

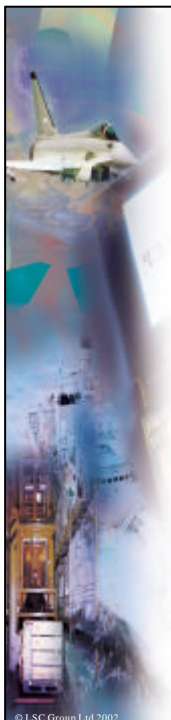
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## **AP224 edition 3**

**Alan Crawford & William Bowland**

**Monday, 11 March 2002  
Myrtle Beach**

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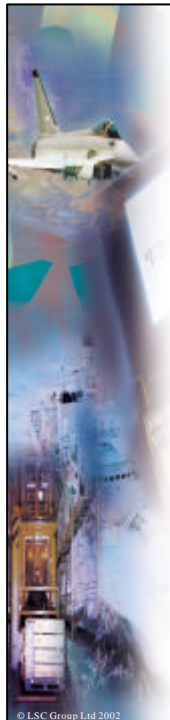


## **Presentation Topics**

- **Current status**
  - ▢ Prepare as NWI for June
- **Project Plan**
  - ▢ PWI AP224 edition 3 – gears feature
  - ▢ Cast and forged component examples
  - ▢ Standard components
  - ▢ Material properties
  - ▢ Suggested improvements to include

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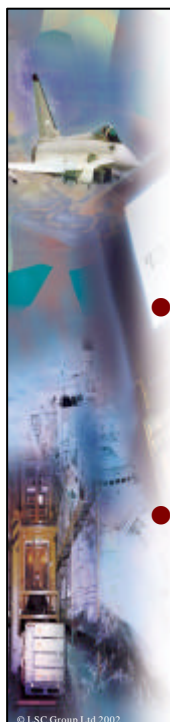
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## PWI current status

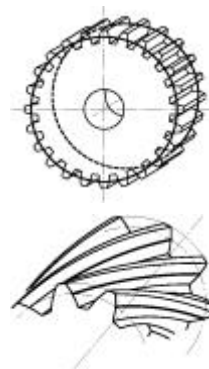
- **Gear manufacturing data**
  - ▢ Updated feature parameters work by WSA
- **References to standard parts**
  - ▢ Quantifiable task
- **Pre-formed materials**
  - ▢ Castings + forgings input from trials
- **Material properties**
  - ▢ Facilitate the use of composite base shape?
- **Loose ends**

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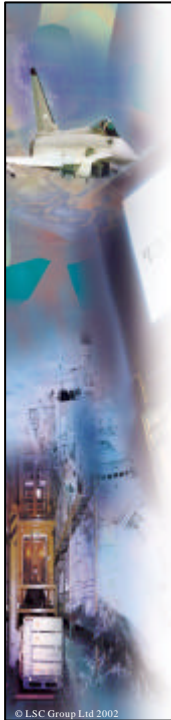


## AP224 Gear Feature

- **Scope...**
  - ▢ Cylindrical gears
  - ▢ Involute teeth
  - ▢ Spur & helical form
- **Source information...**
  - ▢ ISO 1122-1: Definitions related to geometry
  - ▢ Symbols consistent with AGMA & ANSI



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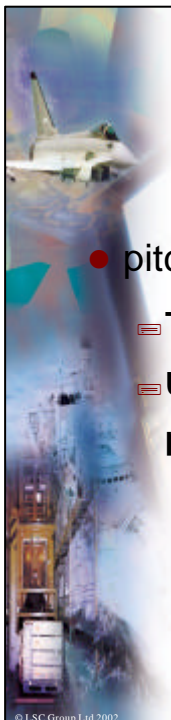


# Requirements

- Master parameter set
- Spur gear parameters
- Helical gear parameters
- Derived parameters
- Gear modifications
- Feature application requirements

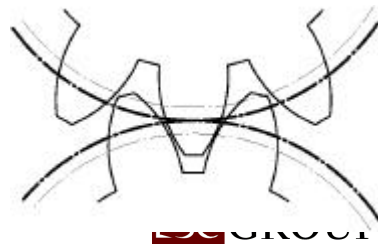
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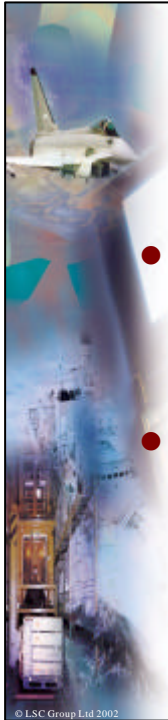


## Master Parameters (1 of 5)

- pitch\_diameter ( $D$ )
  - ▮ The diameter of the pitch circle
  - ▮ Use pitch diameter to derive diametral or circular pitch values



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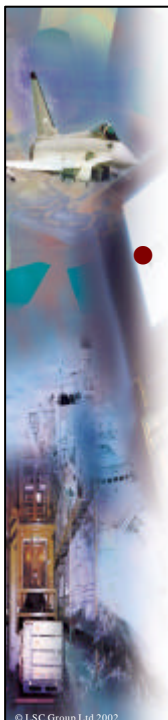


## Master Parameters (2 of 5)

- root\_diameter ( $D_R$ )
  - ⇒ The diameter formed by the “bottom land” between teeth
- outside\_diameter ( $D_o$ )
  - ⇒ The diameter formed by the tips of the teeth

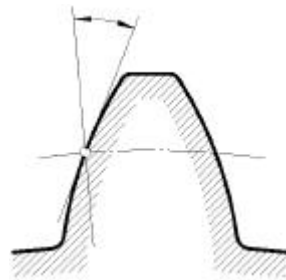
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## Master Parameters (3 of 5)

- pressure\_angle (  $\phi$  )
  - ⇒ The angle subtended by a tangent to the tooth profile and a radial line, at its pitch point



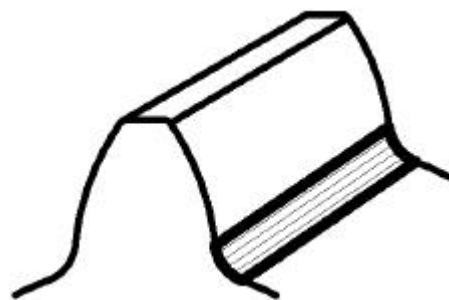
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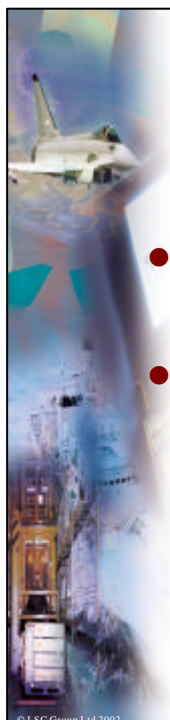
## Master Parameters (4 of 5)

- root\_fillet\_radius (  $r_f$  )
  - ⇒ The radius of the fillet between the flank and the root circle



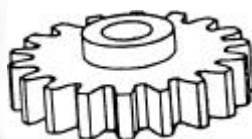
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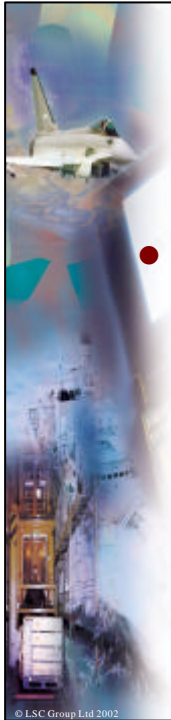
## Master Parameters (5 of 5)

- number\_of\_teeth ( $N$ )
  - ⇒ Clearly a fundamental parameter
- internal\_or\_external\_gear
  - ⇒ Special property of spur and helical gears that they may be internal or external



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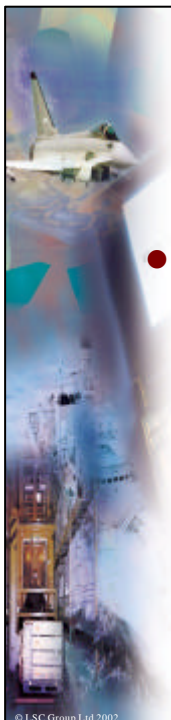
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## Spur Gear Parameters

- **Spur gears require no additional parameters to those defined by the supertype**

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## Helical Gear Parameters (1 of 2)

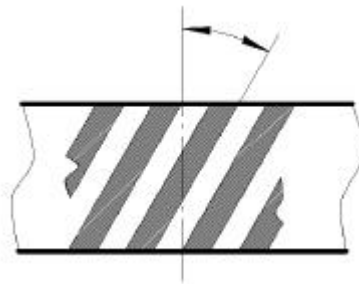
- **left\_or\_right\_twist**
  - ▢ **The helical twist is defined as begin either left or right according to the right hand rule**

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## Helical Gear Parameters (2 of 2)

- helix\_angle ( ? )

- ⇒ The angle between the tangent to the to a helix and the straight line generator of the cylinder on which it lies



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## Derived Parameters (1 of 3)

- diametral\_pitch  $(P_d = N/D)$

- ⇒ The number of teeth per unit length along the pitch circle (spur gear)

- circular\_pitch  $(P = pD/N)$

- ⇒ The distance along the pitch circle between corresponding flanks of adjacent teeth (spur gear)

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## Derived Parameters (2 of 3)

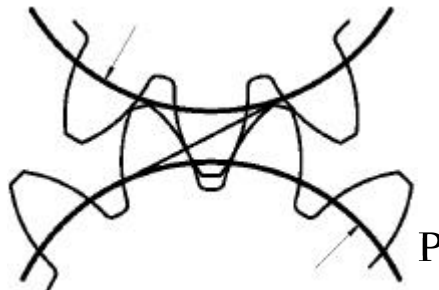
- axial\_pitch ( $P_a = pD / N \tan y$ )
  - ⇒ The distance between corresponding points of adjacent teeth measured parallel to the gear axis (helical gear)
  - ⇒ Normal diametral and circular pitches can also be derived for helical gears

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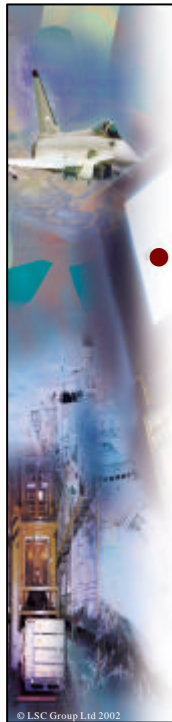


## Derived Parameters (3 of 3)

- base\_diameter ( $D_b = D \cos f$ )
  - ⇒ Diameter of the imaginary base circle from which the involute geometry of a tooth profile is defined



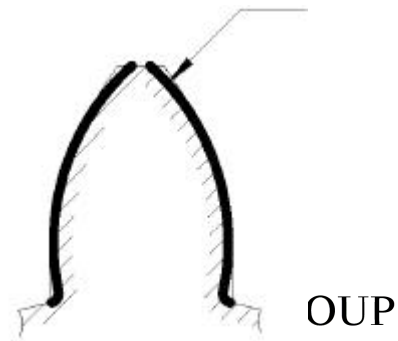




## Gear Modifications (1 of 6)

- **Tip relief...**

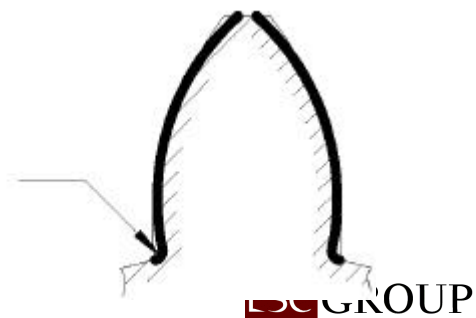
- ⇒ Removal of material at the tip of the tooth
- ⇒ Parameterise?



## Gear Modifications (2 of 6)

- **Root relief...**

- ⇒ Removal of material at the root of the tooth
- ⇒ Parameterise?

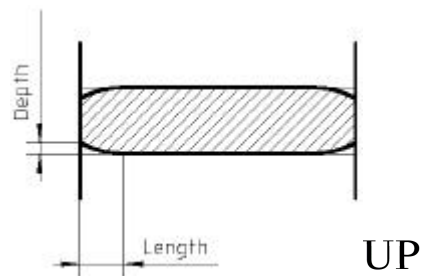


## Gear Modifications (3 of 6)

- End relief...

- ≡ Linear or progressive reduction of tooth thickness towards each end face of a gear

- ≡ Parameterise?

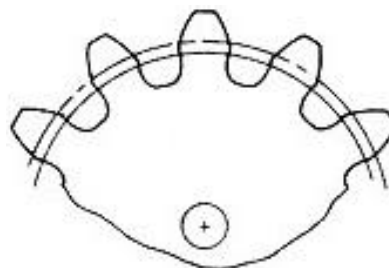


## Gear Modifications (4 of 6)

- Undercutting...

- ≡ Facilitates subsequent machining operations

- ≡ Parameterise?



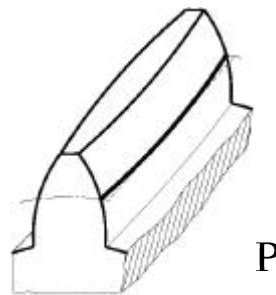
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## Gear Modifications (5 of 6)

- **Crowning...**

- ≡ Progressive reduction of tooth thickness towards each end face of a gear

- ≡ Parameterise?

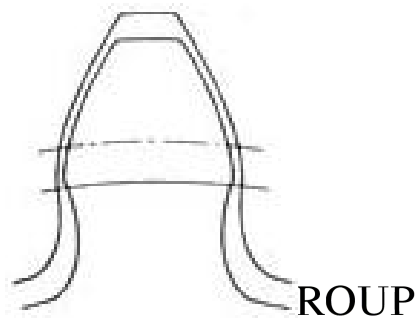


## Gear Modifications (6 of 6)

- **Corrected pinions...**

- ≡ Improves meshing of pinions with a small number of teeth

- ≡ Parameterise?



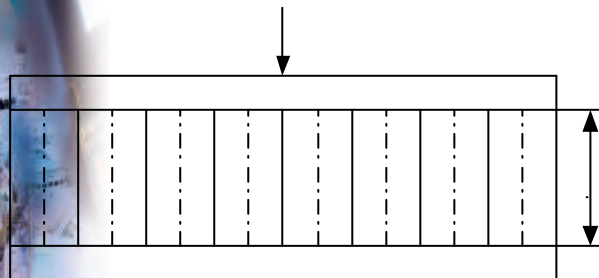
# Feature Application Parameters

- **applied\_shape**
  - ⇒ Specifies the physical shape of the part that defines where the gear feature will be applied
- **partial\_profile**
  - ⇒ Specifies the limitations to be applied on the gear feature.

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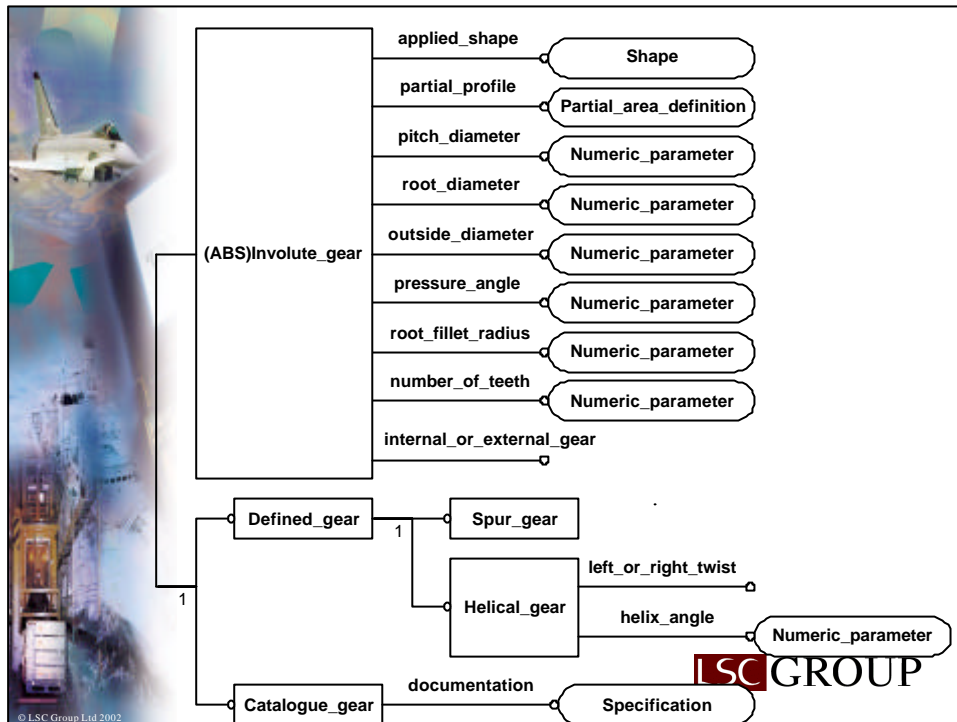
# Feature Application Parameters

applied\_shape



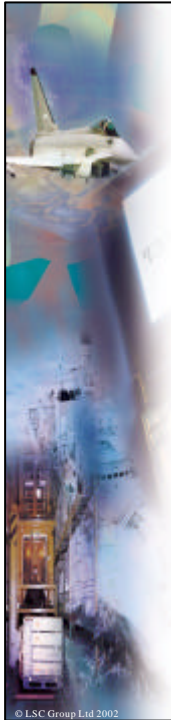
partial\_profile

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## References to standard parts

- Include bought-out items in assemblies
- Mainly an issue for the creation of designs
- Assumed adoption of AP214 approach

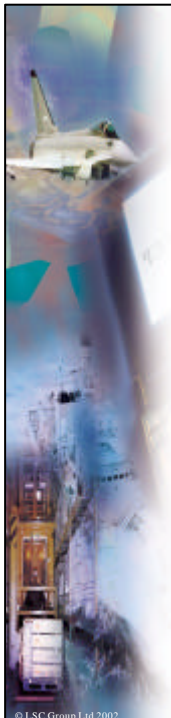


## Pre formed materials

- **Example cast / forged items**
  - ▢ currently under trial manufacture
- **Casting AP ?**

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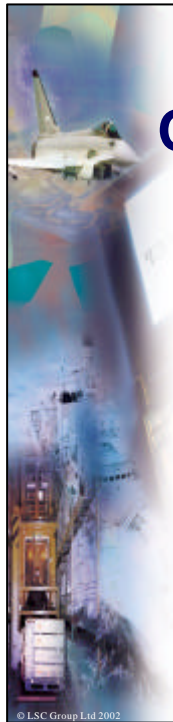
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## Material properties

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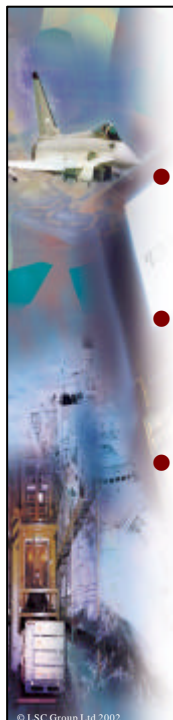


## Other items AP224 edition 3

### Loose ends

- To build on the advantages of AP224
- Ensure any ambiguous definitions are made clear
- No changes affecting compatibility
- Look to at ease of use of feature information

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## Feature structure

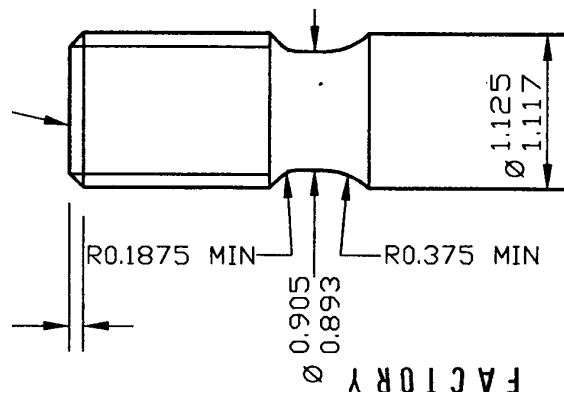
- Structure for design representation
  - ≡ Base\_shape
  - ≡ All other features
- Observations from UK AP224 users
  - ≡ Comparison with compound features
  - ≡ Designer imposed structure would be ignored
- Is this an application issue?
  - ≡ Build/adjust structure dynamically in receiving application
  - ≡ Discard structure / do not hold as AP224

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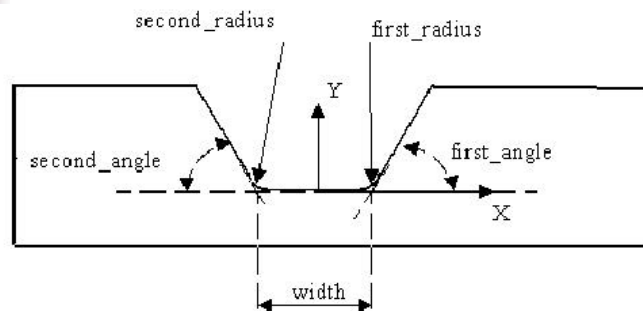
## Shank relief – groove application

- Consider common geometry of threaded fastener shank relief, as illustrated



## Shank relief – groove application

- The *best* way to represent this using AP224 is probably the 'groove' feature, utilising a square\_u\_profile [4.2.211]

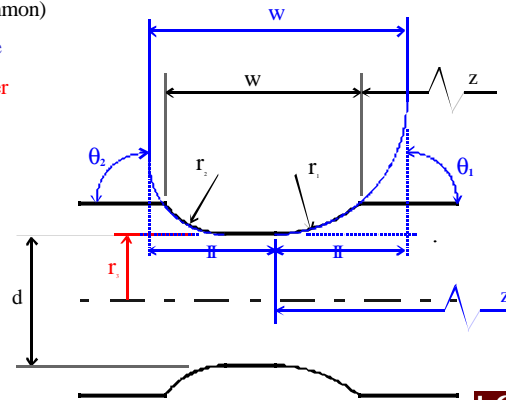


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# Shank relief – groove application

## Dimensions key

- design (& common)
- AP224 feature
- process planner

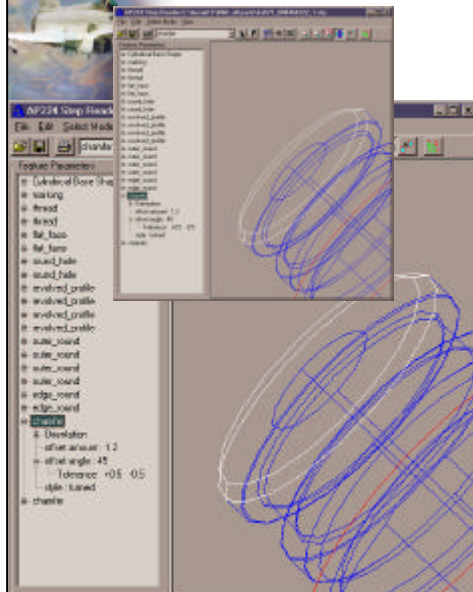


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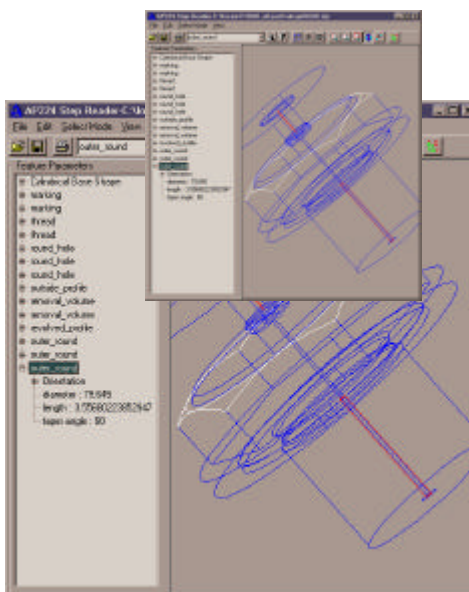
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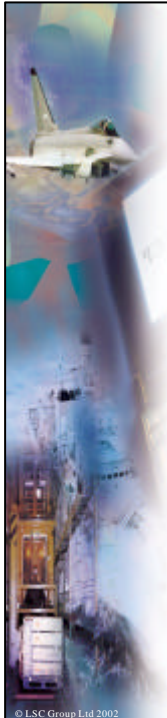
## common parameters feature types

### ● chamfer



### ● outer\_round



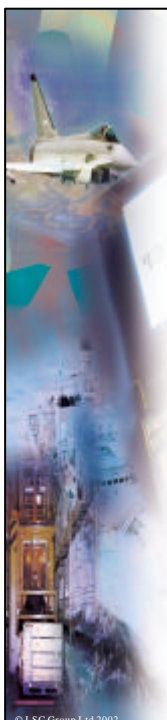


## Outer\_round dimensions

- **outer\_round to shoulder [4.2.136]**
  - ▢ Length is not a parameter
  - ▢ Has to be calculated using adjoining feature positions for z axis
- **Problem in use**
  - ▢ Can be viewed or calculated interactively
  - ▢ For automation can be calculated if
- **Chance to simplify position for user?**
  - ▢ Make consistent with [4.2.135] Outer\_diameter
  - ▢ Add an optional parameter
  - ▢ Application to add reference dimension?
  - ▢ New feature (!)

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## Nominal geometry

- **Witness marks – ‘cutting\_in’ operation**
- **Corner relief for edge geometry**
- **Currently handled (UK)**
  - ▢ as notes on the most appropriate surface of a feature
  - ▢ As note on feature to identify as nominal
- **Other peoples experience?**

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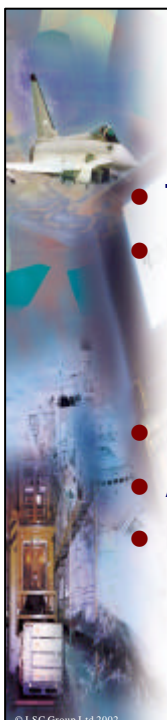


## Notes in AP224 (1 of 2)

- **UK RAMP has found notes of value in AP224**
- **STEPTrans prepares notes as**
  - ⇒ **AIM elements for property definition**
    - **property\_definition.name = 'part property'**
    - **property\_definition.description = 'part note'**
  - ⇒ **ARM application object property\_characteristic as a property\_parameter**

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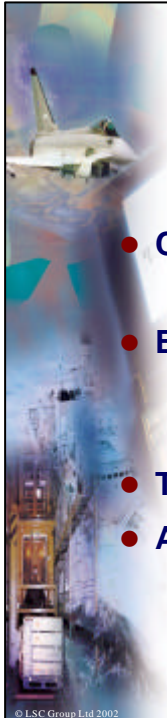


## Notes in AP224 (2 of 2)

- **This approach is not 'in the standard'**
- **Example notes from RAMPparts**
  - ⇒ **SURFACE ROUGHNESS 3.2 microns all over**
  - ⇒ **FEATURE DIMENSION flat chamfer to a depth slightly exceeding the depth of the thread**
- **Formalise the SCRA approach**
- **Additional classifications for notes?**
- **Formalise a structure classification ?**

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## Reference dimensions

- Can be easier to read a drawing than a model
  - ▢ After automated manufacture the inspection
- Easy to over-dimension a part
  - ▢ Can result in odd tolerances
  - ▢ & subtractive geometry
- This is really an application issue!
- Any suggestions for reference information

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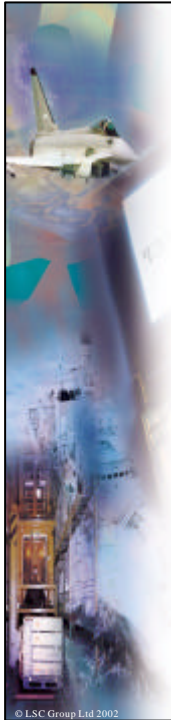


## quantity information in AP224

- Quantity [4.2.132.1]
- Quantity unit of measure [4.2.132.2]
- Why?
- In 4.2.44 quantity ordered is part of customer order

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## Clarify bases\_shape

- **base\_shape relation to material stock**

- ⇒ **Bounded geometry component**

- ⇒ **For castings this is material**

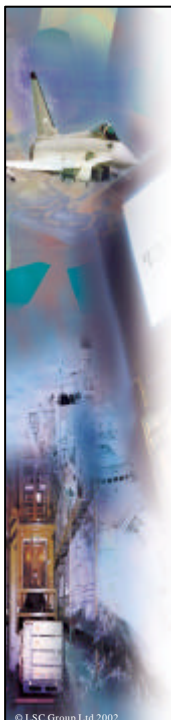
"A Base\_shape is the initial shape of the material before machining of the features."

**Implicit\_base\_shape has a placement**

**Explicit\_base\_shape does not**

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Monday, 11 March 2002

Myrtle Beach

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