Industrial Automation
(Automação de Processos Industriais)

GRAFCET
(Sequential Function Chart) 2/2

http://users.isr.ist.utl.pt/~jag/courses/api1213/api1213.html

2011-2013 Prof. José Gaspar

Syllabus:

Chap. 3 – PLC Programming languages [2 weeks]

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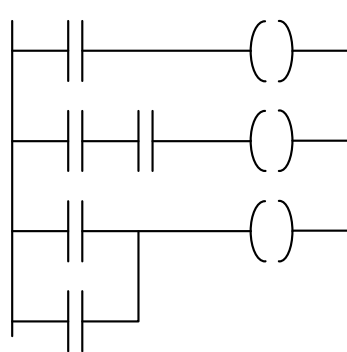The GRAFCET norm.
Elements of the language.
Modelling techniques using GRAFCET.

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

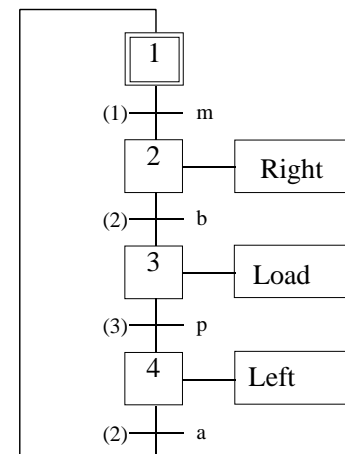# PLC Programming languages
(IEC 1131-3)

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)

```
    ┌───┐
    │ 1 │
    └───┘
(1) ──┤── m
    ┌───┐       ┌───────┐
    │ 2 │───────│ Right │
    └───┘       └───────┘
(2) ──┤── b
    ┌───┐       ┌───────┐
    │ 3 │───────│ Load  │
    └───┘       └───────┘
(3) ──┤── p
    ┌───┐       ┌───────┐
    │ 4 │───────│ Left  │
    └───┘       └───────┘
(2) ──┤── a
```
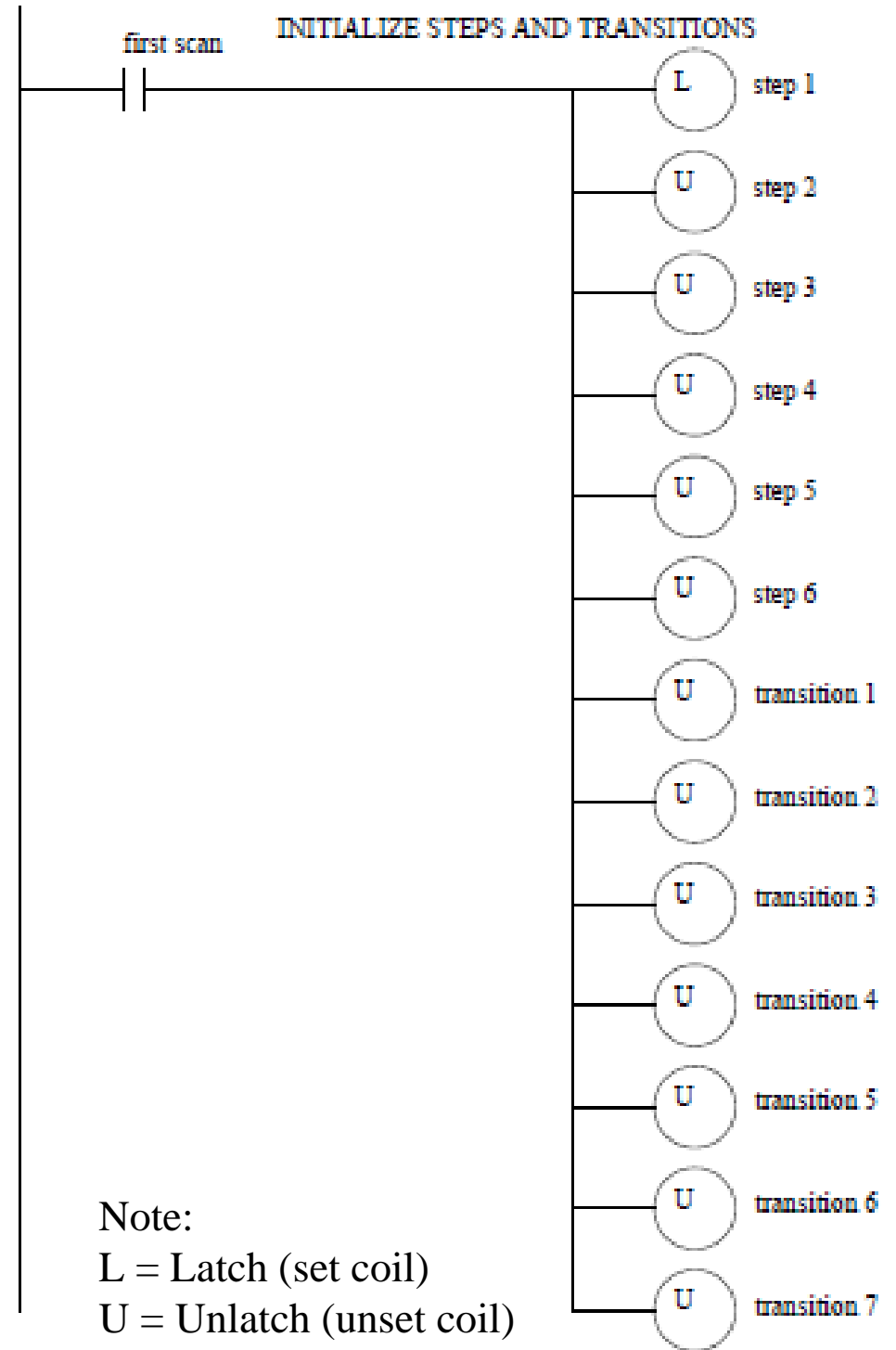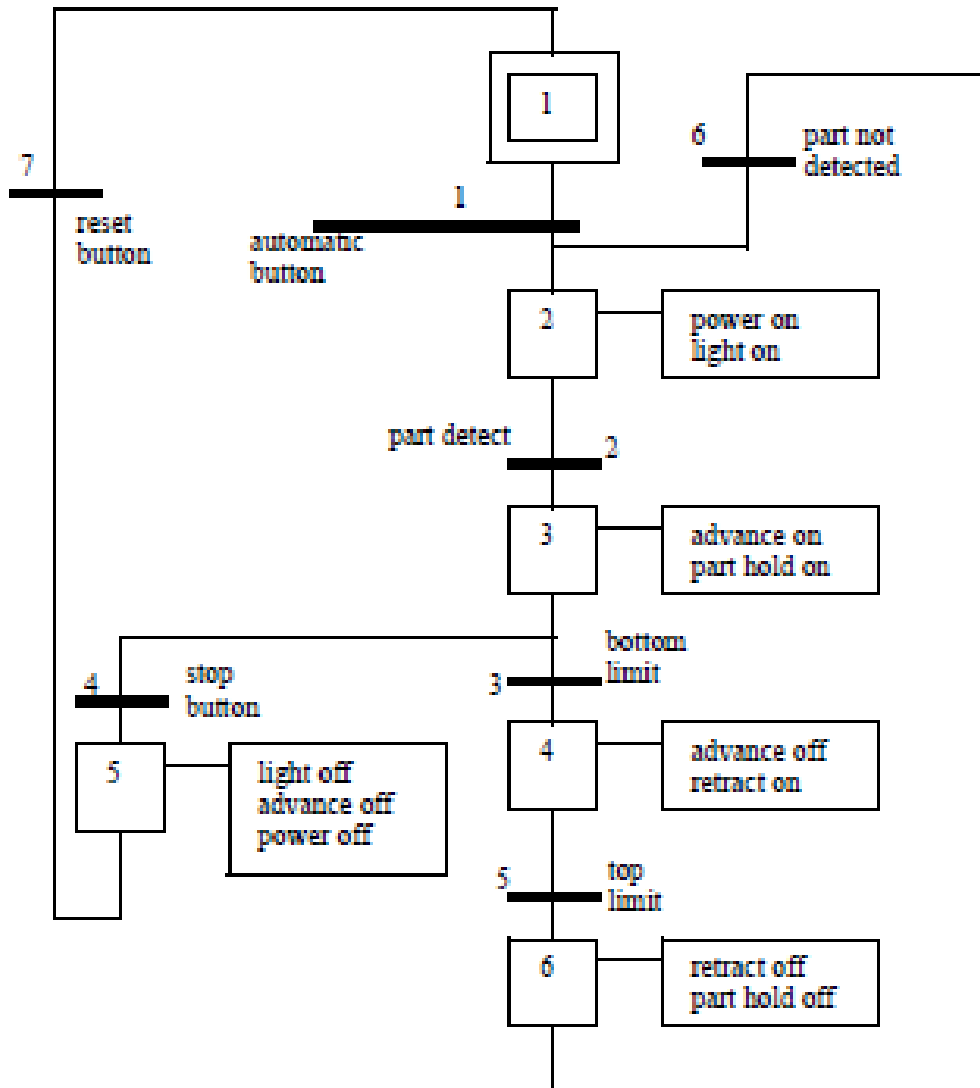
GRAFCET vs Ladder

Grafcet/SFC can be converted directly to ladder logic:

0. Assign one Boolean variable to each step (s_i) and transition (t_j)
1. Initialize steps and transitions
2. Check transitions
3. Perform activities for steps
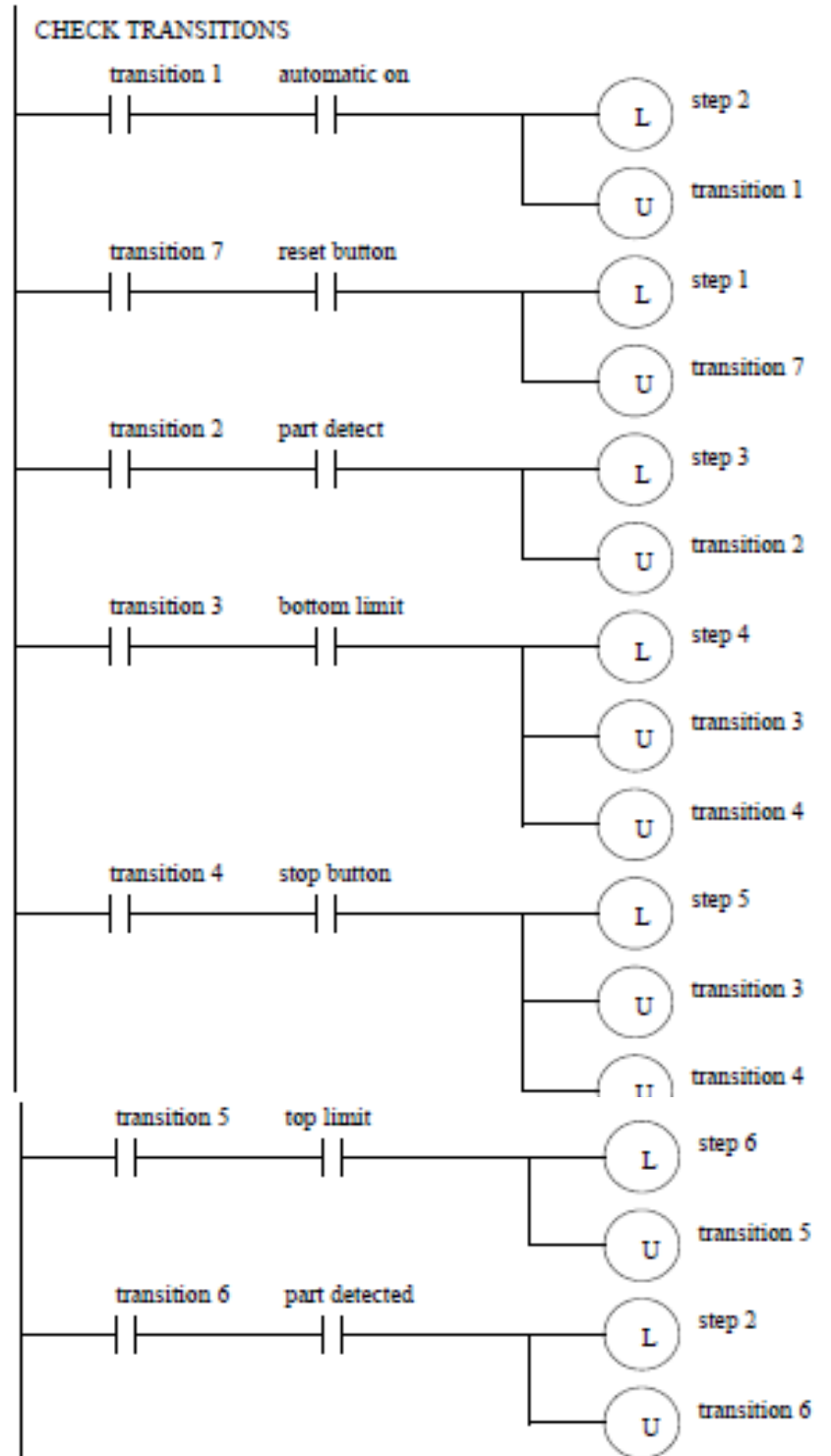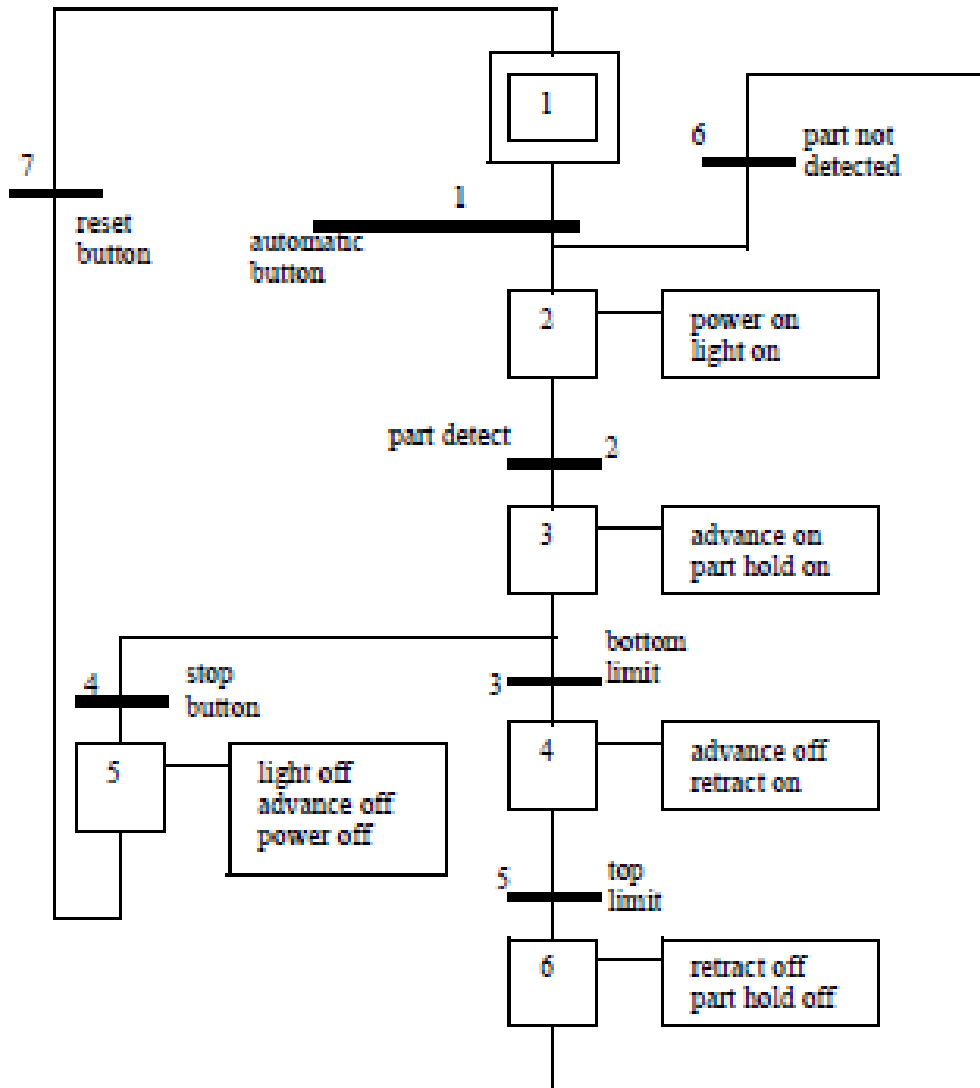4. Enable transitions

Ref: [Hugh Jack 2008]

IST / DEEC / API

1. Initialize steps and transitions

INITIALIZE STEPS AND TRANSITIONS

first scan

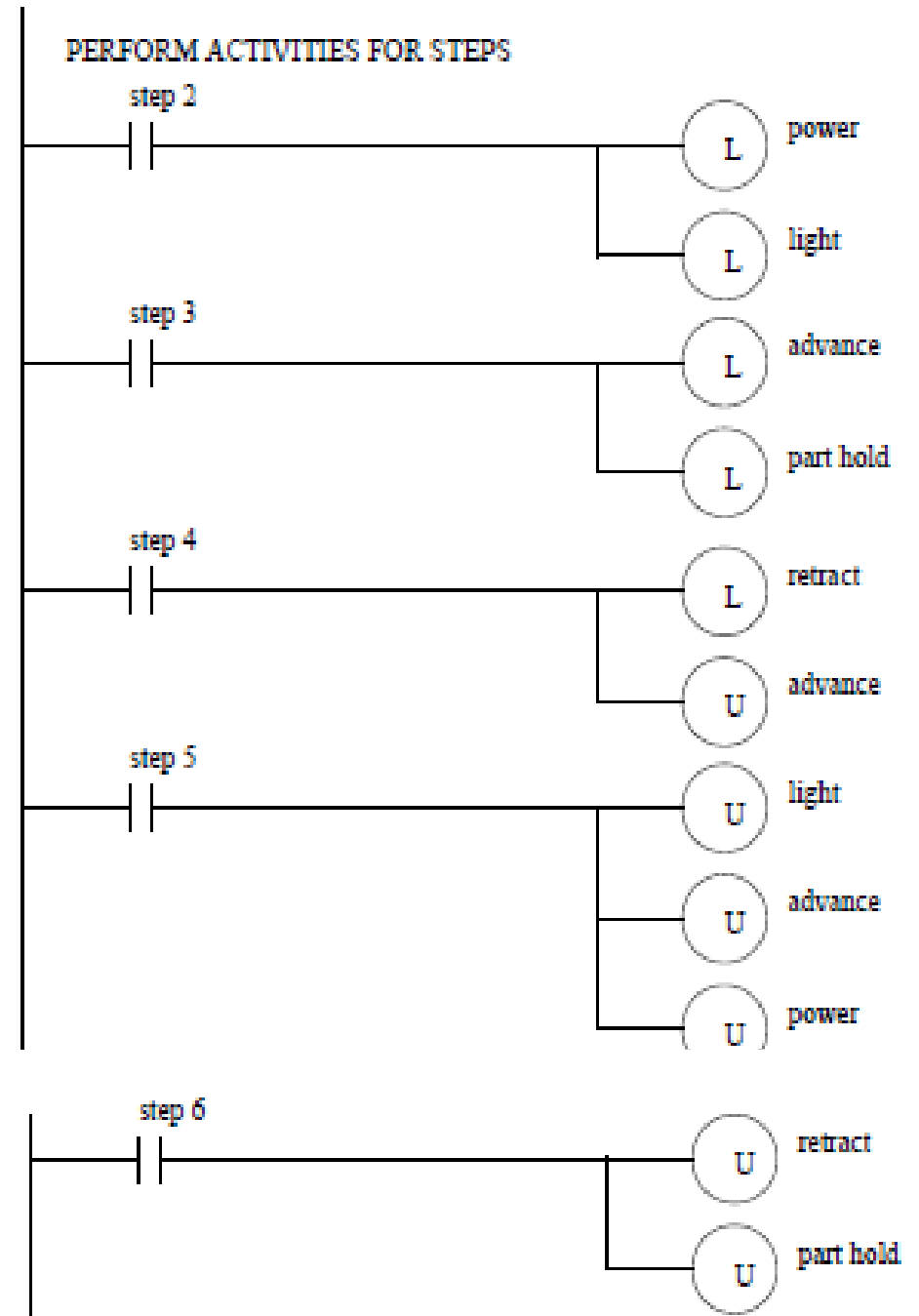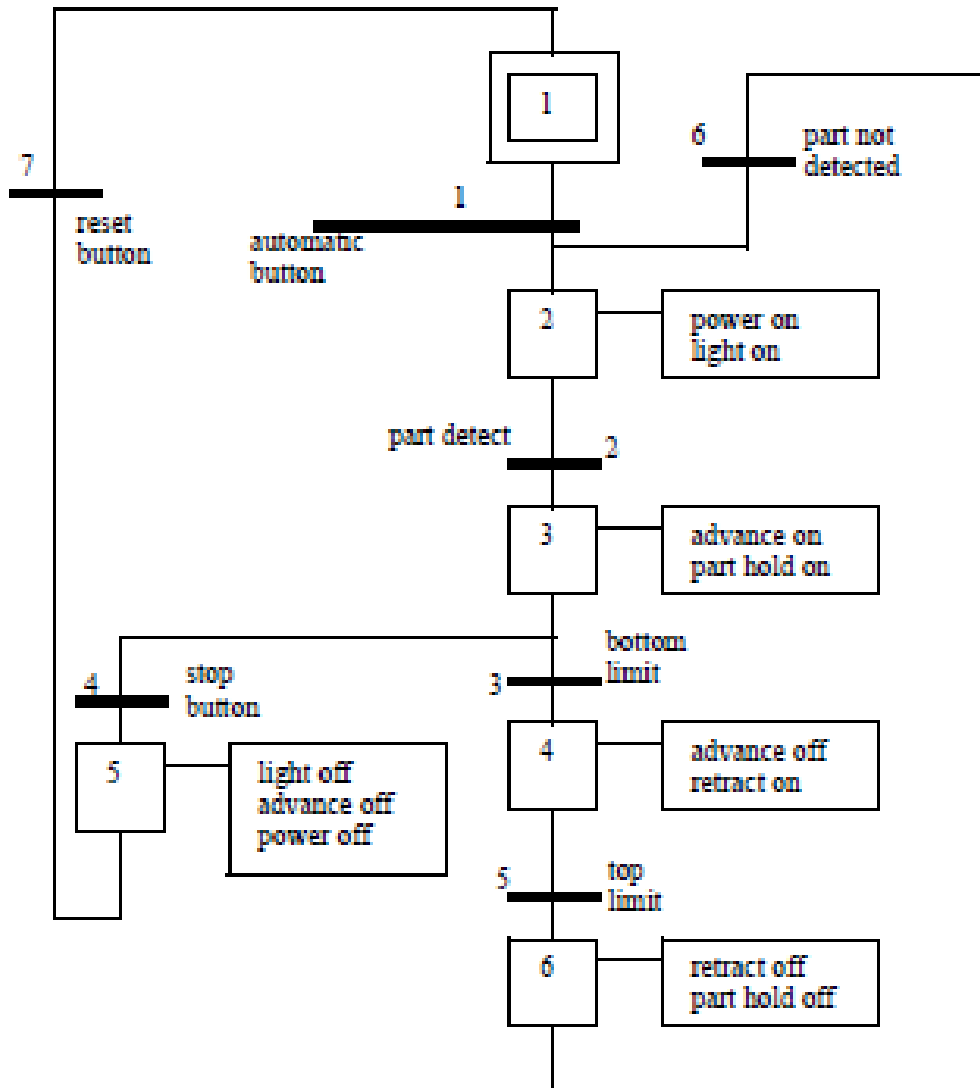| L | step 1 |
U	step 2
U	step 3
U	step 4
U	step 5
U	step 6
U	transition 1
U	transition 2
U	transition 3
U	transition 4
U	transition 5
U	transition 6
U	transition 7

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

2. Check transitions

3. Perform activities for steps
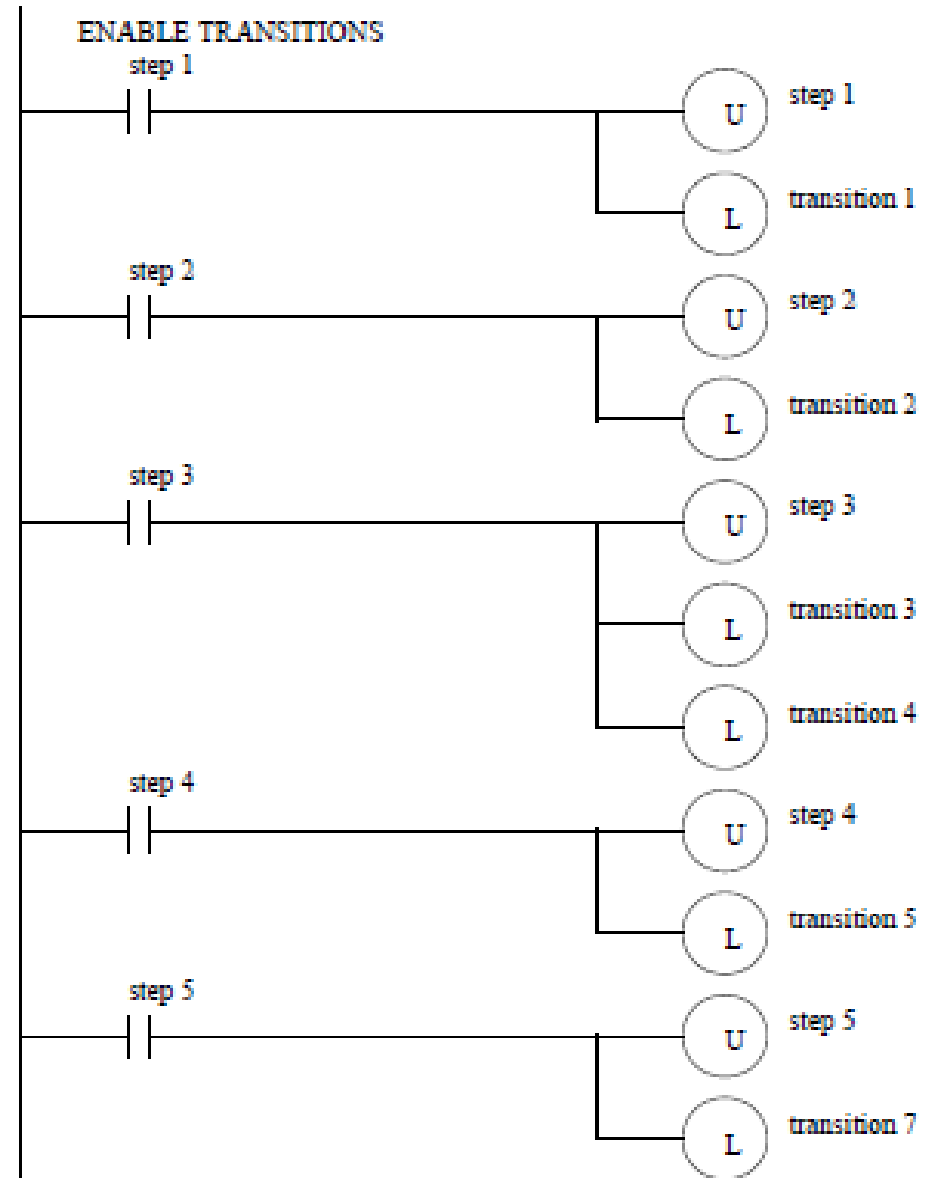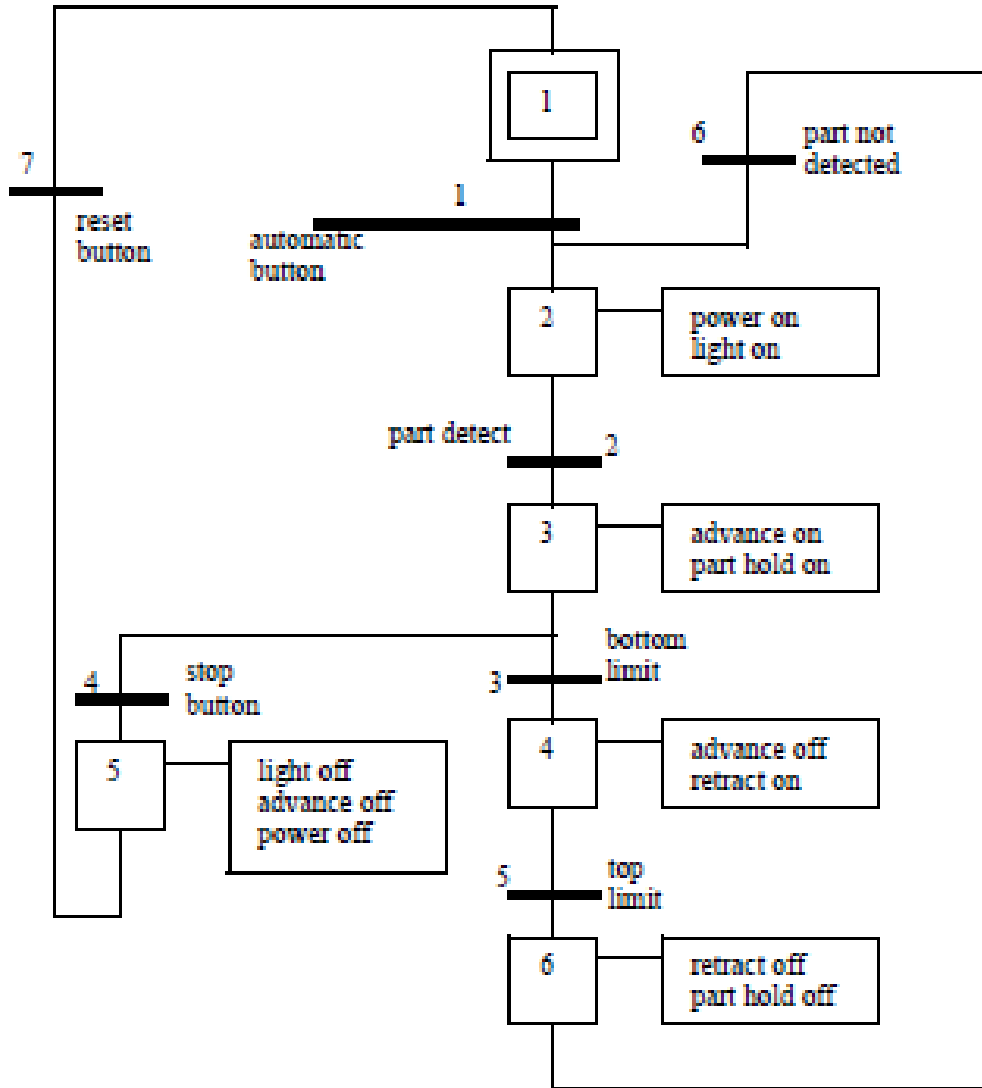

PERFORM ACTIVITIES FOR STEPS

4. Enable transitions

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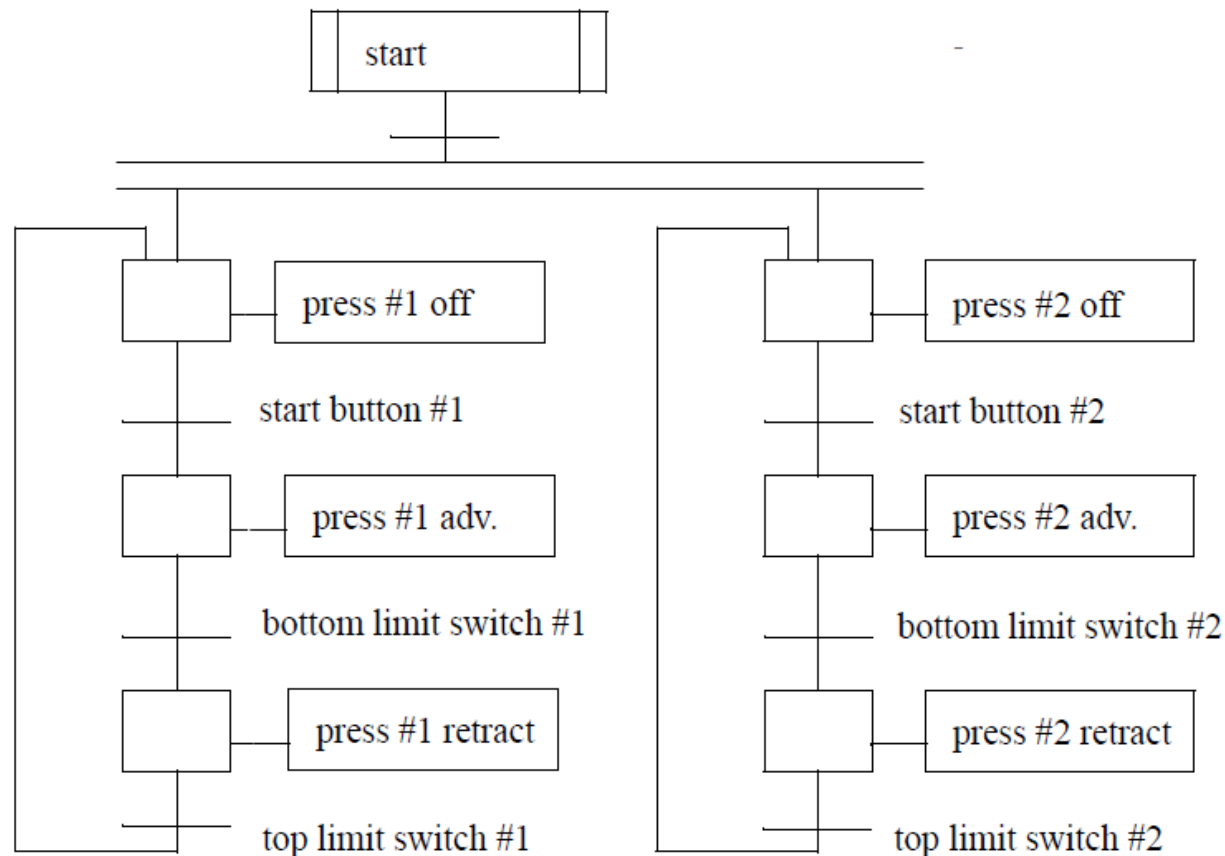
Further study: discuss the advantages of using SFC as compared with using Ladder in this problem.

From [Hugh Jack 2008]
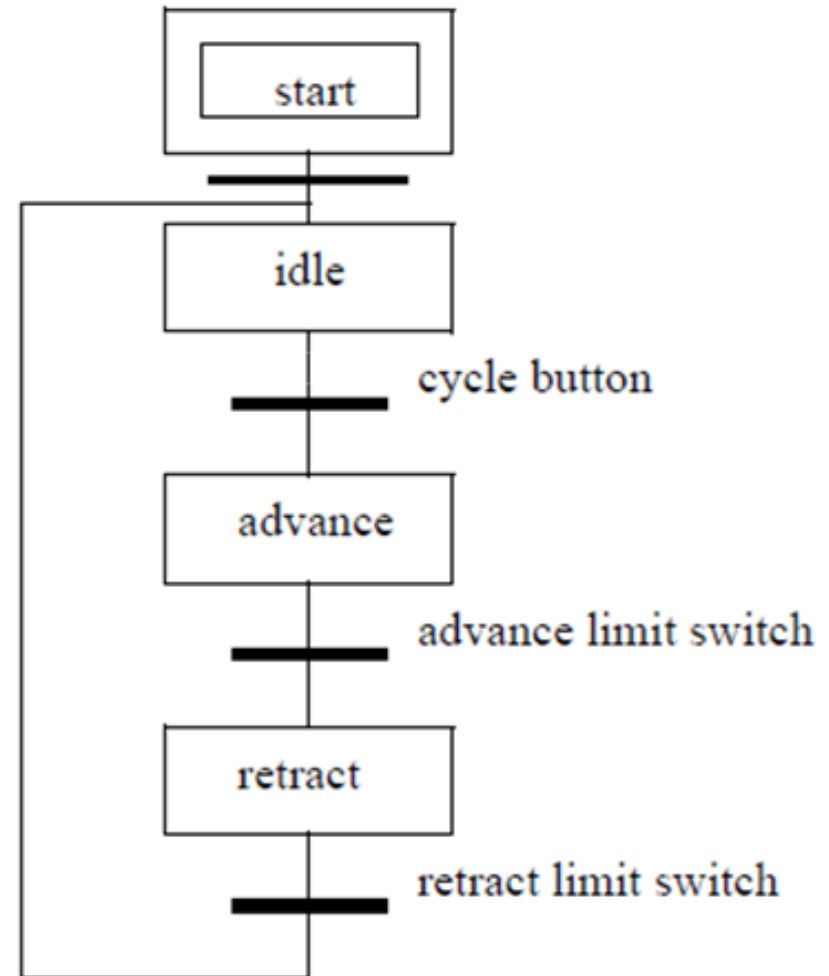
GRAFCET   Practice Problem 2

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]

start

| press #1 off | | press #2 off |

start button #1 | start button #2

| press #1 adv. | | press #2 adv. |

bottom limit switch #1 | bottom limit switch #2

| press #1 retract | | press #2 retract |

top limit switch #1 | top limit switch #2

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 11