

# *Automation (21-541)*

*Advanced Manufacturing Laboratory  
Department of Industrial Engineering  
Sharif University of Technology*

*Session # 10*



## *Session Schedule*

- *Computer-Aided Design (CAD)*
  - *Geometric modeling*
  - *Geometric data exchange*



## Computer-Aided Design (CAD)

### ▪ Geometric data exchange

- *The heart of any CAD model is the component database.*

*This includes*

- *The graphics entities like points, lines, arcs, circles etc. and the co-ordinate points, which define the location of these entities.*
- *This geometric data is used in all downstream applications of CAD, which include*
  - *Finite element modeling and analysis,*
  - *Process planning,*
  - *Estimation,*
  - *CNC programming,*
  - *Robot programming,*
  - *Programming of co-ordinate measuring machines,*
  - *ERP system programming and simulation.*

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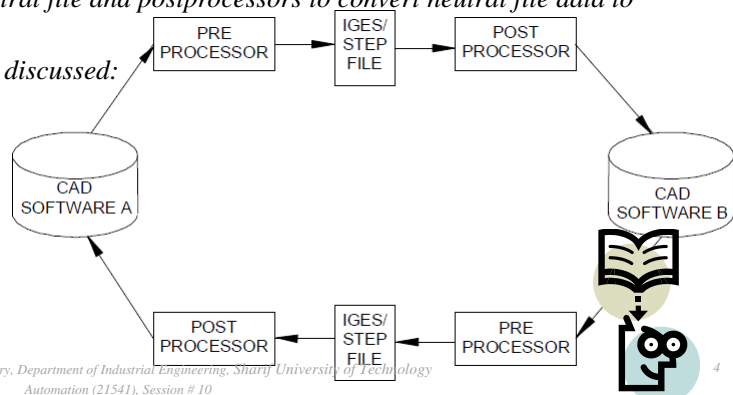


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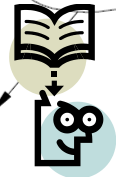
## Computer-Aided Design (CAD)

### ▪ Geometric data exchange

- *A solution to the problem of direct translators is to use neutral files.*
- *These neutral files will have standard formats and software packages can have pre-processors to convert drawing data to neutral file and postprocessors to convert neutral file data to drawing file.*
- *Three types of neutral files are discussed:*
  - *Drawing exchange files (DXF)*
  - *IGES files*
  - *STEP files*



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## Computer-Aided Design (CAD)

- *Geometric data exchange*

- *Drawing exchange files/formats (DXF)*

*is a CAD data file format developed by Autodesk for enabling data interoperability between AutoCAD and other programs.*

- *The basic organization of a DXF file is as follows:*

- *HEADER section*
    - *CLASSES section*
    - *TABLES section*
    - *BLOCK section*
    - *ENTITIES section*
    - *OBJECTS section*
    - *THUMBNAILIMAGE section*
    - *END OF FILE*

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```

0
SECTION
2
HEADER
9
.
.
.
AcDbEntity
8
0
100
AcDbLine
10
.
.
.
LINE
5
12D
.
.
.
ENDSEC
0
EOF

```



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## Computer-Aided Design (CAD)

- *Geometric data exchange*

- *Drawing exchange files/formats (DXF) structures:*

- *BLOCKS section – This section contains Block Definition entities describing the entities comprising each Block in the drawing.*
    - *ENTITIES section – This section contains the drawing entities, including any Block References.*
    - *OBJECTS section – Contains the data that apply to nongraphical objects, used by AutoLISP and ObjectARX applications.*
    - *THUMBNAILIMAGE section – Contains the preview image for the DXF file.*

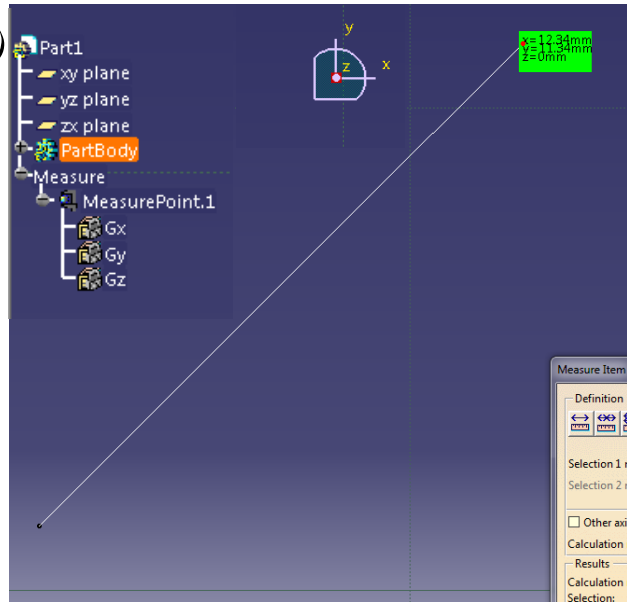
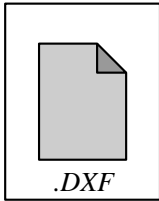
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## Computer-Aided Design (CAD)

- Geometric data exchange
  - Drawing exchange files/formats (DXF):



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## Computer-Aided Design (CAD)

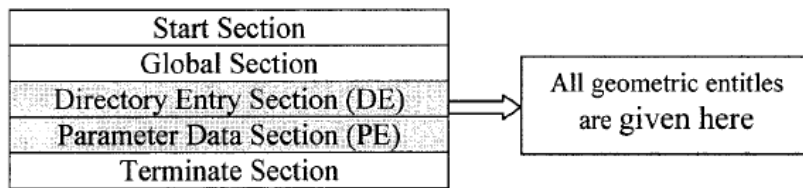
- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES)

1H,,1H:,4HSLOT,37HS1\$DUA2:[IGESLIB.BDRAFT.B2I]SLOT.IGS; ,	S	1
17HBravo3 BravoDRAFT,31HBravo3->IGES V3.002 (02-Oct-87),32,38,6,38,15,	G	1
4HSLOT,1.,1,4HINCH,8,0.08,13H871006.192927,1.E-06,6.,	G	2
31HD. A. Harrod, Tel. 313/995-6333,24HAPPLICON - Ann Arbor, MI,4,0;	G	3
116 1 0 1 0 0 0 0 0	1D	4
116 1 5 1 0 0 0 0 0	1D	1
116 2 0 1 0 0 0 0 0	1D	2
116 1 5 1 0 0 0 0 0	1D	3
100 3 0 1 0 0 0 0 0	1D	4
100 1 2 1 0 0 0 0 0	1D	5
100 4 0 1 0 0 0 0 0	1D	6
100 1 2 1 0 0 0 0 0	1D	7
110 5 0 1 0 0 0 0 0	1D	8
110 1 3 1 0 0 0 0 0	1D	9
110 6 0 1 0 0 0 0 0	1D	10
110 1 3 1 0 0 0 0 0	1D	11
116,0.,0.,0.,0,0,0,0;	1D	12
116,5.,0.,0.,0,0,0,0;	1P	1
100,0.,0.,0.,0.,1.,0.,-1.,0,0;	3P	2
100,0.,5.,0.,5.,-1.,5.,1.,0,0;	5P	3
110,0.,-1.,0.,5.,-1.,0.,0,0;	7P	4
110,0.,1.,0.,5.,1.,0.,0,0;	9P	5
S 1G 4D 12P 6	11P	6
	T	1

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## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES):
    - The IGES committee was established in the year 1979.
    - The CAD/CAM Integrated Information Network (CIIN) of Boeing served as the preliminary basis of IGES.

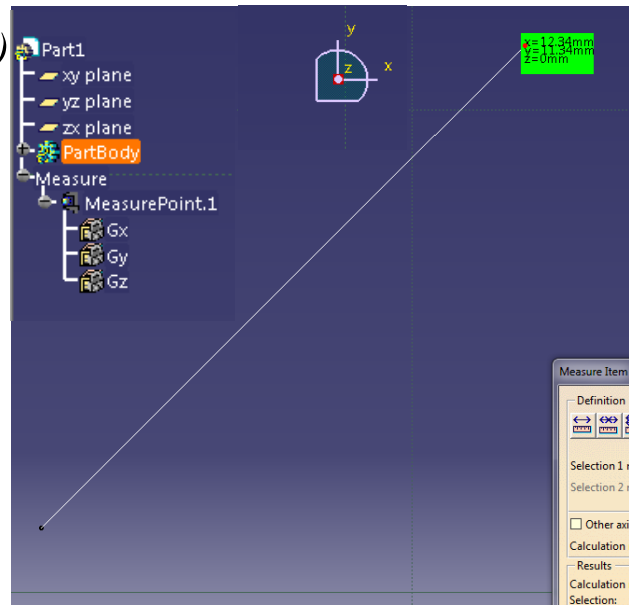
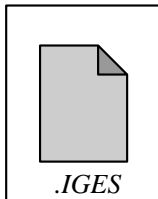


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## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES)



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## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES):

- Start Section

*The Start section is a human readable introduction to the file.*

*It is commonly described as a "prologue" to the IGES file.*

*This section contains information such as the names of the sending (source) and receiving (target) CAD/CAM systems, and a brief description of the product being converted*

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section

## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES):

- Global Section

*The Global section includes information that describe the preprocessor and information needed by the postprocessor to interpret the file.*

- Characters used as delimiters between individual entries and between records (usually commas and semicolons respectively)
      - The name of the IGES file itself, Vendor and software version of sending (source) system,
      - Date and time of file generation,
      - Model space scale,
      - Model units,
      - Minimum resolution and maximum coordinate values,
      - Name of the author of IGES file

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section

## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES):
    - Directory Entry Section (DE)
      - The DE section is a list of all the entities defined in the IGES file together with certain attributes associated with them.
      - The entry for each entity occupies two 80-character records which are divided into a total of twenty 8-character fields
      - The first and the eleventh (beginning of the second record of any given entity) fields contain the entity type number such as 100 for circle, 110 for lines, etc.
      - The second field contains a pointer to the parameter data entry for the entity in the PD section.

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section

## Computer-Aided Design (CAD)

- Geometric data exchange
  - Initial Graphic Exchange Specification (IGES):
    - Directory Entry Section (DE)

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section

Column	1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72	73-80
Line 1	Entity Type	Parameter Entry Pointer					Transformation Matrix		Visible Entity Switch	Sequence Number
Line 2	Entity Type									Sequence Number

## Computer-Aided Design (CAD)

- *Geometric data exchange*
  - *Initial Graphic Exchange Specification (IGES):*
    - *Parameter Data Section (PE)*
      - *The PD section contains the actual data defining each entity listed in the DE section*
        - *A straight line entity is defined by the six coordinates of its two endpoints*
      - *Each entity has always two records in the DE section,*
        - *The number of records required for each entity in the PD section varies from one entity to another (the minimum is one record) and depends on the amount of data.*
      - *Parameter data are placed in free format in columns 1 through 64.*

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section

## Computer-Aided Design (CAD)

- *Geometric data exchange*
  - *Initial Graphic Exchange Specification (IGES):*

Field	1	2	3	4	5	6	7	8	..	73-80
Circle	100	Z	X	Y	X <sub>1</sub>	Y <sub>1</sub>	X <sub>2</sub>	Y <sub>2</sub>		Sequence Number
Line	110	X <sub>1</sub>	Y <sub>1</sub>	Z <sub>1</sub>	X <sub>2</sub>	Y <sub>2</sub>				Sequence Number

- *Termination Section*
  - *The Terminate section contains a single record which specifies the number of records in each of the four preceding sections for checking purposes.*

Start Section
Global Section
Directory Entry Section (DE)
Parameter Data Section (PE)
Terminate Section



## Homework : AT-G-07-#

- *In this HW you will try the direct translation of geometric data related to your group format to a simple IGES format.*
  - *Given a simple .IGES file you should find the LINE (110) entities.*
  - *You should map the line data into your designed CIM database.*
- *The HW should be sent to [Fvalilai@Sharif.edu](mailto:Fvalilai@Sharif.edu) till Monday, 5<sup>th</sup> of Khordad (May, 26<sup>th</sup> ,2014)*
- *Email subject: "AT-G-07-#"*

## Computer-Aided Design (CAD)

- *Geometric data exchange*
  - *Standard for the Exchange of Product data (STEP, ISO 10303):*
    - *The STEP is the enabler for seamless exchange of product data which is critical to CAD/CAM/CAE systems.*
    - *STEP itself is the basis for Product Data Management System (PDM).*
    - *It covers border functionalities. It includes methods of representing all critical product specifications such as*
      - *Shape information,*
      - *Materials,*
      - *Tolerances,*
      - *Finishes and*
      - *Product structure.*

## Computer-Aided Design (CAD)

### ■ Geometric data exchange

- Standard for the Exchange of Product data (STEP, ISO 10303):

```

ISO-10303-21;
HEADER;
FILE_DESCRIPTION(
/* description */ ('A minimal AP214 example with a single part'),
/* implementation_level */ ('2:1');
FILE_NAME(
/* name */ ('demo'),
/* time_stamp */ ('2003-12-27T11:57:53'),
/* author */ ('Lothar Klein'),
/* organization */ ('LKSoft'),
/* preprocessor_version */ (''),
/* originating_system */ ('IDA-STEP'),
/* authorization */ ('');
FILE_SCHEMA (('AUTOMOTIVE_DESIGN { 1 0 10303 214 2 1 1}'))
ENDSEC;
DATA;
#10=ORGANIZATION('00001', 'LKSoft', 'company');
#11=PRODUCT_DEFINITION_CONTEXT('part definition', #12, 'manufacturing');
#12=APPLICATION_CONTEXT('mechanical design');
#13=APPLICATION_PROTOCOL_DEFINITION('automotive_design', 2003, #12);
#14=PRODUCT_DEFINITION('0', $, #15, #11);
#15=PRODUCT_DEFINITION_FORMATION('1', $, #16);
#16=PRODUCT('A0001', 'Test Part 1', $, $, #18);
#17=PRODUCT_RELATED_PRODUCT_CATEGORY('part', $, #16);
#18=PRODUCT_CONTEXT('', #12, '');
#19=APPLIED_ORGANIZATION_ASSIGNMENT(#10, #20, #16);
#20=ORGANIZATION_ROLE('id owner');
ENDSEC;
END-ISO-10303-21;

```

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### Initial STEP Architecture

