Industrial Automation
(Automação de Processos Industriais)

GRAFCET
(Sequential Function Chart) 2/2

http://users.isr.ist.utl.pt/~jag/courses/api1516/api1516.html

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Syllabus:

Chap. 3 – PLC Programming languages [2 weeks]

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Chap. 4 - GRAFCET *(Sequential Function Chart)* **[1 week]**
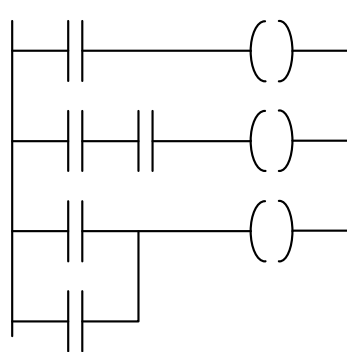The GRAFCET norm.
Elements of the language.
Modelling techniques using GRAFCET.

...
Chap. 5 – CAD/CAM and CNC Machines [1 week]

PLC Programming languages
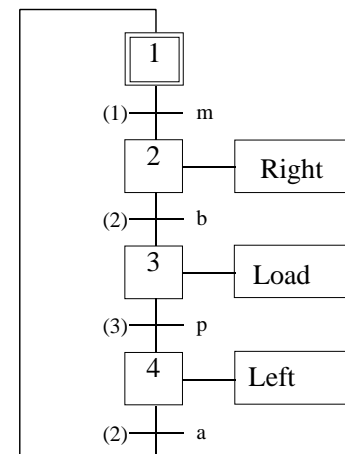# (IEC 1131-3)

Ladder Diagram

Structured Text

```
If  %I1.0  THEN
   %Q2.1 := TRUE
ELSE
   %Q2.2 := FALSE
END_IF
```

Instruction List

```
LD       %M12
AND      %I1.0
ANDN     %I1.1
OR       %M10
ST       %Q2.0
```

Sequential Function Chart (GRAFCET)

GRAFCET   vs Ladder

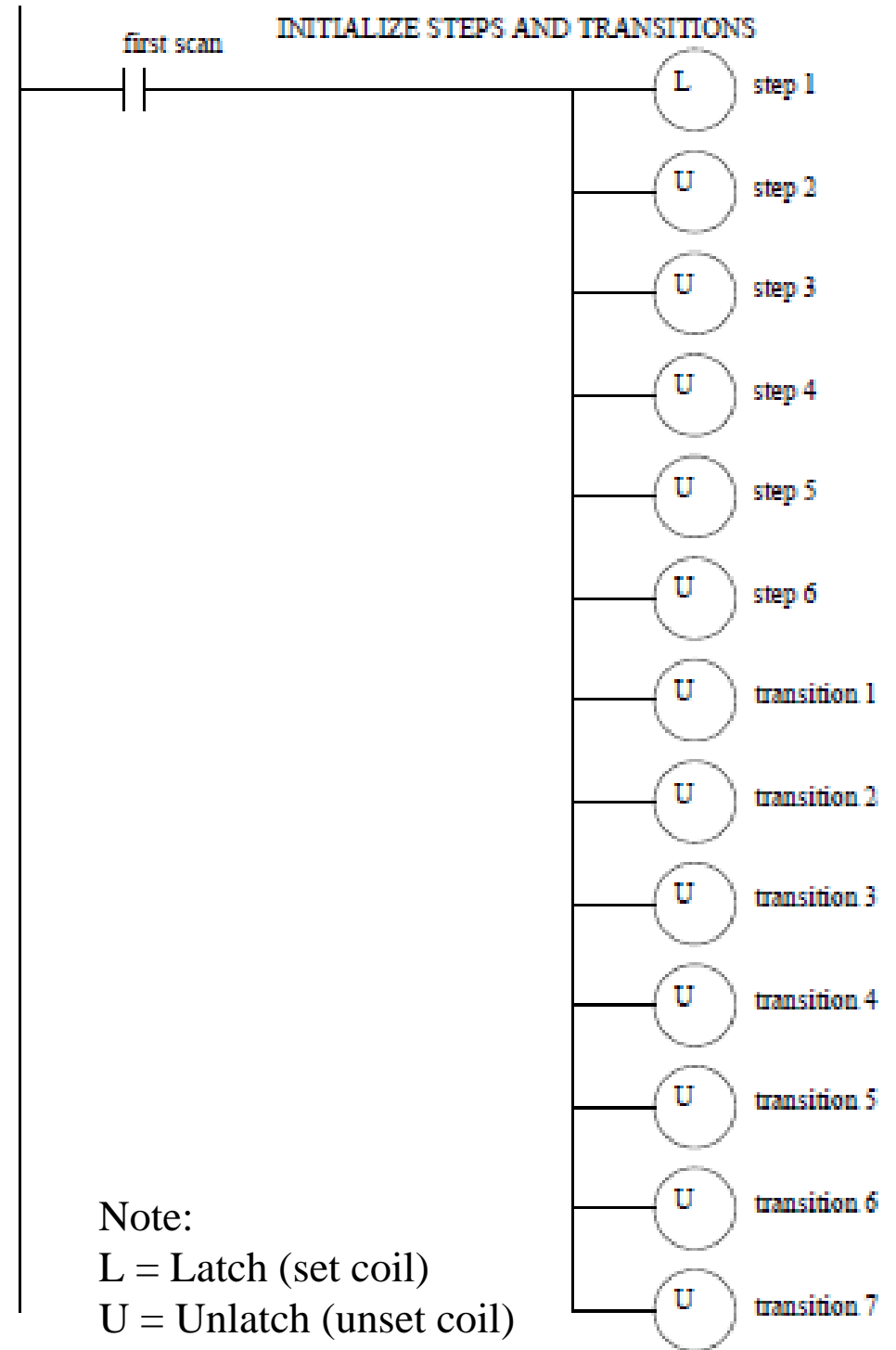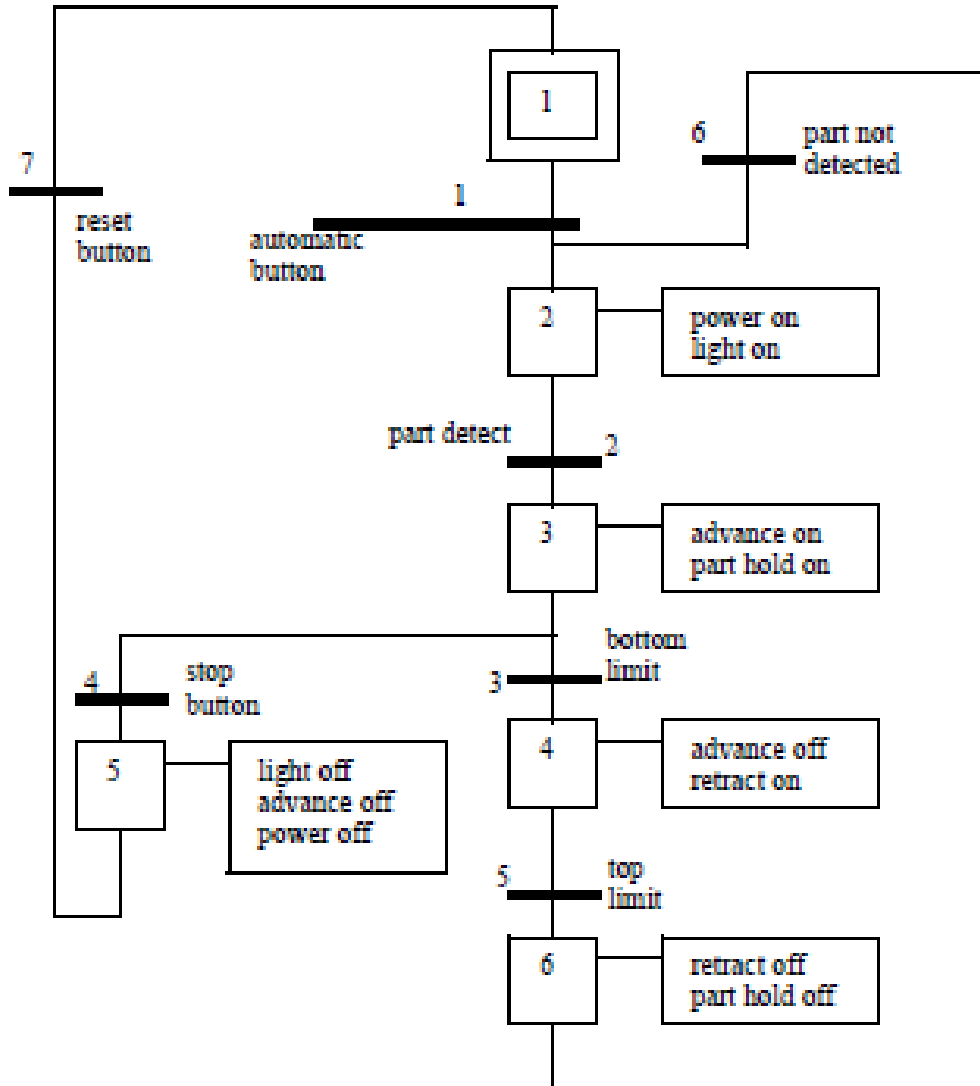**GRAFCET/SFC can be converted directly to ladder logic**

Memory variables:
Assign one Boolean variable to each step (si) and transition (tj)

Code:
1. Initialize steps and transitions
2. Check transitions and activate steps
3. Perform activities for steps
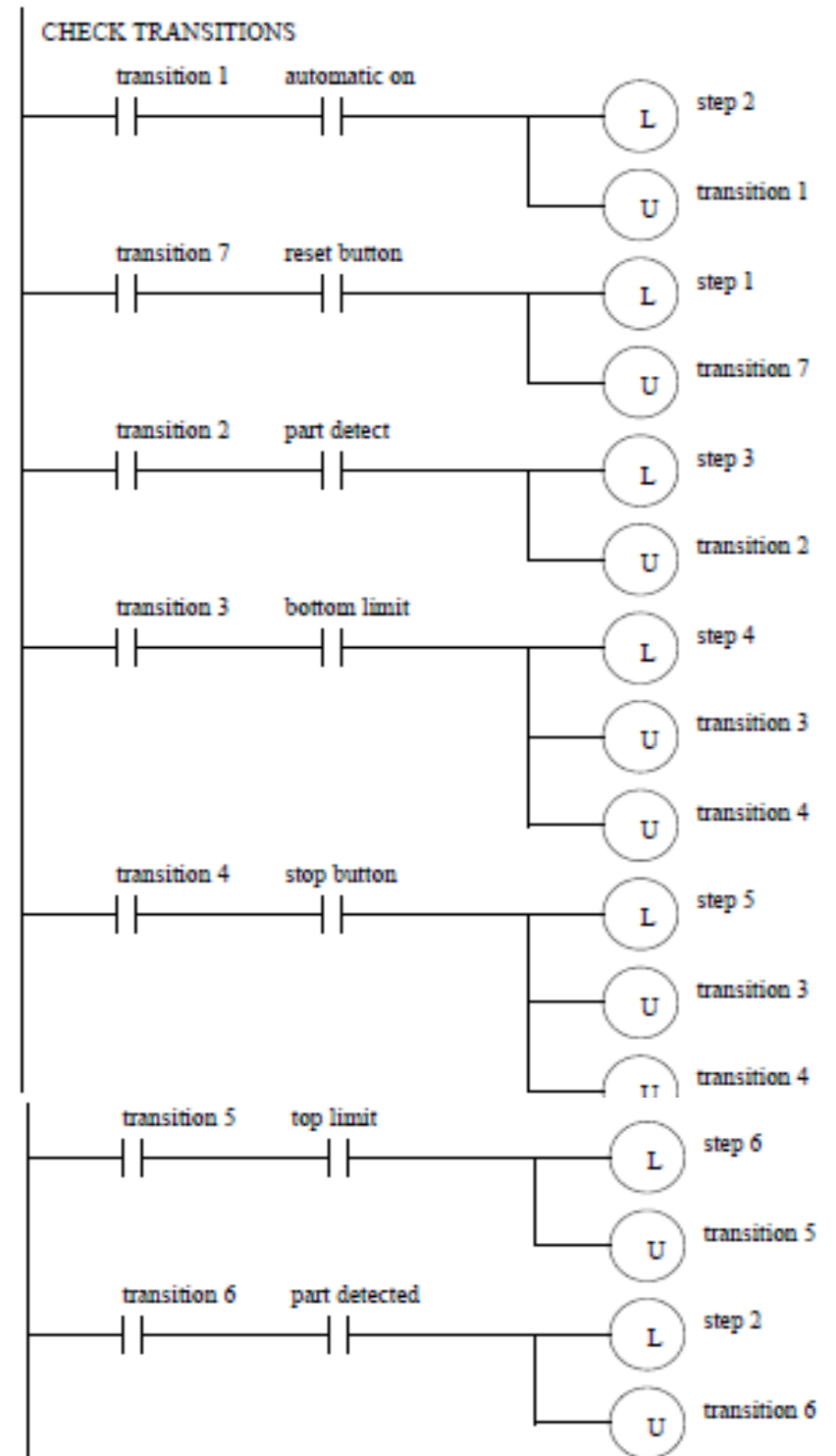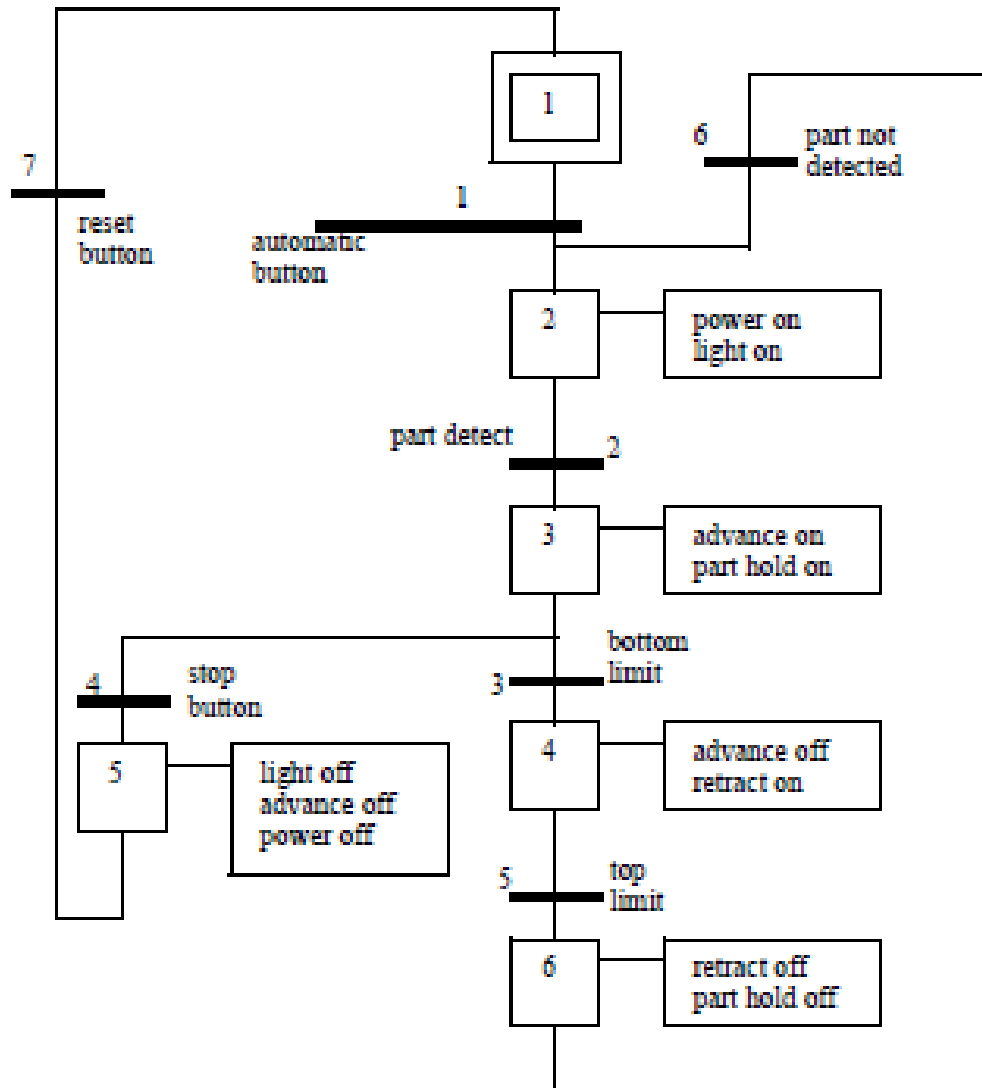4. Enable transitions (jump to 2.)

Ref: [Hugh Jack 2008]

IST / DEEC / API

1. Initialize steps and transitions

first scan

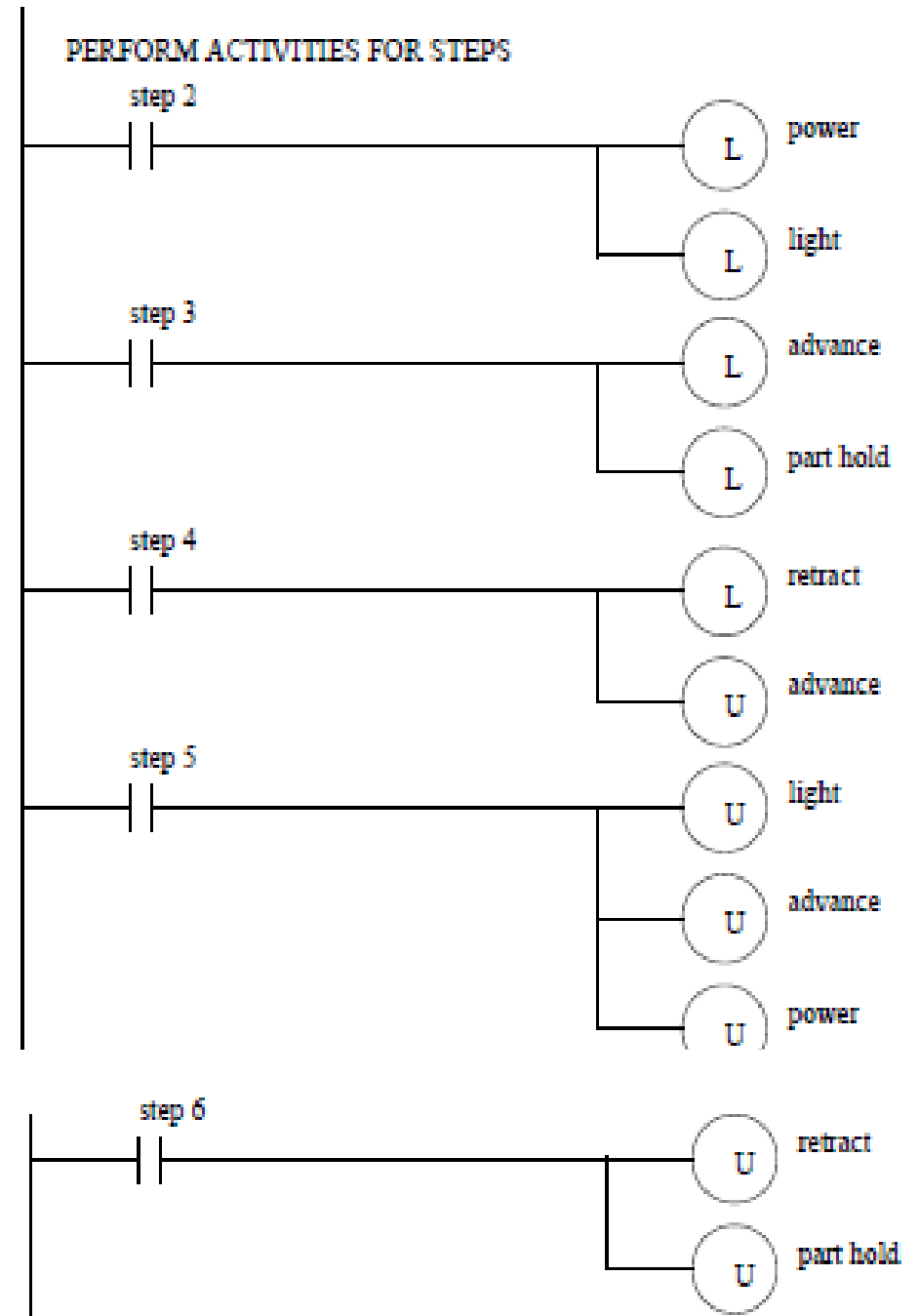| L | step 1 |
U	step 2
U	step 3
U	step 4
U	step 5
U	step 6
U	transition 1
U	transition 2
U	transition 3
U	transition 4
U	transition 5
U	transition 6
U	transition 7

Note:
L = Latch (set coil)
U = Unlatch (unset coil)

2. Check transitions & activate steps

CHECK TRANSITIONS

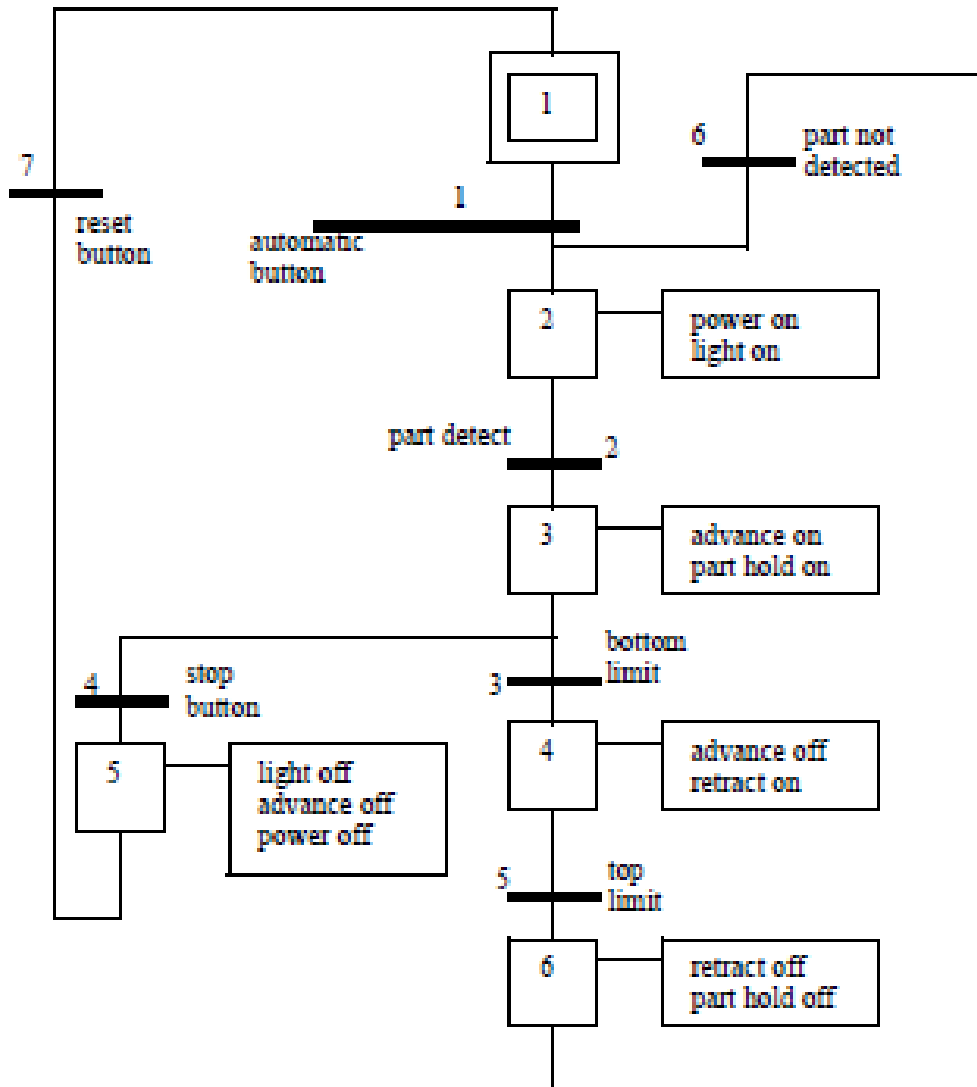| transition 1 | automatic on | | L | step 2 |
transition 1	automatic on		U	transition 1
transition 7	reset button		L	step 1
transition 7	reset button		U	transition 7
transition 2	part detect		L	step 3
transition 2	part detect		U	transition 2
transition 3	bottom limit		L	step 4
transition 3	bottom limit		U	transition 3
			U	transition 4
transition 4	stop button		L	step 5
transition 4	stop button		U	transition 3
			U	transition 4
transition 5	top limit		L	step 6
transition 5	top limit		U	transition 5
transition 6	part detected		L	step 2
transition 6	part detected		U	transition 6

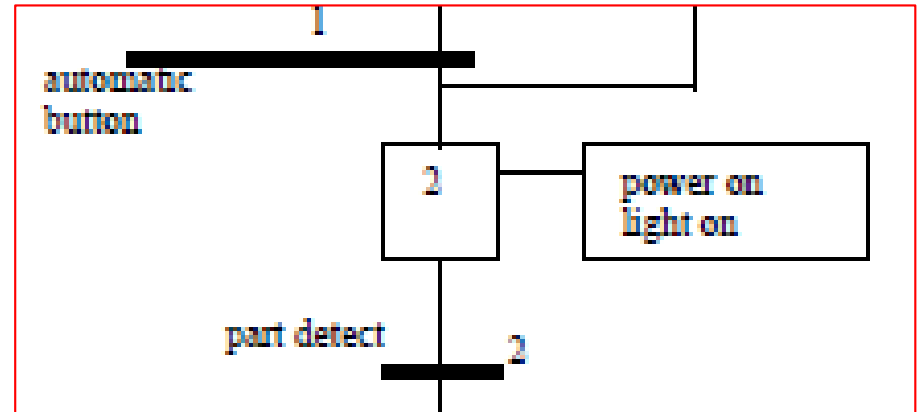# 3. Perform activities for steps

PERFORM ACTIVITIES FOR STEPS

4. Enable transitions

Discussion: not-keeping vs keeping steps active

1)

CHECK TRANSITIONS

2)

PERFORM ACTIVITIES FOR STEPS

3)

ENABLE TRANSITIONS
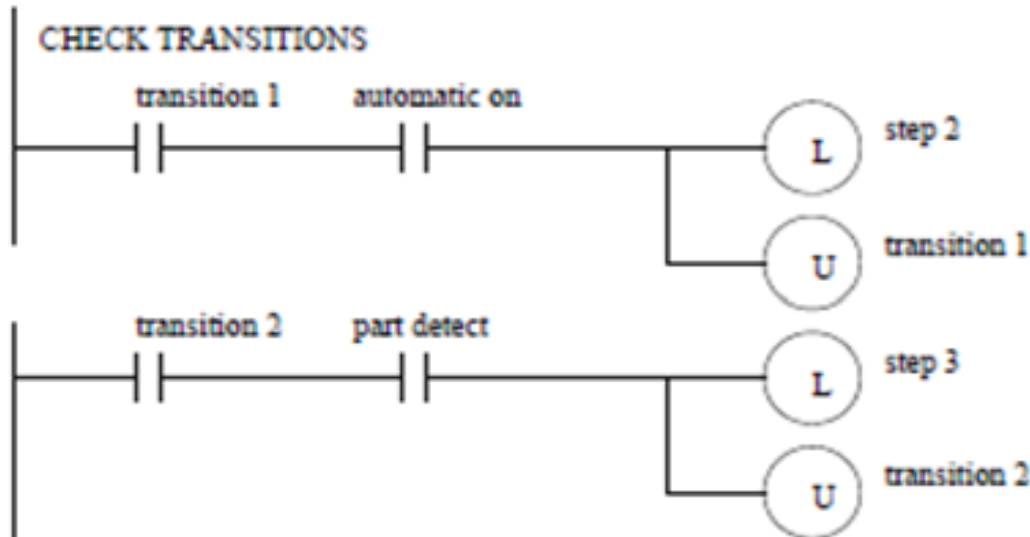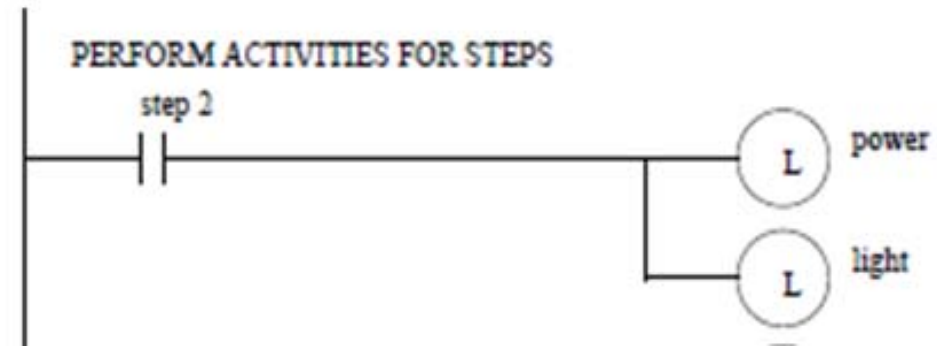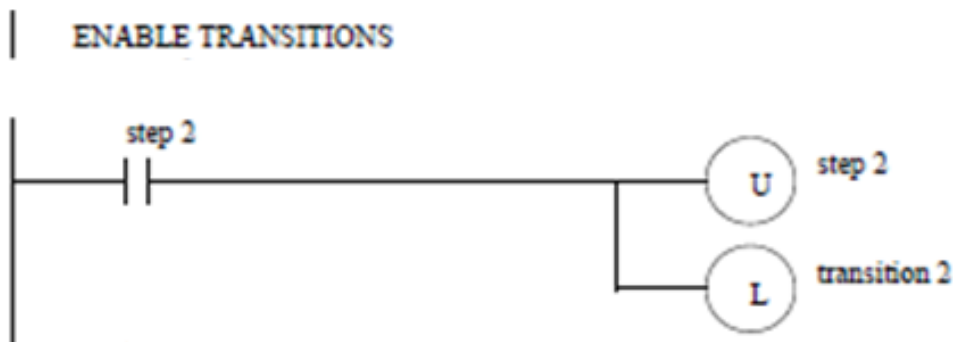

If step2 is active then it is going to be made inactive (unlatched). In Unity-Pro step2 gets inactive only after transposing transition2.

Page 9

GRAFCET   **Practice Problem 1**

Draw **one SFC** for one stamping press that can **advance and retract** when a **cycle button** is pushed, and then stop until the button is pushed again. The press has **limit switches** indicating stop advancing and stop retracting.

Further study: discuss the advantages of using SFC as compared with using Ladder in this problem.

From [Hugh Jack 2008]
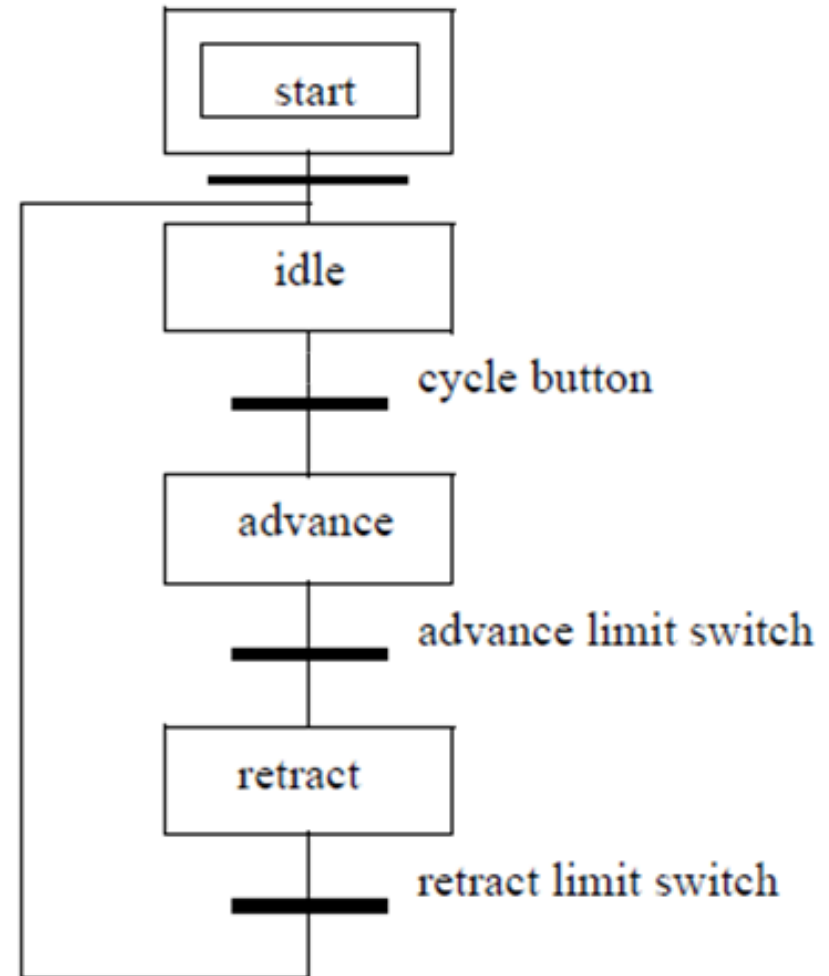
GRAFCET   **Practice Problem 2**

Develop **one SFC** for a two person assembly station. The station has **two presses** that may be used at the same time, **independently**. Each press has a cycle button that will start the advance of the press. A bottom limit switch will stop the advance, and the cylinder must then be retracted until a top limit switch is hit. The two presses are enabled only after a common starting procedure.
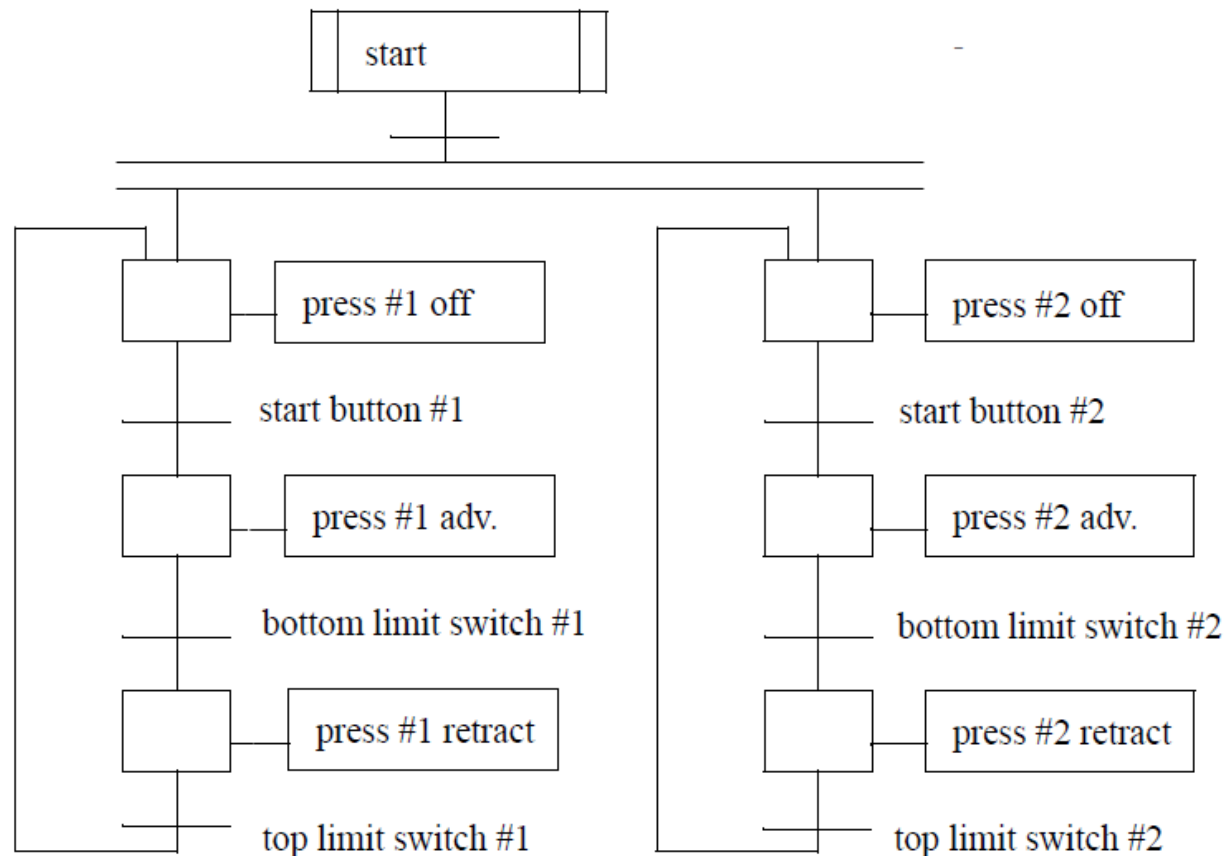
From [Hugh Jack 2008]

GRAFCET **Practice Problem 3**

Design a garage door controller using an SFC. The behavior of the garage door controller is as follows:

- There is a single button in the garage and a single button remote control. When the button is pushed the door will move up or down.
- There are top/bottom limit switches to stop the motion of the door.

- If the button is pushed once while moving, the door will stop. A second push will start motion again in the opposite direction.
- There is a light beam across the bottom of the door. If the beam is cut while the door is closing the door will stop and reverse.

- There is a garage light that will be on for 5 minutes after the door opens or closes.

From [Hugh Jack 2008] Page 12