

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 (High Level Programming)

- 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**, e.g. a gear
 - **automating** the **production** of Pro/ENGINEER deliverables, such as **BOMs, drawings, and manufacturing operations**
 - improving product quality by performing **design rule verification**.

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 (Material Requirement Planning/Enterprise Resource Planning) 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

Pro/E Program Tool (Low-Level Micro Programming)

- ❑ 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.
- ❑ “recorded modeling actions” + data input/output + controls

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:

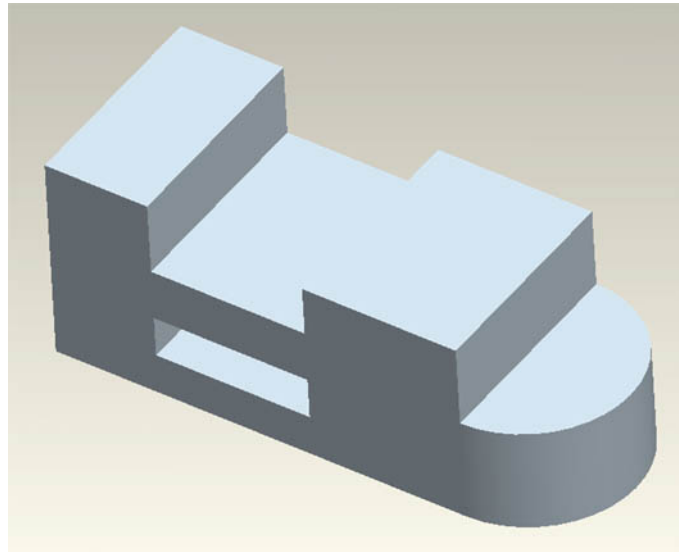
MODIFY d# = value

□ 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 LESSONS

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 (C)
 - API – Advanced Programming Interface (C++, High Level)
 - Script Files (Micro)
 - Menu Systems (Template)
- 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 them 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.