

Integrated Automation System Case Study

By

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Integrated Automation System ?

- **Totally integrated automation (TIA)** can be define as the interaction of extensive single components, machine, tool and services (spare part service, etc.) to achieve an automation solution.
- The interaction performs integration across the four automation levels of the automation pyramid:
 1. Management level
 2. Operator's level
 3. Controller's level
 4. Field level

Benefits of Integrated Automation System ?

- **Design and engineering:**

Intelligent tools support the selection of the appropriate components as well as the optimum design of the automation solution.

- **Installation and startup:**

The consistent use of established standards such as PROFIBUS and PROFINET reduces interfacing costs to a minimum

- **Maintenance:**

Efficient diagnostics concepts can be implemented, Intelligent maintenance strategies allow potential sources of faults to be recognized, analyzed and cleared

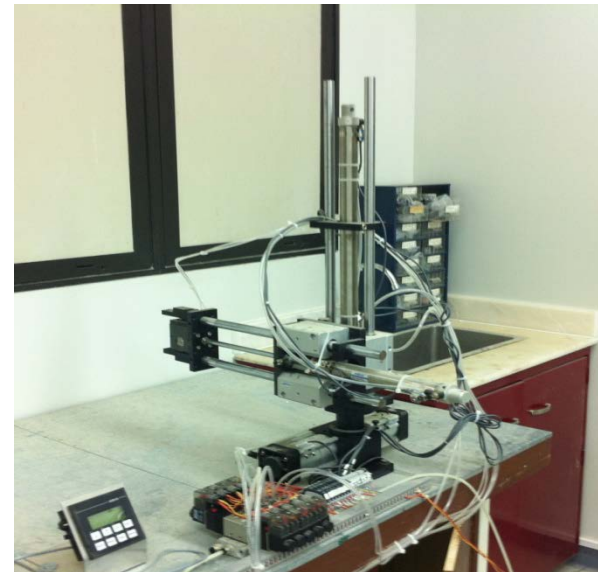
- **Modernization and expansion:**

Existing automation solutions can be adapted to changing requirements without any difficulty
Reliability

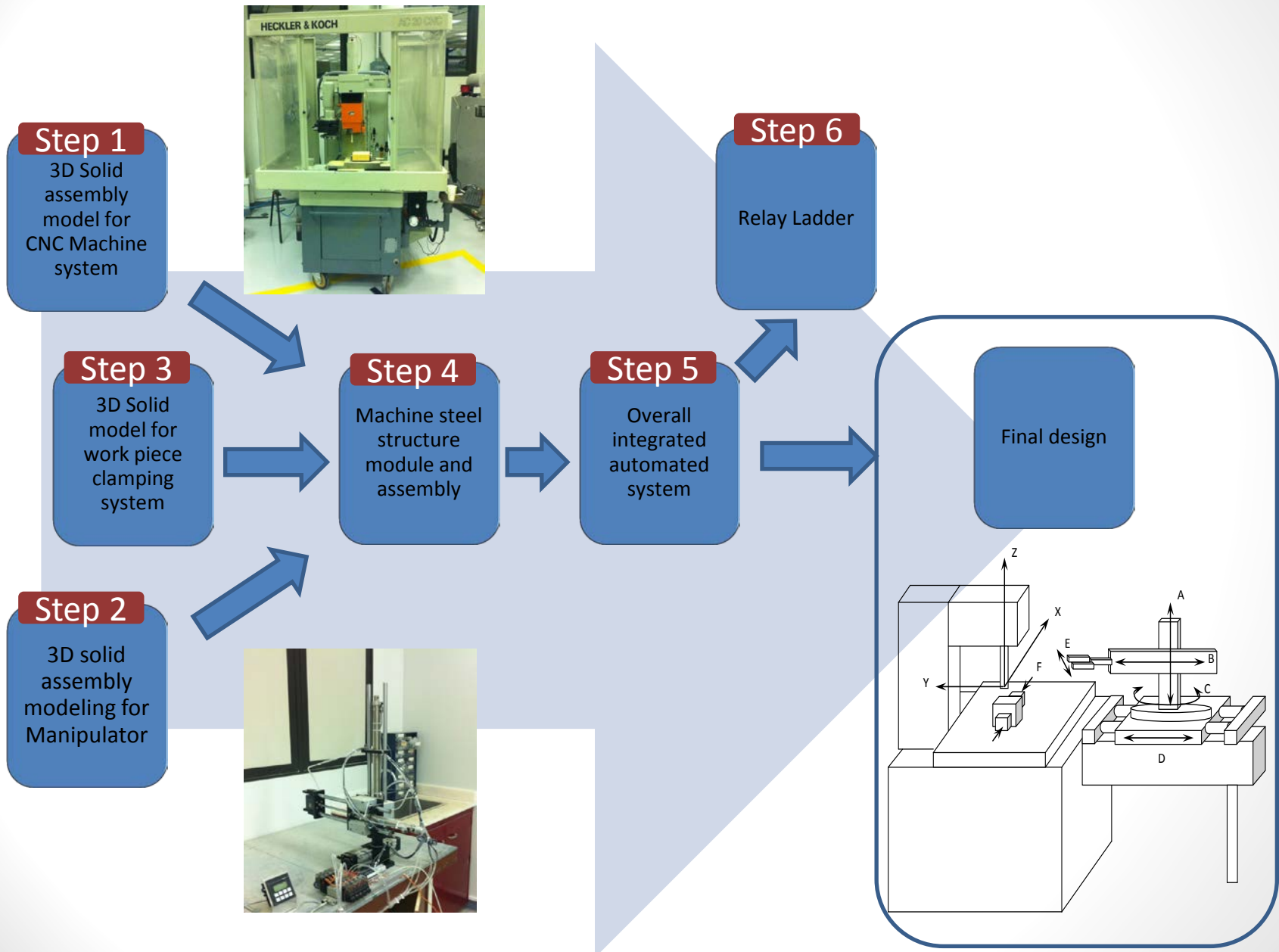
- **Safety machine operation.**

Project Objectives

- Model a 3D CAD system cover the integration system between discrete control Cartesian robot and small CNC Milling machine. This will be the first step for development of integrated automation system.
- Identify the movement sequence for pneumatic manipulator with CNC vertical milling machine and write the Relay Ladder logic program to carry out the proposed manipulator movement sequence.



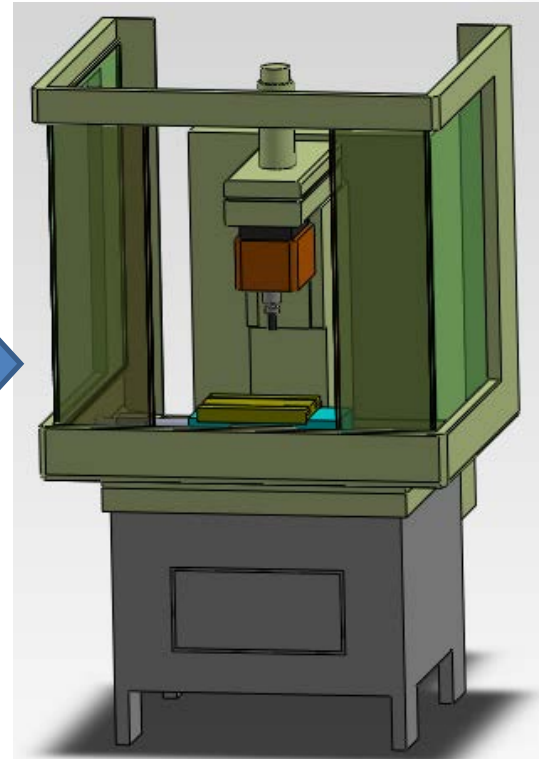
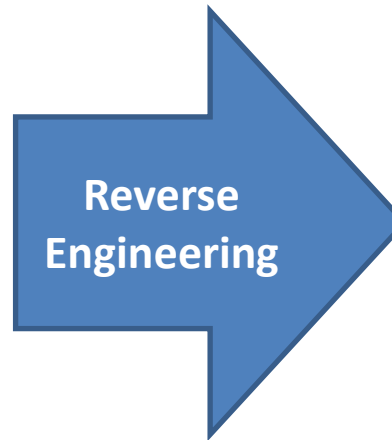
Project Roadmap or Methodology



Step1: 3D solid assembly model for CNC vertical milling machine



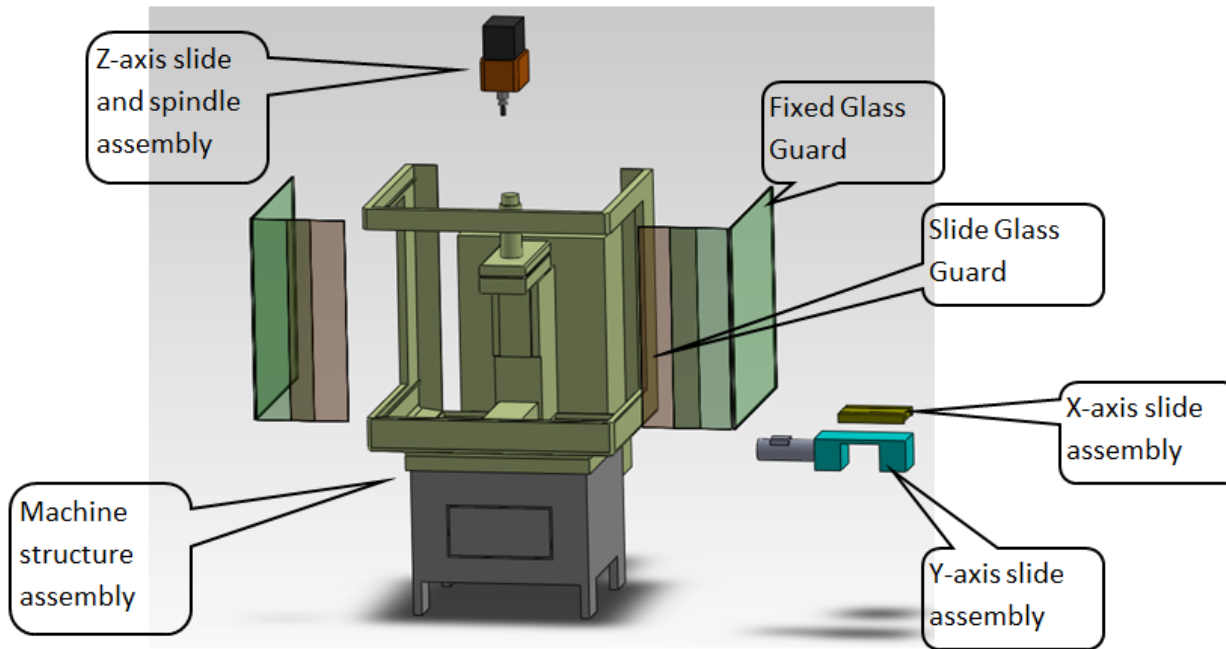
Actual CNC milling machine



3D solid model

Step1: 3D solid assembly model for CNC vertical milling machine

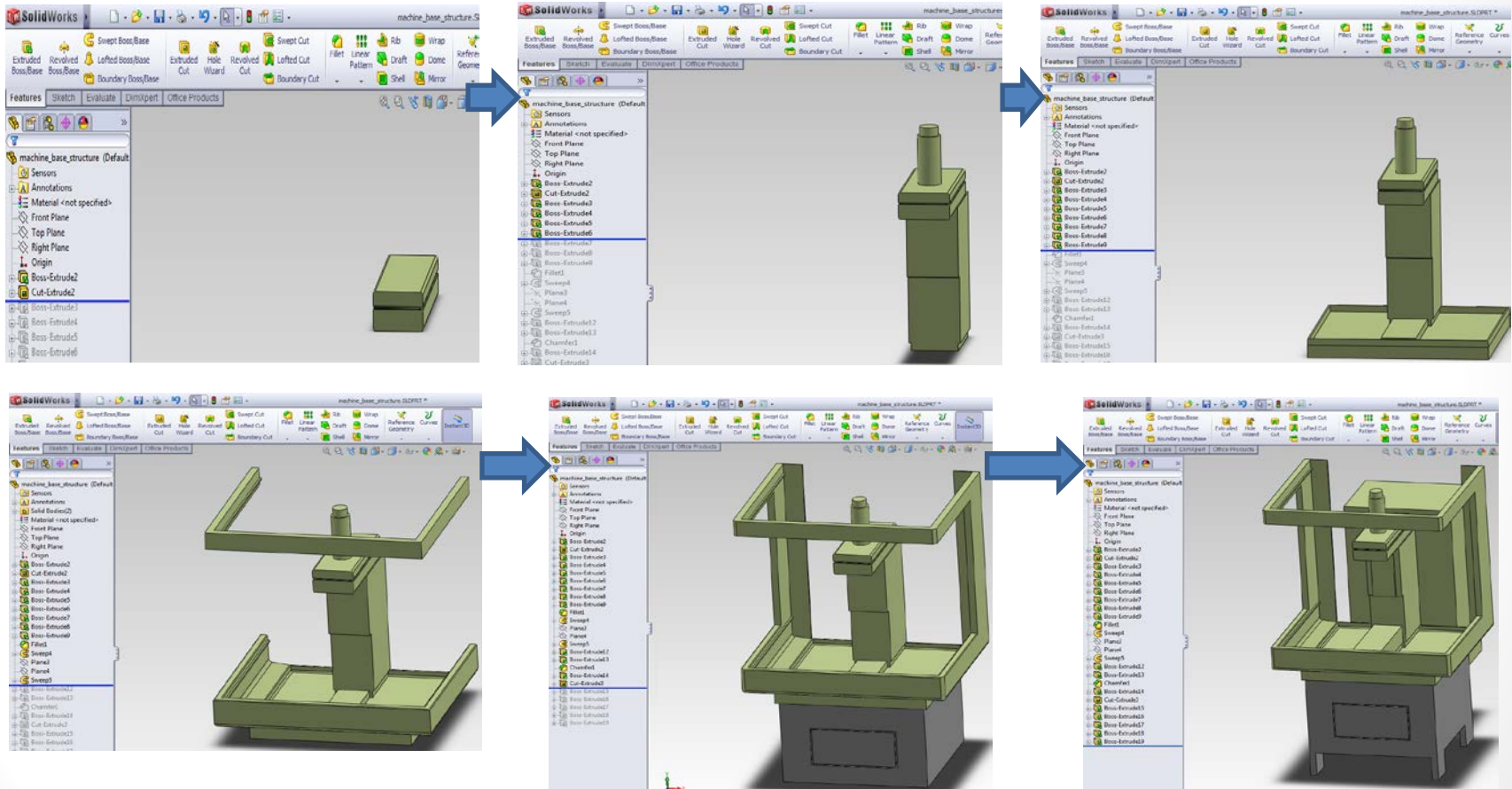
- 1) Modeling the 3D machine structure.
- 2) Modeling machine slide assembly (X,Y and Z axes).
- 3) Modeling the glass doors and machine assembly



Explode Drawing for Machine Assembly

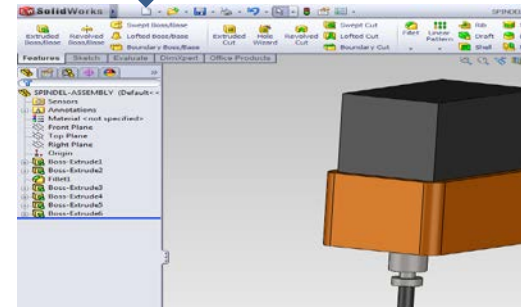
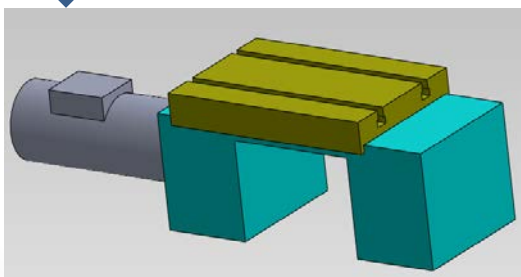
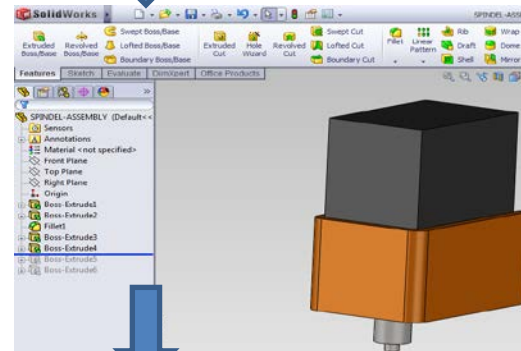
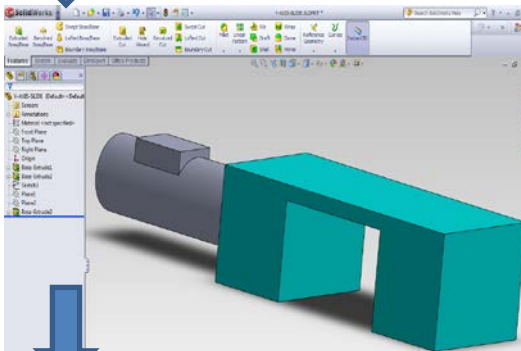
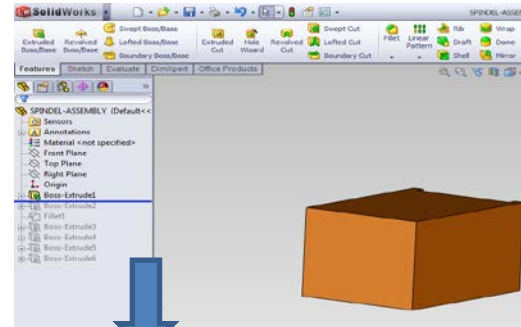
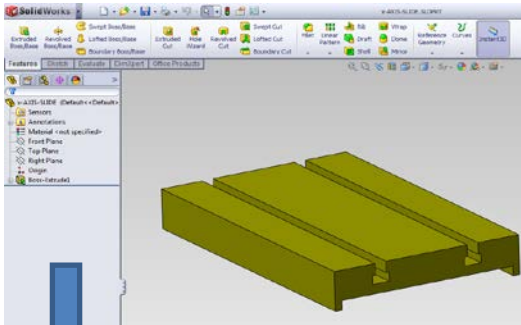
Step1: 3D solid assembly model for CNC vertical milling machine

1) Modeling the 3D machine structure (using extrude, sweep tools).



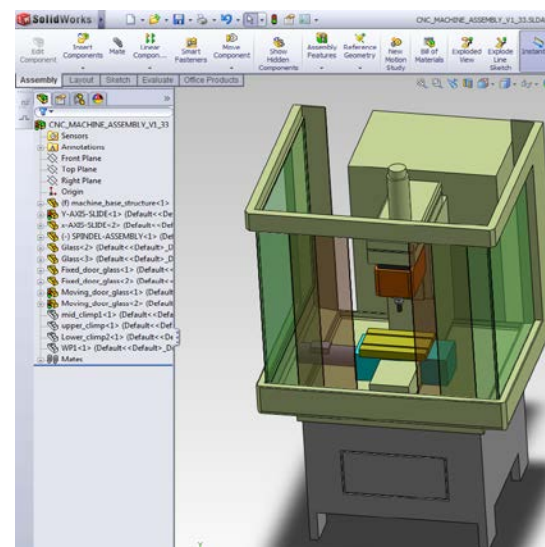
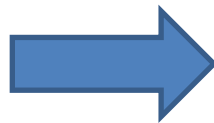
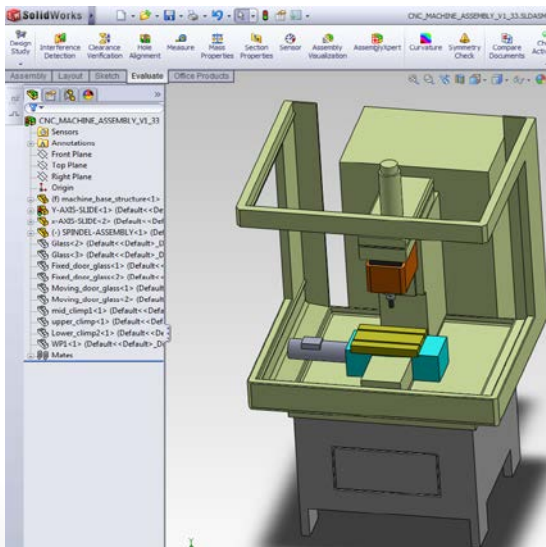
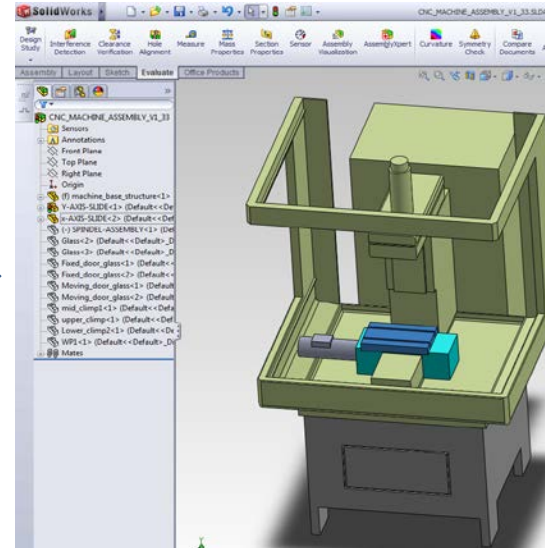
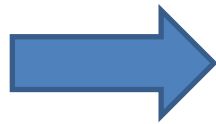
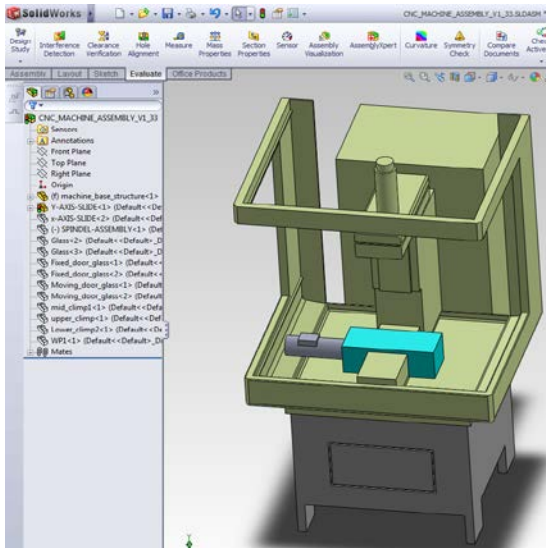
Step1: 3D solid assembly model for CNC vertical milling machine

2) Modeling machine slide assembly (X,Y and Z axes), (using extrude and extrude cut tools)

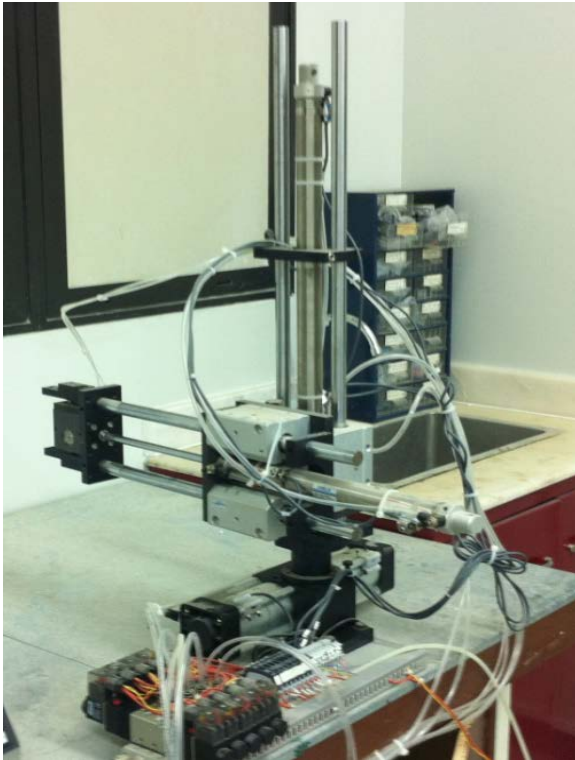


Step1: 3D solid assembly model for CNC vertical milling machine

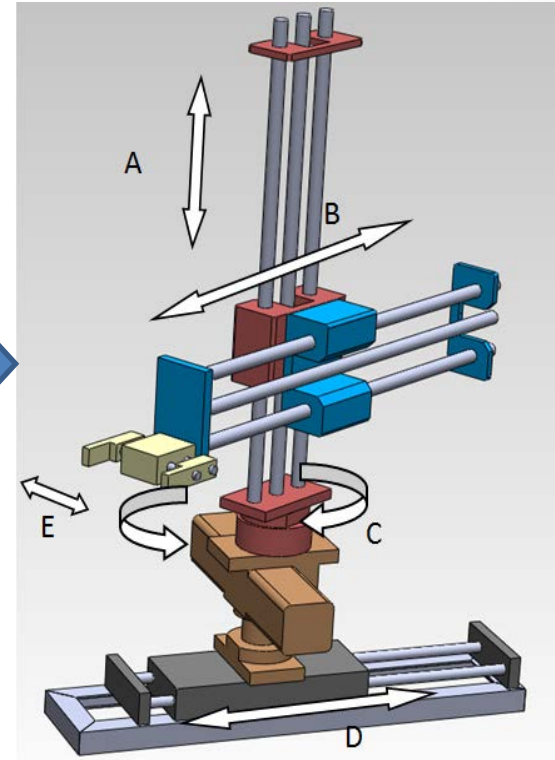
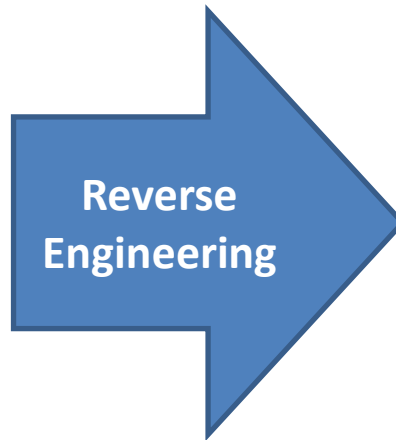
3) Modeling the glass doors and machine assembly (using mate tool for assembly)



Step2: 3D solid assembly modeling for Manipulator



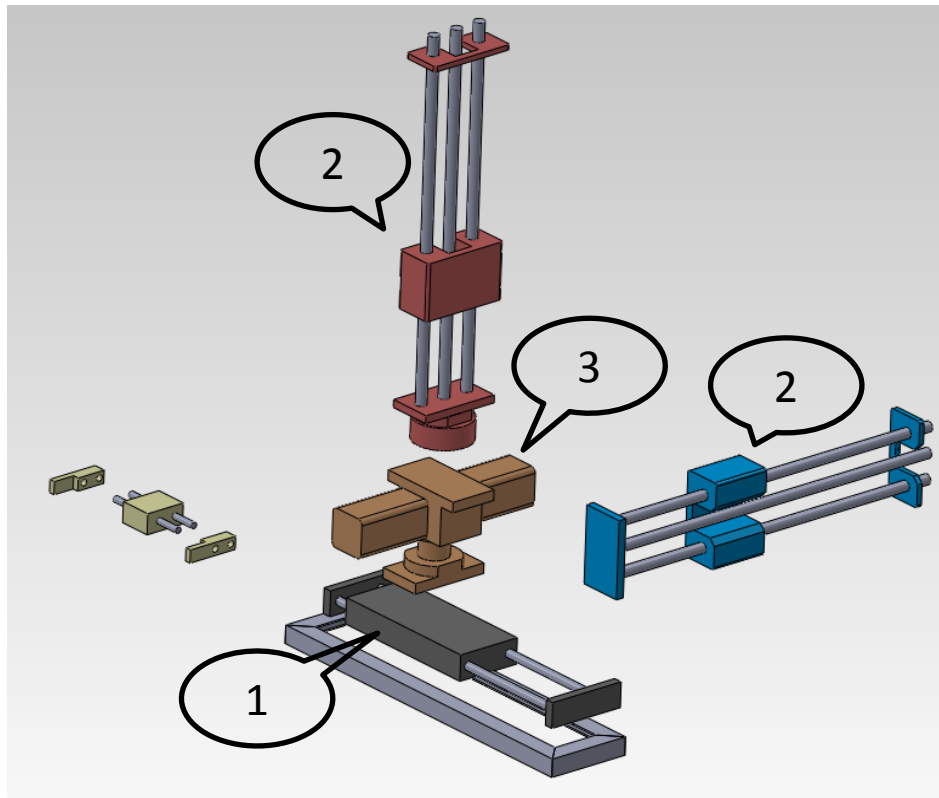
Actual pneumatic manipulator



3D solid model

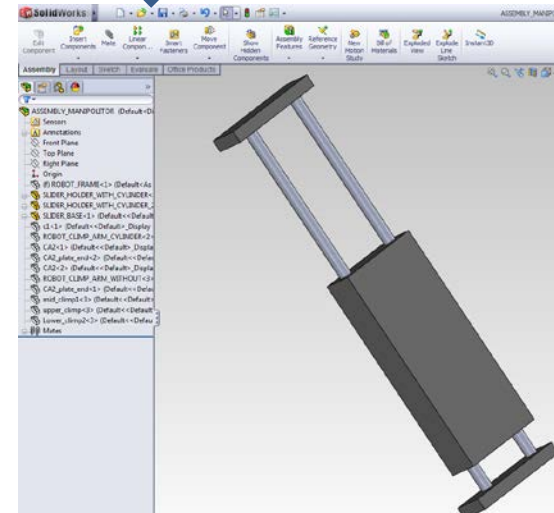
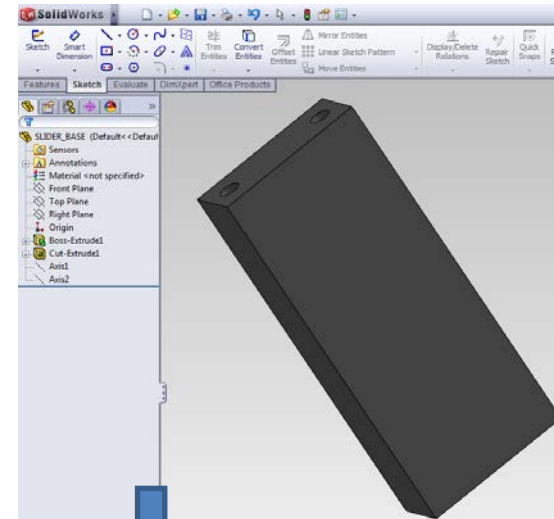
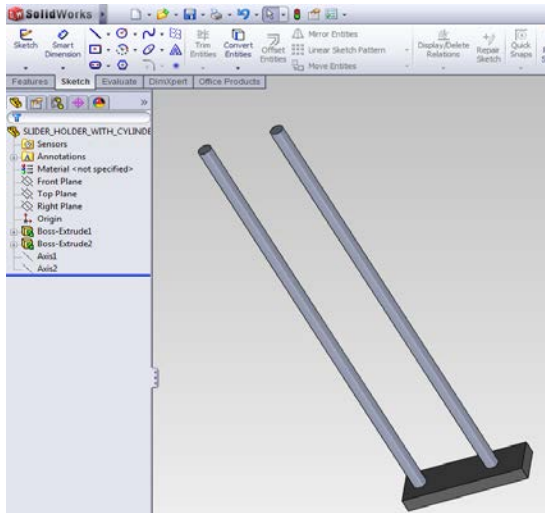
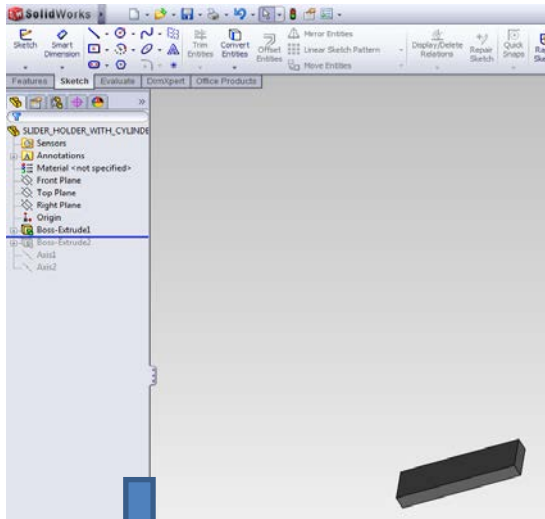
Step2: 3D solid assembly modeling for Manipulator

- 1) Modeling manipulator slide *D*.
- 2) Modeling manipulator slide *A and B*.
- 3) Modeling the angular displacement *c*.



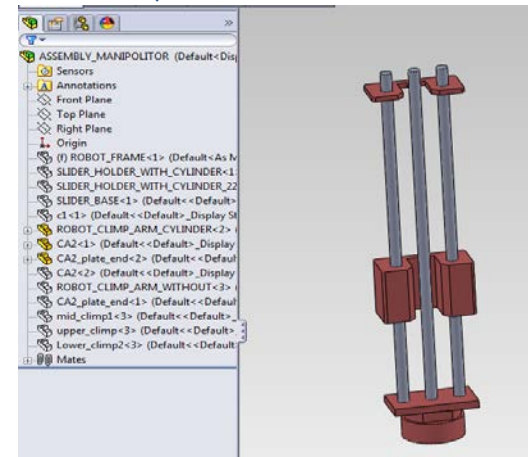
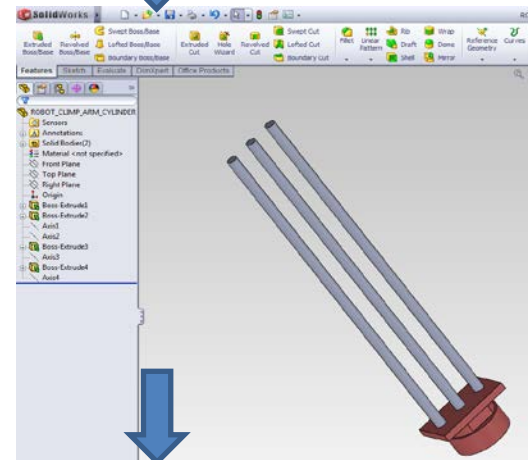
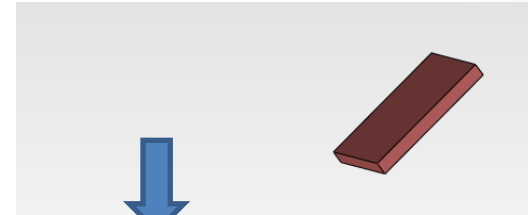
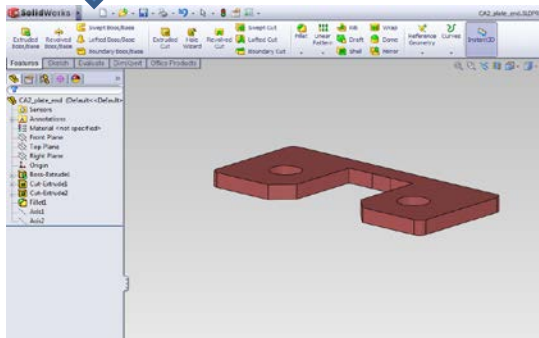
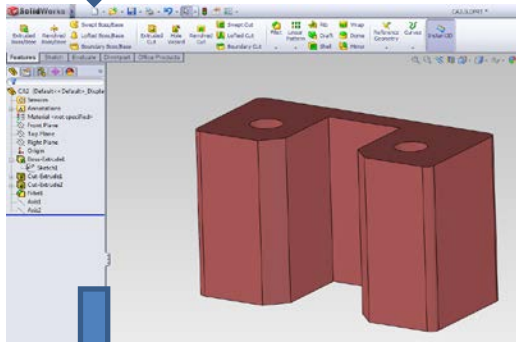
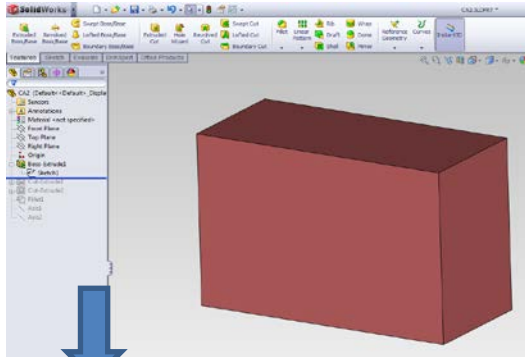
Step2: 3D solid assembly modeling for Manipulator

1) Modeling manipulator slide D.



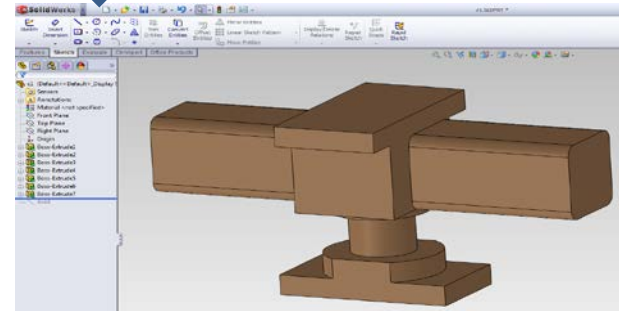
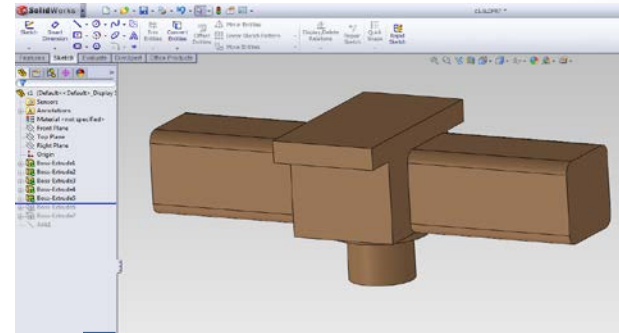
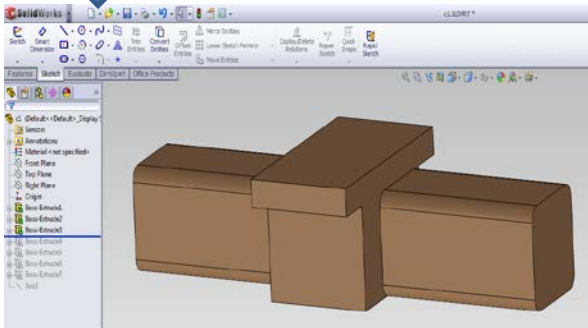
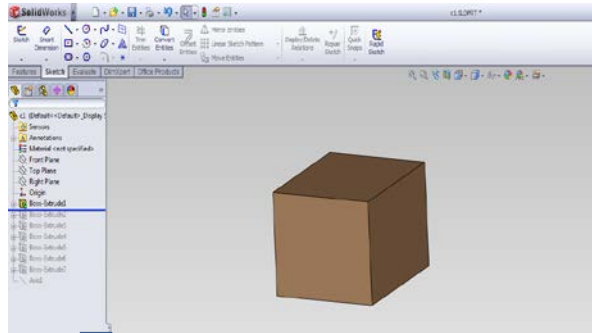
Step2: 3D solid assembly modeling for Manipulator

2) Modeling manipulator slide A and B.

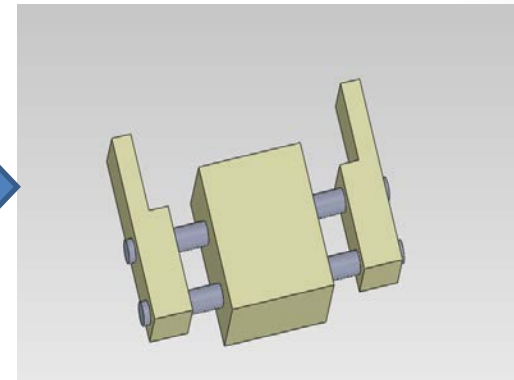
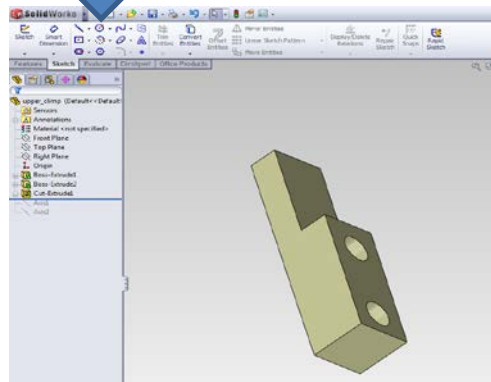
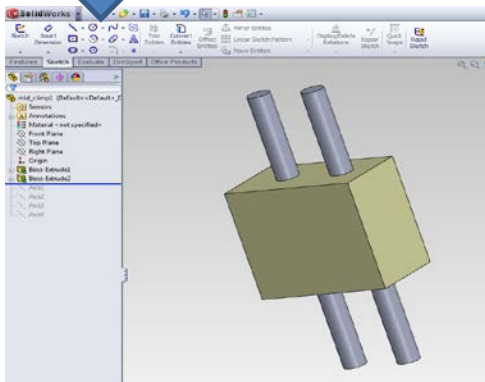
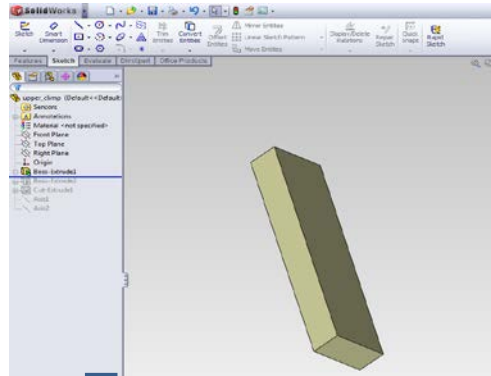
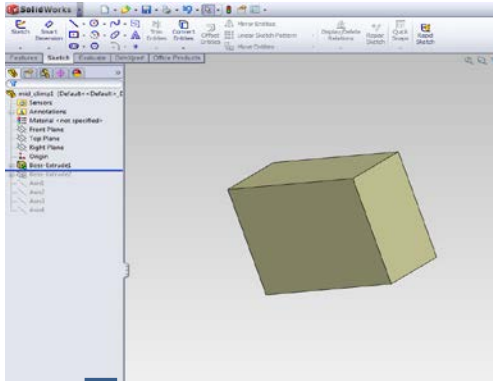


Step2: 3D solid assembly modeling for Manipulator

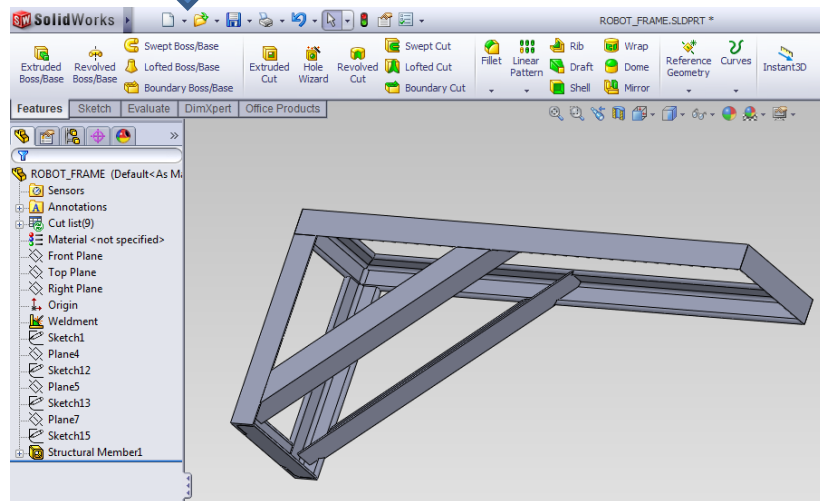
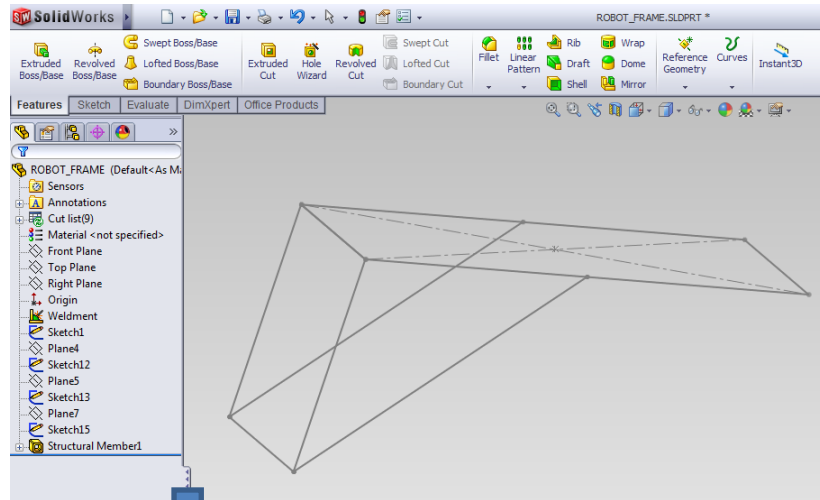
3) Modeling the angular displacement c .



Step3: 3D Solid model for work piece clamping system

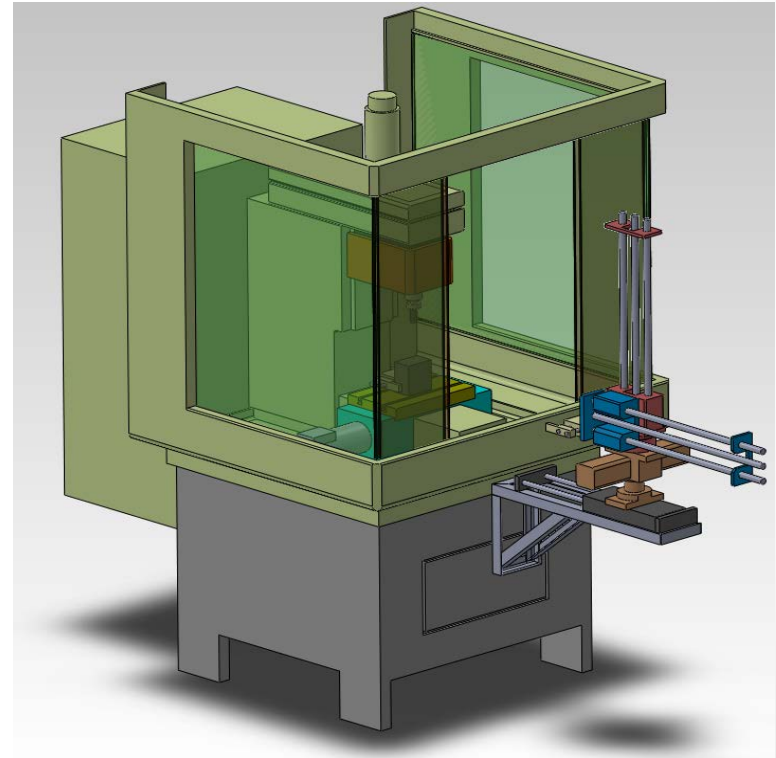
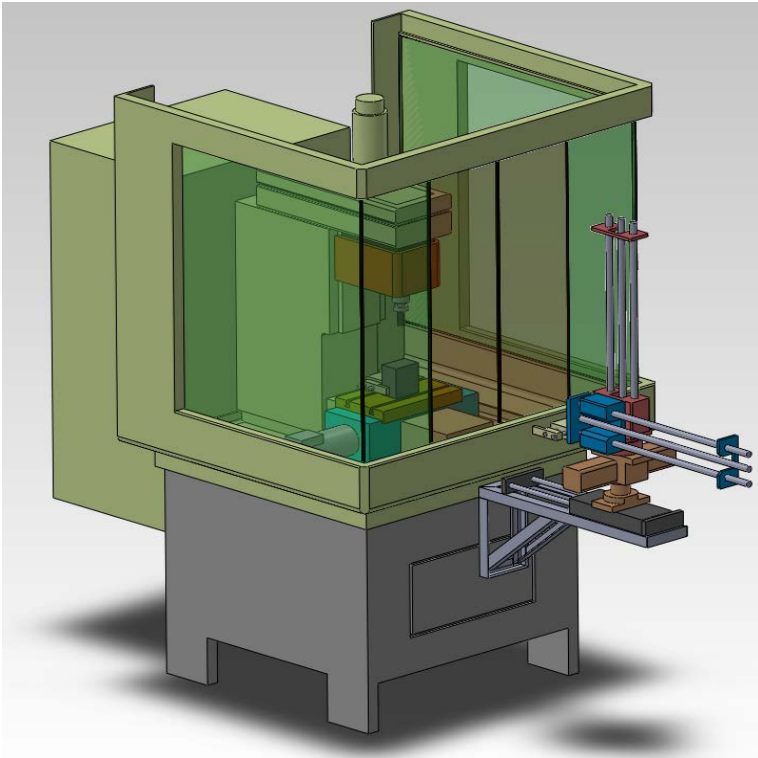


Step4: Machine steel structure module and assembly



Step5: solid assembly modeling for integrated automation system structure

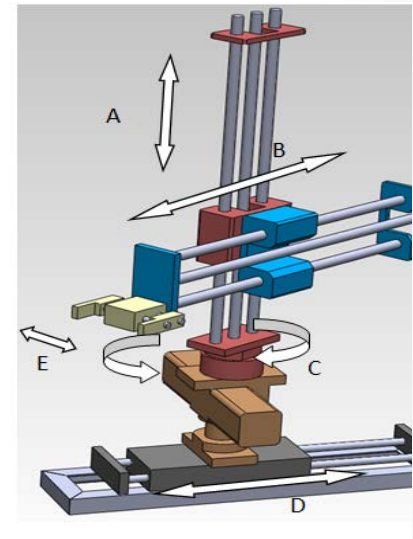
- Home position CNC milling machine
- Home manipulator position



Step5: solid assembly modeling for integrated automation system structure

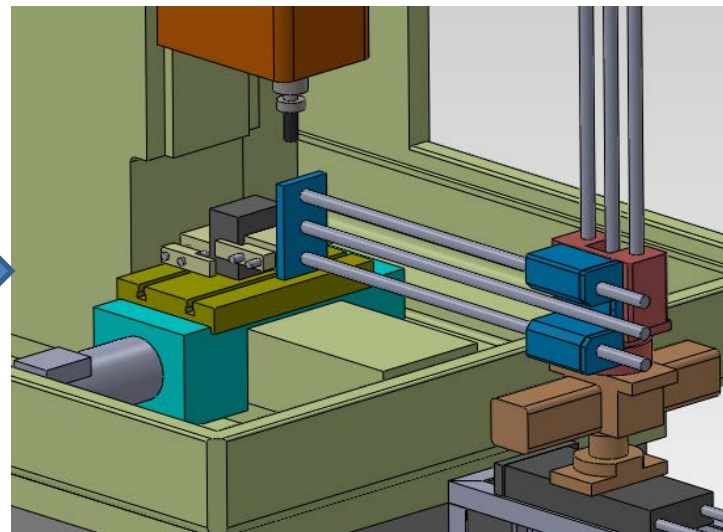
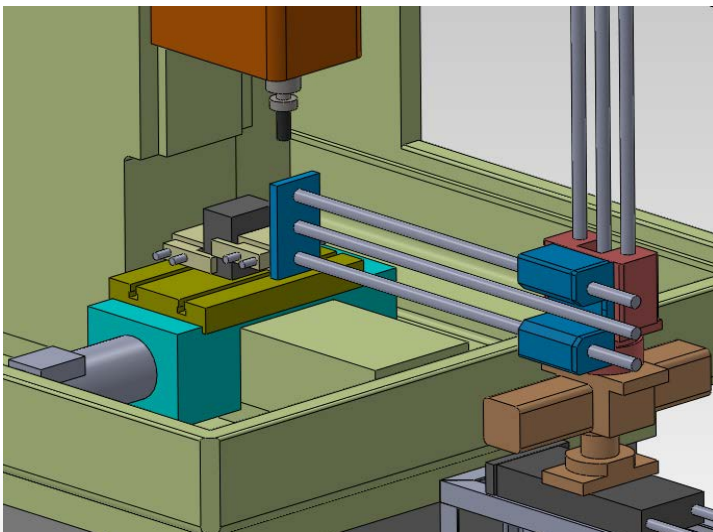
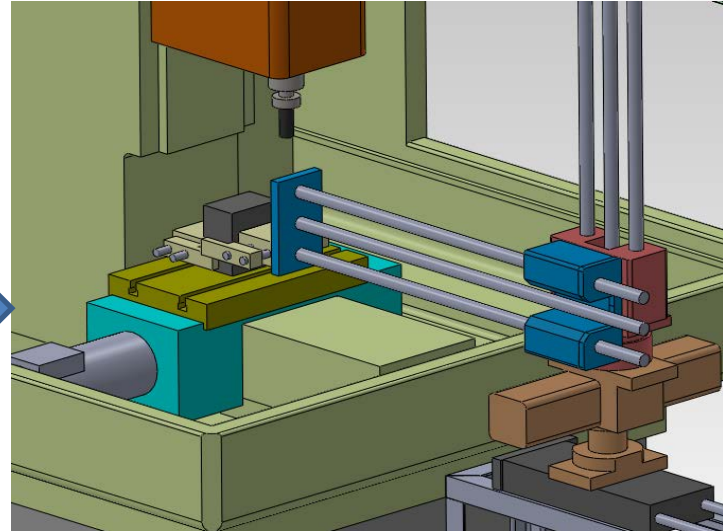
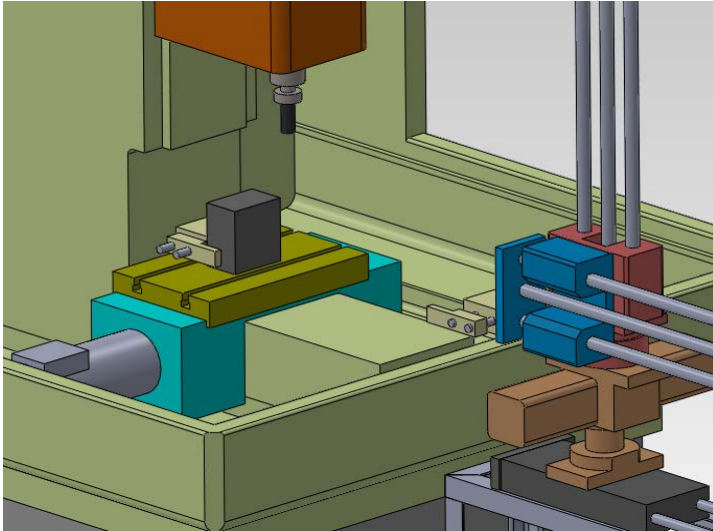
- Manipulator Machine Sequence

Label	Actuator Name	Movement label	Functions
A	Manipolator Vertical Arm	A+	Moving Up Position
		A-	Moving Down Position
B	Manipolator Horizontal Arm	B+	Arm Forward Position
		B-	Arm Backward Position
C	Manipolator Angular Rotation	C+	Rotate Arm B counter clockwise[1]
		C-	Rotate Arm B clockwise[1]
D	Manipolator Horizontal Slide	D+	Movement Toward CNC m/c
		D-	Movement Outward CNC m/c
E	End-effect Manipolator Gripper	E+	Open Gripper
		E-	Close Gripper
F	Pneumatic Power Caming Fixture (CNC milling m/c)	F+	Open fixture
		F-	Close fixture
G	Pneumatic power glass door silde movement	G+	Door open
		G-	Door close



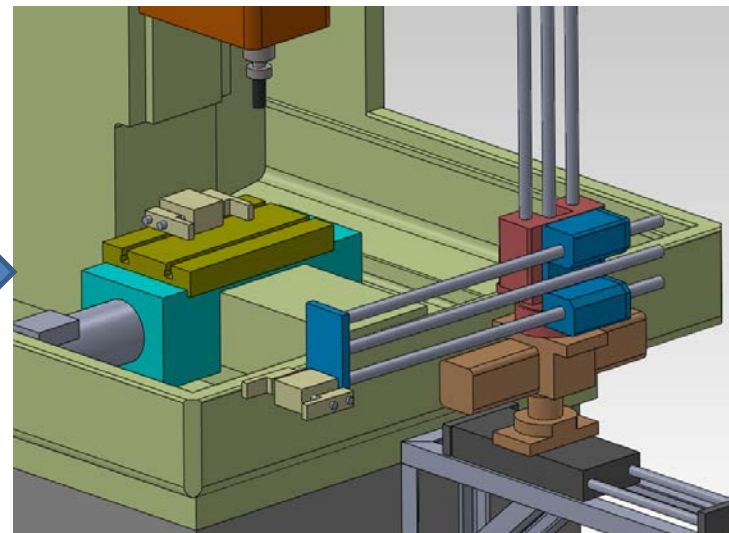
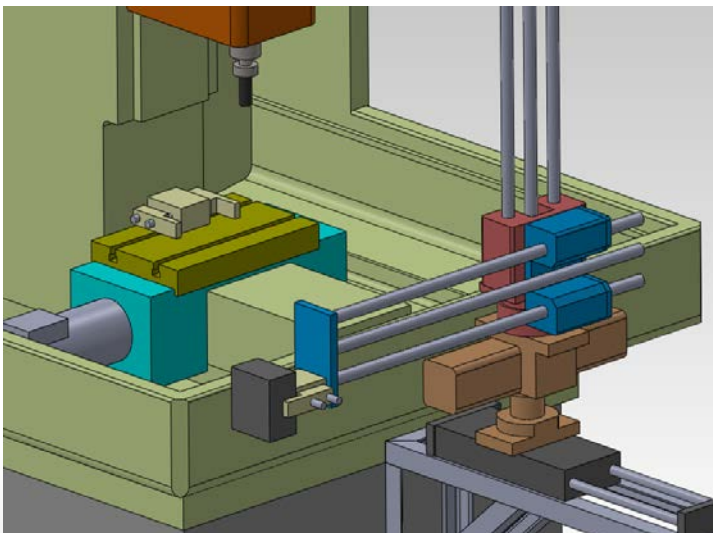
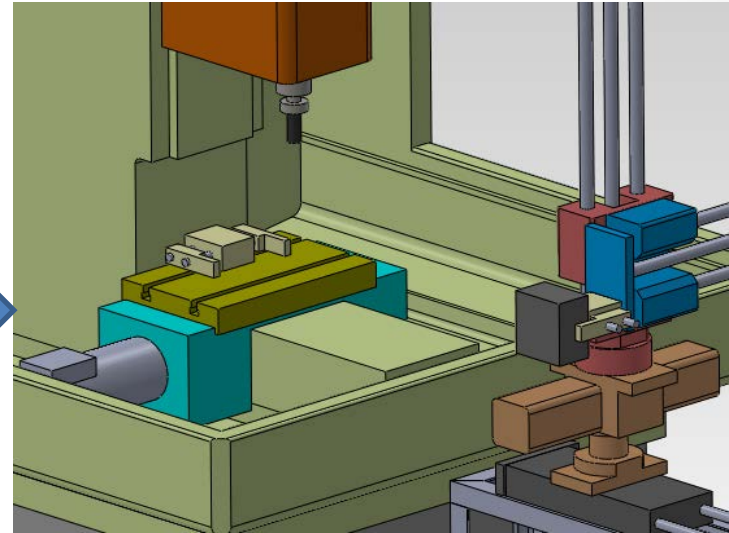
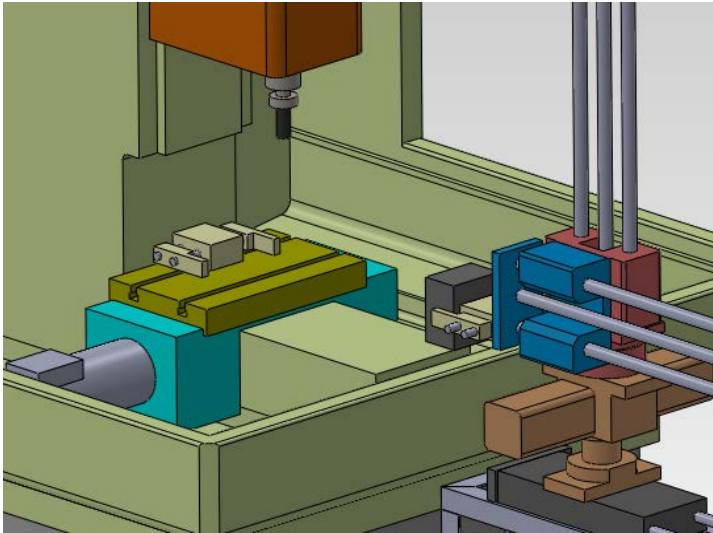
Step5: solid assembly modeling for integrated automation system structure

- Manipulator Machine Sequence



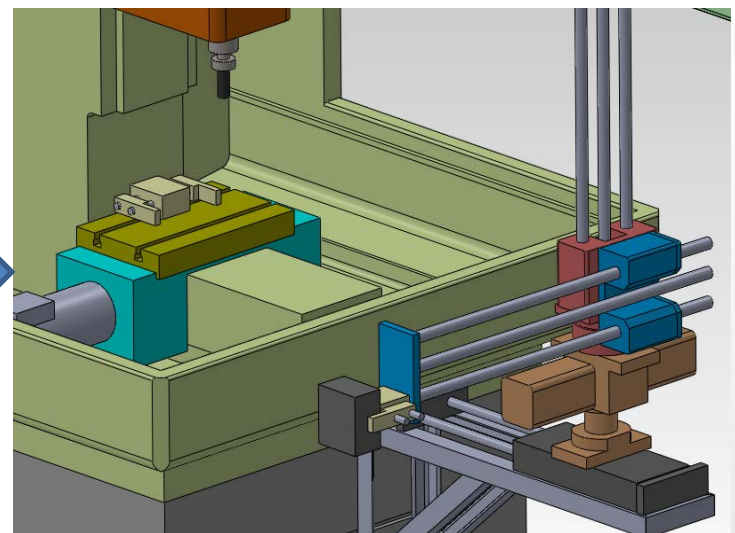
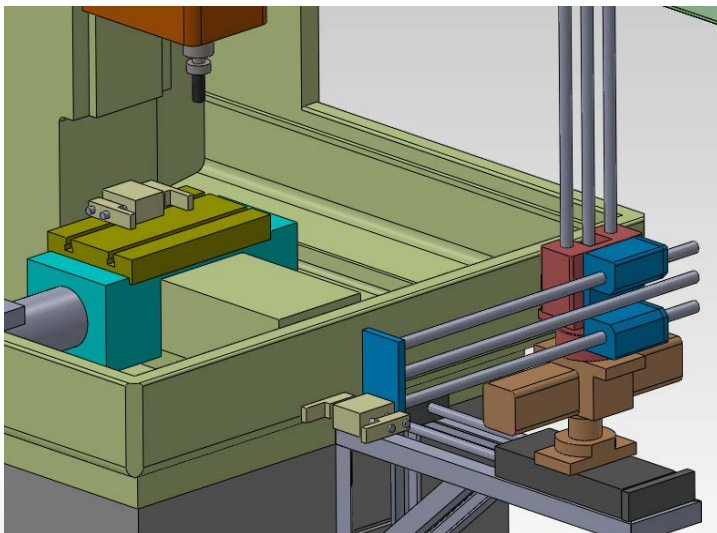
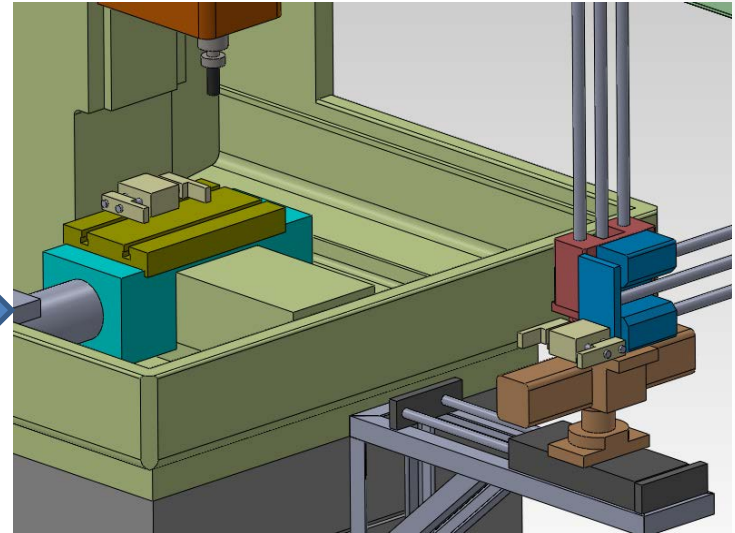
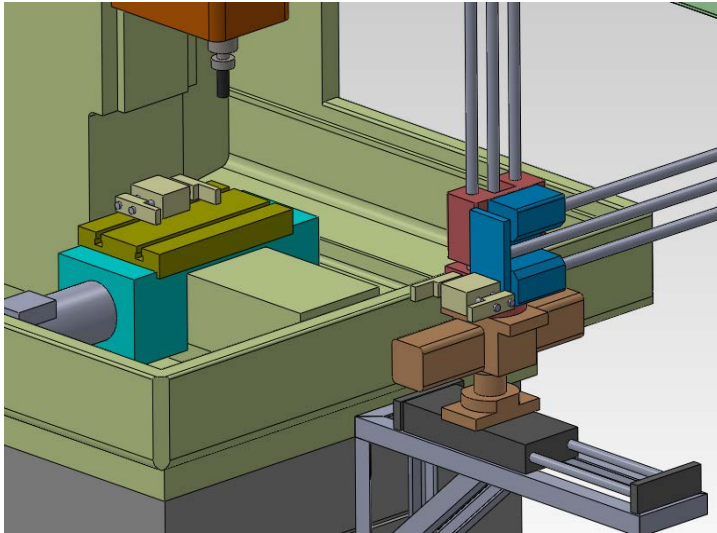
Step5: solid assembly modeling for integrated automation system structure

- Manipulator Machine Sequence



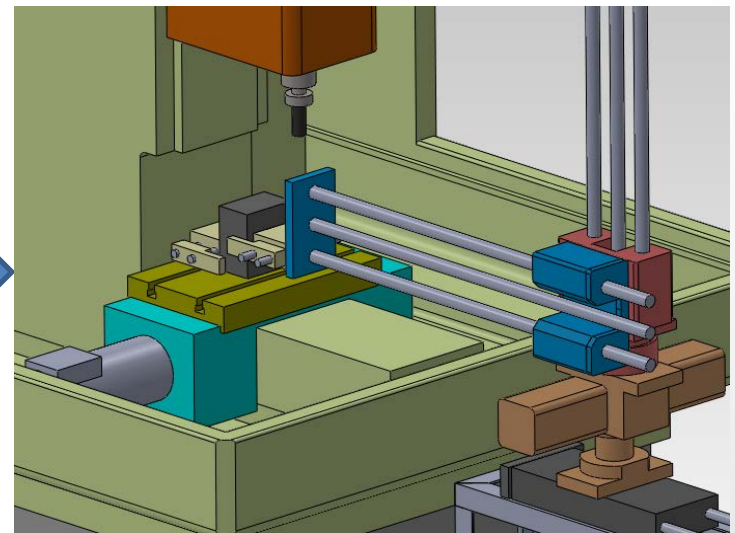
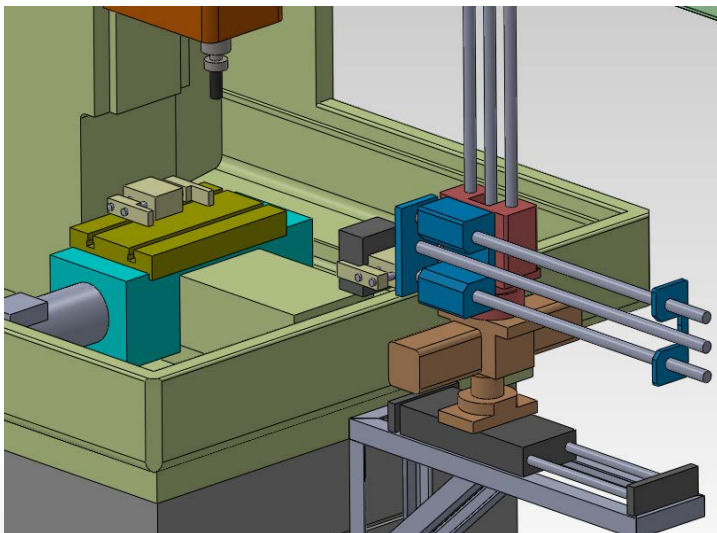
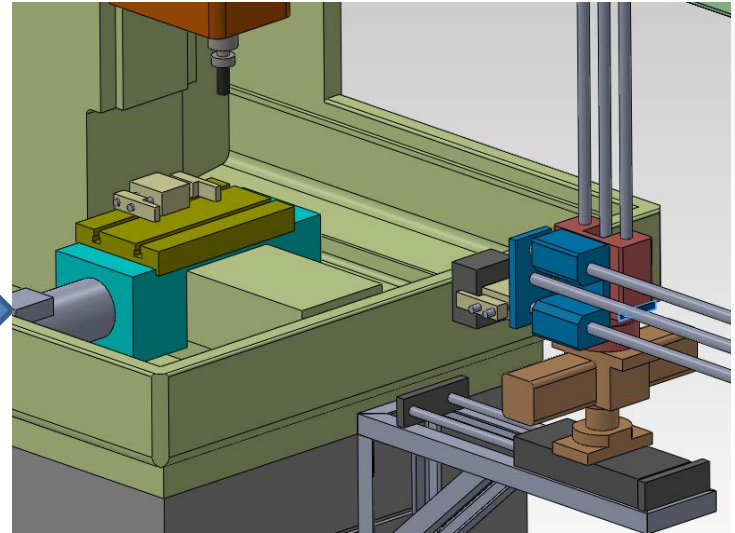
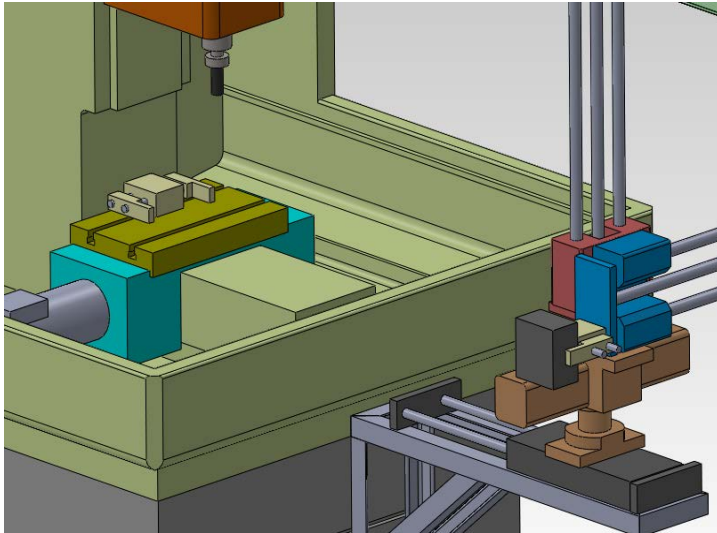
Step5: solid assembly modeling for integrated automation system structure

- Manipulator Machine Sequence



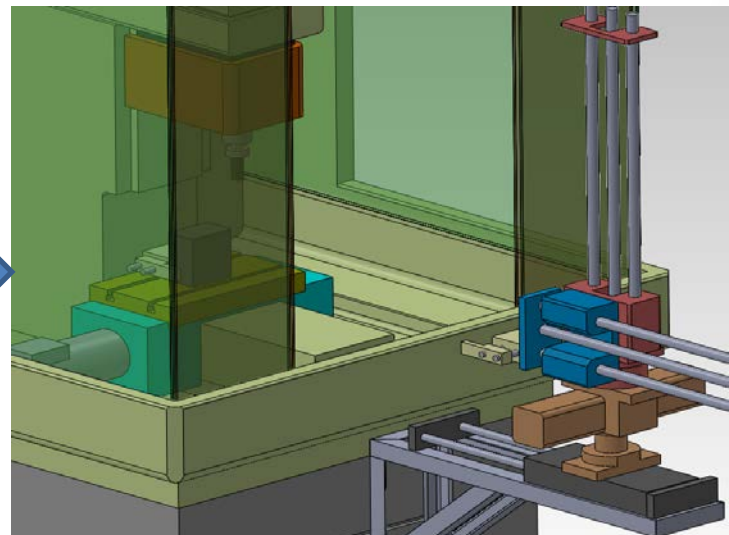
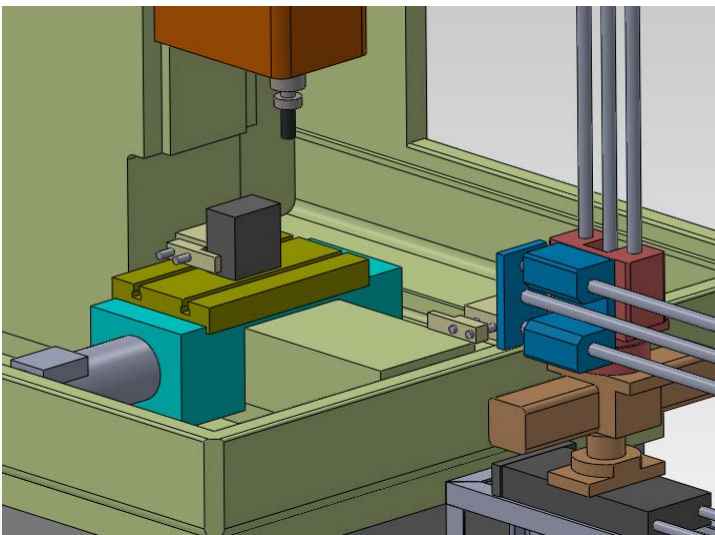
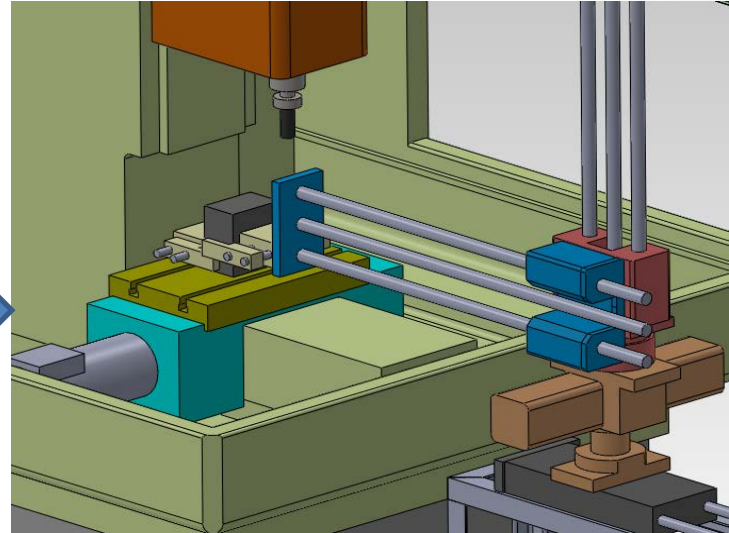
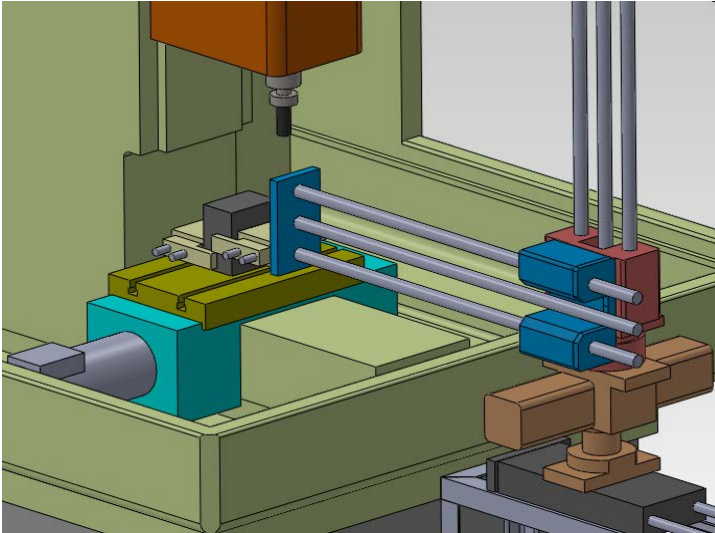
Step5: solid assembly modeling for integrated automation system structure

- Manipulator Machine Sequence



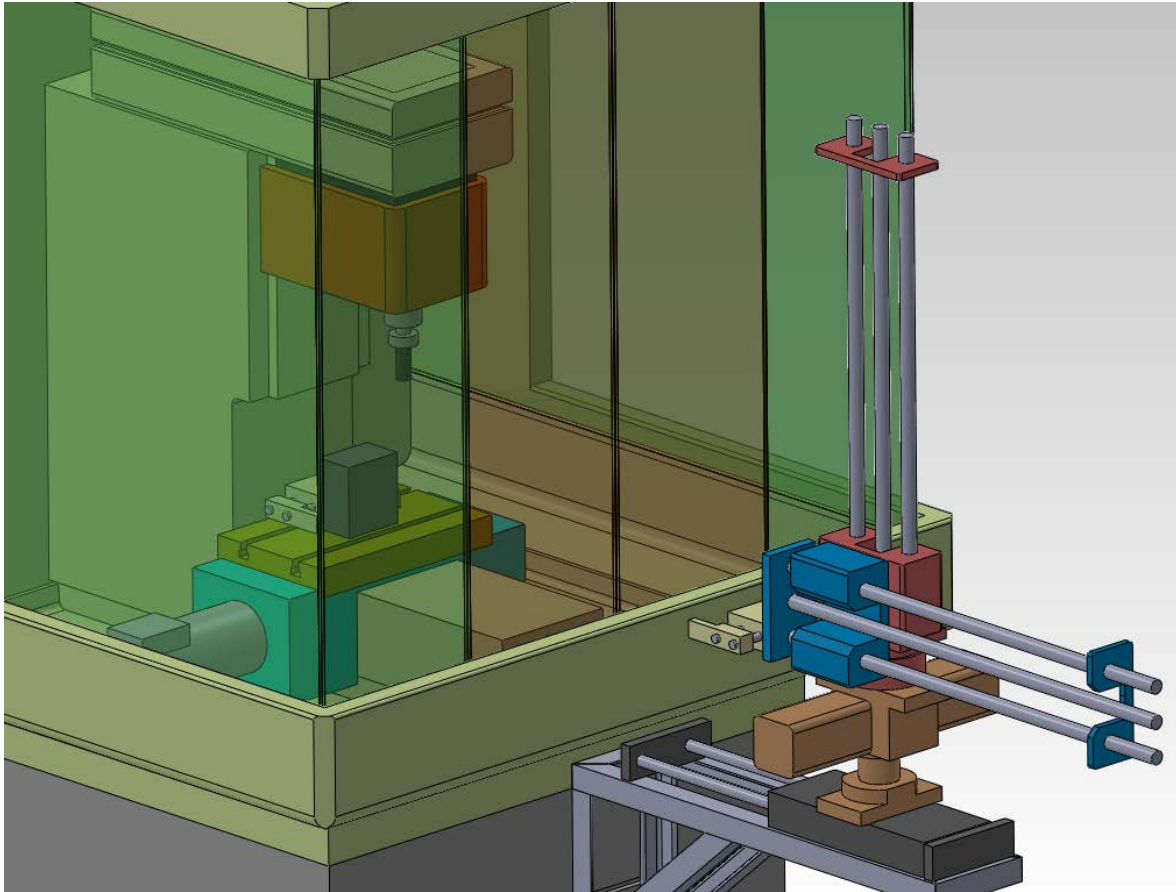
Step5: solid assembly modeling for integrated automation system structure

- Manipulator Machine Sequence



Step5: solid assembly modeling for integrated automation system structure

- **Manipulator Machine Sequence**

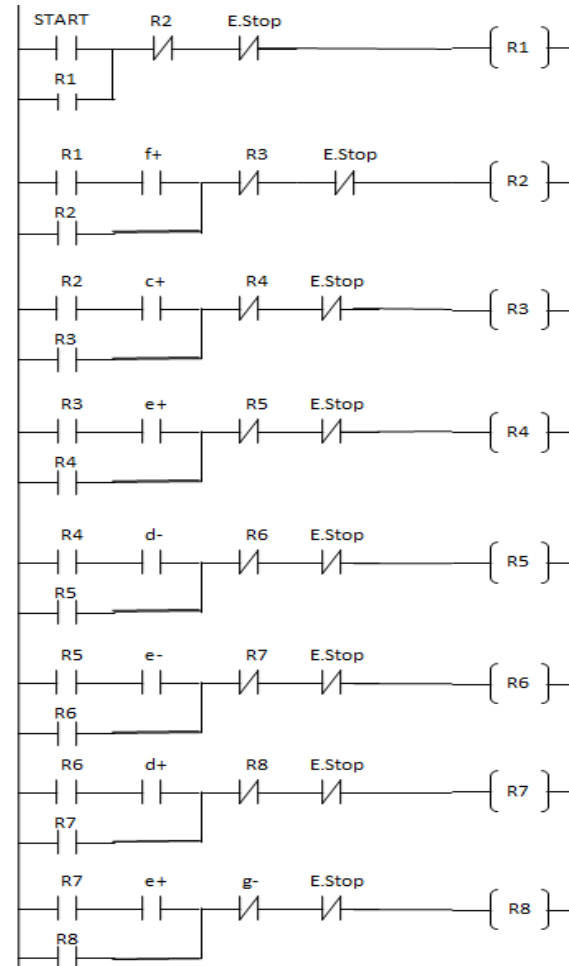


Step6: Relay Ladder Logic program

- Relay Ladder Logic program for given machine sequence according CASCAT Method ref[3,4].

START,

Machine cycle	Group #
G+, D+,B+, E-, F+,	Group #1
B-,C+,	Group #2
B+,E+,	Group #3
B-,D-,	Group #4
B+,E-,	Group #5
B-,C-, D+,	Group #6
B+, F-,E+,	Group #7
B-, D-,G-	Group #8

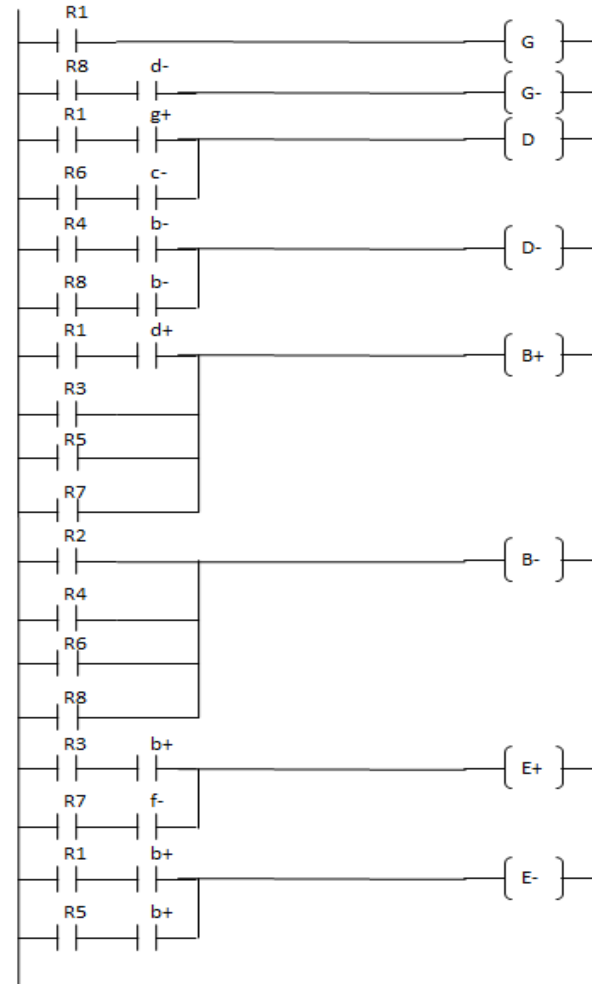


Step6: Relay Ladder Logic program

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B-,C-, D+,	Group #6
B+, F-,E+,	Group #7
B-, D-,G-	Group #8

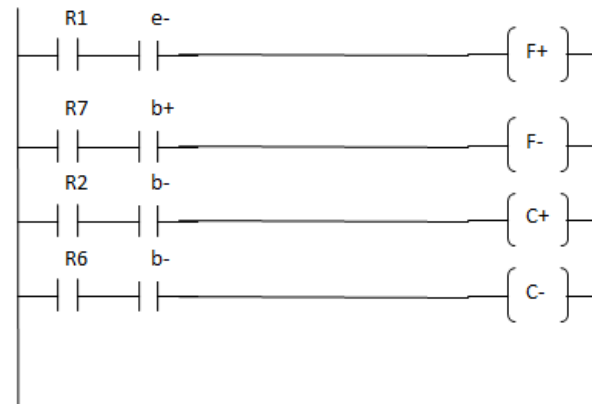


Step6: Relay Ladder Logic program

- Relay Ladder Logic program for given machine sequence

START,

Machine cycle	Group #
G+, D+,B+, E-, F+,	Group #1
B-,C+,	Group #2
B+,E+,	Group #3
B-,D-,	Group #4
B+,E-,	Group #5
B-,C-, D+,	Group #6
B+, F-,E+,	Group #7
B-, D-,G-	Group #8



Summery and Conclusion

- Integrated automatic system between vertical CNC machine and discrete pneumatic manipulator is selected for current case study.
- The two sub-systems mainly the vertical CNC milling machine and pneumatic manipulators are both available in Industrial Engineering Department laboratory. Where reverse engineering procedure is used to obtain its dimensions to be used in 3D modeling through CAD software available in College of Engineering computer laboratory.

Summery and Conclusion

- It was decided to use CAD system to model and verify the operations of the integrated automatic manufacturing cell. Where steel welded structure also included in the model to establish the integration between two sub-systems.
- The machine sequence for the pneumatic manipulator was identified and tested virtually using the 3D CAD model developed in current project.
- Pneumatic power clamping system is also considered on the proposed integrated automatic manufacturing cell.

Summery and Conclusion

- The final mounting dimensions that represent the main integration between CNC milling machine, manipulator, steel welded basement and power clamping system are identified to be used later for actual cell production.
- For simplicity it was decided to model cubic shape workpiece, and two jaw with coupler movements is considered for pneumatic power clamping fixture.
- Finally, the Relay Ladder Logic program for controlling the manipulator operation sequence is written for Simians Simatic S7-300 PLC.

THANK YOU

FOR

Listening