min step width specification == min_width_spec.
  IF product_range == Yoghurt_pot THEN
    'Section_destack_horizontal' and 'Provide_seal_surface' functions are
    performed using the same form.
  additional_function == Provide_seal_surface.
  Require minimum sealing surface area (mm2) == additional_spec.
END_RULE;
RULE Section_destack_horizontal_adjacency_data FOR (Section_destack_horizontal):
  adjacent_feature_type == Side_wall.
END_RULE;
RULE Destack_horizontal_position FOR (Section_destack_horizontal);
  + connect_adj_wall.height) THEN
    Top of flange is below top surface of horizontal
    enclosure wall. Reduction in destack function.
    Additional height required for "Section destack vertical" function – unnecessary increase in product weight and
    material content. Advise relocate flange to be flush with
    top of horizontal enclosure wall, ie connect_wall.position[2]
    == connect_adj_wall.position[2] + connect_wall.height
    - connect_wall.height.
  + connect_adj_wall.height) THEN
    Top of flange is above top surface of horizontal
    enclosure wall. Drastic reduction in section thickness
    leading to severe structural weakness. Advise
    relocate flange to be flush with top of horizontal
    enclosure wall, ie connect_wall.position[2] ==
    connect_adj_wall.position[2] + connect_wall.height
    - connect_wall.height.
END_RULE;
RULE Destack_horizontal_enclose_relation FOR (Section_destack_horizontal);
  IF connect_taper_on_wall.angle != 0.0 AND connect_taper_on_adjacent_wall.angle != 0.0
  AND connect_taper_on_wall.angle < connect_taper_on_adjacent_wall.angle THEN
    IF (connect_wall.inner_dia - (2.0*taper_allowance_difference - 2.0*taper_allowance) <
    (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent)) THEN
      Flange inner diameter smaller than inner diameter
      of horizontal enclosure wall. Flange encroaching on
      "Enclose_horizontal" function. Advise Increase
      connect_wall.inner_dia to a minimum of
      (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent
      + (2.0*taper_allowance_difference - 2.0*taper_allowance)).
    IF connect_taper_on_wall.angle == 0.0 OR connect_taper_on_adjacent_wall.angle == 0.0
    OR connect_taper_on_wall.angle == connect_taper_on_adjacent_wall.angle THEN
      IF (connect_wall.inner_dia - 2.0*taper_allowance_difference) <
      (connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent) THEN
        Flange inner diameter smaller than inner diameter
of horizontal enclosure wall. Flange encroaching on
'Enclose_horizontal' function. Advise Increase
connect_wall.inner_dia to a minimum of
(connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent +
2.0*taper_allowance_difference).

IF connect_taper_on_wall.angle > connect_taper_on_adjacent_wall.angle THEN
IF (connect_wall.inner_dia + 2.0*taper_allowance) > (connect_wall_adjacent.inner_dia +
2.0*connect_wall_adjacent.thickness + 2.0*taper_allowance_adjacent +
2.0*taper_allowance_difference) THEN
Flange inner diameter larger than corresponding
outer diameter of horizontal enclosure wall. Drastically
reduced section thickness leading to severe structural
weakness or flange and horizontal enclosure wall not
in contact – Product functionality lost. Advise decrease
connect_wall.inner_dia to a maximum of (connect_wall_adjacent.
inner_dia + 2.0*connect_wall_adjacent.thickness +
2.0*taper_allowance_adjacent + 2.0*taper_allowance_difference
- 2.0*taper_allowance).

IF connect_taper_on_wall.angle == 0.0 OR connect_taper_on_adjacent_wall.angle == 0.0
OR connect_taper_on_wall.angle == connect_taper_on_adjacent_wall.angle THEN
IF connect_wall.inner_dia > (connect_wall_adjacent.inner_dia + 2.0*connect_wall_adjacent.
thickness + 2.0*taper_allowance_adjacent - 2.0*taper_allowance_difference) THEN
Flange inner diameter larger than corresponding
outer diameter of horizontal enclosure wall. Drastically
reduced section thickness leading to severe structural
weakness or flange and horizontal enclosure wall not
in contact – Product functionality lost. Advise decrease
connect_wall.inner_dia to a maximum of (connect_wall_adjacent.
inner_dia + 2.0*connect_wall_adjacent.thickness +
2.0*taper_allowance_adjacent - 2.0*taper_allowance_difference).

END_RULE;
RULE Destack_horizontal_step_width FOR (Section_destack_horizontal);
IF product_range == Yoghurt-pot THEN
IF connect_seal.additional_function == 'Section_destack_horizontal' THEN
min_destack_width = connect_seal.additional_spec.
IF ((connect_wall.inner_dia/2.0 + connect_wall_width + taper_allowance) -
(connect_adj_wall.inner_dia/2.0 + taper_allowance_adjacent)) < min_destack_width THEN
Step width less than minimum step width
specification. Stacked product above supported
on horizontal enclosure wall. Destack height
calculations for 'Section destack vertical' function
erroneous. Advise increase connect_wall.width to
a minimum of (min_destack_width - width_difference).
END_RULE;
END_ENTITY;

ENTITY Section_destack_vertical
SUBTYPE OF (Yoghurt_pot_functional_requirements_data, Flower_pot_functional_requirements_data);
adjacent_feature_type : STRING;
height_difference : dimension;
connect_wall : Lip;
connect_adj_wall : flange;
RULE Section_destack_vertical_requirements_data FOR (Section_destack_vertical);
Require protruding height of each (stacked) product (mm) == height_difference.
END_RULE;
RULE Section_destack_vertical_adjacency_data FOR (Section_destack_vertical);
adjacent_feature_type == Flange.
END_RULE;
RULE Destack_vertical_position FOR (Section_destack_vertical);
Base of lip below base of section destack
horizontal wall. Drastic reduction in section
thickness leading to severe structural weakness.
Possible erroneous calculation of destack function. Advise relocate connect_wall.position[2]
to connect_adj_wall.position[2].
Base of lip above base of section destack horizontal wall. Reduction in destack function.
Unnecessary aesthetic feature on base of flange – significant increase in production cost due to extra material in product over a production run. Advise relocate connect_wall.position[2] to connect_adj_wall.position[2].
END_RULE;
RULE Destack_vertical_horizontal_relation FOR (Section_destack_vertical);
IF connect_wall.inner_dia < (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width) THEN
Lip inner diameter smaller than outer diameter of section destack horizontal wall. Lip encroaching on 'section destack horizontal' function. Advise increase connect_wall.inner_dia to a minimum of (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width)
IF connect_wall.inner_dia > (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width) THEN
Lip inner diameter greater than outer diameter of section destack horizontal wall. Drastically reduced section thickness leading to severe structural weakness. Lip and section destack horizontal wall not in contact. Advise decrease connect_wall.inner_dia to a maximum of (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width)
END_RULE;
RULE Destack_vertical_height FOR (Section_destack_vertical);
Lip height insufficient to achieve 'destack' function. Product functionality lost. Advise increase connect_wall.height to (height_difference + connect_adj_wall.position[2] + connect_adj_wall.thickness – connect_wall.position[2]).
Lip height higher than specified to achieve 'destack' function. Destack height is greater than specified – unnecessary material in product. Advise decrease connect_wall.height to (height_difference + connect_adj_wall.position[2] + connect_adj_wall.thickness – connect_wall.position[2]).
END_RULE;
END_ENTITY:
ENTITY Flower_pot_functional_requirements_data
ABSTRACT SUPERTYPE OF (ONE OF (Enclose_horizontal, Enclose_below,
Section_destack_horizontal, Section_destack_vertical, Insert_destack, Drainage_clearance, Drainage));
SUBTYPE OF (Functional_requirements_data);
END_ENTITY;
ENTITY Drainage
SUBTYPE OF (Flower_pot_functional_requirements_data);
adjacent_feature_type : STRING;

WHERE
area_for_drainage : = 3.1416*SQ(connect_hole.diameter/2.0);
total_drainage : = connect_hole.hole_numb*area_for_drainage;
req_area_per_hole := drain_area/connect_hole.hole_numb;
recom_diameter := SQRT(req_area_per_hole/3.1416)*2.0;
recom_hole_no := CEIL (drain_area/area_for_drainage);
RULE Drainage_requirements_data FOR (Drainage);
Require drainage area (mm2) == drain_area.
END_RULE;
RULE Drainage_adjacency_data FOR (Drainage):
adjacent_feature_type == Base_wall.
END_RULE;
RULE Drainage_hole_depth FOR (Drainage);
IF connect_hole.depth < connect_wall.thickness THEN
Hole depth less than thickness of base wall. Blind holes – drainage function not achieved. Advise increase hole depth to a minimum of connect_wall.thickness.
Top of hole grouping lower than topside of base wall. Blind holes - drainage function not achieved. Advise increase connect_hole.depth to a minimum of (connect_wall.position[2] + connect_wall.thickness - connect_hole.position[2]).
END_RULE;
RULE Drainage_hole_position FOR (Drainage);
END_RULE;
RULE Drainage_hole_diameter FOR (Drainage)
IF connect_hole.diameter > 14.0 THEN
Diameter of holes is too large. Excessive soil loss from base of flower pot when soil is dry. Advise decrease connect_hole.diameter to a maximum of 14.0.
END_RULE;
RULE Drainage_area FOR (Drainage);
IF total_drainage < drain_area THEN
Holes area is not large enough to provide adequate drainage. Advise increase connect_hole.diameter (maximum 14.0) or increase connect_hole.hole_numb. Increasing connect_hole.hole_numb may increase the product cost by increased mould complexity. Necessary connect_hole.diameter at present numbers == recom_diameter. Recommended connect_hole.hole_numb at present diameter == recom_hole_no.
END_RULE;
END_ENTITY;

ENTITY Drainage_clearance
SUBTYPE OF (Flower_pot_functional_requirements_data);
adjacent_feature_type : STRING;
drain_height : dimension;
additional_function : STRING;
additional_spec : dimension;
connect_insert : Spaced_ribs OR Spaced_bosses;
connect_adj_wall : Base_wall;
connect_dest : Insert_destack;
RULE Drainage_clearance_requirements_data FOR (Drainage_clearance);
Require drainage clearance height (mm) == drain_height.
'Drainage_clearance' and 'Insert_destack' functions can be performed
using the same form.
IF Use same form for 'Insert_destack' THEN
For 'Drainage_clearance' feature MUST be below base wall.
'Section_destack_horizontal' function – no longer required.
'Section_destack_vertical' function – no longer required.
additional_function = Insert_destack.
Require protruding height of each (stacked) product (mm) == additional_spec.
IF Do not use same form for 'Insert_destack' THEN
additional_function = none.
END_RULE;
RULE Drainage_clearance_adjacency_data FOR (Drainage_clearance):
adjacent_feature_type == Base_wall.
END_RULE;
RULE Drainage_clearance_position FOR (Drainage_clearance);
Connect_insert not on underside of base wall.
Drainage clearance function not achieved.
Connect_insert MUST be on underside of base wall. Advise relocate connect_insert.position[2]
Top of connect_insert not in contact with base wall.
Product functionality lost. Advise relocate
connect_insert to connect_adj_wall.position[2] -
connect_insert.height.
END_RULE;
RULE Drainage_clearance_height FOR (Drainage_clearance);
IF connect_dest.additional_function == 'Drainage_clearance' THEN
drain_height = connect_dest.additional_spec.
IF (connect_adj_wall.position[2] - connect_insert.position[2]) < drain_height THEN
'connect_dest' insufficient to achieve
'drainage_clearance' function. Product functionality
lost.
IF connect_insert.height < drain_height THEN
Advise change connect_insert.height to drain_height
and relocate connect_insert.position[2] to connect_adj_wall.
IF connect_insert.height >= drain_height THEN
IF (connect_adj_wall.position[2] - connect_insert.position[2]) > drain_height THEN
Connect_insert.height higher than specified to achieve
'drainage_clearance' function. Drainage clearance higher than
specified, unnecessary material in the product. Advise
END_RULE;
ENTITY PTPlus_functional_requirements_data
ABSTRACT SUPERTYPE OF (ONE OF (Locate_in_lid, Locate_on_jar, Break_in_torsion,
Hold_in_lid, Hold_on_jar, Prevent_rotation, Cover_lid_edge));
SUBTYPE OF (Functional_requirements_data);
END_ENTITY;
ENTITY Locate_in_lid
SUBTYPE OF (PTPlus_functional_requirements_data,
Initial_product_definition_functional_requirements);
adjacent_feature_type : STRING;
diameter : dimension;
height : dimension;
connect_wall : Side_wall;
connect_taper_on_wall : Taper;
WHERE
small_angle_rads := (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle := 90 - connect_taper_on_wall.angle;
larger_angle_rads := (remaining_angle/360)*2.0*3.1416;
taper_allowance := (connect_wall.height/2.0* 
\ SIN(small_angle_adjacent_rads)) / 
\ SIN(large_angle_adjacent_rads);
outer_dia := connect_wall.inner_dia + 2.0*connect_wall.thickness + 2.0*taper_allowance;
RULE Locate_in_lid_requirements_data FOR (Locate_in_lid);
Require inner diameter of metal lid (mm) == diameter.
Require height of location surface (mm) == height.
Advise location surface contains flange for 'Hold in lid' function as well as mating with inside lid surface.
END_RULE;
RULE Locate_in_lid_adjacency_data FOR (Locate_in_lid);
adjacent_feature_type == Spaced_bosses.
END_RULE;
RULE Locate_in_lid_height FOR (Locate_in_lid);
IF connect_wall.height > height THEN
Feature location height greater than lid location
surface. An overhang exists. Advise change
connect_wall.height: Location surface height
== height.
IF connect_wall.height < height THEN
Feature height smaller than lid location
surface. Location surface is under-utilised.
Possible problems with 'hold in lid'
function. Advise change connect_wall.height:
Location surface height == height.
END_RULE;
RULE Locate_in_lid_location FOR (Locate_in_lid);
IF outer_dia > diameter THEN
Connect_wall outer_diameter greater than inside
diameter of lid. This is an interference fit.
Advise change connect_wall outer_diameter:
Location diameter == diameter.
IF connect_taper_on_wall.angle != 0.0 THEN
outer_diameter = outer_diameter - 2.0*taper_allowance.
Connect_wall.inner_dia = outer_diameter - 2.0*connect_wall.thickness.
IF outer_dia < diameter THEN
Connect_wall outer_diameter smaller than inside
diameter of lid. An insert of some kind is required.
Advise change connect_wall outer_diameter:
Location diameter == diameter.
IF connect_taper_on_wall.angle != 0.0 THEN
outer_diameter = outer_diameter - 2.0*taper_allowance.
Connect_wall.inner_dia = outer_diameter - 2.0*connect_wall.thickness.
END_RULE;
END_ENTITY;

ENTITY Break_in_torsion
SUBTYPE OF (PTPlus_functional_requirements_data,
Initial_product_definition_functional_requirements);
adjacent_feature_type : STRING;
torsion_req : dimension;

END_ENTITY;

A6/14
connect_boss : Spaced_bosses;
connect_wall : Side_wall;
WHERE
min_group_dia : = connect_wall.inner_dia + connect_boss.boss_dia;
max_group_dia : = connect_wall.inner_dia + connect_wall.thickness -
connect_boss.boss_dia;
yield : = 29.0;
boss_area : = 3.1416*SQ(connect_boss.boss_dia/2.0);
total_area : = boss_area*connect_boss.boss_numb;
Force : = yield*total_area;
Torque_calculation : = Force*connect_boss.axis_dia/2.0;
Reverse_force : = Torque_calculation(connect_boss.boss_dia/2.0);
Reverse_total_area : = Reverse_force/yield;
Reverse_boss_area : = Reverse_total_area/connect_boss.boss_numb;
recom_diameter : = SQRT(Reverse_boss_area/3.1416);
recom_boss_no : = FLOOR(Reverse_total_area/boss_area);
RULE Break_in_torsion_requirements_data FOR (Break_in_torsion);
Require breakage torsion (Nmm) == torsion_req.
END_RULE;
RULE Break_in_torsion_adjacency_data FOR (Break_in_torsion):
adjacent_feature_type == Side_wall.
END_RULE;
RULE Torsion_position FOR (Break_in_torsion);
Top of boss grouping not in contact with wall.
Lost product functionality. Advise reposition
connect_boss.position[2] to (connect_wall.position[2] -
connect_boss.height).
Top of boss grouping is higher than underside of
side wall. Possible loss of function if boss grouping
is contained in side wall. Advise relocate connect_boss.
END_RULE;
RULE Torsion_group_diameter FOR (Break_in_torsion);
IF (connect_boss.axis_dia + connect_boss.boss_dia) > (connect_wall.inner_dia +
2.0*connect_wall.thickness) THEN
Group outer diameter greater than that of supporting
wall. Breakage torsion drastically reduced from that
intended and cannot be evaluated. Advise decrease
group diameter to be in full contact with supporting
wall ie min_group_dia <= connect_boss.axis_dia <=
max_group_dia.
IF (connect_boss.axis_dia - connect_boss.boss_dia) < connect_wall.inner_dia THEN
Group inner diameter smaller than that of supporting
wall. Breakage torsion drastically reduced from that
intended and cannot be evaluated. Advise increase
group diameter to be in full contact with supporting
wall ie min_group_dia <= connect_boss.axis_dia <=
max_group_dia.
END_RULE;
RULE Torsion_torque FOR (Break_in_torsion);
IF Torque_calculation < torsion_req THEN
Feature cross sectional area not large enough to
provide failure at the torque specified. Tampering
with the jar may be indicated erroneously. The lid
can be removed from the jar too easily. Advise
increase connect_boss.boss_numb to recom_boss_no
or increase connect_boss.boss_dia to recom_diameter.
IF Torque_calculation > torsion_req THEN
Feature cross sectional area too large to provide
failure at the torque specified. Difficulty in removing
the lid from the jar. Advise decrease connect_boss.boss_numb to recom_boss_no or decrease connect_boss.boss_dia to recom_diameter.

END_RULE;
END_ENTITY;

ENTITY Locate_on_jar
SUBTYPE OF (PTPlus_functional_requirements_data,
Initial_product_definition_functional_requirements);
adjacent_feature_type: STRING;
diameter: dimension;
height: dimension;
connect_wall: Side_wall;
connect_boss: Spaced_bosses;
connect_taper_on_wall: Taper;

WHERE
small_angle_rads = (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle = 90 - connect_taper_on_wall.angle;
larger_angle_rads = (remaining_angle/360)*2.0*3.1416;
taper_allowance = (connect_wall.height*SINE(small_angle_rads))/
SINE(larger_angle_rads);

min_inner_dia = connect_boss.axis_dia + connect_boss.boss_dia -
2.0*connect_wall.thickness - 2.0*taper_allowance;
max_inner_dia = connect_boss.axis_dia - connect_boss.boss_dia - 2.0*taper_allowance;
min_outer_dia = connect_boss.axis_dia + connect_boss.boss_dia +
2.0*connect_wall.thickness - 2.0*taper_allowance;
max_outer_dia = connect_wall.inner_dia + 2.0*connect_wall.thickness;

RULE Locate_on_jar_requirements_data FOR (Locate_on_jar);
Require outer diameter of jar neck (mm) == diameter.
Require height of location surface (mm) == height.
Advise location surface contains flange for 'Hold in lid' function as well as mating with inside lid surface.
END_RULE;
RULE Locate_on_jar_adjacency_data FOR (Locate_on_jar):
adjacent_feature_type == Spaced_bosses.
END_RULE;
RULE Locate_on_jar_height FOR (Locate_on_jar);
IF connect_wall.height > height THEN
Feature location height greater than jar location surface. An overhang exists. Advise change connect_wall.height:
Location surface height == height.
IF connect_wall.height < height THEN
Feature height smaller than jar location surface. Location surface is underutilised.
Possible problems with 'hold_onjar' function. Advise change connect_wall.
Location surface height == height.
END_RULE;
RULE Locate_on_jar_position FOR (Locate_on_jar);
Feature position too high. Shortened length of bridges - Torque calculation no longer valid,
connect_wall.height).
Top of location wall not in contact with boss grouping.
Lost product functionality. Advise reposition connect_wall.
position[2] to (connect_boss.position[2] -
connect_wall.height).
RULE Locate_on_jar_torsion FOR (Locate_on_jar);
IF connect_wall.inner_dia > (connect_boss.axis_dia - connect_boss.boss_dia - 2.0*taper_allowance) THEN
    Wall inner diameter is greater than that of adjacent boss grouping. Breakage torsion drastically reduced and cannot be evaluated.
    Advise decrease connect_wall.inner_dia to be in full contact with boss grouping ie min_inner_dia <= connect_wall.inner_dia <= max_inner_dia.
IF (connect_wall.inner_dia + 2.0*connect_wall.thickness - 2.0*taper_allowance) < (connect_boss.axis_dia + connect_boss.boss_dia) THEN
    Wall outer diameter is smaller than that of adjacent boss grouping. Breakage torsion drastically reduced and cannot be evaluated.
    Advise increase outer_dia to be in full contact with boss grouping ie min_outer_dia <= outer_dia <= max_outer_dia.
END_RULE;

ENTITY Hold_in_lid
    SUBTYPE OF (PTPlus_functional_requirements_data);
    adjacent_feature_type : STRING;
    fixin_lidiameter : dimension;
    connect_wall : Flange;
    connect_adj_wall : Side_wall;
    connect_taper_on_wall : Taper;
    connect_taper_on_adjacent_wall : Taper;
    WHERE
        small_angle_adjacent_rads := (connect_taper_on_adjacent_wall.angle/360)*2.0*3.1416;
        remaining_angle_adjacent := 90 - connect_taper_on_adjacent_wall.angle;
        larger_angle_adjacent_rads := (remaining_angle_adjacent/360)*2.0*3.1416;
            SINE(small_angle_adjacent_rads))/
            SINE(large_angle_adjacent_rads);
        taper_allowance_adjacent2 := ((connect_adj_wall.height*SINE(small_angle_adjacent_rads))/
            SINE(large_angle_adjacent_rads);
        small_angle_rads := (connect_taper_on_wall.angle/360)*2.0*3.1416;
        remaining_angle := 90 - connect_taper_on_wall.angle;
        larger_angle := (remaining_angle/360)*2.0*3.1416;
        taper_allowance := (connect_wall.height*SINE(small_angle_radians))/
            SINE(large_angle_radians);
        IF (taper_allowance == 0.0) AND (taper_allowance_adjacent != 0.0) THEN
            taper_allowance_difference := ((connect_wall_adjacent.height - connect_wall.position[2])*
                SINE(small_angle_adjacent_rads))/
                SINE(large_angle_adjacent_rads);
        IF (taper_allowance != 0.0) OR (taper_allowance_adjacent == 0.0) THEN
            taper_allowance_difference := 0.0;
RULE Hold_in_lid_requirements_data FOR (Hold_in_lid);
Require maximum fixing diameter, ie diameter inside lid (mm) == fixing_diameter.
END_RULE;
RULE Hold_in_lid_adjacency_data FOR (Hold_in_lid);
adjacent_feature_type == Side_wall.
END_RULE;
RULE Hold_in_lid_position FOR (Hold_in_lid);
+ connect_adj_wall.height) THEN
Top of flange is below top surface of location wall.
Difficulty fitting the product into the lid. Possible sealant leakage around the edge of the lid. Advise relocate flange to be flush with top of location wall,
+ connect_wall.height - connect_wall.height.
+ connect_adj_wall.height) THEN
Top of flange is above top surface of location wall.
Drastic reduction in section thickness leading to severe structural weakness. Problems fitting the product into the lid. Advise relocate flange to be flush with top of location wall, ie connect_wall.position[2] ==
connect_adj_wall.position[2] + connect_wall.height
- connect_wall.height.
END_RULE;
RULE Hold_in_lid_location_relation FOR (Hold_in_lid);
IF connect_taper_on_wall.angle != 0.0 AND connect_taper_on_adjacent_wall.angle != 0.0
AND connect_taper_on_wall.angle < connect_taper_on_adjacent_wall.angle THEN
IF (connect_wall.inner_dia - (2.0*taper_allowance_difference - 2.0*taper_allowance) <
(connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent) THEN
Flange inner diameter smaller than inner diameter of location wall. Contact with jar neck causing increased torque for lid removal. Advise Increase connect_wall.inner_dia to a minimum of
(connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent
+ (2.0*taper_allowance_difference - 2.0*taper_allowance)).
IF connect_taper_on_wall.angle == 0.0 OR connect_taper_on_adjacent_wall.angle == 0.0
OR connect_taper_on_wall.angle == connect_taper_on_adjacent_wall.angle THEN
IF (connect_wall.inner_dia - 2.0*taper_allowance_difference) <
(connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent ) THEN
Flange inner diameter smaller than inner diameter of location wall. Contact with jar neck causing increased torque for lid removal. Advise Increase connect_wall.inner_dia to a minimum of
(connect_wall_adjacent.inner_dia + 2.0*taper_allowance_adjacent
+ 2.0*taper_allowance_difference).
IF connect_taper_on_wall.angle > connect_taper_on_adjacent_wall.angle THEN
IF (connect_wall.inner_dia + 2.0*taper_allowance) > (connect_wall_adjacent.inner_dia +
2.0*connect_wall_adjacent.thickness + 2.0*taper_allowance_adjacent +
2.0*taper_allowance_difference) THEN
Flange inner diameter larger than corresponding outer diameter of location wall. Drastically reduced section thickness leading to severe structural weakness or flange and location wall not in contact - Product functionality lost. Advise decrease connect_wall.inner_dia
to a maximum of (connect_wall_adjacent.inner_dia +
2.0*connect_wall_adjacent.thickness +
2.0*taper_allowance_adjacent + 2.0*taper_allowance_difference
- 2.0 *taper_allowance).
IF connect_taper_on_wall.angle == 0.0 OR connect_taper_on_adjacent_wall.angle == 0.0
OR connect_taper_on_wall.angle == connect_taper_on_adjacent_wall.angle THEN
IF connect_wall.inner_dia > (connect_wall_adjacent.inner_dia + 2.0*connect_wall_adjacent.thickness + 2.0*taper_allowance_adjacent - 2.0*taper_allowance_difference) THEN
  Flange inner diameter larger than corresponding outer diameter of location wall. Drastically reduced section thickness leading to severe structural weakness or flange and location wall not in contact - Product functionality lost. Advise decrease connect_wall.inner_dia to a maximum of (connect_wall_adjacent.inner_dia + 2.0*connect_wall_adjacent.thickness + 2.0*taper_allowance_adjacent - 2.0*taper_allowance_difference).
END_RULE;
RULE Hold_in_lid_fixing FOR (Hold_in_lid);
IF (connect_wall.inner_dia + 2.0*connect_wall.width + 2.0*taper_allowance) > fixin_diameter THEN
  Feature outer diameter larger than maximum fixing diameter. The feature cannot fit inside the lid. Advise change feature outer diameter. Maximum fixing diameter == fixin_diameter.
ENDIF
RULE Hold_onjar_requirements_data FOR (Hold_onjar);
Require minimum fixing diameter, ie thinnest diameter of jar neck (mm) == fixin_diameter.
END_RULE;
RULE Hold_onjar_adjacency_data FOR (Hold_onjar);
  adjacent_feature_type == Side_wall.
END_RULE;
RULE Hold_onjar_position FOR (Hold_onjar);
ENDIF
RULE Hold_onjar_adjust_for_location_wall FOR (Hold_onjar);
ENDIF
RULE Hold_onjar_location_relation FOR (Hold_onjar);
IF outer_dia > (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness) THEN
Flange outer diameter is larger than location wall.
Unnecessary material and weight in the product –
Significant extra cost over a production run.
Unnecessary aesthetic feature. Advise decrease
outer_dia to connect_adj_wall.inner_dia
+ 2.0*connect_adj_wall.thickness.
IF outer_dia < (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.thickness) THEN
Flange outer diameter is smaller than location wall.
Drastically reduced section thickness leading to
excessive structural weakness. Advise increase
outer_dia to connect_adj_wall.inner_dia
+ 2.0*connect_adj_wall.thickness
END_RULE;
RULE Hold_onjar_fixing FOR (Hold_onjar);
IF connect_wall.inner_dia < fixing_diameter THEN
Connect_wall.inner_dia is smaller than minimum
fixing diameter. Feature cannot fit around the jar.
Advise change connect_wall.inner_dia: Minimum
fixing diameter == fixing_diameter.
IF connect_wall.inner_dia > connect_adj_wall.inner_dia THEN
Connect_wall.inner_dia is larger than location
diameter. Fixing function not achieved. Advise
change connect_wall.inner_dia: Location diameter
== connect_adj_wall.inner_dia.
END_RULE;
END_ENTITY;

ENTITY Prevent_rotation
SUBTYPE OF (PTPlus_functional_requirements_data);
adjacent_feature_type : STRING;
min_torque : dimension;
connect_rib : Spaced_ribs;
connect_wall : Flange;
connect_torsion : Break_in_torsion;
WHERE
yield : = 29.0;
rib_length : = (connect_rib.outer_dia - connect_rib.inner_dia)/2.0;
torque_distance : = connect_rib.inner_dia + (rib_length/2.0);
rib_area : = rib_length*connect_rib.width;
total_area : = rib_area*connect_rib.rib_numb;
force : = yield*total_area;
torque_calculation : = force*torsion_distance;
reverse_force : = min_torque/torsion_distance;
reverse_total_area : = reverse_force/yield;
reverse_rib_area : = reverse_total_area/connect_rib.rib_numb;
recom_width : = reverse_rib_area/rib_height;
recom_rib_no : = FLOOR(reverse_total_area/reverse_rib_area);
RULE Prevent_rotation_requirements_data FOR (Prevent_rotation);
Require minimum torque at which rotation
can occur (Nmm) == min_torque.
IF min_torque < connect_torsion.torsion_req THEN
min_torque smaller than torque for break_in_torsion.
Rotation of component will occur – bridges will fail by
elongation. Seal can be broken without detection. Advise
specify min_torque higher than that for break_in_torsion
function, recommended safety margin is times 2 ==
(2.0*connect_torsion.torsion_req).
IF (min_torque > connect_torsion.torsion_req) && (min_torque <
2.0*connect_torsion.torsion_req) THEN
min_torque smaller than recommended safety margin above
torque for break_in_torsion function. Possible rotation of
component - bridges will fail by elongation. Possible non
indication of broken seal. Advise specify min_torque higher
than that for break_in_torsion function, recommended safety
margin is times 2 == (2.0*connect_torsion.torsion_req).
END_RULE;
RULE Prevent_rotation_adjacency_data FOR (Prevent_rotation):
adjacent_feature_type == Flange.
END_RULE;
RULE Prevent_rotation_position FOR (Prevent_rotation);
IF (connect_rib.position[2] + connect_rib.height) <
connect_wall.position[2] THEN
Top of connect_rib not in contact with flange.
Product functionality lost. Advise relocate
connect_rib to connect_wall.position[2] -
connect_rib.height.
IF (connect_rib.position[2] + connect_rib.height) >
connect_wall.position[2] THEN
Top of connect_rib is higher than underside of
flange. Possible loss of function if rib grouping
is contained in flange. Advise relocate
connect_rib.height.
END_RULE;
RULE Prevent_rotation_fixing_relation FOR (Prevent_rotation);
IF connect_rib.outerDia > (connect_wall.innerDia + 2.0*connect_wall.width) THEN
Group outer diameter greater than that of supporting
flange. Torque not applied to lid by area of ribs not
on flange. Torque significantly reduced compared to
full contact. Unable to obtain accurate torque calculation.
Advise decrease connect_rib.outerDia to (connect_wall.
innerDia + 2.0*connect_wall.width)
IF connect_rib.innerDia < connect_wall.innerDia THEN
Group inner diameter smaller than that of supporting
flange. Torque not applied to lid by area of ribs not
on flange. Torque significantly reduced compared to
full contact. Unable to obtain accurate torque calculation.
Advise increase connect_rib.innerDia to connect_wall.
innerDia.
END_RULE;
RULE Prevent_rotation_torque FOR (Prevent_rotation);
IF torque_calculation < min_torque THEN
Feature cross sectional area is not large enough
to provide failure at the torque specified. Rotation
of component - bridges fail by elongation. Non-
indication of a broken seal. Advise increase connect_rib.
rib_numb to recom_rib_no or increase connect_rib.width
to recom_width.
END_RULE;
END_ENTITY;
ENTITY Cover_lid_edge
SUBTYPE OF (PTPlus_functional_requirements_data);
adjacent_feature_type : STRING;
cover_height : dimension;
cover_dia : dimension;
connect_wall : Lip;
connect_adj_wall : Flange;
connect_taper_on_wall: Taper;
connect_taper_on_adjacent_wall: Taper;
connect_hold : Hold_in_lid;
WHERE
small_angle_rads = (connect_taper_on_wall.angle/360)*2.0*3.1416;
remaining_angle = 90 - connect_taper_on_wall.angle;
larger_angle_rads = (remaining_angle/360)*2.0*3.1416;
  SINE(small_angle_adjacent_rads)/
  SINE(large_angle_adjacent_rads);
taper_allowance2 = (connect_wall.height)*
  SINE(small_angle_adjacent_rads)/
  SINE(large_angle_adjacent_rads);
outerDia = connect_wall.inner_dia + 2.0*connect_wall.thickness + 2.0*taper_allowance2;
RULE Cover_lid_edge_requirements_data FOR (Cover_lid_edge);
  Require height of covered edge (mm) == cover_height.
  Require outer diameter of the covered edge (mm) == cover_dia.
END_RULE;
RULE Cover_lid_edge_adjacency_data FOR (Cover_lid_edge):
  adjacent_feature_type == Flange.
END_RULE;
RULE Cover_lid_edge_height FOR (Cover_lid_edge);
  IF connect_wall.height < (cover_height + connect_adj_wall.thickness)
  THEN Height smaller than height of covered edge
  plus adjacent flange. Edge not fully covered
  or in order to cover edge drastic thinning of
corner section is necessary, leading to severe
structural weakness, or lip and flange not in
contact – loss of product functionality. Advise
increase connect_wall.height to a minimum
of (cover_height + connect_adj_wall.thickness);
END_RULE;
RULE Cover_lid_edge_position FOR (Cover_lid_edge);
  connect_adj_wall.height)
  THEN Top of lip is lower than adjacent flange. Drastic thinning
  of section leading to severe structural weakness. Advise
  relocate connect_wall.position[2] to (connect_adj_wall.
  position[2] + connect_adj_wall.thickness –
  connect_wall.height),
  connect_adj_wall.height)
  THEN Top of lip is higher than adjacent flange. Cannot fit
  product in lid – Loss of functionality. Possible
  sealing problems between product and lid. Advise
  relocate connect_wall.position[2] to (connect_adj_wall.
  position[2] + connect_adj_wall.thickness –
  connect_wall.height).
END_RULE;
RULE Cover_lid_edge_fixing_relation FOR (Cover_lid_edge);
  IF connect_wall.inner_dia > (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width +
  2.0*taper_allowance)
  THEN Connect_wall.inner_dia is greater than corresponding
outer diameter of flange. Drastic thinning of section
leading to severe structural weakness or lip and flange
not in contact – Loss of product functionality. Advise
reduce connect_wall.inner_dia to a maximum of
  (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width
  + 2.0*taper_allowance).
  IF connect_wall.inner_dia < (connect_adj_wall.inner_dia + 2.0*connect_adj_wall.width +
  2.0*taper_allowance)
  THEN Connect_wall.inner_dia is smaller than corresponding
outer diameter of flange, encroaching on flange functional
surface. Insufficient space for ‘hold_in_lid’ function to
occur. Problems fixing product into lid. Advise increase
connect_wall.inner_dia to (connect_adj_wall.inner_dia +
2.0*connect_adj_wall.width + 2.0*taper_allowance2). IF outer_dia > connect_hold.fixing_diameter THEN Feature outer diameter larger than maximum fixing diameter specified for hold in lid function. Feature cannot fit inside the lid. Advise change outer_dia: Maximum outer_dia = (connect_hold.fixing_diameter − 2.0*taper_allowance2).

END_RULE;
RULE Cover_lid_edge_cover FOR (Cover_lid_edge) IF connect_wall.inner_dia < cover_dia THEN Feature inner diameter smaller than diameter of edge to be covered. Feature cannot fit over edge. Cover function not achieved. Advise change connect_wall.inner_dia: Edge diameter specified is cover_dia.
END_RULE;
END_ENTITY;

ENTITY Initial_product_definition_data
ABSTRACT SUPERTYPE OF (ONE OF(Yoghurt_pot_initial_product_definition_data, Flower_pot_initial_product_definition_data, P1Plus_initial_product_definition_data));
END_ENTITY;

ENTITY P1Plus_initial_product_definition_data
SUBTYPE OF (Initial_product_definition_data);
RULE Initial_product_definition FOR (P1Plus);
Initial product definition = Locate_in_lid THEN Break_in_torsion THEN Locate_on_jar
END_RULE;
END_ENTITY;

ENTITY Yoghurt_pot_initial_product_definition_data
SUBTYPE OF (Initial_product_definition_data);
RULE Initial_product_definition FOR (Yoghurt_pot);
Initial product definition = Enclose_horizontal THEN Enclose_below
END_RULE;
END_ENTITY;

ENTITY Flower_pot_initial_product_definition_data
SUBTYPE OF (Initial_product_definition_data);
RULE Initial_product_definition FOR (Yoghurt_pot);
Initial product definition = Enclose_horizontal THEN Enclose_below
END_RULE;
END_ENTITY;

ENTITY Form_function_relations_data
ABSTRACT SUPERTYPE OF (ONE OF(Yoghurt_pot_form_function_relations, Flower_pot_form_function_relations, P1Plus_form_function_relations));
END_ENTITY;

ENTITY Yoghurt_pot_form_function_relations
SUBTYPE OF (Form_function_relations_data);
RULE Yoghurt_pot_form_function_relations FOR (Yoghurt_pot_form_function_relations);
IF functional_requirement == Provide_seal_surface THEN
  choice of form == Flange.
IF functional_requirement == Insert_destack THEN
  choice of form == Base_feature or Spaced_ribs.
IF functional_requirement == Section_destack_horizontal THEN
  choice of form == Flange.
IF functional_requirement == Section_destack_vertical THEN
  choice of form == Lip.
END_RULE;
END_ENTITY;

ENTITY Flower_pot_form_function_relations
  SUBTYPE OF (Form_function_relations_data);
RULE Flower_pot_form_function_relations FOR (Flower_pot_form_function_relations);
IF functional_requirement == Enclose_horizontal THEN
  choice of form == Side_wall.
IF functional_requirement == Enclose_below THEN
  choice of form == Base_wall.
IF functional_requirement == Insert_destack THEN
  choice of form == Spaced_ribs.
IF functional_requirement == Section_destack_horizontal THEN
  choice of form == Flange.
IF functional_requirement == Section_destack_vertical THEN
  choice of form == Lip.
IF functional_requirement == Drainage THEN
  choice of form == Spaced_holes.
IF functional_requirement == Drainage_clearance THEN
  choice of form == Spaced_ribs or Spaced_bosses.
END_RULE;
END_ENTITY;

ENTITY PTPlus_form_function_relations
  SUBTYPE OF (Form_function_relations_data);
RULE PTPlus_form_function_relations FOR (PTPlus_form_function_relations);
IF functional_requirement == Locate_in_lid THEN
  choice of form == Side_wall.
IF functional_requirement == Break_in_torsion THEN
  choice of form == Spaced_bosses.
IF functional_requirement == Locate_on_jar THEN
  choice of form == Side_wall.
IF functional_requirement == Hold_in_lid THEN
  choice of form == Flange.
IF functional_requirement == Hold_on_jar THEN
  choice of form == Flange.
IF functional_requirement == Prevent_rotation THEN
  choice of form == Spaced_ribs.
IF functional_requirement == Cover_lid_edge THEN
  choice of form == Lip.
END_RULE;
END_ENTITY;

//FORM FEATURES.

ENTITY Form_features
  ABSTRACT SUPERTYPE OF (ONE OF(Side_wall, Base_feature, Flange, Lip, Spaced_ribs,
  Spaced_bosses, Base_wall, Spaced_holes));
END_ENTITY;

ENTITY Side_wall
  SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
inner_dia : dimension;
height : dimension;
END_ENTITY;

ENTITY Base_feature
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
inner_dia : dimension;
height : dimension;
END_ENTITY;

ENTITY Lip
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
inner_dia : dimension;
height : dimension;
END_ENTITY;

ENTITY Flange
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
inner_dia : dimension;
width : dimension;
height : dimension;
END_ENTITY;

ENTITY Spaced_ribs
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING_ARRAY;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;

rib_numb : integer;
inner_dia : dimension;
outer_dia : dimension;
height : dimension;
width : dimension;
END_ENTITY;

ENTITY Spaced_bosses
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING_ARRAY;
mouldability_type : STRING;
alt_mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
boss_numb : integer;
boss_dia : dimension;
axis_dia : dimension;
height : dimension;
END_ENTITY;

ENTITY Spaced_holes
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING_ARRAY;
mouldability_type : STRING;
alt_mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
hole_numb : integer;
hole_dia : dimension;
axis_dia : dimension;
depth : dimension;
END_ENTITY;

ENTITY Base_wall
SUBTYPE OF (Form_features);
objective1 : STRING;
adjacent_feature_type : STRING;
function_name : STRING;
mouldability_equivalent : STRING;
mouldability_type : STRING;
position : POINT3D;
orientation : POINT3D;
diameter : dimension;
thickness : dimension;
END_ENTITY;
Appendix 7.

Example strategist support for the build up of a yogurt pot product design.
Enter workstation: zipporah

Product ranges where data is available in the Product Range Model are:

1. Yoghurt pot range of products
2. Flower pot range of products
3. PTPlus range of products

Enter choice.

1.

1. Create a new product (Initial product definition).
2. Modify existing product (Interactive product modification).
3. Delete a product and its mould

Enter a choice.

1

Enter name of new product.

Ronan

Functional requirements:

enclose_horizontal
enclose_below
provide_seal_surface
Section_destack_horizontal
Section_destack_vertical
Insert_destack

Specify functional requirements for initial product definition:

FUNCTION – Enclose horizontal

What is the enclosed volume? (mm3) 500000

What is the diameter of the enclosure? (mm) 80

FUNCTION – Enclose below

What is the enclosed diameter? (mm) 70

This diameter specification is smaller than that for adjacent 'Enclose horizontal' function

Consequences:

1. If form matches specification, enclosure not achieved, product functionality lost

Remedial options:

1. Increase diameter specification to a minimum of 80 mm
   - No further options

Change specification? y/ny

Enter new specification: 80

FUNCTION: enclose_horizontal

Forms available for use:

1. side_wall

No more forms available.

FORM FEATURE – SIDE_WALL: Ronan_Fsid_w0

A7/2
Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of central axis of rotation): 0 0 10

Specify feature orientation 1 O 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify inner diameter: 80
Specify side_wall thickness: 2
Specify side_wall height: 70

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT – enclose_horizontal function:

Inner diameter satisfactory for enclose horizontal function

Present wall dimensions mean that the enclosed volume is lower than that specified
Specified volume: 500000 mm³

Consequences:
Enclose horizontal function specification not achieved

Remedial options:
1. Increase inner diameter to: 93 mm
NOTE: Enclose horizontal specification for inner diameter: 80 mm
2. Increase wall height to: 94.5 mm
   – No further options

Change feature inner diameter? y/nn

Present diameter recorded
Change height? y/nn

New height: 94.5

MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/nn

Creating taper on wall Ronan_Mwall0
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok
Do you wish to create a new gate on this wall? y/nn

FUNCTION: enclose_below

Forms available for use:
1. base_wall
No more forms available.
FORM FEATURE-- BASE_WALL: Ronan_Fbs_w10

Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (centre of base): 0 0 8

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify base_wall diameter: 84
Specify base_wall thickness: 3

FORM FEATURE Ronan_Fbs_w10

FUNCTIONALITY ASSESSMENT -- enclose_below function:

Top of base wall is higher than the base of horizontal enclosure wall

Consequences:
1. Base wall encroaching on 'Enclose horizontal' surface-- Loss of functionality

Remedial options:
1. Lower base wall to z position 7

-- No further options

Reposition the feature? y/ny

New feature position: 0 0 7
Diameter satisfactory for enclose below specification
Feature outer diameter satisfactory for enclose below function

MOULDABILITY WALL FEATURE: Ronan_Mwall1

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny

Creating taper on wall Ronan_Mwall1
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees.8

Taper angle ok

Wall thickness is not the same as adjacent wall

Possible consequences:
1. Feeding problems if a thick section is fed by a thin section
2. Stress concentrations at abrupt section changes
3. Abrupt section changes can interfere with the flow of material in the mould causing surface defects
4. Component warpage

Remedial options:
1. Make wall thickness the same or near to that of adjacent wall (2)
2. If the difference in thickness must remain make sure the change is not abrupt
Change wall thickness? y/ny
Enter new wall thickness (mm): 2.0
New thickness ok
Wall features require a blend
Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects
Do you wish to create a blend? y/ny
Creating blend on wall Ronan_Mwall1
Enter inside radius:
Recommended inside radius is between 0.8 and 1.2 mm
0.5 mm is the recommended minimum radius.
Inside blend radius ok
Enter outside radius:
Recommended outside radius is 2.8 mm
This blend radius is less than 2.8 causing thickening corner section
Possible consequences:
1. Shrinkage marks or surface depressions in the corner
2. Widening of the corner angle
3. Curvature of the wall sections either side of the corner
Remedial options:
1. Increase blend radius to 2.8
- No further options
Increase the blend radius? y/ny
Enter new blend radius: 2.8
New radius recorded
Do you wish to create a new gate on this wall? y/ny
WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product
Advise re-analysis of functional features in the given order before proceeding:
0. Ronan_Fsid_w0
1. Ronan_Fbs_w10
Select modification/re-analysis option on main menu
ENTER 'c' to continue:
INITIAL PRODUCT DEFINITION PHASE COMPLETE FOR PRODUCT: Ronan
1. Go on to Interactive product Modification design phase
2. Modification/re–analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

2. Re–run functional analysis.
3. Re–run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:
Name: Ronan_Fsid_w0
Type: side_wall

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT – enclose_horizontal function:

Inner diameter satisfactory for enclose horizontal function
Enclosed volume satisfactory for enclose horizontal function

MOULDABILITY WALL FEATURE: Ronan_MwalIO
Wall thickness ok
Wall thickness relative to adjacent wall ok

2. Re–run functional analysis.
3. Re–run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:
Name: Ronan_Fhs_w10

FORM FEATURE Ronan_Fhs_w10
FUNCTIONALITY ASSESSMENT – enclose_below function:

Top of base wall is not in contact with base of horizontal enclosure wall

Consequences:
1. Product functionality lost

Remedial options:
1. Relocate base wall to z position 8

–No further options

Reposition the feature? y/ny

New feature position: 0 0 8
Diameter satisfactory for enclose below specification
Feature outer diameter satisfactory for enclose below function
MOULDABILITY WALL FEATURE: Ronan_Mwall1

Wall thickness ok

Wall thickness relative to adjacent wall ok

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 4

Returning to main menu

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Session terminated. Ron>
Appendix 8.

Example strategist support for the build up of a PTPlus product design.
Enter workstation: zipporah

Product ranges where data is available in the Product model are:
1. Yoghurt pot range of products
2. Flower pot range of products
3. PTPlus range of products
Enter choice.
3

1. Create a new product (Initial product definition).
2. Modify existing product (Interactive product modification).
3. Delete a product and its mould
Enter choice.
1

Enter name of new product.
Ronan

Functional requirements:
locate_in_lid
locate_on_jar
break_in_torsion
hold_in_lid
hold_on_jar
prevent_rotation
cover_lid_edge

Specify functional requirements for initial product definition:

FUNCTION – locate_in_lid

What is the inner diameter of the metal lid? (mm) 52.44

Note: location surface contains flange for 'hold_in_lid' function as well as mating with inside lid surface
What is the height of the location surface? (mm) 3

FUNCTION – break_in_torsion

What is the breakage torsion required? (N.mm) 1220

FUNCTION – locate_on_jar

What is the outer diameter of the jar neck? (mm) 50.08
What is the height of the location surface? (mm) 3.5

FUNCTION: locate_in_lid

Forms available for use:
1. side_wall
No more forms available.

FORM FEATURE - SIDE_WALL: Ronan_Fsid_w0

A8/2
Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of central axis of rotation): 0 0 10

Specify feature orientation: 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

specify inner diameter: 50.44

specify side_wall thickness: 1.3

specify side_wall height: 2

FORM FEATURE Ronan_Fsid_w0

FUNCTIONALITY ASSESSMENT – locate_in_lid function:

Feature height is smaller than the height of the lid location surface
The location surface height is 3 mm.

Consequence:
The location surface is under utilised
Possible problems with 'hold_in_lid' function
Change feature height? y/ny

Enter new height: 3

Feature position is currently: 0 0 10
Do you wish to adjust the position for the new location? y/nn

Feature outer diameter is greater than the inside diameter of the lid
The location diameter is 52.44 mm.

Consequence:
This is an interference fit
Change feature diameter? y/ny

New outer diameter: 52.44

To maintain constant inner diameter new thickness should be: 1
Do you wish to adjust the thickness? y/ny

New thickness: 1

MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny

Creating taper on wall Ronan_Mwall0
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees: 8

Taper angle ok
Do you wish to create a new gate on this wall? y/ny
Creating gate on wall Ronan_Mwall0
Feeding distance: 82.4272

Enter gate position X Y Z 26.22 0 12

Feeding distance ok

This product is tubular:

Possible choices of gate type:
1. Rectangular edge gate
2. Pin gate
3. Diaphragm gate
4. Ring gate

Enter choice:

Gate type is rectangular edge gate

FUNCTION: break_in_torsion

Forms available for use:
1. spaced_bosses
No more forms available.

FORM FEATURE—SPACED_BOSSES: Ronan_Fsp_bs0

Do you wish to see feature dimensioning instructions? y/n

Specify feature position (base of group central axis): 0 0 9.75

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify number of bosses: 5

Specify boss diameters: .17

Specify diameter between boss axes: 52

Specify bosses height: .25

FORM FEATURE Ronan_Fsp_bs0

FUNCTIONALITY ASSESSMENT—break_in_torsion function:

Torque specification: 1220
Feature position satisfactory for break in torsion function
Group diameter satisfactory for break in torsion function
Torque calculation 2013.45

Feature cross sectional area is too large to provide failure at the torque specified

Possible consequences:
1. Difficulty in removing the lid from the jar

Remedial options:
1. Decrease the number of bosses
2. Decrease the diameter of the bosses
Recommended number of bosses: 3
Necessary boss diameter at present numbers: 0.103007

No further options

Decrease the number of bosses? y/ny

Enter number of bosses: 3

Recommended boss diameter: 0.171679

Change the diameter of bosses? y/nn

Present diameter recorded
New torque = 1208.07 Nm

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos0

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/nn

Solid boss height ok

Solid boss width ok

Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/nn

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos1

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/nn

Solid boss height ok

Solid boss width ok

Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects
Do you wish to create a blend? y/n

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbo2
Solid boss orientation ok
Solid boss features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould
Do you wish to create a taper? y/n
Solid boss height ok
Solid boss width ok
Solid boss features require a blend
Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects
Do you wish to create a blend? y/n

FUNCTION: locate_on_jar

Forms available for use:
1. side_wall
No more forms available.

FORM FEATURE--SIDE_WALL: Ronan_Fsid_w1
Do you wish to see feature dimensioning instructions? y/n

Specify feature position (base of central axis of rotation): 0 0 6.25
Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1
Specify inner diameter: 50.08
Specify side_wall thickness: 1
Specify side_wall height: 3.5

FORM FEATURE Ronan_Fsid_w1
FUNCTIONALITY ASSESSMENT--locate_on_jar function:

Feature height satisfactory for locate on jar function
Feature position satisfactory for locate on jar function
Wall outer diameter is less than that of adjacent boss grouping

Consequences:
1. Breakage torsion is drastically reduced from that intended and cannot be estimated

Remedial options:
1. Increase wall diameter to be in full contact with the boss grouping
Maximum outer wall diameter for full contact: 53.3
Minimum outer wall diameter for full contact: 52.17

-No further options

Increase the outer diameter? y/ny

Enter new outer diameter: 52.18

To maintain constant inner diameter new thickness should be: 1.05
Do you wish to adjust the thickness? y/nn

Feature inner diameter is greater than the neck diameter of the jar
The location diameter is 50.08 mm.

Consequence:
An insert of some kind is required
Change feature diameter? y/ny

New inner diameter: 50.08

To maintain constant outer diameter new thickness should be: 1.05
Do you wish to adjust the thickness? y/ny

New thickness: 1.05

MOULDABILITY WALL FEATURE: Ronan_Mwall1
Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould
Do you wish to create a taper? y/ny

Creating taper on wall Ronan_Mwall1
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees.8

Taper angle ok

Wall thickness is not the same as adjacent wall

Possible consequences:
1. Feeding problems if a thick section is fed by a thin section
2. Stress concentrations at abrupt section changes
3. Abrupt section changes can interfere with the flow of material in the mould causing surface defects
4. Component warpage

Remedial options:
1. Make wall thickness the same or near to that of adjacent wall (1)
2. If the difference in thickness must remain make sure the change is not abrupt

-No further options

Change wall thickness? y/nn
Present thickness recorded

Wall features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Do you wish to create a new gate on this wall? y/n

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:

0. Ronan_Fsid_w0
1. Ronan_Fsp bs0
2. Ronan_Fsid_w1

Select modification/re-analysis option on main menu

ENTER 'c' to continue:

INITIAL PRODUCT DEFINITION PHASE COMPLETE FOR PRODUCT: Ronan

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:

Name: Ronan_Fsid_w0

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT—locate_in_lid function:

Feature height satisfactory for locate in lid function

Feature outer diameter is greater than the inside diameter of the lid
The location diameter is 52.44 mm.

Consequence:
This is an interference fit
Change feature diameter? y/n

New outer diameter: 52.44

To maintain constant inner diameter new thickness should be: 0.979055
Do you wish to adjust the thickness? y/n
MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok
Wall thickness relative to adjacent wall ok

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:

Name: Ronan_Fsp_bs0
Type: spaced_bosses

FORM FEATURE Ronan_Fsp_bs0
FUNCTIONALITY ASSESSMENT – break_in_torsion function:

Torque specification: 1220
Feature position satisfactory for break in torsion function
Group diameter satisfactory for break in torsion function
Torque calculation 1208.07
Torque at failure satisfactory for break in torsion function

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos0

Solid boss orientation ok
Solid boss height ok
Solid boss width ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos1

Solid boss orientation ok
Solid boss height ok
Solid boss width ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos2

Solid boss orientation ok
Solid boss height ok
Solid boss width ok

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 1
Enter feature name and type:

Name: Ronan_Fsid_w1
Type: side_wall

FORM FEATURE Ronan_Fsid_w1
FUNCTIONALITY ASSESSMENT—locate_on.jar function:

Feature height satisfactory for locate on jar function
Feature position satisfactory for locate on jar function
Feature in full contact with boss grouping — satisfactory support for break in torsion function
Feature diameter satisfactory for locate on jar function

MOULDABILITY WALL FEATURE: Ronan_Mwall1

Wall thickness ok

Wall thickness is not the same as adjacent wall

Possible consequences:
1. Feeding problems if a thick section is fed by a thin section
2. Stress concentrations at abrupt section changes
3. Abrupt section changes can interfere with the flow of material in the mould causing surface defects
4. Component warpage

Remedial options:
1. Make wall thickness the same or near to that of adjacent wall (1)
2. If the difference in thickness must remain make sure the change is not abrupt

–No further options

Change wall thickness? y/n/n

Present thickness recorded

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice:4

Returning to main menu

1. Go on to Interactive product Modification design phase
2. Modification/re—analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Functional requirements:
1. hold_in_lid
2. hold_on.jar
3. prevent_rotation
4. cover_lid_edge
Select a product function.
What is the maximum fixing diameter, ie diameter inside lid? (mm) 54.8

FUNCTION - hold_in_lid

Forms available for use:
1. flange
No more forms available.

FORM FEATURE - FLANGE: Ronan_Fflang0

Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of axis of rotation): 0 0 12

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify inner diameter: 53

Specify flange width: .5

Specify flange thickness: 1

FORM FEATURE Ronan_Fflang0

FUNCTIONALITY ASSESSMENT - hold_in_lid function:

Feature position satisfactory for hold in lid function

Flange inner diameter is larger than corresponding outer diameter of location wall

Possible consequences:
1. Drastically reduced section thickness leading to excessive structural weakness
2. Flange and location wall not in contact - Product functionality lost

Remedial options:
1. Decrease inner diameter to a maximum of 52.454
   Note: minimum diameter to retain product functionality: 50.4819
   Change feature diameter? y/nn

Enter new inner diameter: 52.44

To maintain constant outer diameter new thickness should be: 0.78
Do you wish to adjust the thickness? y/nn

Feature outer diameter satisfactory for hold in lid function

MOULDABILITY WALL FEATURE: Ronan_Mwall2

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/nn
Creating taper on wall Ronan_Mwall2
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok

Wall thickness relative to adjacent wall ok

Wall features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Creating blend on wall Ronan_Mwall2
Enter inside radius:
Recommended inside radius is between 0.5 and 0.6 mm
0.5 mm is the recommended minimum radius

Inside blend radius ok

Enter outside radius:
Recommended outside radius is 1.5 mm

Outside blend radius ok

Do you wish to create a new gate on this wall? y/n

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:
1. Ronan_Flang0

Select modification/re-analysis option on main menu

ENTER 'c' to continue:

1. Choose another product function
2. Modification/re-analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Session terminated. Ron>
Appendix 9.

Example strategist support for the build up of a flower pot product design.
Product ranges where data is available in the Product model are:
1. Yoghurt pot range of products
2. Flower pot range of products
3. PTPlus range of products

Enter choice.

1. Create a new product (Initial product definition).
2. Modify existing product (Interactive product modification).
3. Delete a product and its mould

Enter choice.

Enter name of existing product.
Ronan

Functional requirements:
1. insert_destack
2. section_destack_horizontal
3. section_destack_vertical
4. drainage
5. drainage_clearance

Select a product function.

FUNCTION – Drainage_clearance

What is the drainage clearance height (mm)? 1.5

SAME FORM: 'Drainage_clearance' and 'Insert_destack' functions can be performed using the same form on flower pot type products:

Do you wish to use same form for 'Insert_destack' function? y/ny

NOTE: For 'Drainage_clearance' the feature MUST be below the base wall
Do you still wish to use the same form for 'Insert_destack'? y/ny

FUNCTION – Insert_destack

NOTE: Using 'insert_destack' function:
1. 'Section_destack_horizontal' function – no longer required.
2. 'Section_destack_vertical' function – no longer required.

What is the required protruding height of each (stacked) product? (mm)?

FUNCTION: drainage_clearance

Forms available for use:
1. spaced_bosses
2. spaced_ribs

Select form: 1

FORM FEATURE – SPACED_BOSSES: Ronan_Fsp_bs0

Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of group central axis): 0 0 3
Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction:0 0 1

Specify number of bosses:3

Specify boss diameters:2

Specify diameter between boss axes:70

Specify bosses height:4

FORM FEATURE Ronan_Fsp_bs0
FUNCTIONALITY ASSESSMENT—drainage_clearance function:

Position of boss grouping satisfactory for 'drainage_clearance' function

Boss height is higher than specified to achieve 'drainage_clearance' function

Consequences:
1. Drainage clearance is greater than specified – unnecessary material in product

Remedial options:
1. Reposition feature to z position 5.5
Change position? y/n

Present height recorded

FORM FEATURE Ronan_Fsp_bs0
FUNCTIONALITY ASSESSMENT—insert_destack function:

Position of boss grouping satisfactory for insert destack function

Boss height is higher than specified to achieve 'insert_destack' function

Consequences:
1. Destack height is greater than specified – unnecessary material in product

Remedial options:
1. Reposition feature to z position 4
Change position? y/n

New position: 0 0 4

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos0

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Creating taper on solid boss Ronan_Msbos0
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees

Taper angle ok
Solid boss height ok
Solid boss width ok
Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/ny

Creating blend on solid boss Ronan_Msbos0
Enter blend radius:
Recommended minimum radius = 0.5 mm
Blend radius ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos1

Solid boss orientation ok
Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny

Creating taper on solid boss Ronan_Msbos1
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees
Taper angle ok

Solid boss height ok
Solid boss width ok
Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/ny

Creating blend on solid boss Ronan_Msbos1
Enter blend radius:
Recommended minimum radius = 0.5 mm
Blend radius ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos2

Solid boss orientation ok
Solid boss features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould.

Do you wish to create a taper? y/n/y

Creating taper on solid boss Ronan_Msbos2
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees

Taper angle ok
Solid boss height ok
Solid boss width ok

Solid boss features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n/y

Creating blend on solid boss Ronan_Msbos2
Enter blend radius:
Recommended minimum radius = 0.5 mm.5

Blend radius ok

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product.

Advise re-analysis of functional features in the given order before proceeding:

1. Ronan_Fsp_hs0

Select modification/re-analysis option on main menu

ENTER 'c' to continue:
c

1. Choose another product function
2. Modification/re-analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session
Appendix 10.

Example strategist support for the build up of a flower pot product and mould design.
Ron> import

Enter workstation: zipporah

Product ranges where data is available in the Product Range Model are:
1. Yoghurt pot range of products
2. Flower pot range of products
3. PTPlus range of products
Enter choice.
2

1. Create a new product (Initial product definition).
2. Modify existing product (Interactive product modification).
3. Delete a product and its mould
Enter choice.
1

Enter name of new product.
Ronan

Functional requirements:
enclose_horizontal
enclose_below
Section_destack_horizontal
Section_destack_vertical
Insert_destack
Drainage
Drainage_clearance

Specify functional requirements for initial product definition:

FUNCTION – Enclose horizontal
What is the enclosed volume? (mm3)77000
What is the diameter of the enclosure? (mm)70

FUNCTION – Enclose below
What is the enclosed diameter? (mm)70

FUNCTION: enclose_horizontal

Forms available for use:
1. side_wall
No more forms available.

FORM FEATURE – SIDE_WALL: Ronan_Fsid_w0
Do you wish to see feature dimensioning instructions? y/n

Specify feature position (base of central axis of rotation): 0 0 12
Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1
Specify inner diameter: 70

A10 / 2
Specify side_wall thickness: 2
Specify side_wall height: 20

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT - enclose_horizontal function:

Inner diameter satisfactory for enclose horizontal function
Enclosed volume satisfactory for enclose horizontal function

MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n y

Creating taper on wall Ronan_Mwall0
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok
Do you wish to create a new gate on this wall? y/n n

FUNCTION: enclose_below

Forms available for use:
1. base_wall
No more forms available.

FORM FEATURE - BASE_WALL: Ronan_Fbs_w10

Do you wish to see feature dimensioning instructions? y/n y

Specify feature position (centre of base): 0 0 0
Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1
Specify base_wall diameter: 74
Specify base_wall thickness: 2

FORM FEATURE Ronan_Fbs_w10
FUNCTIONALITY ASSESSMENT - enclose_below function:

Feature position satisfactory for enclose below function
Diameter satisfactory for enclose below specification
Feature outer diameter satisfactory for enclose below function

MOULDABILITY WALL FEATURE: Ronan_Mwall1

Wall thickness ok

Wall features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Creating taper on wall Ronan_Mwall1
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok

Wall thickness relative to adjacent wall ok

Wall features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Creating blend on wall Ronan_Mwall1
Enter inside radius:
Recommended inside radius is between 0.8 and 1.2 mm
0.5 mm is the recommended minimum radius

Inside blend radius ok

Enter outside radius:
Recommended outside radius is 2.8 mm

Outside blend radius ok

Do you wish to create a new gate on this wall? y/n

Creating gate on wall Ronan_Mwall1
Enter gate position X Y Z 0 0 10

Feeding distance ok

This product is thin walled (thickness < 4mm) and rotational:

Possible choices of gate type:
1. Rectangular edge gate
2. Pin gate
3. Sprue gate

Enter choice: 3

Gate type is sprue gate

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:

0. Ronan_Fsid_w0
1. Ronan_Fbs_w10
Select modification/re-analysis option on main menu

ENTER 'c' to continue: c

INITIAL PRODUCT DEFINITION PHASE COMPLETE FOR PRODUCT: Ronan

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 0

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Functional requirements:
1. insert_destack
2. section_destack_horizontal
3. section_destack_vertical
4. drainage
5. drainage_clearance
Select a product function.

FUNCTION – Drainage

What is the drainage area (mm2) 151

FUNCTION: drainage

Forms available for use:
1. spaced_holes
No more forms available.

FORM FEATURE – SPACED_HOLES: Ronan_Fsp.hl0

Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of group central axis): 0 0 9.75

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify number of holes: 3
Specify hole diameters: 8
Specify diameter between hole axes: 35
Specify depth of holes: 4

FORM FEATURE Ronan_Fsp.hl0
FUNCTIONALITY ASSESSMENT – drainage function:

A10/5
Hole group position satisfactory for drainage function
Hole depth satisfactory for drainage function
Drainage area calculation: 150.797
Hole diameter satisfactory for drainage function

MOULDABILITY HOLE FEATURE: Ronan_Mhole0
Hole orientation ok
Hole features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould
Do you wish to create a taper? y/n
Creating taper on hole Ronan_Mhole0
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees
Taper angle ok
hole to hole distance ok
Hole to side wall distance ok
Hole depth ok - This is a through hole

MOULDABILITY HOLE FEATURE: Ronan_Mhole1
Hole orientation ok
Hole features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould
Do you wish to create a taper? y/n
Creating taper on hole Ronan_Mhole1
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees
Taper angle ok
hole to hole distance ok
Hole to side wall distance ok
Hole depth ok - This is a through hole

MOULDABILITY HOLE FEATURE: Ronan_Mhole2
Hole orientation ok
Hole features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould
Do you wish to create a taper? y/n

Creating taper on hole Ronan_Mhole2
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees

Taper angle ok
hole to hole distance ok
Hole to side wall distance ok
Hole depth ok – This is a through hole

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:
1. Ronan_Fsp_h10

Select modification/re-analysis option on main menu
ENTER 'c' to continue:

1. Choose another product function
2. Modification/re-analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Functional requirements:
1. insert_destack
2. section_destack_horizontal
3. section_destack_vertical
4. drainage
5. drainage_clearance

Select a product function.5

FUNCTION: Drainage_clearance

What is the drainage clearance height (mm) 1.5

SAME FORM: 'Drainage_clearance' and 'Insert_destack' functions can be performed using the same form on flower pot type products:

Do you wish to use same form for 'Insert_destack' function? y/n

FUNCTION: drainage_clearance

Forms available for use:
1. spaced_ribs
2. spaced_bosses

Select form 2

FORM FEATURE– SPACED_BOSSES: Ronan_Fsp_bs0

Do you wish to see feature dimensioning instructions? y/n
Specify feature position (base of group central axis): 0 0 8.5

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify number of bosses: 3

Specify boss diameters: 1.5

Specify diameter between boss axes: 50

Specify bosses height: 1.5

FORM FEATURE Ronan_Fsp_bs0
FUNCTIONALITY ASSESSMENT - drainage_clearance function:

Position of boss grouping satisfactory for drainage_clearance function
Height satisfactory for drainage_clearance function
Found drain clear

UPDATE

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos0

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny

Creating taper on solid boss Ronan_Msbos0
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees

Taper angle ok

Solid boss height ok

Solid boss width is too large

Possible consequences:
1. Sink marks opposite the solid boss
2. Component warpage

Remedial options:
1. Reduce solid boss width to a maximum of: 1.33333

- No further options

Change solid boss width? y/ny

Enter new solid boss width (mm): 1.3

New width ok

Solid boss features require a blend
Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Creating blend on solid boss Ronan_Msbos0
Enter blend radius:
Recommended minimum radius = 0.5 mm

Blend radius ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos1

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Creating taper on solid boss Ronan_Msbos1
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees

Taper angle ok

Solid boss height ok

Solid boss width ok

Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Creating blend on solid boss Ronan_Msbos1
Enter blend radius:
Recommended minimum radius = 0.5 mm

Blend radius ok

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos2

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Creating taper on solid boss Ronan_Msbos2
Enter taper angle:
Recommended minimum draft angle = 5.0 degrees
Taper angle ok
Solid boss height ok
Solid boss width ok
Solid boss features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/ny

Creating blend on solid boss Ronan_Msbos2
Enter blend radius:
Recommended minimum radius = 0.5 mm.
Blend radius ok

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:
1. Ronan_Fsp_bs0

Select modification/re-analysis option on main menu
ENTER 'c' to continue:
1. Choose another product function
2. Modification/re-analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 0
1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

WARNING: Dimensional changes to cavity/core elements and application of tapers during mould design will result in dimensional changes and creation of tapers on corresponding product features

As a consequence of the above, functional relationships within the product may be invalidated

Re-analysis of all functional features in the product must be undertaken in original order of creation

Are you sure you want to go on to mould design? y/ny

Parting line is at 32 mm in the z plane
Making part_line

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVtcv_v10
taper has angle 0.8

Volume diameter ok

Blend has inner 0.8 and outer 2.8

Radius for blend = 2.8
Making blend

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVitcv_v11

taper has angle 0.8

Volume diameter ok, evaluation completed by analysis of previous feature

Blend ok, evaluation completed by analysis of previous feature

Core parting line is at 32 mm in the z plane
Making part_line

INTEGER CORE VOLUME FEATURE: Ronan_CORiter_v10

taper has angle 0.8

Volume diameter ok

Blend has inner 0.8 and outer 2.8

Radius for blend = 0.8

INTEGER CORE VOLUME FEATURE: Ronan_CORiter_v11

taper has angle 0.8

Volume diameter ok, evaluation completed by analysis of previous feature

Blend ok, evaluation completed by analysis of previous feature

No hollow boss features found for conversion to cavity/core representation

INTEGER CAVITY HOLE FEATURE: Ronan_CAVitcv_h10

Blend has radius 0.5

taper has angle 5

Radius for blend = 0.5
Making blend

Creating cavity hole

INTEGER CAVITY HOLE FEATURE: Ronan_CAVitcv_h11

Blend has radius 0.5

taper has angle 5

Radius for blend = 0.5
Making blend
Creating cavity hole

INTEGER CAVITY HOLE FEATURE: Ronan_CAVitch_hl2

Blend has radius 0.5
taper has angle 5

Radius for blend= 0.5
Making blend

No rib features found for conversion to cavity/core representation

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORitch_cr0

Blend has radius 0.5
taper has angle 5

Angle for taper= 5

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORitch_cr1

Blend has radius 0.5
taper has angle 5

Angle for taper= 5

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORitch_cr2

Blend has radius 0.5
taper has angle 5

Angle for taper= 5

Do you wish to change the gated wall? y/nn

CREATING FEEDING SYSTEM:

In order to design the feeding system it is necessary to first identify some parameters of the cooling system:

CAVITY COOLING SYSTEM: Ronan_CS

Number of cooling layers using 7 mm flow ways: 1
Number of cooling layers using 8 mm flow ways: 1
Number of cooling layers using 9 mm flow ways: 1
Number of cooling layers using 10 mm flow ways: 1

Choice of cooling tube diameter for cavity cooling system:
1. 7mm
2. 8mm
3. 9mm
4. 10mm

Lower than 7 mm – insufficient cooling effect – difficulty drilling deep holes
Higher than 10mm – high volume of water to be pumped around the mould for cooling

Maximum cooling effect for Ronan_CS cavity dimensions: 10 mm diameter
Enter choice (1-4):4

CREATING FEEDING SYSTEM:

FEEDING SYSTEM – SPRUE GATE: Ronan_Fsprue_g0

Gate position ok
Moulding machine nozzle inner diameter is 3mm
Gate diameter should be slightly larger than nozzle to allow for misalignment

Lower gate diameter has been calculated as 3.1 mm
Do you wish to change the diameter? y/n/n

Sprue length has been calculated as 29 mm
This allows the minimum cavity block depth (below cavity) to avoid mould distortion, and allows space for the cavity cooling system
Do you wish to change the sprue length? y/n/n

Enter gate taper angle:
Recommended minimum angle = 4.0 degrees (minimum recommended)4

Taper angle ok

CREATING CAVITY COOLING SYSTEM:

CAVITY COOLING SYSTEM: Ronan_CS

Choice of cooling system configurations for mould cavity:
1. paired tube configuration
2. U tube configuration

U tube configuration is not recommended when using sprue gate:
– Cooling flow ways on three sides can cause uneven cooling of the moulding

Possible consequences:
1. Differential section thickness over the moulding
2. Differential shrinkage causing component warping
Remedial options:
1. Used paired tube configuration
   - No further options

Enter choice: 1

STANDARD FLOW WAY: Ronan_CSstd_fl_w0
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_CAV
Configuration: pair
Vertical coordinate: 11 mm
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w1
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_CAV
Configuration: pair
Vertical coordinate: 11 mm
Making standard flow way

In order to calculate remaining cavity cooling system parameters it is necessary to establish cavity block dimensions:

CREATING CAVITY BLOCK FOR: Ronan_CAV

INTEGER CAVITY RECTANGULAR MOULD BLOCK: Ronan_CAVitcv_rbl0
Cavity block position: 0 0 – 19
Depth of cavity block: 48.6 mm

Choice of standard guide pin diameters:
1. 10 mm
2. 13 mm
3. 16 mm
4. 19 mm
5. 22 mm
6. 25 mm
7. 32 mm
8. 38 mm

Recommendation: Use smallest suitable guide pin diameter to minimise size and weight of mould assembly

Recommended size for current mould parameters: 3. 16 mm
Enter choice:(1–8):3

Guide pin diameter is 16 mm

Cavity block length: 178.659 mm

Cavity block width: 222 mm

INTEGER CAVITY CIRCULAR LAND: Ronan_CAVitcv_crl0
Circular land position: 0 0 29.6
Circular land depth: 2.4 mm
Circular land diameter: 84.5584 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf0
Periferal land position: 57.3296 57.3296 29.6
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf1
Periferal land position: -57.3296 57.3296 29.6
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf2
Periferal land position: 57.3296 -57.3296 29.6
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf3
Periferal land position: -57.3296 -57.3296 29.6
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

COMPLETING CAVITY COOLING SYSTEM:

STANDARD FLOW WAY: Ronan_CSstd_fl_w0
Standard flow way position: -89.3296 57.9999 11
Standard flow way length: 178.659 mm
STANDARD FLOW WAY: Ronan_CSStd_fl_w1
Standard flow way position: -89.3296 -57.9999 11
Standard flow way length: 178.659 mm

CREATING CORE COOLING SYSTEM:

CORE COOLING SYSTEM: Ronan_CS

Number of standard flow ways using 7 mm flow ways: 3
Number of standard flow ways using 8 mm flow ways: 3
Number of standard flow ways using 9 mm flow ways: 3
Number of standard flow ways using 10 mm flow ways: 3

Choice of cooling tube diameter for shallow core cooling system:
1. 7mm
2. 8mm
3. 9mm
4. 10mm

Maximum cooling effect for Ronan_CS core dimensions: 10 mm diameter

Enter choice (1-4): 4

Choice of cooling system configurations for shallow mould core at diameter 10 mm:
1. Z tube configuration
2. single tube configuration

Using Z tube configuration 'Cooler' water entering the mould at the gated end provides uneven cooling of the moulding

Possible consequences:
1. Differential section thickness over the moulding
2. Differential shrinkage causing component warping

Recommendation – Use single tube configuration

Enter choice: 2

STANDARD FLOW WAY: Ronan_CSStd_fl_w2
Position: -89.3296 -26 53
Length: 178.659 mm
Diameter: 10 mm
Orientation: 0
Cavity/core name: Ronan_COR
Configuration: single
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w3
Position: -89.3296 0 53
Length: 178.659 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR

Configuration: single
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w4
Position: -89.3296 26 53
Length: 178.659 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR

Configuration: single
Making standard flow way

INTEGER CORE RECTANGULAR BLOCK: Ronan_CORitcr_rbl0
Core block position: 0 0 34.4
length: 178.659 mm
width: 222 mm
depth: 47 mm
guide_pin_diameter: 16 mm

INTEGER CORE CIRCULAR LAND: Ronan_CORitcr_crl0
Circular land position: 0 0 32
Circular land depth: 2.4 mm
Circular land diameter: 84.5584 mm

INTEGER CORE PERIFERAL LAND: Ronan_CORitcr_pf0
Periferal land position: 57.3296 57.3296 32
Periferal land depth: 2.4 mm
INTEGRER CORE PERIFERAL LAND :Ronan_CORitcr_pf1
Periferal land position: -57.3296 57.3296 32
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

INTEGRER CORE PERIFERAL LAND :Ronan_CORitcr_pf2
Periferal land position: 57.3296 -57.3296 32
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

INTEGRER CORE PERIFERAL LAND :Ronan_CORitcr_pf3
Periferal land position: -57.3296 -57.3296 32
Periferal land depth: 2.4 mm
Periferal land diameter: 15.3297 mm

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session3

Selecting display program: 1

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 3

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options
Enter choice: 4

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 6

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

WARNING: Re-analysis of features other than as advised by the strategist can invalidate functional relationships within the product. —

Re-analysis of all functional features in the product must be undertaken in the original order of creation

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:

Name: Ronan_Fsid_w0
Type: side_wall

Do you wish to see feature dimensioning instructions? y/n

Do you wish to change the feature position? y/n

Do you wish to change the feature orientation? y/n

Do you wish to change the feature inner diameter? y/n

Specify inner diameter: 56

Do you wish to change the feature thickness? y/n

Do you wish to change the feature height? y/n

Specify side_wall height: 31

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT — enclose_horizontal function:

Present wall dimensions mean that the enclosed diameter is lower than that specified
Specified diameter: 70 mm
Consequences:
Enclose horizontal function specification not achieved

Remedial options:
1. Increase inner diameter to 70 mm—No further options
Change feature inner diameter? y/nn

Present diameter recorded
Enclosed volume satisfactory for enclose horizontal function

MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok
Wall thickness relative to adjacent wall ok

2. Re–run functional analysis.
3. Re–run mouldability analysis.
4. Return to previous menu.

Enter choice: 1

Enter feature name and type:
Name: Ronan_Fbs_w10
Type: base_wall

Do you wish to see feature dimensioning instructions? y/nn
Do you wish to change the feature position? y/nn
Do you wish to change the feature orientation? y/nn
Do you wish to change the feature diameter? y/nn

Specify diameter: 60
Do you wish to change the feature thickness? y/nn

FORM FEATURE Ronan_Fbs_w10
FUNCTIONALITY ASSESSMENT – enclose_below function:

Feature position satisfactory for enclose_below function
Base wall diameter is smaller than that specified for the 'Enclose below' function

Consequences:
1. Enclosure not achieved, product functionality lost

Remedial options:
1. Increase diameter to a minimum of 70 mm
- No further options
Change diameter? y/nn

Feature outer diameter satisfactory for enclose below function

MOULDABILITY WALL FEATURE: Ronan_Mwall1
Wall thickness ok

Wall thickness relative to adjacent wall ok

2. Re-run functional analysis.
3. Re-run mouldability analysis.
4. Return to previous menu.

Enter choice: 4

Returning to main menu

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 1

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 1

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 6

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

WARNING: Dimensional changes to cavity/core elements and application of tapers during mould design will result in dimensional changes and creation of tapers on corresponding product features. As a consequence of the above, functional relationships within the product may be invalidated.

Re-analysis of all functional features in the product must be undertaken in original order of creation.

Are you sure you want to go on to mould design? y/ny
Parting line is at 43 mm in the z plane
Making part_line

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVitcv_v10
taper has angle 0.8
Volume diameter ok
Blend has inner 0.8 and outer 2.8
Radius for blend= 2.8

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVitcv_v11
taper has angle 0.8
Volume diameter ok, evaluation completed by analysis of previous feature
Blend ok, evaluation completed by analysis of previous feature
Core parting line is at 43 mm in the z plane
Making part_line

INTEGER CORE VOLUME FEATURE: Ronan_CORitcr_v10
taper has angle 0.8
Volume diameter ok
Blend has inner 0.8 and outer 2.8
Radius for blend= 0.8

INTEGER CORE VOLUME FEATURE: Ronan_CORitcr_v11
taper has angle 0.8
Volume diameter ok, evaluation completed by analysis of previous feature
Blend ok, evaluation completed by analysis of previous feature
No hollow boss features found for conversion to cavity/core representation

INTEGER CAVITY HOLE FEATURE: Ronan_CAVitcv_h10
Blend has radius 0.5
taper has angle 5
Radius for blend= 0.5
Making blend

Angle for taper= 5
Making taper

INTEGER CAVITY HOLE FEATURE: Ronan_CAVitcv_h11
Blend has radius 0.5
taper has angle 5
Radius for blend = 0.5
Making blend
Angle for taper = 5
Making taper

INTEGER CAVITY HOLE FEATURE: Ronan_CAVity_h12
Blend has radius 0.5
taper has angle 5
Radius for blend = 0.5
Making blend
Angle for taper = 5
Making taper

No rib features found for conversion to cavity/core representation

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORiocr_hbs0
Blend has radius 0.5
taper has angle 5
Angle for taper = 5
Making taper

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORiocr_hbs1
Blend has radius 0.5
taper has angle 5
Angle for taper = 5
Making taper

Creating core boss and cavity hole

INTEGER CORE BOSS FEATURE: Ronan_CORiocr_hbs2
Blend has radius 0.5
taper has angle 5
Angle for taper = 5
Making taper
Do you wish to change the gated wall? y/ny

Please indicate which wall you wish to gate:
0. Ronan_Mwall1
1. Ronan_Mwall0

Enter choice: 1

Enter gate position X Y Z 30.0 43

Feeding distance ok

This product is thin walled (thickness < 4mm) and rotational:

Possible choices of gate type:
1. Rectangular edge gate
2. Pin gate
3. Sprue gate

Enter choice: 1

Gate type is rectangular edge gate

CREATING FEEDING SYSTEM:

In order to design the feeding system it is necessary to first identify some parameters of the cooling system:

CAVITY COOLING SYSTEM: Ronan_CS

Number of cooling layers using 7 mm flow ways: 1
Number of cooling layers using 8 mm flow ways: 1
Number of cooling layers using 9 mm flow ways: 1
Number of cooling layers using 10 mm flow ways: 1

Choice of cooling tube diameter for cavity cooling system:
1. 7mm
2. 8mm
3. 9mm
4. 10mm

Lower than 7 mm - insufficient cooling effect - difficulty drilling deep holes
Higher than 10mm - high volume of water to be pumped around the mould for cooling

Maximum cooling effect for Ronan_CS cavity dimensions: 10 mm diameter

Enter choice (1-4): 4

CREATING FEEDING SYSTEM:

FEEDING SYSTEM - RECTANGULAR EDGE GATE: Ronan_FSrected_g0

WARNING: Application of tapers on Ronan_Mwall0 for manufacturing reasons has increased the width of the cavity opening at the parting line by 0.865742 mm
Consequences:
1. Edge gate position no longer on edge of cavity:
   - Reduced land length—weakness in mould construction can lead to wear or failure

Remedial options:
1. Adjust gate position

   - No further options
Do you wish to adjust the gate position? y/ny

New gate position: 30.4329 0 43
Gate position ok

Gate land length:
Land length should be as small as possible and in any case between 0.5 and 0.75 mm
Enter land length.5
Land length ok

Gate depth:
Gate depth has been calculated as 1.4 mm
Do you wish to change the depth?y/nn

Gate width:
Gate width has been calculated as 2.21946 mm
Do you wish to change the width?y/nn

**FEEDING SYSTEM** – CIRCULAR RUNNER:Ronan_FScirc_r0

Runner length:
Runner length has been calculated as 20.0671 mm
This calculation is based on minimum distance between cavity and main sprue
Do you wish to change the length?y/nn

Runner diameter:
Runner diameter has been calculated as 2 mm
This calculation is based on minimum diameter to ensure cavity is filled before plastic in runner solidifies
Do you wish to change the diameter?y/nn

**FEEDING SYSTEM** – MAIN FEEDING SPRUE:Ronan_FSmaint_s0

Main sprue position: 50.9999 0 48
Enter main sprue taper angle:
Recommended minimum angle = 4.0 degrees (minimum recommended)4

Taper angle ok
Lower diameter of sprue = 3.1 mm to match machine nozzle diameter of 3 mm
No nozzle recess required
Sprue length has been calculated as 60 mm

This allows the minimum cavity block depth (below cavity) to avoid mould distorsion, and allows space for the cavity cooling system.

Note: 5 mm of the sprue length is to create a sprue puller in the core block

Do you wish to change the sprue length? y/n

CREATING CAVITY COOLING SYSTEM:

CAVITY COOLING SYSTEM: Ronan_CS

Choice of cooling system configurations for mould cavity:
1. paired tube configuration
2. U tube configuration

U tube configuration recommended when using single rectangular edge gate:

Bottom of the U cooling the gated side provides more even cooling of the moulding, can reduce cycle time.

Enter choice: 2

STANDARD FLOW WAY: Ronan_CS std_fl_w0

Diameter: 10 mm
Orientation: 0

Cavity/core_name: Ronan_CAV

Configuration: U_tube
Vertical coordinate: 22 mm
Making standard flow way

STANDARD FLOW WAY: Ronan_CS std_fl_w1

Diameter: 10 mm
Orientation: 0

Cavity/core_name: Ronan_CAV

Configuration: U_tube
Vertical coordinate: 22 mm
Making standard flow way

STANDARD FLOW WAY: Ronan_CS std_fl_w2

Diameter: 10 mm
Orientation: 1.5708

Cavity/core_name: Ronan_CAV

Configuration: U_tube
Vertical coordinate: 22 mm
Making standard flow way
In order to calculate remaining cavity cooling system parameters it is necessary to establish cavity block dimensions:

**CREATING CAVITY BLOCK FOR:** Ronan_CAV

**INTEGER CAVITY RECTANGULAR MOULD BLOCK:** Ronan_CAVitcv_rbl0

Cavity block position: 00-12

Depth of cavity block: 52.6 mm

Choice of standard guide pin diameters:
1. 10 mm
2. 13 mm
3. 16 mm
4. 19 mm
5. 22 mm
6. 25 mm
7. 32 mm
8. 38 mm

Single rectangular edge gate causes unbalanced forces in the mould, tending to open the mould on one side

Possible consequences:
1. Larger wall section thickness one side of the mould than on the other

Remedial options
Use guide pin size one larger than that recommended to ensure alignment of mould halves

- No further options

Recommended size for current mould parameters: 3. 16 mm

This product has a single rectangular edge gate – USE NEXT SIZE UP

Enter choice:(1-8): 3

Guide pin diameter is 16 mm

Cavity block length: 186 mm

Cavity block width: 208 mm

**INTEGER CAVITY RECTANGULAR LAND:** Ronan_CAVitcv_rcl0

Rectangular land position: 00 40.6

Rectangular land depth: 2.4 mm

Rectangular land length: 122.866 mm

Rectangular land width: 70.8656 mm

**COMPLETING CAVITY COOLING SYSTEM:**

**STANDARD FLOW WAY:** Ronan_CSstd_fl_w0
Standard flow way position: -92.9999 50.9999 22
Standard flow way length: 175 mm
STANDARD FLOW WAY:Ronan_CSstd_fl_w1
Standard flow way position: -92.9999 –50.9999 22
Standard flow way length: 175 mm
STANDARD FLOW WAY:Ronan_CSstd_fl_w2
Standard flow way position: 76.9999 –104 22
Standard flow way length: 160 mm
LOWEST DIAMETER FOR CORE =:52.9999

CREATING CORE COOLING SYSTEM:

CORE COOLING SYSTEM:Ronan_CS

Choice of cooling system configurations for deep mould core:

1. Baffled straight hole system –
Large cooling capacity, easy to manufacture.

2. Angled hole system –
Does not work for the deepest cores, hard to manufacture due to angled holes, small cooling capacity compared to baffle system.

3. Stepped circuit system –
Holes drilled through core into cavity, requiring plugging and finishing, small cooling capacity compared to baffle system.

Use baffle system for deep core:

Number of baffle flow ways using 12 mm flow ways: 1
Number of baffle flow ways using 13 mm flow ways: 1
Number of baffle flow ways using 14 mm flow ways: 1
Number of baffle flow ways using 15 mm flow ways: 1
Number of baffle flow ways using 16 mm flow ways: 1

Choice of cooling tube diameter for deep core cooling system:
1. 12mm
2. 13mm
3. 14mm
4. 15mm
5. 16mm

Maximum cooling effect for Ronan_CS core dimensions: 16 mm diameter

Enter choice (1–5): 5

Number of baffle flow ways through the centre of the core: 1
Diameter of standard flow way to connect baffle flow ways has been calculated as 10 mm

STANDARD FLOW WAY: Ronan_CSstd_fl_w3

Position: -92.9999 0.69
Length: 186 mm
Diameter: 10 mm
Orientation: 0
Cavity/core name: Ronan_COR
Configuration: deep
Making standard flow way

BAFFLE FLOW WAY: Ronan_CSbff_fl_w0

Baffle flow way position: -2.49993 0 92.4
Baffle flow way diameter: 16 mm
Baffle flow way length: 64.4 mm
Configuration: deep
Cavity/core name: Ronan_COR
Making baffle flow way

BAFFLE BLADE: Ronan_CSbff_fl_bl0

Baffle blade: -2.49993 0 92.4
Baffle blade length: 48.4 mm
Baffle blade width: 15.5 mm
Baffle blade thickness: 2 mm
Configuration: deep
Cavity/core name: Ronan_COR
Making baffle blade

INTEGER CORE RECTANGULAR BLOCK: Ronan_CORicr_rbl0

Core block position: 0 0 45.4
length: 186 mm
width: 208 mm
depth: 47 mm

guide_pin_diameter: 16 mm

INTEGER CORE RECTANGULAR LAND: Ronan_CORicr_rc10
Rectangular land position: 0 0 43

Rectangular land depth: 2.4 mm

Rectangular land length: 122.866 mm

Rectangular land width: 70.8656 mm

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 1

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 3

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 4

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 6

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Session terminated.
Appendix 11.

Example strategist support for the build up of a PTPlus product and mould design.
Ron> import

Enter workstation: zipporah

Product ranges where data is available in the Product Range Model are:
1. Yoghurt pot range of products
2. Flower pot range of products
3. PTPlus range of products
Enter choice.
3

1. Create a new product (Initial product definition).
2. Modify existing product (Interactive product modification).
3. Delete a product and its mould
Enter choice.
1

Enter name of new product.
Ronan

Functional requirements:
locate_in_lid
locate_on_jar
break_in_torsion
hold_in_lid
hold_on_jar
prevent_rotation
cover_lid_edge

Specify functional requirements for initial product definition:

FUNCTION – locate_in_lid

What is the inner diameter of the metal lid? (mm) 52.44

Note: location surface contains flange for 'hold_in_lid' function as well as mating with inside lid surface

What is the height of the location surface? (mm) 3.0

FUNCTION – break_in_torsion

What is the breakage torsion required? (Nmm) 1220

FUNCTION – locate_on_jar

What is the outer diameter of the jar neck? (mm) 50.08

What is the height of the location surface? (mm) 3.5

FUNCTION: locate_in_lid

Forms available for use:
1. side_wall
No more forms available.

FORM FEATURE – SIDE_WALL: Ronan_Fsid_w0
Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of central axis of rotation): 0 0 10

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify inner diameter: 50.44

Specify side_wall thickness: 1

Specify side_wall height: 3.0

FORM FEATURE Ronan_Fsid_w0
FUNCTIONALITY ASSESSMENT - locate_in_lid function:

Feature height satisfactory for locate in lid function
Feature diameter satisfactory for locate in lid function

MOULDABILITY WALL FEATURE: Ronan_Mwall0

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny

Creating taper on wall Ronan_Mwall0
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok
Do you wish to create a new gate on this wall? y/ny

Creating gate on wall Ronan_Mwall0

Enter gate position X Y Z 26.22 0 12

Feeding distance ok

This product is tubular:

Possible choices of gate type:
1. Rectangular edge gate
2. Pin gate
3. Diaphragm gate
4. Ring gate

Enter choice: 1

Gate type is rectangular edge gate

FUNCTION: break_in_torsion

Forms available for use:
1. spaced_bosses
No more forms available.
Do you wish to see feature dimensioning instructions? y/n

Specify feature position (base of group central axis): 0 0 9.75

Specify feature orientation 1 O 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify number of bosses: 3

Specify boss diameters: .17

Specify diameter between boss axes: 52

Specify bosses height: .25

FORM FEATURE Ronan_Fsp_bs0

FUNCTIONALITY ASSESSMENT—break_in_torsion function:

Torque specification: 1220
Feature position satisfactory for break in torsion function
Group diameter satisfactory for break in torsion function
Torque calculation: 1208.07
Torque at failure satisfactory for break in torsion function

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos0

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Solid boss height ok

Solid boss width ok

Solid boss features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos1

Solid boss orientation ok

Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n
Solid boss height ok
Solid boss width ok
Solid boss features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/nn

MOULDABILITY SOLID BOSS FEATURE: Ronan_Msbos2
Solid boss orientation ok
Solid boss features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/nn

Solid boss height ok
Solid boss width ok
Solid boss features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/nn

FUNCTION: locate_on_jar

Forms available for use:
1. side_wall
No more forms available.

FORM FEATURE- SIDE_WALL: Ronan_Fsid_w1

Do you wish to see feature dimensioning instructions? y/nn

Specify feature position (base of central axis of rotation): 0 0 6.25

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify inner diameter: 50.08
Specify side_wall thickness: 1
Specify side_wall height: 3.5

FORM FEATURE Ronan_Fsid_w1
FUNCTIONALITY ASSESSMENT- locate_on_jar function:
Feature height satisfactory for locate on jar function
Feature position satisfactory for locate on jar function

Wall outer diameter is less than that of adjacent boss grouping

Consequences:
1. Breakage torsion is drastically reduced from that intended and cannot be estimated

Remedial options:
1. Increase wall diameter to be in full contact with the boss grouping
   Maximum outer wall diameter for full contact: 53.83
   Minimum outer wall diameter for full contact: 52.17

---No further options

Increase the outer diameter? y/n
Enter new outer diameter: 52.18

To maintain constant inner diameter new thickness should be: 1.05
Do you wish to adjust the thickness? y/n

New thickness: 1.05

Feature diameter satisfactory for locate on jar function

MOULDABILITY WALL FEATURE: Ronan_Mwall1

Wall thickness ok

Wall features require a taper

Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/n

Creating taper on wall Ronan_Mwall1
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok

Wall thickness is not the same as adjacent wall

Possible consequences:
1. Feeding problems if a thick section is fed by a thin section
2. Stress concentrations at abrupt section changes
3. Abrupt section changes can interfere with the flow of material in the mould causing surface defects
4. Component warpage

Remedial options:
1. Make wall thickness the same or near to that of adjacent wall (1)
2. If the difference in thickness must remain make sure the change is not abrupt

---No further options

Change wall thickness? y/n

Present thickness recorded
Wall features require a blend

Possible consequences of non inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/n

Do you wish to create a new gate on this wall? y/n

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:

0. Ronan_Fsid_w0
1. Ronan_Fsp_bs0
2. Ronan_Fsid_w1

Select modification/re-analysis option on main menu

ENTER 'c' to continue:

INITIAL PRODUCT DEFINITION PHASE COMPLETE FOR PRODUCT: Ronan

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

WARNING: Dimensional changes to cavity/core elements and application of tapers during mould design will result in dimensional changes and creation of tapers on corresponding product features

As a consequence of the above, functional relationships within the product may be invalidated

Re-analysis of all functional features in the product must be undertaken in original order of creation

Are you sure you want to go on to mould design? y/n

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVitcv_vl0

taper has angle 0.8

Volume diameter ok

No blend required between Ronan_Mwall1 and Ronan_Mwall0
Entity boundaries do not meet

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVitcv_vl1

taper has angle 0.8

Volume diameter ok, evaluation completed by analysis of previous feature
Blend ok, evaluation completed by analysis of previous feature

Core parting line is at 13 mm in the z plane
INTEGER CORE VOLUME FEATURE: Ronan_CORitr_cvl0

taper has angle 0.8

Volume diameter ok.

No blend required between Ronan_Mwall1 and Ronan_Mwall0.
 Entity boundaries do not meet.

INTEGER CORE VOLUME FEATURE: Ronan_CORitr_cvl1

taper has angle 0.8

Volume diameter ok, evaluation completed by analysis of previous feature.

Blend ok, evaluation completed by analysis of previous feature.

We have a group volume.

Location = 9.75

Identifying local insert features that make up group volume.

INTEGER CAVITY GROUP VOLUME FEATURE: Ronan_CAVitr_grv0

Cavity volume diameter is too small, an overhang exists.

Possible consequences:
1. Split mould required.
2. If there is a rim the component cannot be removed from the mould even if it is split – COMPONENT NON MOULDABLE.

Remedial options:
1. Increase volume diameter to a minimum of 52.2776 mm.
   - No further options.

Change volume diameter? y/n/y

Enter new volume diameter (mm): 52.28

New diameter ok.

INTEGER CORE GROUP VOLUME FEATURE: Ronan_CORitr_grv0

Core volume diameter is too large, an overhang exists.

Possible consequences:
1. For an overhang of up to 1.5 mm, stripping of the component from the core is required for removal.
2. If the overhang is larger than 1.5 mm the component cannot be removed from the mould unless a collapsible core can be designed.

Remedial options:
1. Reduce volume diameter to a minimum of 50.4399 mm.
   - No further options.
WARNING: changing the core group volume diameter also changes the CAVITY group volume diameter, which can result in the need for a split cavity
Maximum diameter on core to prevent split cavity requirement :52.4399
Minimum diameter on core to prevent split cavity requirement :52.2776

Change volume diameter? y/n

Present diameter recorded – Component stripping required

INTEGER CAVITY GROUP VOLUME FEATURE: Ronan_CAViter_grv0

Volume diameter ok

No hollow boss features found for conversion to cavity/core representation

All solid boss features are part of a group volume in the cavity/core

No rib features found for conversion to cavity/core representation

No hole features found for conversion to cavity/core representation

Do you wish to change the gated wall? y/n

CREATING FEEDING SYSTEM:

In order to design the feeding system it is necessary to first identify some parameters of the cooling system:

CAVITY COOLING SYSTEM: Ronan_CS

Number of cooling layers using 7 mm flow ways: 1

Number of cooling layers using 8 mm flow ways: 1

Number of cooling layers using 9 mm flow ways: 1

Number of cooling layers using 10 mm flow ways: 1

Choice of cooling tube diameter for cavity cooling system:

1. 7mm
2. 8mm
3. 9mm
4. 10mm

Lower than 7 mm – insufficient cooling effect – difficulty drilling deep holes

Higher than 10mm – high volume of water to be pumped around the mould for cooling

Maximum cooling effect for Ronan_CS cavity dimensions: 10 mm diameter

Enter choice (1-4):4

CREATING FEEDING SYSTEM:

FEEDING SYSTEM – RECTANGULAR EDGE GATE: Ronan_FSrected_g0

WARNING: Application of tapers on Ronan_Mwall0 for manufacturing reasons has increased the width of the cavity opening at the parting line by 0.0837814 mm
Consequences:
1. Edge gate position no longer on edge of cavity:
   - Reduced land length—weakness in mould construction can lead to wear or failure

Remedial options:
1. Adjust gate position
   - No further options
Do you wish to adjust the gate position? y/ny

New gate position: 26.2619 0 12

Gate position 26.2619 0 12 is not on the parting line

Consequences:
1. Component and feed system cannot be ejected—COMPONENT NON MOULDABLE
2. Gate and runner system cannot be machined into cavity block—MOULD NON MANUFACTURABLE

Remedial options:
1. Move gate to parting line
   - No further options
Gate position has been recalculated to 26.2619 0 13
Do you wish to change the new position? y/ny

Enter new gate position (X Y Z): 26.2619 0 13
New position recorded

Gate land length:
Land length should be as small as possible and in any case between 0.5 and 0.75 mm
Enter land length.5
Land length ok

Gate depth:
Gate depth has been calculated as 0.7 mm
Do you wish to change the depth? y/nn

Gate width:
Gate width has been calculated as 1.33192 mm
Do you wish to change the width? y/nn

FEEDING SYSTEM—CIRCULAR RUNNER: Ronan_FScirc_r0

Runner length:
Runner length has been calculated as 20.458 mm
This calculation is based on minimum distance between cavity and main sprue
Do you wish to change the length? y/nn

Runner diameter:
Runner diameter has been calculated as 2 mm

This calculation is based on minimum diameter to ensure cavity is filled before plastic in runner solidifies
Do you wish to change the diameter? y/n

FEEDING SYSTEM – MAIN FEEDING SPRUE: Ronan_FSmain_s0

Main sprue position: 47.2199 0 18
Enter main sprue taper angle:
Recommended minimum angle = 4.0 degrees (minimum recommended) 4.0

Taper angle ok

Lower diameter of sprue = 3.1 mm to match machine nozzle diameter of 3 mm

No nozzle recess required

Sprue length has been calculated as 47 mm

This allows the minimum cavity block depth (below cavity) to avoid mould distortion, and allows space for the cavity cooling system.
Note: 5 mm of the sprue length is to create a sprue puller in the core block
Do you wish to change the sprue length? y/n

CREATING CAVITY COOLING SYSTEM:

CAVITY COOLING SYSTEM: Ronan_CS

Choice of cooling system configurations for mould cavity:
1. paired tube configuration
2. U tube configuration

U tube configuration recommended when using single rectangular edge gate:

Bottom of the U cooling the gated side provides more even cooling of the moulding, can reduce cycle time.

Enter choice: 2

STANDARD FLOW WAY: Ronan_CSstd_f1_w0

Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_CAV
Configuration: U_tube
Vertical coordinate: -8 mm
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_f1_w1

Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_CAV
Configuration: U_tube
Vertical coordinate: -8 mm
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w2
Diameter: 10 mm
Orientation: 1.5708
Cavity/core_name: Ronan_CAV
Configuration: U_tube
Vertical coordinate: -8 mm
Making standard flow way

In order to calculate remaining cavity cooling system parameters it is necessary to establish cavity block dimensions:

CREATING CAVITY BLOCK FOR: Ronan_CAV

INTEGER CAVITY RECTANGULAR MOULD BLOCK: Ronan_CAVtccv_rbl0

Cavity block position: 0 0 -29

Depth of cavity block: 39.6 mm

Choice of standard guide pin diameters:
1. 10 mm
2. 13 mm
3. 16 mm
4. 19 mm
5. 22 mm
6. 25 mm
7. 32 mm
8. 38 mm

Single rectangular edge gate causes unbalanced forces in the mould, tending to open the mould on one side.

Possible consequences:
1. Larger wall section thickness on one side of the mould than on the other

Remedial options
Use guide pin size one larger than that recommended to ensure alignment of mould halves

– No further options

Recommended size for current mould parameters: 3. 16 mm

This product has a single rectangular edge gate – USE NEXT SIZE UP

Enter choice: (1–8): 3

Guide pin diameter is 16 mm
Cavity block length: 178.44 mm
Cavity block width: 200.44 mm
Making rblck

INTEGER CAVITY RECTANGULAR LAND: Ronan_CAVitcv_rc10
Rectangular land position: 0 0 10.6
Rectangular land depth: 2.4 mm
Rectangular land length: 114.524 mm
Rectangular land width: 62.5237 mm
Making rcld

COMPLETING CAVITY COOLING SYSTEM:
STANDARD FLOW WAY: Ronan_CSstd_fl_w0
Standard flow way position: -89.2199 47.2199 -8
Standard flow way length: 167.44 mm
STANDARD FLOW WAY: Ronan_CSstd_fl_w1
Standard flow way position: -89.2199 -47.2199 -8
Standard flow way length: 167.44 mm
STANDARD FLOW WAY: Ronan_CSstd_fl_w2
Standard flow way position: 73.2199 -100.22 -8
Standard flow way length: 152.44 mm

CREATING CORE COOLING SYSTEM:
CORE COOLING SYSTEM: Ronan_CS
Number of standard flow ways using 7 mm flow ways: 2
Number of standard flow ways using 8 mm flow ways: 2
Number of standard flow ways using 9 mm flow ways: 2
Number of standard flow ways using 10 mm flow ways: 2

Choice of cooling tube diameter for shallow core cooling system:
1. 7mm
2. 8mm
3. 9mm
4. 10mm

Maximum cooling effect for Ronan_CS core dimensions: 10 mm diameter
Enter choice (1-4): 4

Choice of cooling system configurations for shallow mould core at diameter 10 mm:
1. paired tube configuration

2. U_tube configuration

U_tube configuration recommended when using single edge gate or single pin gate:

Bottom of the U cooling the gated side provides more even cooling of the moulding, can reduce cycle time.

Enter choice: 2

STANDARD FLOW WAY: Ronan_CSstd_fl_w3
Position: -89.2199 -13 34
Length: 141.44 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w4
Position: -89.2199 13 34
Length: 141.44 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way

STANDARD FLOW WAY: Ronan_CSstd_fl_w5
Position: 47.2199 100.2234
Length: 118.22 mm
Diameter: 10 mm
Orientation: 4.7124
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way

INTEGER CORE RECTANGULAR BLOCK: Ronan_CORitcr_rbl0
Core block position: 0 0 15.4
length: 178.44 mm
width: 200.44 mm
depth: 42 mm
guide_pin_diameter: 16 mm

INTEGER CORE RECTANGULAR LAND: Ronan_CORicer_rcl0

Rectangular land position: 0 0 13
Rectangular land depth: 2.4 mm
Rectangular land length: 114.524 mm
Rectangular land width: 62.5237 mm

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 1

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 3

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 4

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

A11/15
Enter choice: 3

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 1

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 6

1. Go on to Interactive product Modification design phase
2. Modification/re-analysis of existing forms
3. Display options
4. Go on to mould design
5. End session

Functional requirements:
1. hold_in_lid
2. hold_on_Jar
3. prevent_rotation
4. cover_lid_edge

Select a product function. 1

FUNCTION – hold_in_lid

What is the maximum fixing diameter, ie diameter inside lid? (mm) 54.8

FUNCTION: hold_in_lid

Forms available for use:
1. flange

No more forms available.

FORM FEATURE – FLANGE: Ronan_Fflang0

Do you wish to see feature dimensioning instructions? y/n/n

Specify feature position (base of axis of rotation): 0 0 12

Specify feature orientation 1 0 0 major axis is X direction
0 1 0 major axis is Y direction, 0 0 1 major axis is Z direction: 0 0 1

Specify inner diameter: 52.44
Specify flange width: .5
Specify flange thickness: 1.0

FORM FEATURE Ronan_Fflang0
FUNCTIONALITY ASSESSMENT—hold_in_lid function:
- Feature position satisfactory for hold in lid function
- Inner diameter satisfactory for hold in lid function
- Feature outer diameter satisfactory for hold in lid function
- Found hold_lid

UPDATE

MOULDABILITY WALL FEATURE: Ronan_Mwall2

Wall thickness ok
Wall features require a taper
Consequences of non-inclusion of a taper can be difficulty in removal of the component from the mould

Do you wish to create a taper? y/ny
Creating taper on wall Ronan_Mwall2
Enter taper angle:
Recommended minimum draft angle = 0.8 degrees

Taper angle ok
Wall thickness relative to adjacent wall ok
Wall features require a blend

Possible consequences of non-inclusion:
1. Stress concentrations in the component
2. Turbulent flow around the corner can cause surface defects

Do you wish to create a blend? y/ny
Creating blend on wall Ronan_Mwall2
Enter inside radius:
Recommended inside radius is between 0.5 and 0.6 mm
0.5 mm is the recommended minimum radius

Inside blend radius ok
Enter outside radius:
Recommended outside radius is 1.5 mm

Outside blend radius ok
Do you wish to create a new gate on this wall? y/nn

WARNING: Application of tapers for manufacturing objectives may invalidate the functional relationships within the product

Advise re-analysis of functional features in the given order before proceeding:
Select modification/re-analysis option on main menu

ENTER 'c' to continue:

1. Choose another product function
2. Modification/re-analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

WARNING: Dimensional changes to cavity/core elements and application of tapers during mould design will result in dimensional changes and creation of tapers on corresponding product features.

As a consequence of the above, functional relationships within the product may be invalidated.

Re-analysis of all functional features in the product must be undertaken in original order of creation.

Are you sure you want to go on to mould design? y/n/y

Parting line is at 13 mm in the z plane

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVItcv_v0

taper has angle 0.8

Volume diameter ok

No blend required between Ronan_Mwall1 and Ronan_Mwall0

Entity boundaries do not meet

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVItcv_v1

taper has angle 0.8

Volume diameter ok

Blend has inner 0.5 and outer 1.5

INTEGER CAVITY VOLUME FEATURE: Ronan_CAVItcv_v2

taper has angle 0.8

Volume diameter ok, evaluation completed by analysis of previous feature

Blend ok, evaluation completed by analysis of previous feature

Core parting line is at 13 mm in the z plane

INTEGER CORE VOLUME FEATURE: Ronan_CORItcr_v0

taper has angle 0.8

Volume diameter ok
No blend required between Ronan_Mwall1 and Ronan_Mwall0
Entity boundaries do not meet

INTEGER CORE VOLUME FEATURE: Ronan_CORitcr_vl1
taper has angle 0.8
Volume diameter ok
No blend required between two core volumes of the same diameter

INTEGER CORE VOLUME FEATURE: Ronan_CORitcr_vl2
taper has angle 0.8
Volume diameter ok, evaluation completed by analysis of previous feature
Blend ok, evaluation completed by analysis of previous feature

We have a group volume
Location = 9.75

Identifying local insert features that make up group volume

INTEGER CAVITY GROUP VOLUME FEATURE: Ronan_CAVitcr_grv0
Volume diameter ok

INTEGER CORE GROUP VOLUME FEATURE: Ronan_CORitcr_llfVO
Core volume diameter is too large, an overhang exists

Possible consequences:
1. For an overhang of up to 1.5 mm, stripping of the component from the core is required for removal
2. If the overhang is larger than 1.5 mm, the component cannot be removed from the mould unless a collapsible core can be designed

Remedial options:
1. Reduce volume diameter to a minimum of 50.4399 mm
   No further options

WARNING: changing the core group volume diameter also changes the CAVITY group volume diameter, which can result in the need for a split cavity
Maximum diameter on core to prevent split cavity requirement: 52.4399
Minimum diameter on core to prevent split cavity requirement: 52.2776

Change volume diameter? y/nn

Present diameter recorded – Component stripping required
In Mould_manuf

INTEGER CAVITY GROUP VOLUME FEATURE: Ronan_CAVitcr_grv0
Volume diameter ok
No hollow boss features found for conversion to cavity/core representation

All solid boss features are part of a group volume in the cavity/core

No rib features found for conversion to cavity/core representation

No hole features found for conversion to cavity/core representation

LOWEST Z FOR CAVITY = 6.25

Do you wish to change the gated wall? y/n/y

Please indicate which wall you wish to gate:
0. Ronan_Mwall1
1. Ronan_Mwall0
2. Ronan_Mwall2

Enter choice: 0

Enter gate position X Y 25.5 0 6.25

Feeding distance ok

This product is tubular:

Possible choices of gate type:
1. Rectangular edge gate
2. Pin gate
3. Diaphram gate
4. Ring gate

Enter choice: 2

Gate type is pin gate

WARNING: Use of a pin gate requires a three plate mould.
Other possible gate types only require two plate moulds
Do you still want to specify a pin gate type? y/n/y

Gate type is pin gate

- Three plate mould required

CREATING FEEDING SYSTEM:

In order to design the feeding system it is necessary to first identify some parameters of the cooling system:

CAVITY COOLING SYSTEM: Ronan_CS

Number of cooling layers using 7 mm flow ways: 1
Number of cooling layers using 8 mm flow ways: 1
Number of cooling layers using 9 mm flow ways: 1
Number of cooling layers using 10 mm flow ways: 1

Choice of cooling tube diameter for cavity cooling system:
1. 7mm
2. 8mm  
3. 9mm  
4. 10mm  
Lower than 7 mm – insufficient cooling effect – difficulty drilling deep holes  
Higher than 10mm – high volume of water to be pumped around the mould for cooling  
Maximum cooling effect for Ronan_CS cavity dimensions: 10 mm diameter  
Enter choice (1-4):4  
CREATING FEEDING SYSTEM:  
FEEDING SYSTEM – PIN GATE: Ronan_FSpin_g0  
WARNING: Application of tapers on Ronan_Mwall1 for manufacturing reasons has decreased the base diameter of the cavity by 0.0279271 mm  
Consequences:  
1. Pin gate position no longer same distance from edge of section:  
Remedial options:  
1. Adjust gate position  
– No further options  
Do you wish to adjust the gate position? y/ny  
New gate position: 25.486 0 6.25  
Gate position ok  
Gate land length:  
Land length should be as small as possible and in any case between 0.5 and 0.75 mm  
Enter land length.5  
Land length ok  
Gate diameter:  
Gate diameter has been calculated as 1.22121 mm  
Do you wish to change the diameter?y/nn  
Enter gate taper angle:  
Recommended minimum angle = 4.0 degrees (minimum recommended)4.0  
Taper angle ok  
Min under:18  
Secondary sprue length has been calculated as 34.75 mm  
This allows the minimum cavity block depth (below cavity) to avoid mould distortion, and allows space for the cavity cooling system  
Do you wish to change the secondary sprue length?y/nn  
FEEDING SYSTEM – TRAPESOIDAL RUNNER: Ronan_FStrap_r0  
Runner length:
Runner length has been calculated as 45.486 mm
This calculation is based on minimum distance between pin gate secondary sprue and a central main sprue
Do you wish to change the length? y/n

Secondary sprue diameter at junction with runner: 3.64821

Runner width:
Runner width has been calculated as 3.64821 mm
This calculation is based on the diameter of the secondary sprue where it joins the runner. Runner width should be at least as large as the sprue diameter up to a maximum of 10 mm
Do you wish to change the width? y/n

FEEDING SYSTEM - MAIN FEEDING SPRUE: Ronan_FSmain_s0
Main sprue position: 0 0 -32.6482
Enter main sprue taper angle:
Recommended minimum angle = 4.0 degrees (minimum recommended) 4.0
Taper angle ok

Lower diameter of sprue = 3.1 mm to match machine nozzle diameter of 3 mm
Sprue length has been calculated as 18 mm
This allows the minimum backing plate depth to avoid mould distortion
Do you wish to change the sprue length? y/n

CREATING CAVITY COOLING SYSTEM:

CAVITY COOLING SYSTEM: Ronan_CS
Choice of cooling system configurations for mould cavity:
1. paired tube configuration
2. U tube configuration

U tube configuration recommended when using single pin gate:
Bottom of the U cooling the gated side provides more even cooling of the moulding, can reduce cycle time.
Enter choice: 2

STANDARD FLOW WAY: Ronan_CSstd_fl_w0
Diameter: 10 mm
Orientation: 0
Cavity/core name: Ronan_CAV
Configuration: U tube
Vertical coordinate: -8 mm
Making standard flow way
In order to calculate remaining cavity cooling system parameters it is necessary to establish cavity block dimensions:

**CREATING CAVITY BLOCK FOR: Ronan_CAV**

**INTEGER CAVITY RECTANGULAR MOULD BLOCK :Ronan_CAVtcv_rbl0**

**Cavity block position:** 00-29

**Depth of cavity block:** 39.6 mm

**Choice of standard guide pin diameters:**
1. 10 mm
2. 13 mm
3. 16 mm
4. 19 mm
5. 22 mm
6. 25 mm
7. 32 mm
8. 38 mm

**Recommendation:** Use smallest suitable guide pin diameter to minimise size and weight of mould assembly.

**Recommended size for current mould parameters:** 2. 13 mm

**Enter choice:** (1–8): 2

**Guide pin diameter is 13 mm**

**Cavity block length:** 142.54 mm

**Cavity block width:** 189.44 mm
INTEGER CAVITY CIRCULAR LAND: Ronan_CAVitcv_cr0
Circular land position: 0 0 10.6
Circular land depth: 2.4 mm
Circular land diameter: 63.4678 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf0
Periferal land position: 45.2698 45.2698 10.6
Periferal land depth: 2.4 mm
Periferal land diameter: 13.5499 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf1
Periferal land position: -45.2698 45.2698 10.6
Periferal land depth: 2.4 mm
Periferal land diameter: 13.5499 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf2
Periferal land position: 45.2698 -45.2698 10.6
Periferal land depth: 2.4 mm
Periferal land diameter: 13.5499 mm

INTEGER CAVITY PERIFERAL LAND: Ronan_CAVitcv_pf3
Periferal land position: -45.2698 -45.2698 10.6
Periferal land depth: 2.4 mm
Periferal land diameter: 13.5499 mm

INTEGER CAVITY BACKING PLATE: Ronan_CAVitcv_bk0
Backig plate position: 0 0 -50.6482
Backig plate width: 189.44 mm
Backig plate length: 142.54 mm
Backig plate depth: 21.6482 mm
Making backing block

COMPLETING CAVITY COOLING SYSTEM:
STANDARD FLOW WAY: Ronan_CSstd_fl_w0
Standard flow way position: -71.2698 47.7199 -8
Standard flow way length: 123.99 mm
STANDARD FLOW WAY:Ronan_CSstd_fl_w1
Standard flow way position: -71.2698 -47.7199 -8
Standard flow way length: 123.99 mm
STANDARD FLOW WAY:Ronan_CSstd_fl_w2
Standard flow way position: 47.7199 -94.7199 -8
Standard flow way length: 147.44 mm
LOWEST DIAMETER FOR CORE =: 50.4399
CREATING CORE COOLING SYSTEM:
CORE COOLING SYSTEM:Ronan_CS
Number of standard flow ways using 7 mm flow ways: 2
Number of standard flow ways using 8 mm flow ways: 2
Number of standard flow ways using 9 mm flow ways: 2
Number of standard flow ways using 10 mm flow ways: 2
Choice of cooling tube diameter for shallow core cooling system:
1. 7mm
2. 8mm
3. 9mm
4. 10mm
Maximum cooling effect for Ronan_CS core dimensions: 10 mm diameter
Enter choice (1-4): 4
Choice of cooling system configurations for shallow mould core at diameter 10 mm:
1. paired tube configuration
2. U_tube configuration
U tube configuration recommended when using single edge gate or single pin gate:
Bottom of the U cooling the gated side provides more even cooling of the moulding, can reduce cycle time.
Enter choice: 2
STANDARD FLOW WAY:Ronan_CSstd_fl_w3
Position: -71.2698 -13 34
Length: 123.99 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way
STANDARD FLOW WAY: Ronan_CSstd_fl_w4
Position: -71.2698 13 34
Length: 123.99 mm
Diameter: 10 mm
Orientation: 0
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way
STANDARD FLOW WAY: Ronan_CSstd_fl_w5
Position: 47.7199 94.7199 34
Length: 112.72 mm
Diameter: 10 mm
Orientation: 4.7124
Cavity/core_name: Ronan_COR
Configuration: U_tube
Making standard flow way
INTEGER CORE RECTANGULAR BLOCK: Ronan_CORitc_rbi0
Core block position: 0 0 15.4
length: 142.54 mm
width: 189.44 mm
depth: 42 mm
guide_pin_diameter: 13 mm

INTEGER CORE CIRCULAR LAND : Ronan_CORitc_cr10
Circular land position: 0 0 13
Circular land depth: 2.4 mm
Circular land diameter: 63.4678 mm

INTEGER CORE PERIFERAL LAND : Ronan_CORitc_pf10
Periferalland position: 45.2698 45.2698 13
Periferalland depth: 2.4 mm
Periferalland diameter: 13.5499 mm

INTEGER CORE PERIFERAL LAND : Ronan_CORitcr_pf1
Periferalland position: -45.2698 45.2698 13
Periferalland depth: 2.4 mm
Periferalland diameter: 13.5499 mm

INTEGER CORE PERIFERAL LAND : Ronan_CORitcr_pf2
Periferalland position: 45.2698 -45.2698 13
Periferalland depth: 2.4 mm
Periferalland diameter: 13.5499 mm

INTEGER CORE PERIFERAL LAND : Ronan_CORitcr_pf3
Periferalland position: -45.2698 -45.2698 13
Periferalland depth: 2.4 mm
Periferalland diameter: 13.5499 mm

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Selecting display program: 1

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 3

Display options:
1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 4

Display options:

1. Show product only
2. Product and feeding system
3. Cavity block
4. Core block
5. Cooling system
6. Exit display options

Enter choice: 6

1. Choose another product function
2. Modification/re_analysis of existing functional forms
3. Display options
4. Go on to mould design
5. End session

Session terminated. Ron>