Programming in Pro/ENGINEER Wildfire

- Interactive graphical programming is carried in Pro/E at two different levels.
  - At the higher level, C++ program are supported through Pro/ENGINEER API Toolkit.
  - At lower level, a micro programming environment, Pro/E PROGRAM Tool, is supported.
- These programming environments serve different needs.
- It is very typical for a CAD system to support at least these two levels of interactive graphics programming.

Pro/ENGINEER API Toolkit

- Pro/ENGINEER API Toolkit allows customers to extend, automate, and customize a wide range of Pro/ENGINEER design-through-manufacturing functionality.
- Pro/ENGINEER API Toolkit consists of a library of functions:
  - an application-programming interface (API), written in the C programming language. These functions are typically used by MIS organizations to create applications that run in parallel with Pro/ENGINEER and to integrate product information with the customer's corporate MRP/ERP systems.
  - applications used extensively by companies participating in PTC's Cooperative Software Partner (CSP) program to interface their commercial information management products with Pro/INTRALINK.
  - Normally, participation of a three day tutorial on the API Toolkit is needed to get the API Toolkit function module.

Typical Toolkit Applications

- The extensive Pro/ENGINEER API Toolkit provides programmatic access for creating, interrogating, and manipulating almost every aspect of the engineering model and its data management.
  - automating the creation of complex features
  - automating the production of Pro/ENGINEER deliverables, such as BOMs, drawings, and manufacturing operations
  - improving product quality by performing design rule verification based on inputs from an external, knowledge-based system.

Specific Pro/ENGINEER API Toolkit Function

- Customization of the Pro/ENGINEER-Foundation menu system
- Datum, solid, and manufacturing feature creation
- Assemblies
- Drawing automation
- Access to model geometry

Pro/INTRALINK Access

- The Pro/E API Toolkit provides complete access to the information within the Pro/INTRALINK environment, allowing customers to further leverage the product information contained within Pro/INTRALINK.
- Specifically, this functionality allows:
  - Integration with MRP/ERP Systems
  - Custom client applications, such as Web integrated clients
  - Triggered verification, notification and enforcement of business process actions

Use of Pro/E API Toolkit

Product Capabilities:

- Create automated, single-use or derived designs by geometric and parametric constraints
- Extend the Pro/ENGINEER user interface with custom processes seamlessly embedded in the interface
- Customize the Pro/ENGINEER menu system
- Collaborate between Pro/ENGINEER applications
- Access peer-to-peer communications for better application diagnoses

Customer Benefits:

- Integrate expert systems and knowledge-based applications into the Pro/ENGINEER environment.
- Improve product quality with design rule verification based on inputs from an external, knowledge-based systems.

Pro/E Program Tool (Micro)

- The Pro/E Program environment, on the other hand, support quick and relatively straightforward interactive graphical programming in Pro/E for every users.
- The programming environment is simply Pro/E and *Microsoft Notepad* or *Word*.
- One can enter the Pro/E PROGRAM environment, by clicking **Tools > Program…** from the pull-down menu in the Pro/E **PART** or **ASSEMBLY** mode.
- To show or edit the program, one can click **Show Design** or **Edit Design** from the **PROGRAM** menu.

A Typical Pro/E PROGRAM Routine

Any of the followings:

- Input variables
- Relations
- IF-ELSE clauses
- Lists of all the features, and parts
- INTERACT statements
- MASSPROP statement

After the Pro/E PROGRAM routine is edited, the user will be asked whether the changes are to be incorporated (in the message window at the bottom). To proceed, enter Y. If N entered, the program will not be executed and changes will be lost.

Input Variables

- The INPUT statement must define the name and type of the variable. Variable names must always begin with a character. The following variable types are supported:
- Number
  - String: This enables the user to enter parameters or model names.
  - Logical (YES_NO): Enter either Y or N.
- An example:
  - INPUT
    THICKNESS NUMBER
    "Enter wall thickness for the cylinder"
    END INPUT

Relations

- All valid relations in a Pro/ENGINEER model can be entered in a Pro/PROGRAM.
- An example:
  - d0 = d6 * 2
- Here, d0 and d6 are dimension ID name.

IF-ELSE Clauses

- Conditional statements, i.e. IF _ ELSE, can be used to create a program branch.

  For example:

  ```
  ADD PROTRUSION.....
  IF d1 > d2
  ADD HOLE ...
  END ADD
  ENDIF
  ADD CUT.....
  END ADD
  ```

- So, when d1 is smaller than d2, a CUT is added, instead of a HOLE.

Lists of Features and Parts

- The program that Pro/E PROGRAM brings up simply includes all feature building commands used in creating the model and the properties of these features.
- All features and parts are listed in the program.
- For instance, the ADD feature by EXTRUSION operation is recorded as:

```
ADD FEATURE (initial number 8)
 INTERNAL FEATURE ID 106
 PARENTS = 100(#7)
 PROTRUSION: Extrude
  NO.     ELEMENT NAME       INFO
  ---     ------------       ------------
   1      Feature Name       Defined
   2      Extrude Feat type  Solid
   3      Material           Add
   4      Section            Defined
   4.1    Reference Sketch   F7(SKETCH_2)
   5      Feature Form       Solid
   6      Direction          Side 2
   7      Depth              Defined
   7.1    Side One           Defined
   7.1.1  Side One Depth     None
   7.2    Side Two           Defined
   7.2.1  Side Two Depth     Variable
   7.2.2  Value              70.00
 SECTION NAME = Sketch 2
 FEATURE'S DIMENSIONS:
 d11 = 70.00
END ADD
```

Additional operations can be added, and this ADD operation can be changed.

INTERACT

- INTERACT statements provide a placeholder for creating interactive part. They can be inserted anywhere within the FEATURE ADD - END ADD.
- Here is an example,

```
ADD PROTRUSION.....
IF d1 > d2
ADD HOLE.....
ELSE
INTERACT
END IF
ADD CUT.....
```

- In this example, an alternate set of features will be created if d1 is not greater than d2. The ADD CUT command has to be input by the user.

MASSPROP

- The MASSPROP statement is used to update mass properties each time geometry changes. Format is as follows:

  MASSPROP
  END MASSPROP

Other Operations for Feature Editing

- Changing feature dimension

  The dimensions of features in the program can be updated by a DIMENSION statement with:

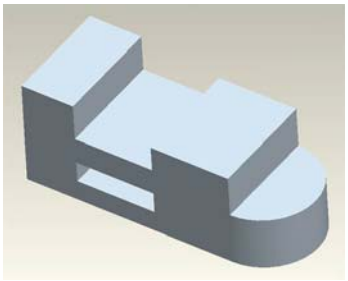
  MODIFY d# = value

- Editing Errors

  Common editing errors include:

  - Having an IF statement without an END IF statement or vice versa
  - Typing a variable name incorrectly in a relation or a condition
  - Reordering a child before the parent
  - Deleting a parent feature

An Example Part and the PROGRAM Window



The Pro/Program for this Part Model

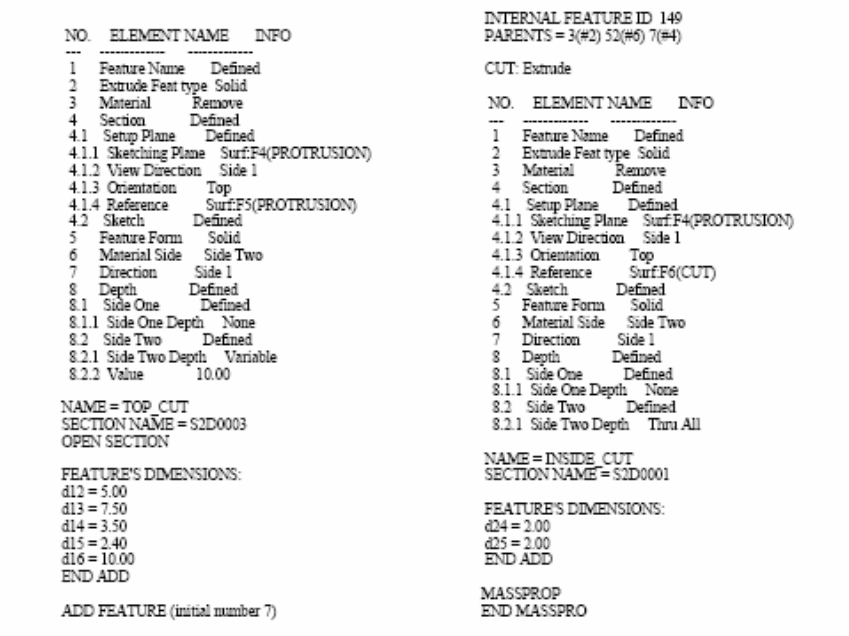
- Start Pro/E
- Open the Part Model file: **part5.prt**
- Use Pull Down Menu **Tool > Program…**

An Example Part and the PROGRAM Window

- In the **PROGRAM** Window
  - **Show Design** and **Edit Design** options will display the Pro/Program that is used to create the displayed part model.
  - **Edit Design** option allows you make changes to the model through "Programming Logic" rather than through "drawing and modeling". Automated tasks can be achieved. If you exit from the Edit window and answer "Yes" in the message window at the bottom of the screen to the prompt: "Do you want to incorporate your changes into the model?" The programmed change will be added to the existing model. You can start from a simple template model to write various programs.
  - The **J-Link** function allows you to load in Java codes.

The List of the Pro/E PROGRAM for this Part Model

```
VERSION 2.0
REVNUM 365
LISTING FOR PART LESSON5

INPUT
END INPUT

RELATIONS
END RELATIONS

ADD FEATURE (initial number 1)
INTERNAL FEATURE ID  1

DATUM PLANE

 NO.   ELEMENT NAME   INFO
 ---   ------------   ------------
 1     Feature Name   Defined
 2     Constraints    Defined
 2.1   Constraint #1  Defined
 2.1.1 Constr Type    X Axis
 3     Flip Datum Dir Defined
 4     Fit            Defined
 4.1   Fit Type       Default

NAME = RIGHT

END ADD

ADD FEATURE (initial number 2)
INTERNAL FEATURE ID  3

DATUM PLANE

 NO.   ELEMENT NAME   INFO
 ---   ------------   ------------
 1     Feature Name   Defined
 2     Constraints    Defined
 2.1   Constraint #1  Defined
 2.1.1 Constr Type    Y Axis
 3     Flip Datum Dir Defined
 4     Fit            Defined
 4.1   Fit Type       Default

NAME = TOP

END ADD

ADD FEATURE (initial number 3)
INTERNAL FEATURE ID  5

DATUM PLANE

 NO.   ELEMENT NAME   INFO
 ---   ------------   ------------
 1     Feature Name   Defined
 2     Constraints    Defined
 2.1   Constraint #1  Defined
 2.1.1 Constr Type    Z Axis
 3     Flip Datum Dir Defined
 4     Fit            Defined
 4.1   Fit Type       Default

NAME = FRONT

END ADD

ADD FEATURE (initial number 4)
INTERNAL FEATURE ID  7
PARENTS = 1(#1) 3(#2) 5(#3)

PROTRUSION: Extrude

 NO.   ELEMENT NAME      INFO
 ---   ------------      ------------
 1     Feature Name      Defined
 2     Extrude Feat type Solid
 3     Material          Add
 4     Section           Defined
 4.1   Setup Plane       Defined
 4.1.1 Sketching Plane   FRONT:F3(DATUM PLANE)
 4.1.2 View Direction    Side 1
 4.1.3 Orientation       Top
 4.1.4 Reference         TOP:F2(DATUM PLANE)
 4.2   Sketch            Defined
 5     Feature Form      Solid
 6     Direction         Side 2
 7     Depth             Defined
 7.1   Side One          Defined
 7.1.1 Side One Depth    None
 7.2   Side Two          Defined
 7.2.1 Side Two Depth    Variable
 7.2.2 Value             10.00

NAME = BLOCK
SECTION NAME = S2D0001

FEATURE'S DIMENSIONS:
d2 = 20.00
d3 = 10.00
d4 = 10.00
END ADD

ADD FEATURE (initial number 5)
INTERNAL FEATURE ID  28
PARENTS = 7(#4)

PROTRUSION: Extrude

 NO.   ELEMENT NAME      INFO
 ---   ------------      ------------
 1     Feature Name      Defined
 2     Extrude Feat type Solid
 3     Material          Add
 4     Section           Defined
 4.1   Setup Plane       Defined
 4.1.1 Sketching Plane   Surf:F4(PROTRUSION)
 4.1.2 View Direction    Defined
 4.1.3 Orientation       Right
 4.1.4 Reference         Surf:F4(PROTRUSION)
 4.2   Sketch            Defined
 5     Feature Form      Solid
 6     Material Side     Side Two
 7     Direction         Side 2
 8     Depth             Defined
 8.1   Side One          Defined
 8.1.1 Side One Depth    None
 8.2   Side Two          Defined
 8.2.1 Side Two Depth    Variable
 8.2.2 Value             5.00

NAME = ROUND_END
SECTION NAME = S2D0002
OPEN SECTION

FEATURE'S DIMENSIONS:
d9 = 5.00
END ADD

ADD FEATURE (initial number 6)
INTERNAL FEATURE ID  52
PARENTS = 7(#4) 28(#5)

CUT: Extrude
```



```
NO.   ELEMENT NAME     INFO
---   ------------     ------------
 1    Feature Name     Defined
 2    Extrude Feat type  Solid
 3    Material         Remove
 4    Section          Defined
 4.1  Setup Plane      Defined
 4.1.1 Sketching Plane  Surf:F4(PROTRUSION)
 4.1.2 View Direction   Side 1
 4.1.3 Orientation      Top
 4.1.4 Reference        Surf:F5(PROTRUSION)
 4.2  Sketch           Defined
 5    Feature Form     Solid
 6    Material Side    Side Two
 7    Direction        Side 1
 8    Depth            Defined
 8.1  Side One         Defined
 8.1.1 Side One Depth   None
 8.2  Side Two         Defined
 8.2.1 Side Two Depth   Variable
 8.2.2 Value            10.00

NAME = TOP_CUT
SECTION NAME = S2D0003
OPEN SECTION

FEATURE'S DIMENSIONS:
d12 = 5.00
d13 = 7.50
d14 = 3.50
d15 = 2.40
d16 = 10.00
END ADD

ADD FEATURE (initial number 7)

INTERNAL FEATURE ID  149
PARENTS = 3(#2) 52(#6) 7(#4)

CUT: Extrude

 NO.   ELEMENT NAME     INFO
 ---   ------------     ------------
  1    Feature Name     Defined
  2    Extrude Feat type  Solid
  3    Material         Remove
  4    Section          Defined
  4.1  Setup Plane      Defined
  4.1.1 Sketching Plane  Surf:F4(PROTRUSION)
  4.1.2 View Direction   Side 1
  4.1.3 Orientation      Top
  4.1.4 Reference        Surf:F6(CUT)
  4.2  Sketch           Defined
  5    Feature Form     Solid
  6    Material Side    Side Two
  7    Direction        Side 1
  8    Depth            Defined
  8.1  Side One         Defined
  8.1.1 Side One Depth   None
  8.2  Side Two         Defined
  8.2.1 Side Two Depth   Thru All

NAME = INSIDE_CUT
SECTION NAME = S2D0001

FEATURE'S DIMENSIONS:
d24 = 2.00
d25 = 2.00
END ADD

MASSPROP
END MASSPRO
```

Program in AutoCAD

- Widely Used and Easy to Implement
- Powerful Interactive Graphics Programming Tools
  - AutoLISP
  - ADS – AutoCAD Development System
  - API – Advanced Programming Interface
  - Script Files
  - Menu Systems
- Extensive Tutorial Materials (@MECH410/520 web page)

Summary

- Interactive Graphics Programming is traditionally carried out using graphics routines in a special package.
- Today all CAD systems offer different levels of Interactive Graphics Programming capabilities.
- This unique capability of CAD systems allows their to be further developed into most convenient and more productive design tools.
  - Customization
  - User interface improvement (menu, etc.)
  - Repetitive and complex tasks
  - Guidelines for design
- It is essential not to limit one's capability of using CAD system simply as a modeling program or drafting tool.