PICASSO Publishable Summary

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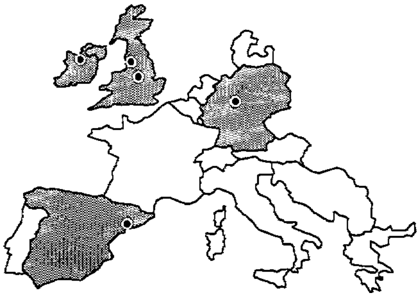
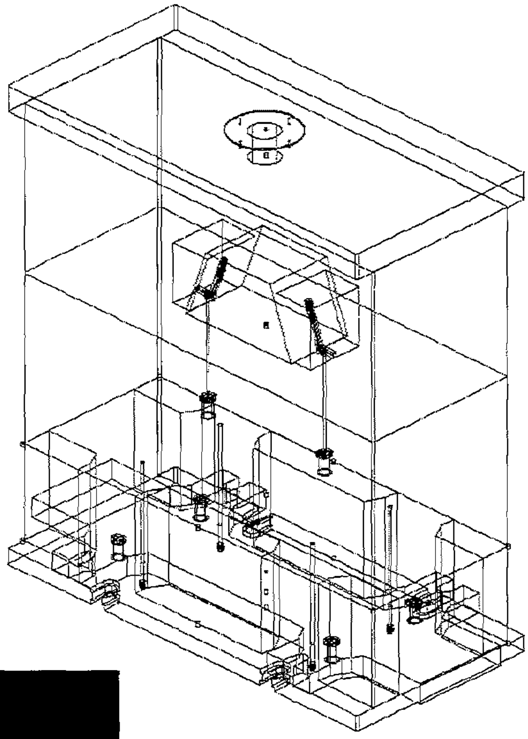
13rite-EuRam Project BE-5693: CEC Contract BRE2-CT92-0273

Practical and Intelligent CAD for Assembly Objects





.SDELCAM

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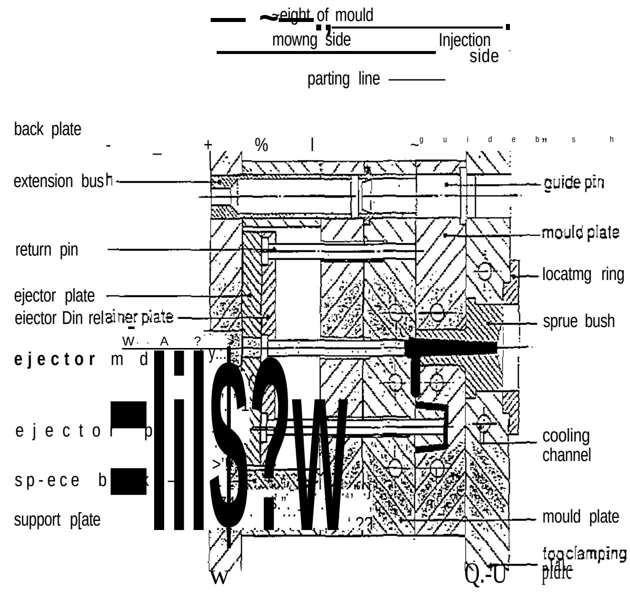
1. Industrial Problem

- Mechanical Engineering Assemblies
- Parts Classifiable using an advanced Group Technology approach but not necessarily available from 'standzu-d' catalogues
- Typified by Mould and Press Tool Companies
- Design is a high proportion of overall cost
- Design is high proportion of overall lead-time
- Requested delivery times very short (major reason for getting a contract)
- Many such companies are SMES sub-contracted to large companies
- CAD is essential (for transfer with client) yet offers insufficient help to designer for assembly design

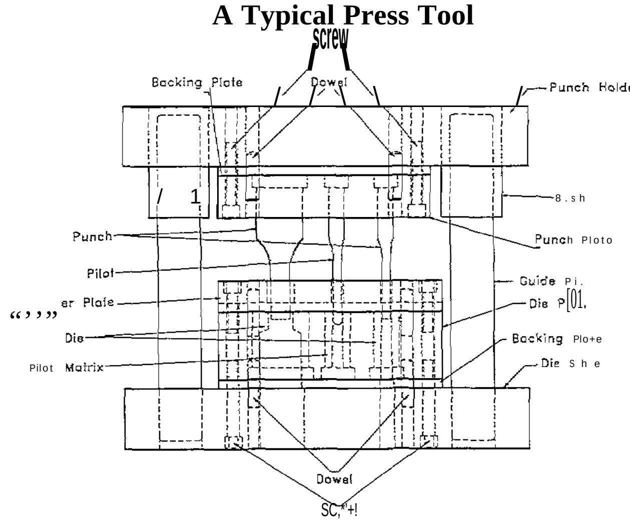
A Typical Mould Tool



2. Industrial Reauivements

- Designer must have access to a large library of the components which are being assembled
- Designer must be assisted in choosing a set of compatible components from this library
- Generation of drawings and bills of material from the finished design must be as automatic as possible
- Component catalogues must be **eady** extensible
- Many different types of assembly must be able to be designed - assembly types must be extensible
- Designer must be helped to determine suitable tolerances for components to ensure the assembly fimctions correctly

A Typical Press Tool



3. Project Objective

PICASSO aimed to develop a design methodology and supporting CAD tools to help in the design of mechanical engineering assemblies from parts which are readily classifiable according to an advanced group technology (GT) approach, but not necessarily available from standard catalogues. This type of industry is typified by mould and press tool companies, who are represented in the project.

4. PICASSO Design Methodology

There are two phases of use within the PICASSO design methodology:

- Configuration ('Super user')
  - By system vendor:
    - Define component catalogues
    - Define assembly types
  - By system manager at user site:
    - Add extra components
    - Add extra assembly types
- Assembly design ('normal user')

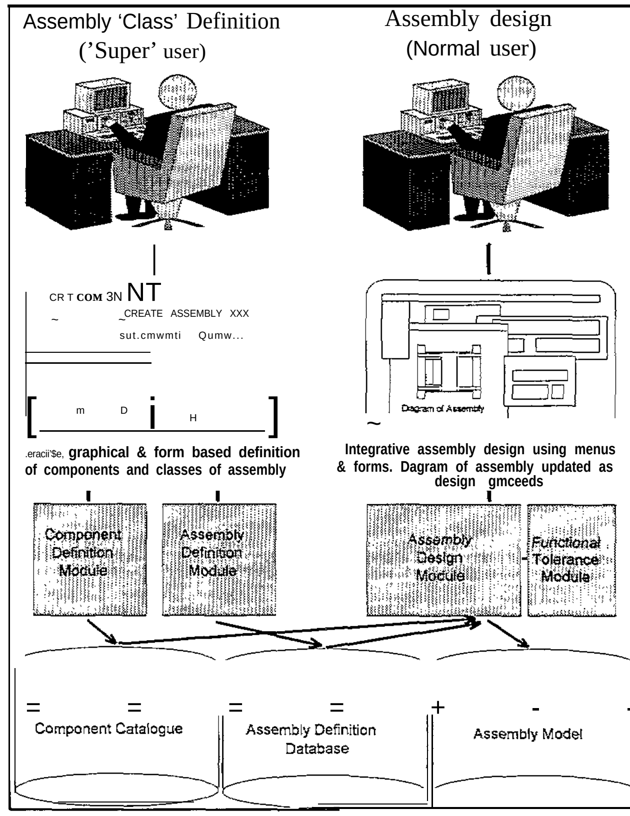
The configuration phase builds a catalogue of component definitions and a database of assembly definitions.

The design phase uses these two databases to build the final assembly model.

There are two configuration modules:

. Component Definition
. Assembly Definition

The assembly design module incoq30rates a functional tolerancing module to determine tolerances automatically y from component function.



5. The PICASSO Consortium

Delcanr International plc (U. K.) were one of the first companies to develop computer programs to modeI complex free-fcmrr shapes in 3D and manufacture them via CNC. Their major product DUCTS is used world-wide for the design and manufacture of mechanical parts - specializing in complex shapes. Delcam have implemented the PICASSO design system by further developing DUCTS according to specifications from the consortium.

Mares 5A. (Spain) are designers and manufacturers ofmould tools - specializing in large tools for components such as car bumpers, dashboards and bottle crates. They are Vpical pICASSO end-users in that hey must use CAD, yet they feel that the potential benefits from CAD are not yet available in current commercird systems. They contributed to Ihe specifications, and generated databases of component definitions and assembly definitions.

The Institut fiir Maschinenwesen of The Technical University of Clausthal (Germany) have significant experience in the development of product models and designer support systems. A research area for the institute is the determination of design tolerances based upon functional requirements of an assembly or its components. In PICASSO they concentrated on the use of tolerances within the assembly design process.

The University of Liverpool (U. K.) are researching into intelligent CAD/CAM - especially the application of knowledge-based systems and neural networks. They have developed an experimental press tool design system which can generate fully detailed tool designs with minimal user input. In PICASSO Liverpool University worked with press tool companies to act as a second industrial user with a similar role to Mares.

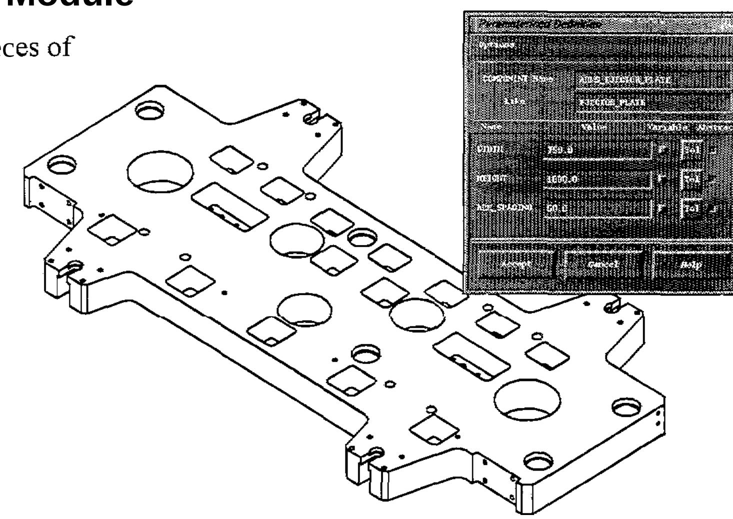
Tecnocad Ltd (Ireland) specialise in software for mould too[design, and their product CAMold represents the state of the art in this area. They are an associated partner to Delcam, acting as consultants - enabling their considerable experience in the design of mould tool assemblies to speed the work of the other collaborators.

6. Com~onent Definition Module

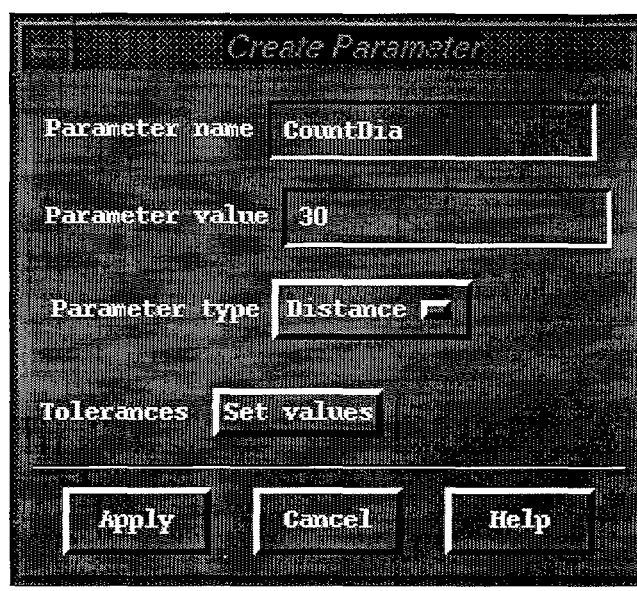
A component type is defined by two pieces of information:

- Parameterised geometry
- Extra data attributes

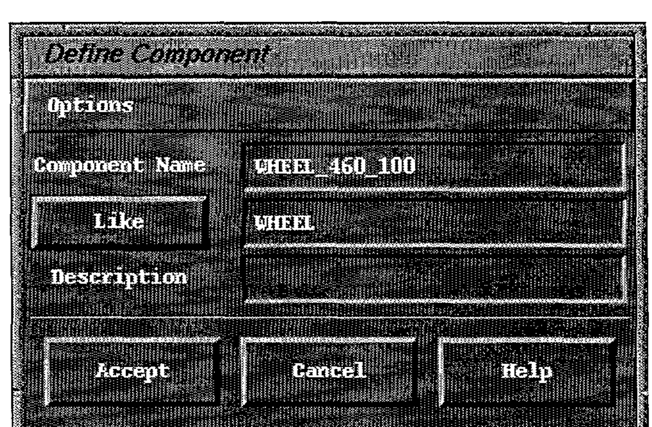
The steps in defining a new type of component are as follows.

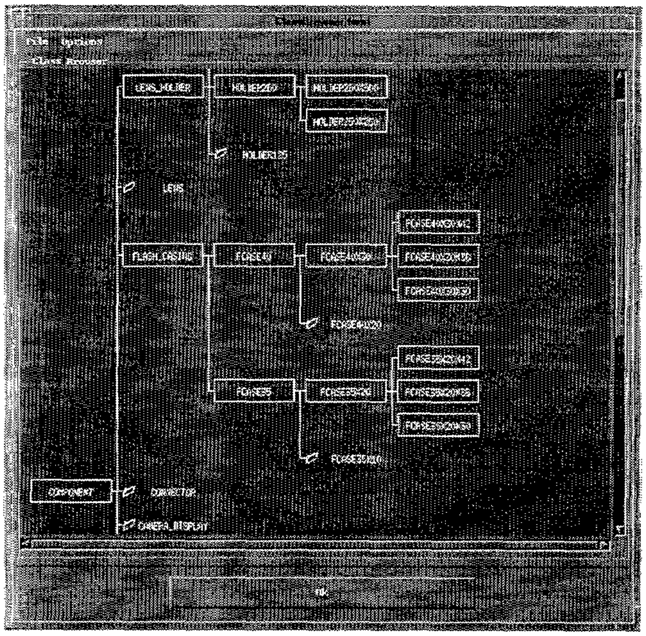


1, Define some parameters.
2. Draw the component, using parameters instead of numbers. PICASSO will build 'relational geometry' which wi] 1 change automatic] ly if the parameters are altered.

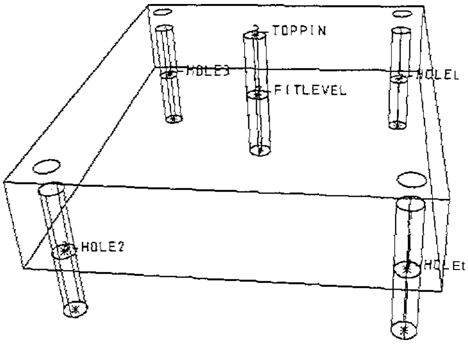


3. Name and classify the component. The component is classified into an advanced Group Technology hierarchy by positioning it as being 'LIKE' (i.e. a specialisation OQ another existing component type.

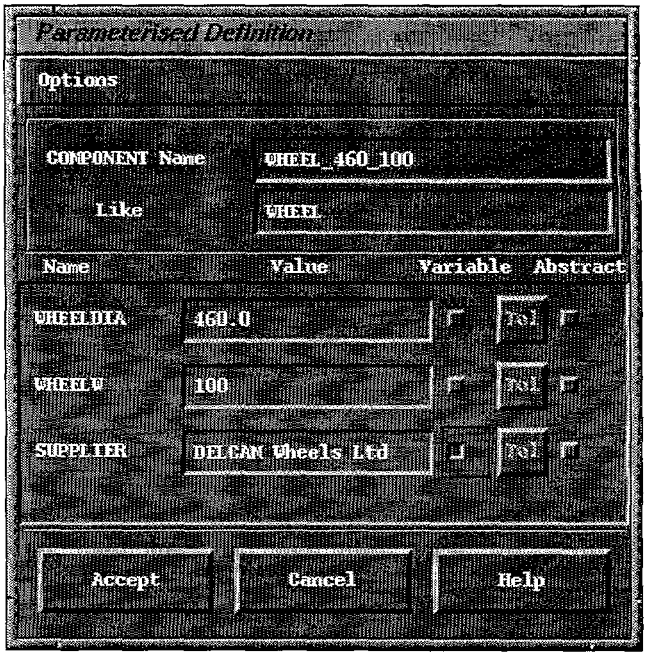




4. The component type can be classified graphically using the *component class* b~owser.



5. The geometry is selected and *attackmeirfs* are defined. Attachments are named 'faces' on the component which can be used to orientate and attach the component to other components in an assembly.

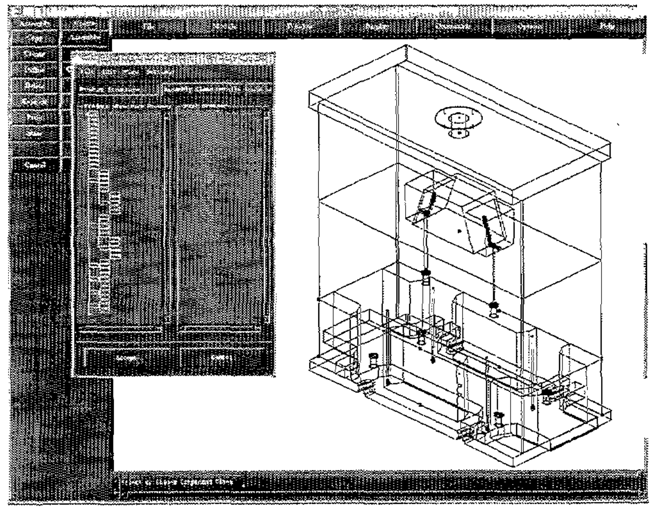


6. The components parameters (attributes which alter the geometry) are derived automatically from the geometry. Extra attributes can then be added manually. Tolerances can be associated with any attribute (+/- or limit and fit codes).

7. Assembly Definition Module

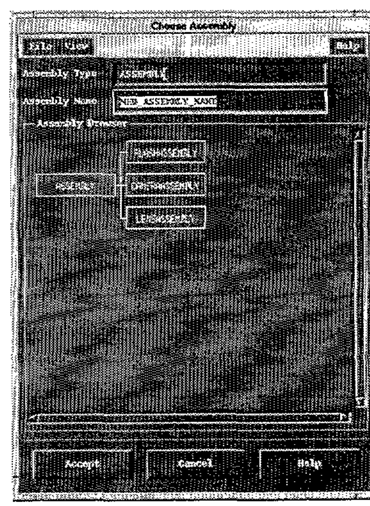
An assembly type is defined by three pieces of information:

- Product structure (list of sub-components)
- Extra data attributes describing the assembly
- Rules (relationships between sub-components)

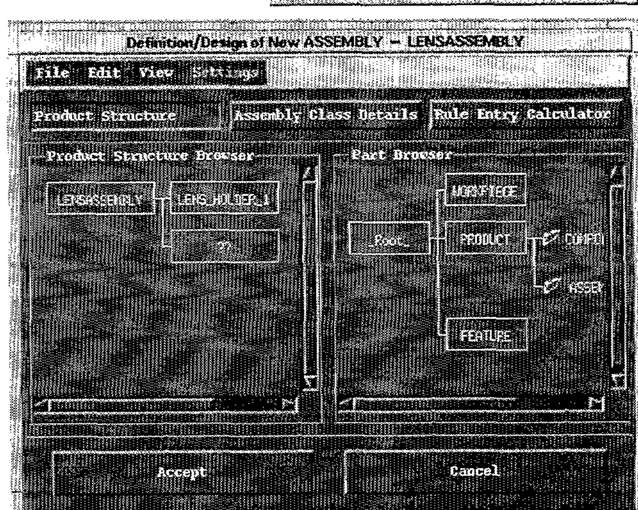


Assembly definitions, once created, are stored in the main database where they can be simultaneously accessed by ail users at a site.

The steps in defining a new type of assembly are as follows.

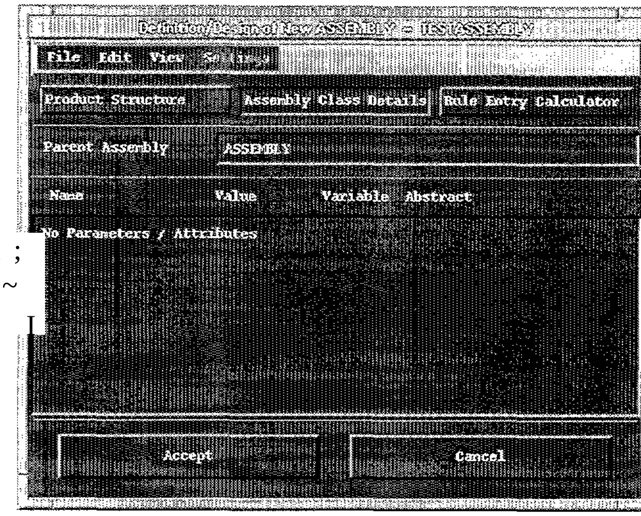


1. Name and classifi the assembly. The assembly is classified into an advanced Group Technology hierarchy by positioning it as being 'LIKE' (i.e. a specialisation of) another existing assembly type.

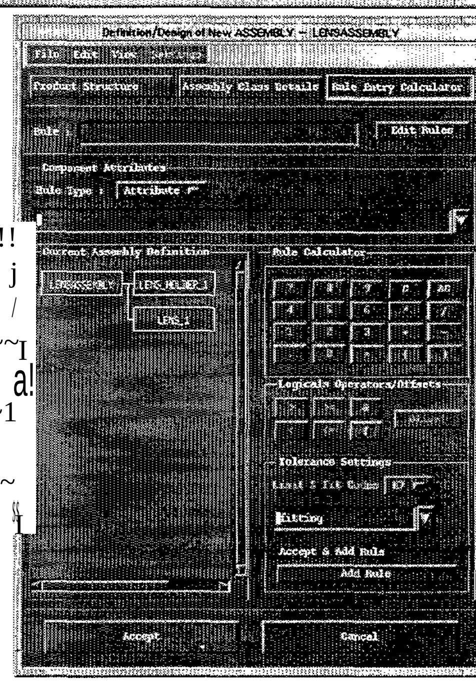


2. The assembly definition form has three pages, one for each type of data to be entered.
   - Product structure (default page)
   - Assembly attributes
   - Assembly rules

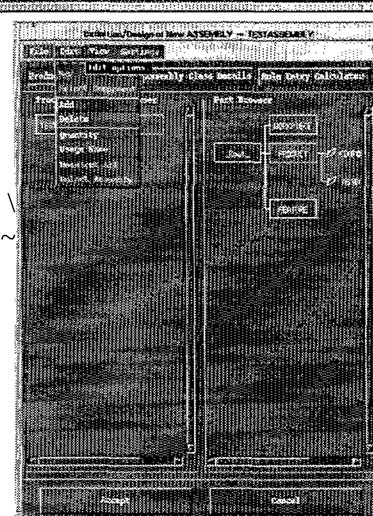
   The product structure page (shown) allows sub-components or sub-assemblies to be added to or deleted from the assembly (shown in the left-hand *Product structure homer). New* sub-components are chosen graphically by clicking in the right-hand *Part browser.*



3. Attributes of the assembly can be defined via the second page of the assembly definition form.



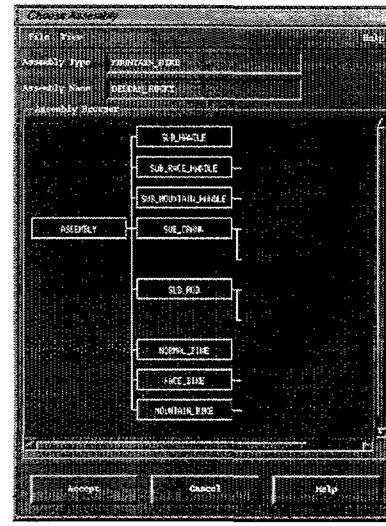
4. Rules (relationships between components in an assembly) are defined via the third page of the form. Rules contain three types of information.
   - How components are positioned with respect to each other.
   - How the size of one component restricts allowed sizes of connecting components.
   - The ‘function’ of the mating between components (affecting the tolerances). e.g. Slide fit.



5. Mistakes in the definition can be rectified by returning to the appropriate page of the form and altering the definition. Sub-components, attributes and rules can be removed and re-specified.

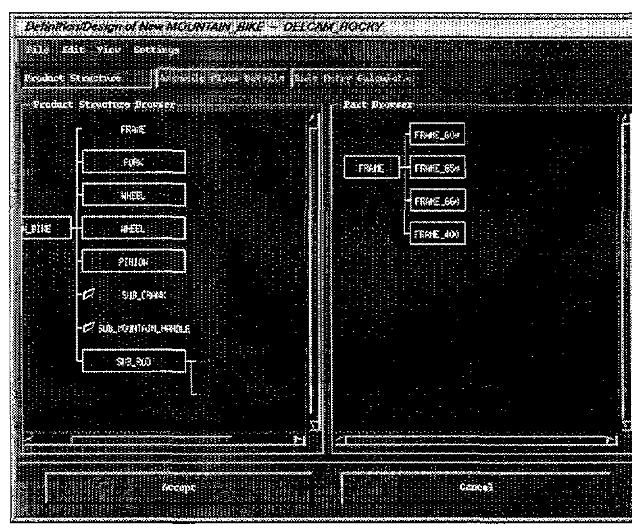
8. Assembly Design Module (including Functional Tolerancing)

To design an assembly, the following steps are required.

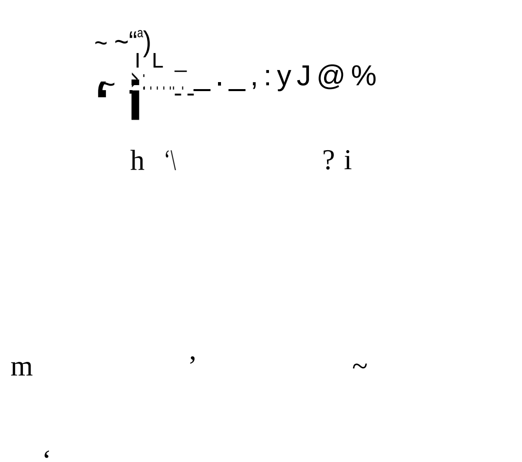


1. Specify the type of assembly to be designed, and name the new assembly.

   A pair of browsers appear. The left-hand browser contains the *Product sfructzwe* (i.e. the list of sub-component types) for the assembly being designed. The right-hand *Part browser* contains the available choices of component for the component type selected in the left-hand browser. Only choices which fulfil the constraints specified in the assembly's rules are shown.

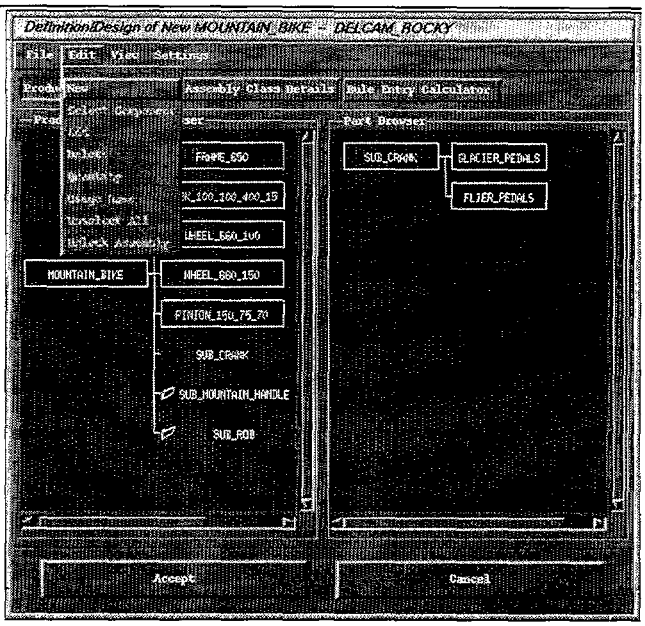


2. For each sub-component type in the assembly:
   - The system selects the component type which it thinks the user should specifi next.
   - The user can over-ride this choice by selecting the component type in the left-hand browser which he/she wants to speci@ next.
   - The available component choices for that type are shown in the right-hand browser.
   - The user selects the component required from the right hand browser.



The current state of the assembly design is continuously displayed in the graphics window.

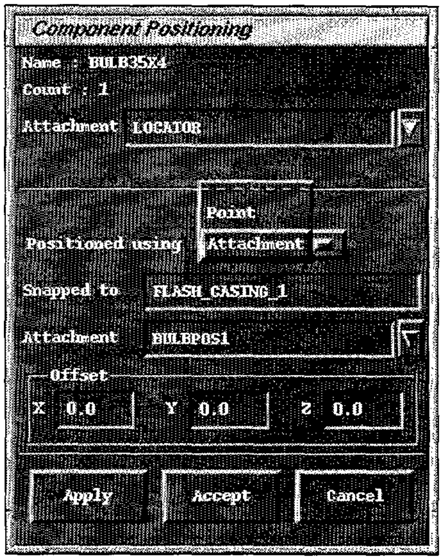
- Initially, a default representation of the assembly is displayed, with all components drawn at their default size in blue.
- As each component is fully specified, it is re-drawn in yellow.
- Fully defined assemblies and sub-assemblies are drawn in white.



Sub-assemblies can be treated in two ways;

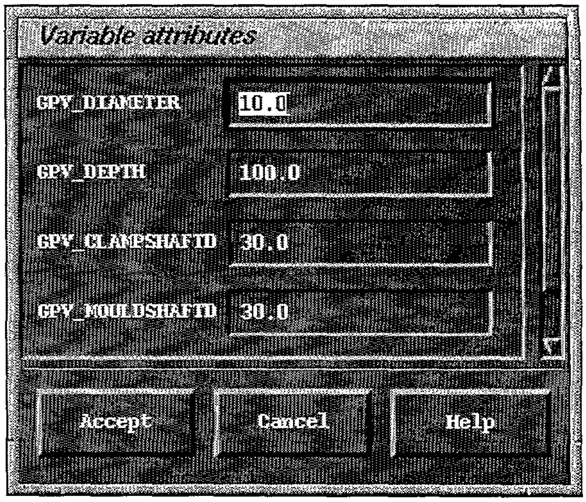
- like normal components, and selected from a list of existing choices, or
- by defining a completely new sub-assembly.

When defining new sub-assemblies, ru~es are propagated to ensure consistency between the sub-assembly and the main assembly.



Components are normally positioned automatically as they are specified.

Components can however be positioned manually if required. This is useful for assemblies where the position of components if different in each instance designed, or where variable numbers of components are required, and hence rules cannot be written to define the component positions.



Sets of standard sizes are normally defined for components in the database. This helps to ensure designers can only choose sizes which are available in-house or from standard suppliers.

Where sizes cannot be standardised (because no two components have the same size) the attributes are marked as *variabfe* in the component definition, and the system will prompt for the sizes during the design as the component is selected.

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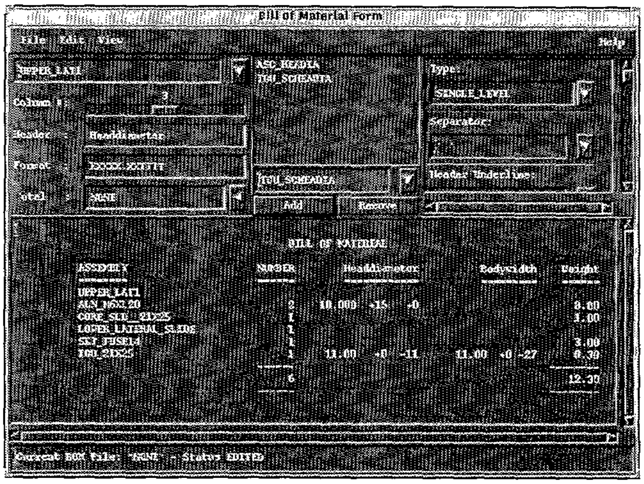
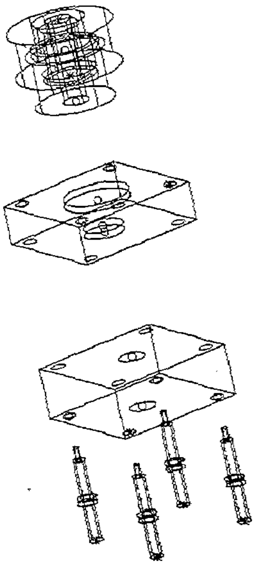
Once an assembly design is complete, the system determines tolerances for component attribute values automatically using the assembly rules which specifi the function of each component mating. User sites can define their own set of tolerance functions (e.g. Slide fit, press fit, sealing fit), but the ISO standard set of tolerance functions is supplied as standard.

The derived tolerances can be displayed in Bills of Material, which can be generated automatically.





The assembly model generated has parametric relationships between each component.

- Any change to one component will cause other attached components to redefine accordingly
- . Exploded views of the assembly (as per car workshop manuals) can be generated automatically, as the system understands how components flt together.

A few mouse clicks are enough to design a complex assembly.