Industrial Automation

(Automação de Processos Industriais)

GRAFCET

(Sequential Function Chart) 3/3

http://users.isr.ist.utl.pt/~jag/courses/api19b/api1920.html

Prof. José Gaspar, rev. 2019/2020

GRAFCET **vs Ladder**

GRAFCET/SFC can be converted directly to ladder logic

Memory variables:

Assign one Boolean variable to each step (s_i) and transition (t_j)

Code to run once:

1. Initialize steps and transitions

Code to run at **every scan cycle**:

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

Ref: [Hugh Jack 2008]

GRAFCET/SFC vs Ladder

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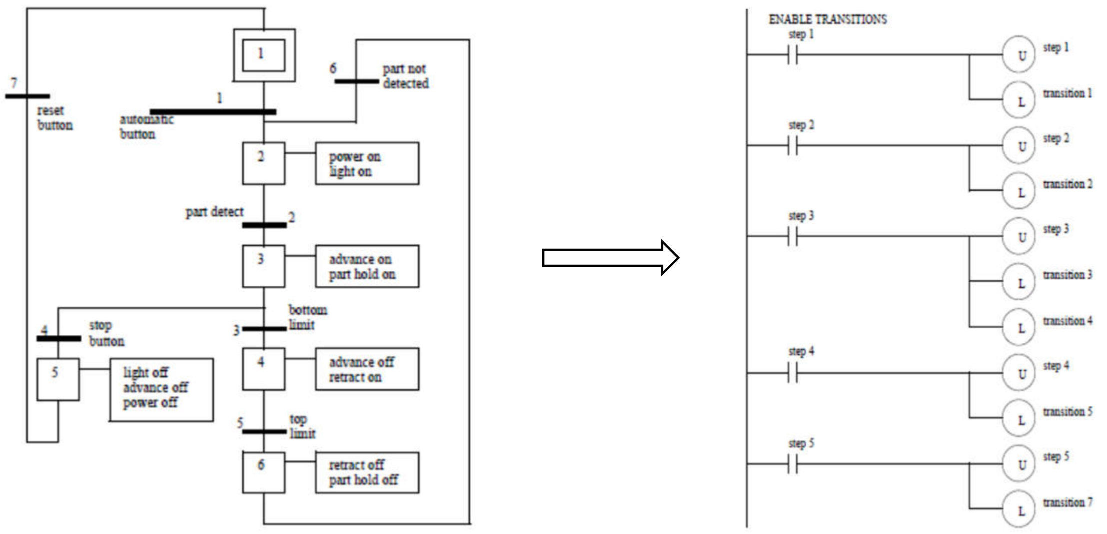

Memory variables:

Assign one Boolean variable to each step (s_i) and transition (t_j).

Create memories to keep output values.

Code to run once:

1. Initialize steps and transitions

Code to run at **every scan cycle**:

2. Check transitions and activate steps
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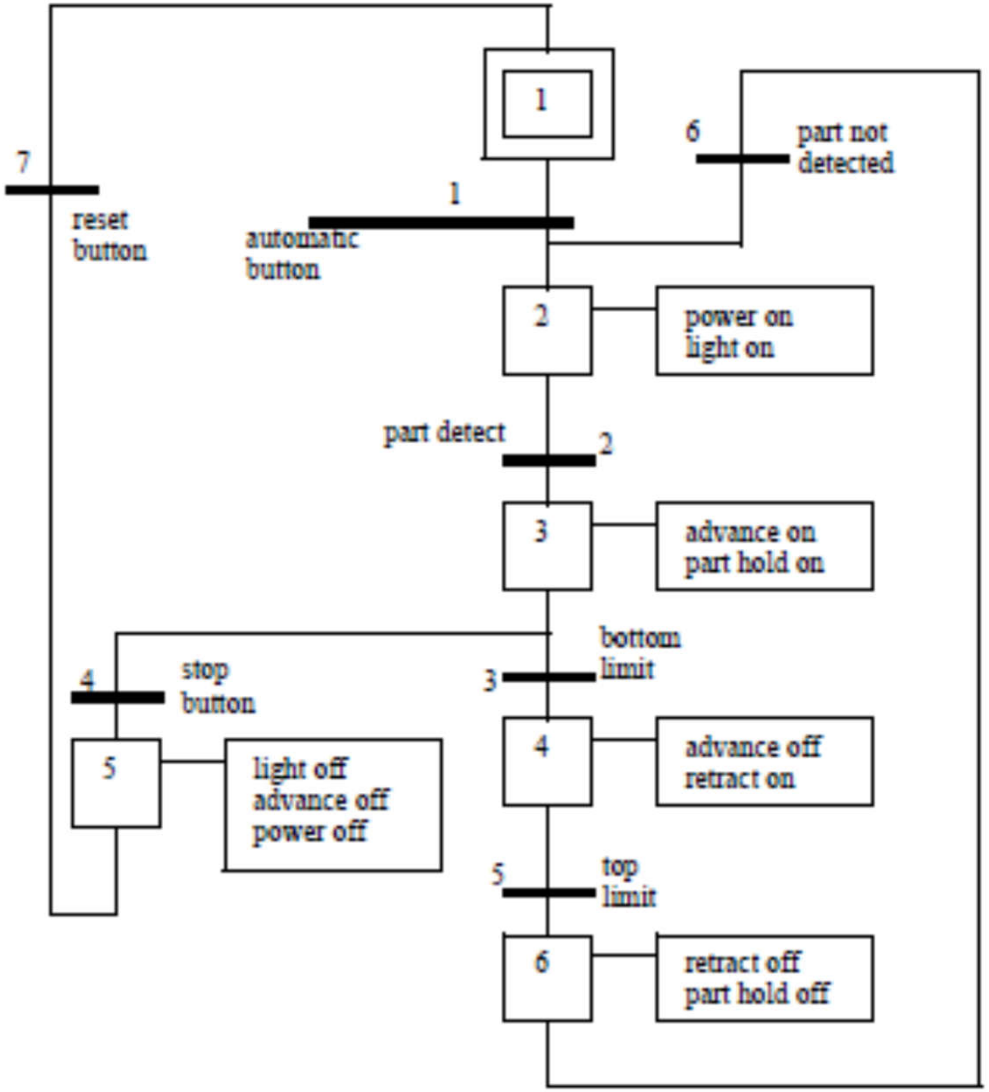
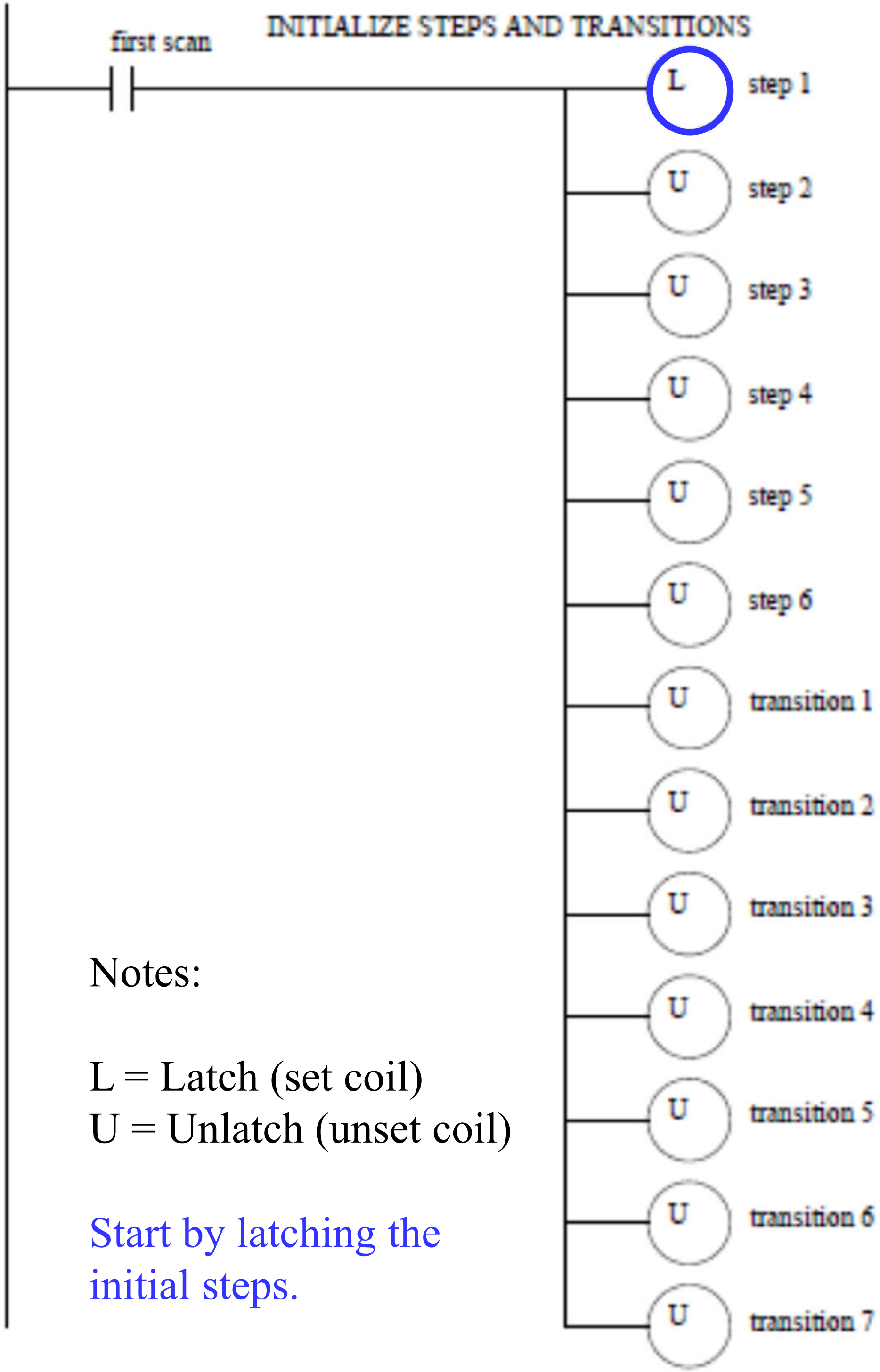
1. Initialize steps and transitions



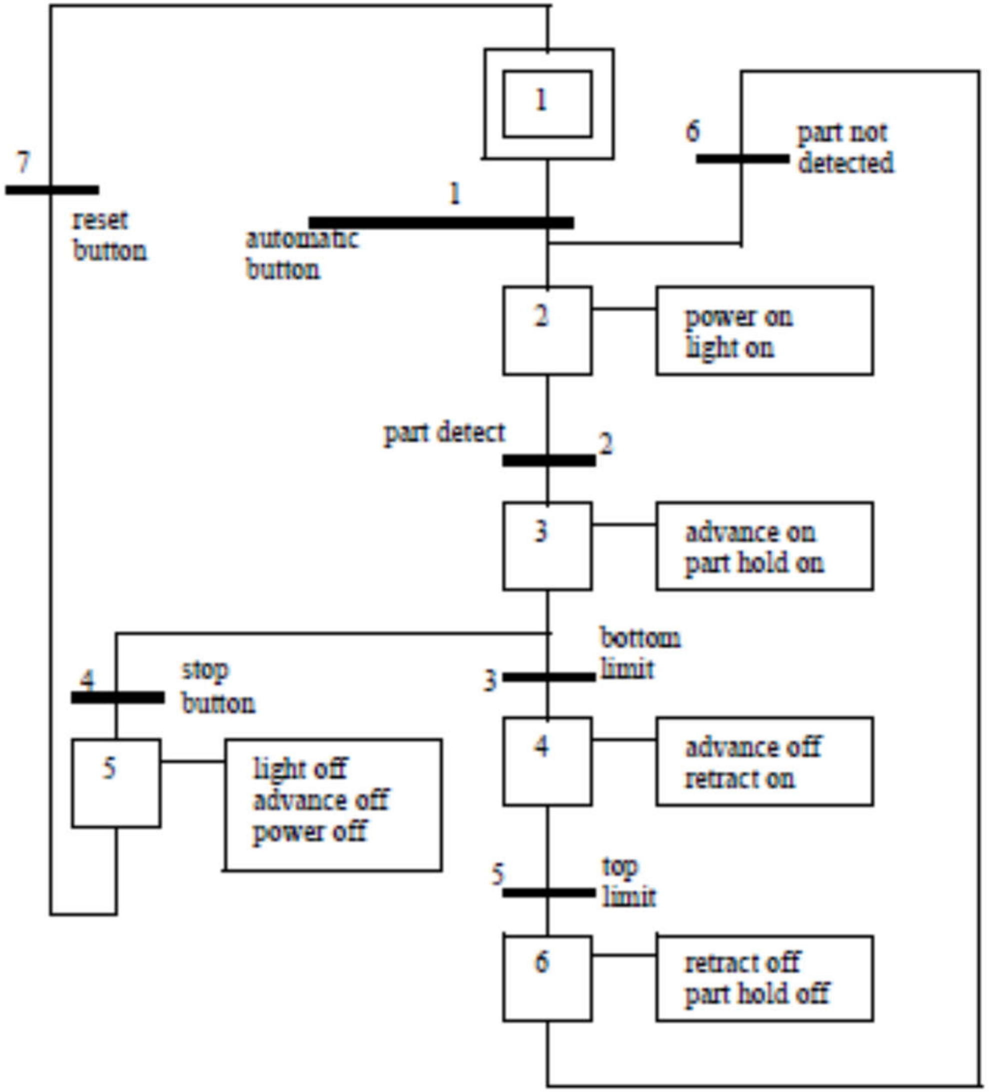


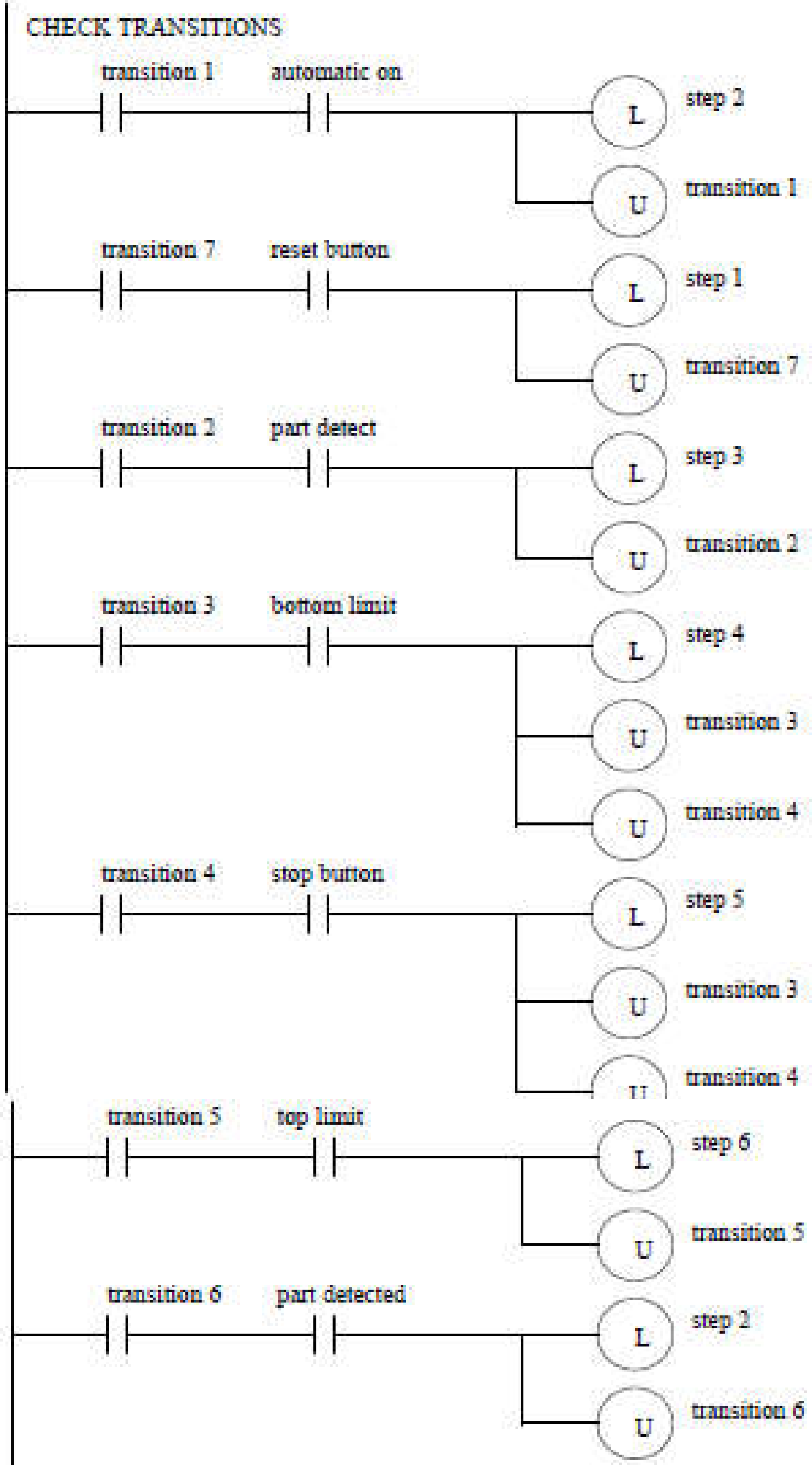
Notes:

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

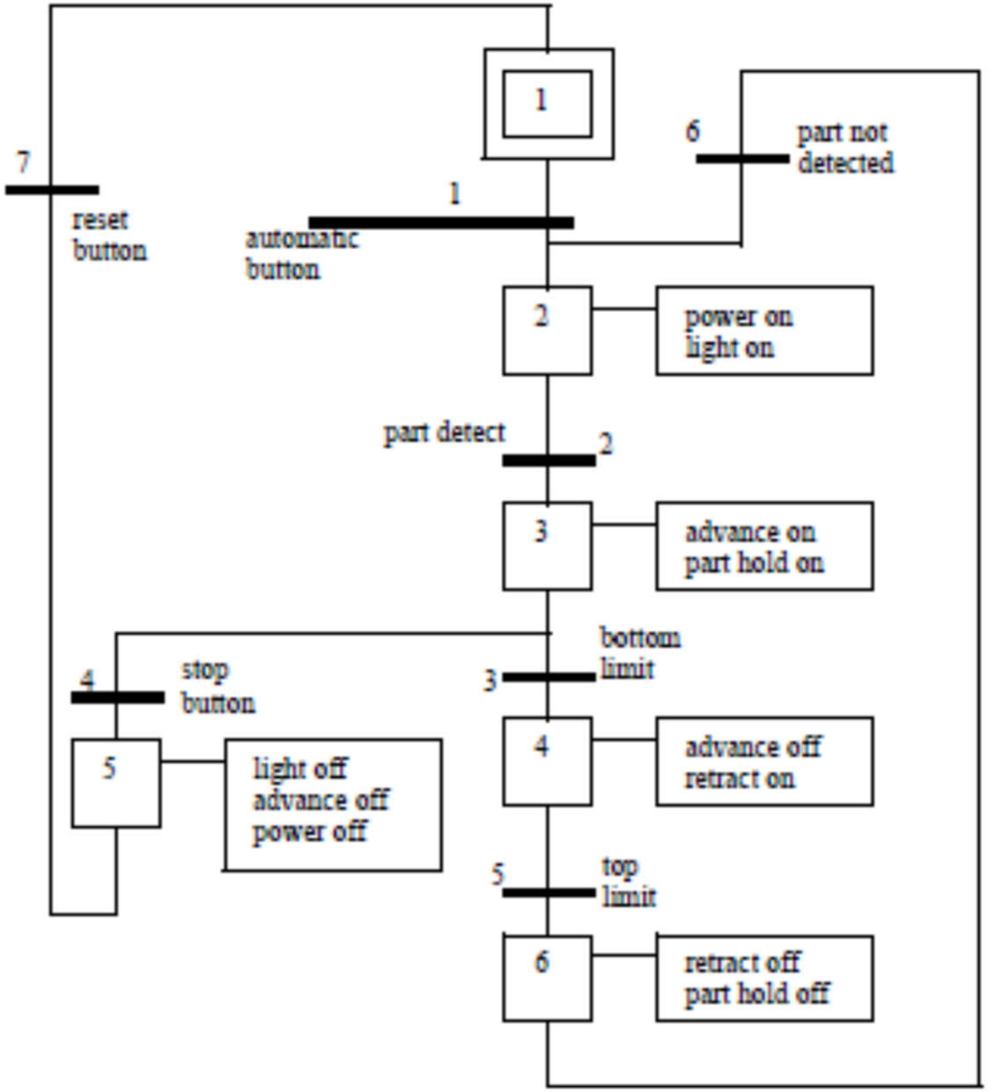
Start by latching the initial steps.

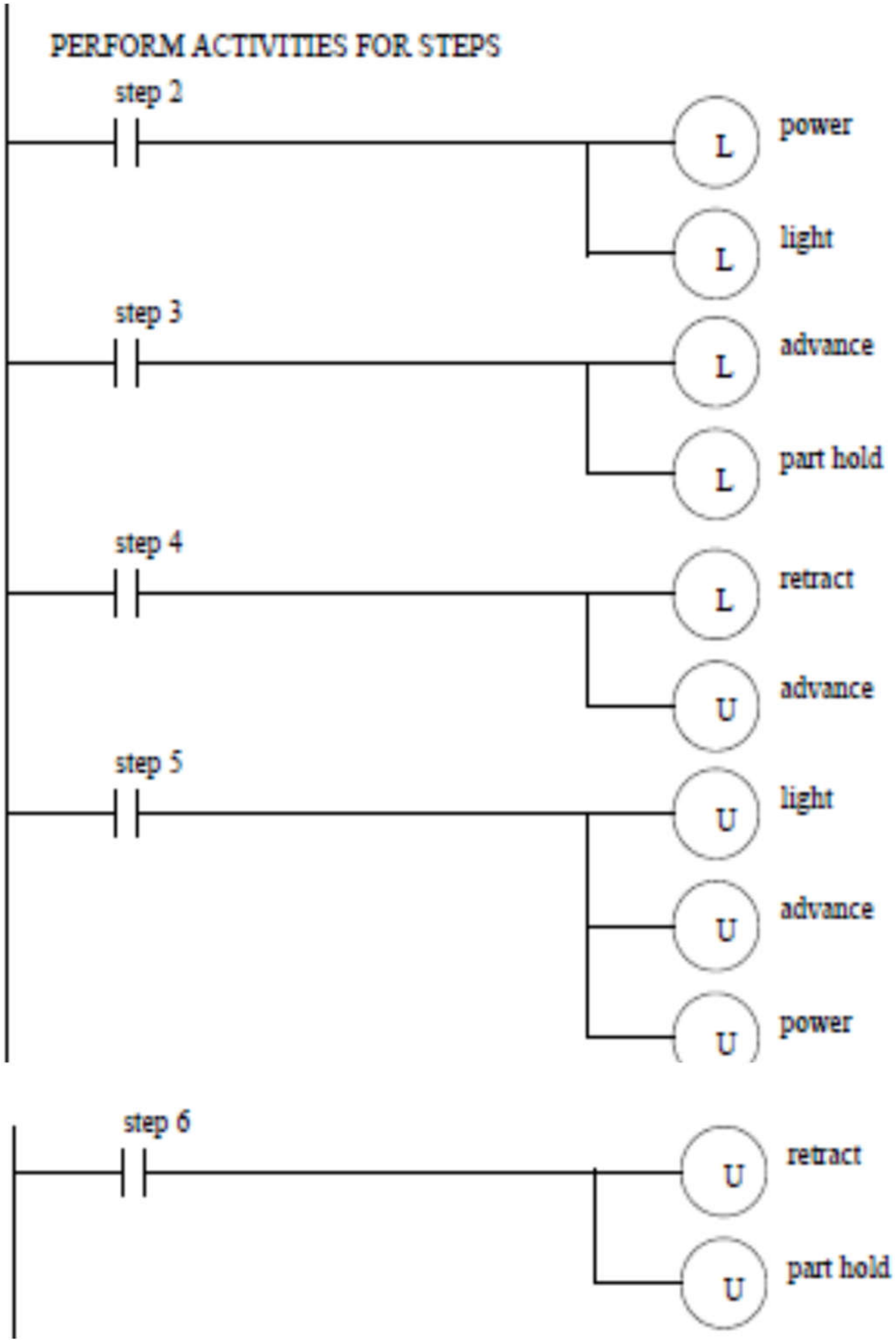
2. Check transitions & activate steps



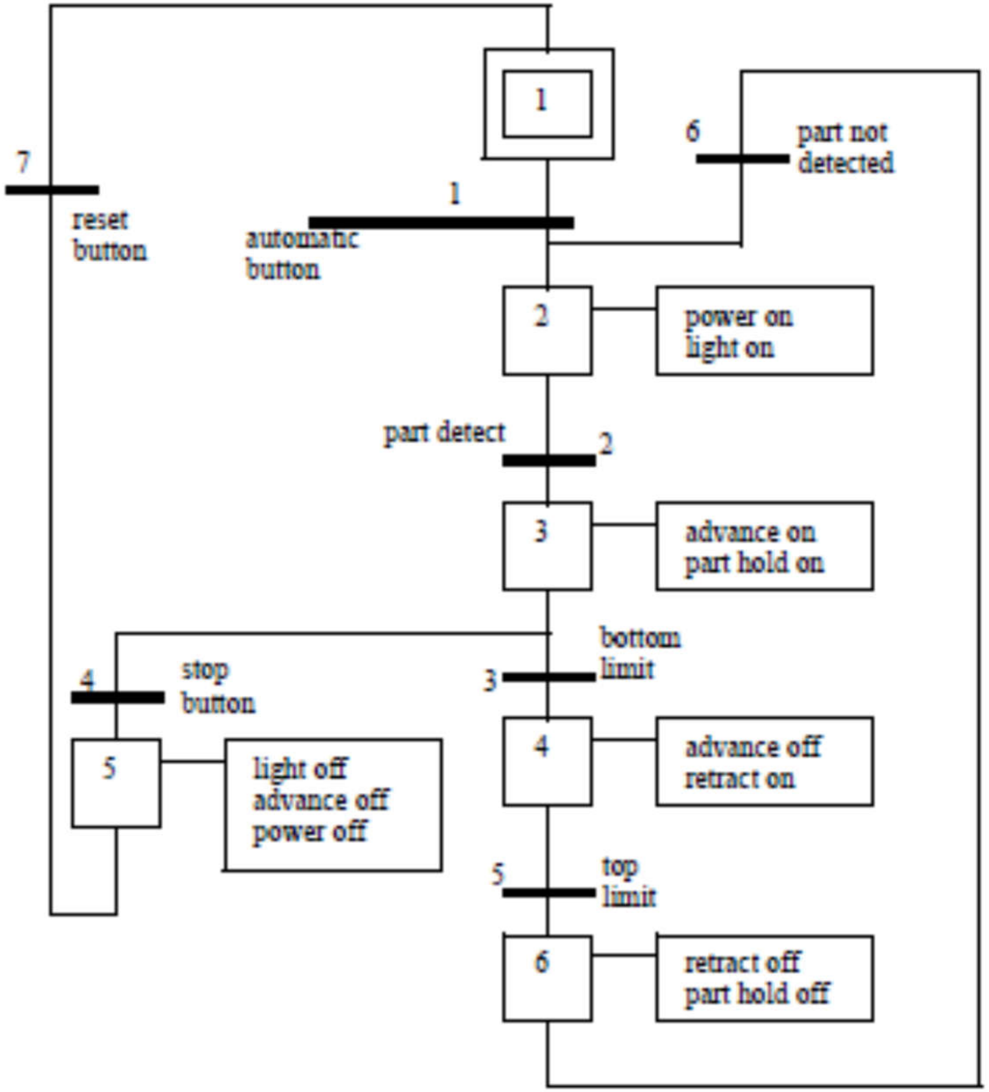


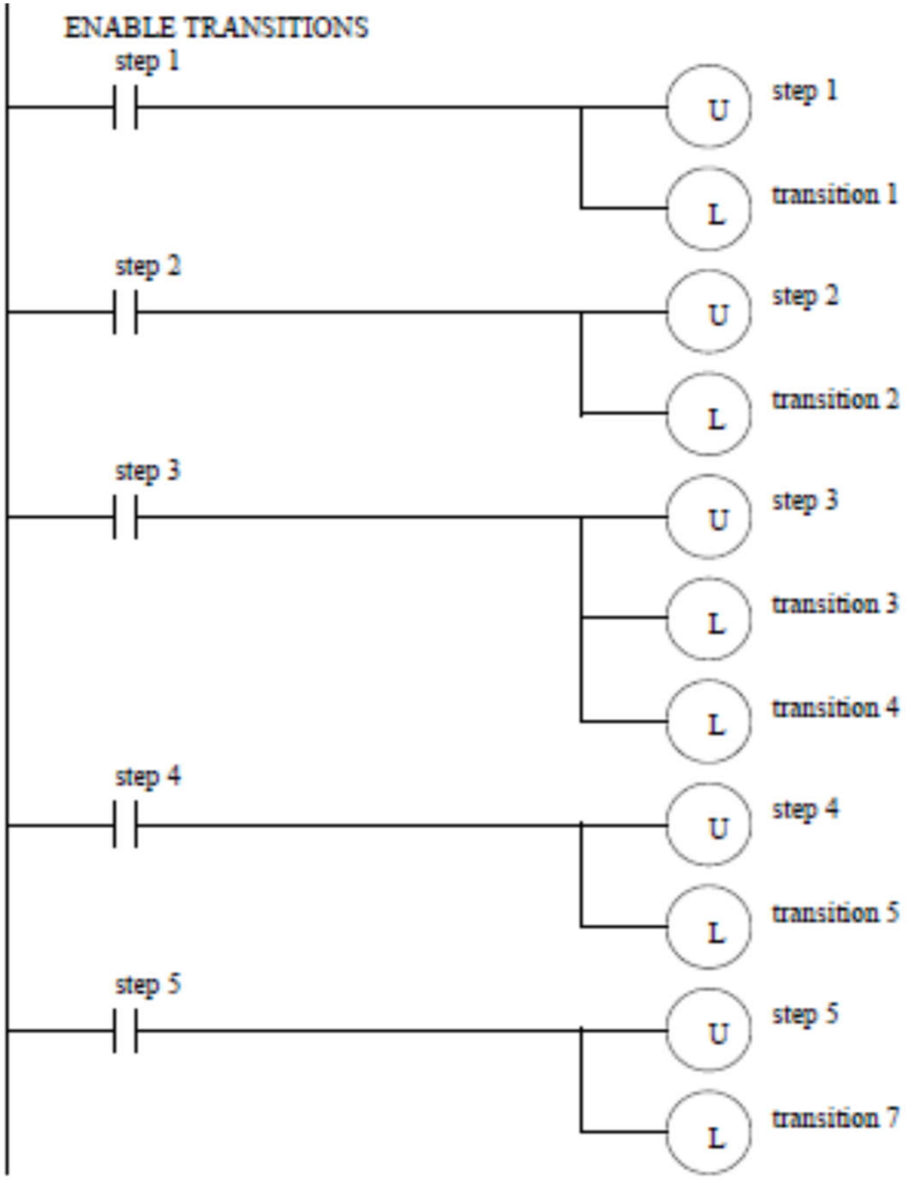
3. Perform activities for steps





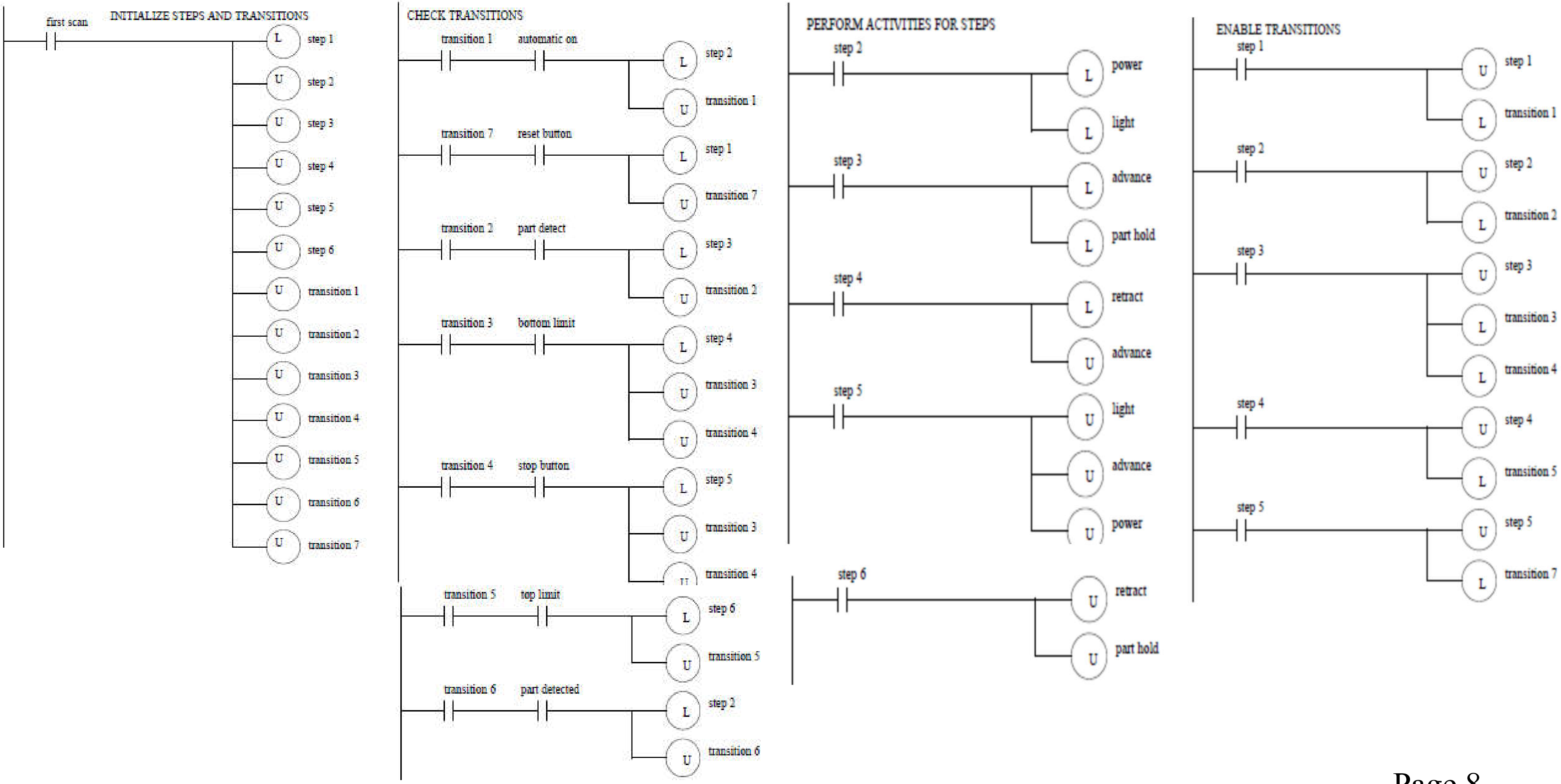
4. Enable transitions



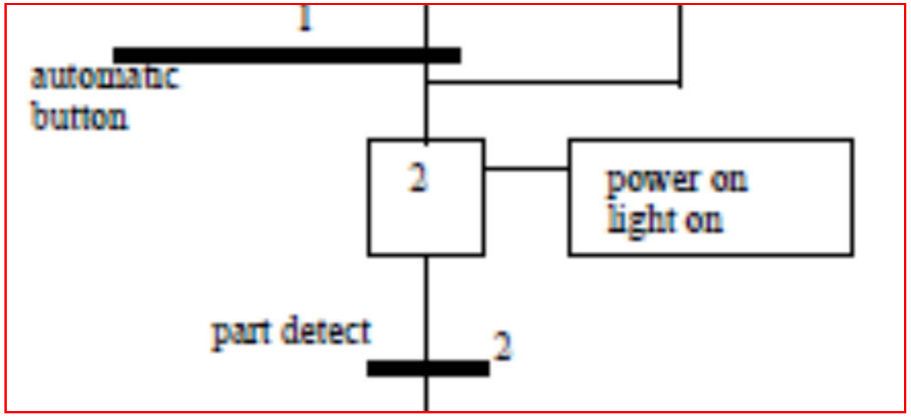


Note: all active steps are made inactive.

The complete program, four sections:

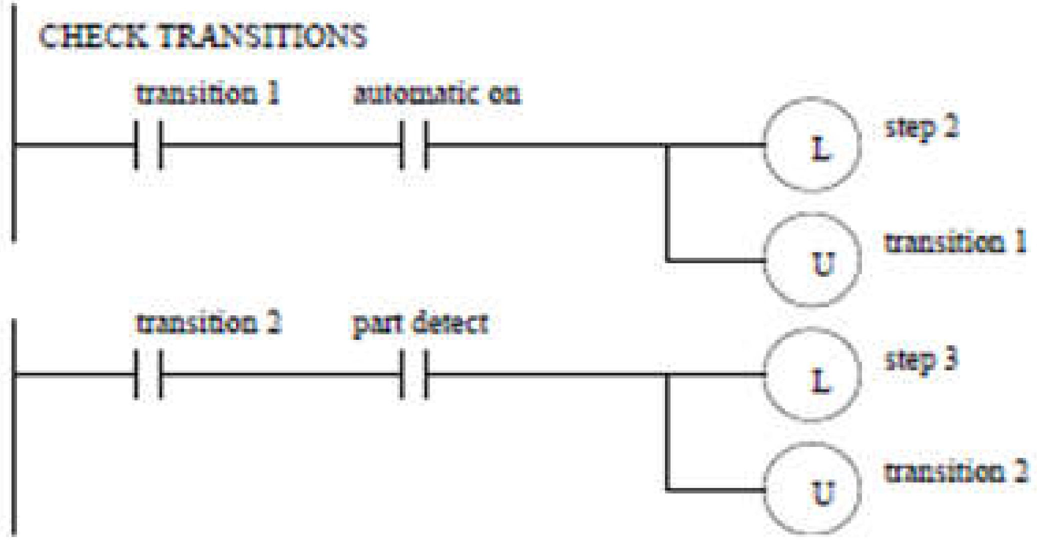


Discussion: not-keeping vs keeping steps active

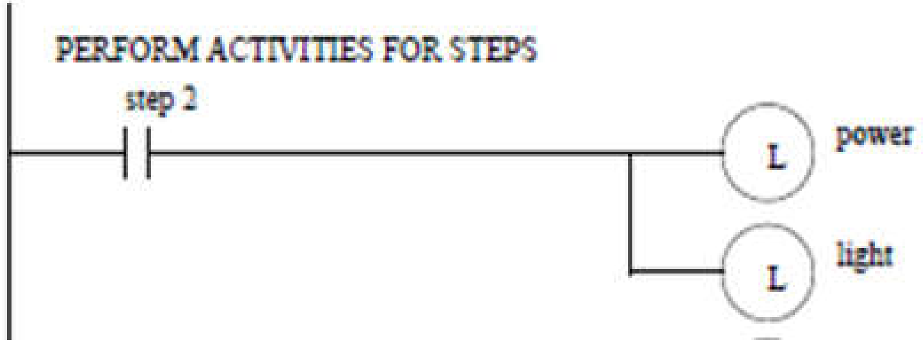


Small part of the Grafcet to analyse

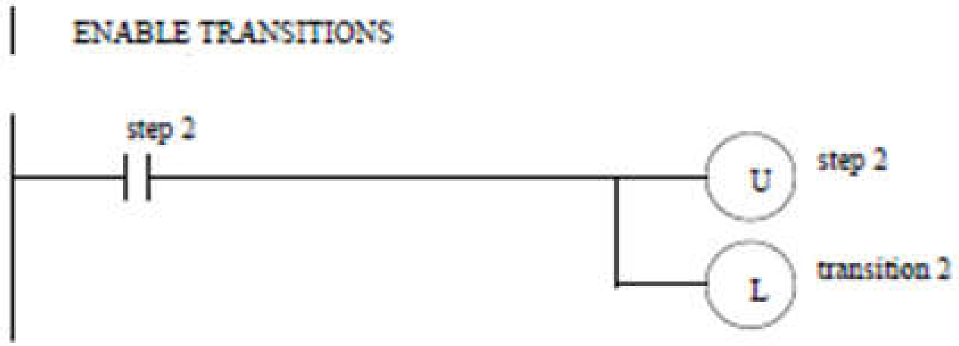
1)



2)



3)



*If step2 is **active in 1** then its work is done in 2 and it is going to be made **inactive (unlatched) in 3**.*

*Note: code parts 1, 2 and 3 run in a single scan cycle; **latched outputs imply they have no spikes**.*

*Note2: **Unity Pro** is not like this, step2 gets inactive only after transposing transitions2.*

Homework challenges:

Convert the ladder code shown in the previous slides to a structured text program.

Consider simulating the ladder diagram, ladder instructions one-by-one, saving all variables:

- Steps (1..6)
- Transitions (1..6)
- Inputs (automatic button, part detect, …)
- Outputs (power, light, advance, …)

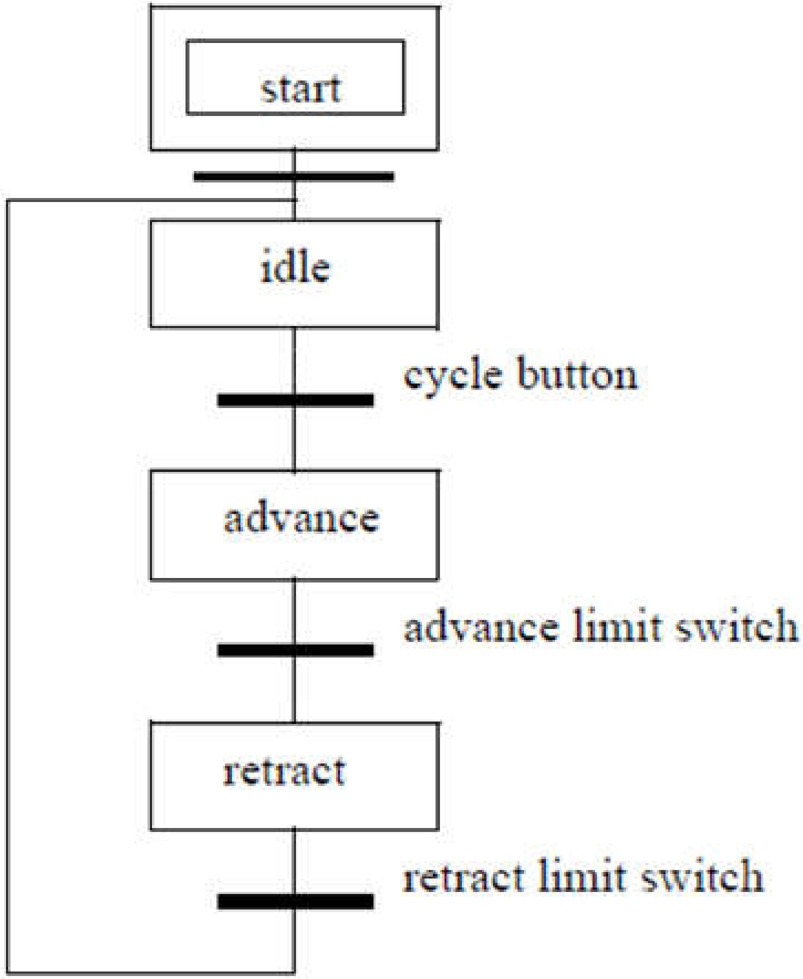
Confirm that:

- Step variables are active *at most one scan cycle*
- Outputs are set/unset (latched/unlatched) and therefore *do not need the steps being active all the time*.

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.

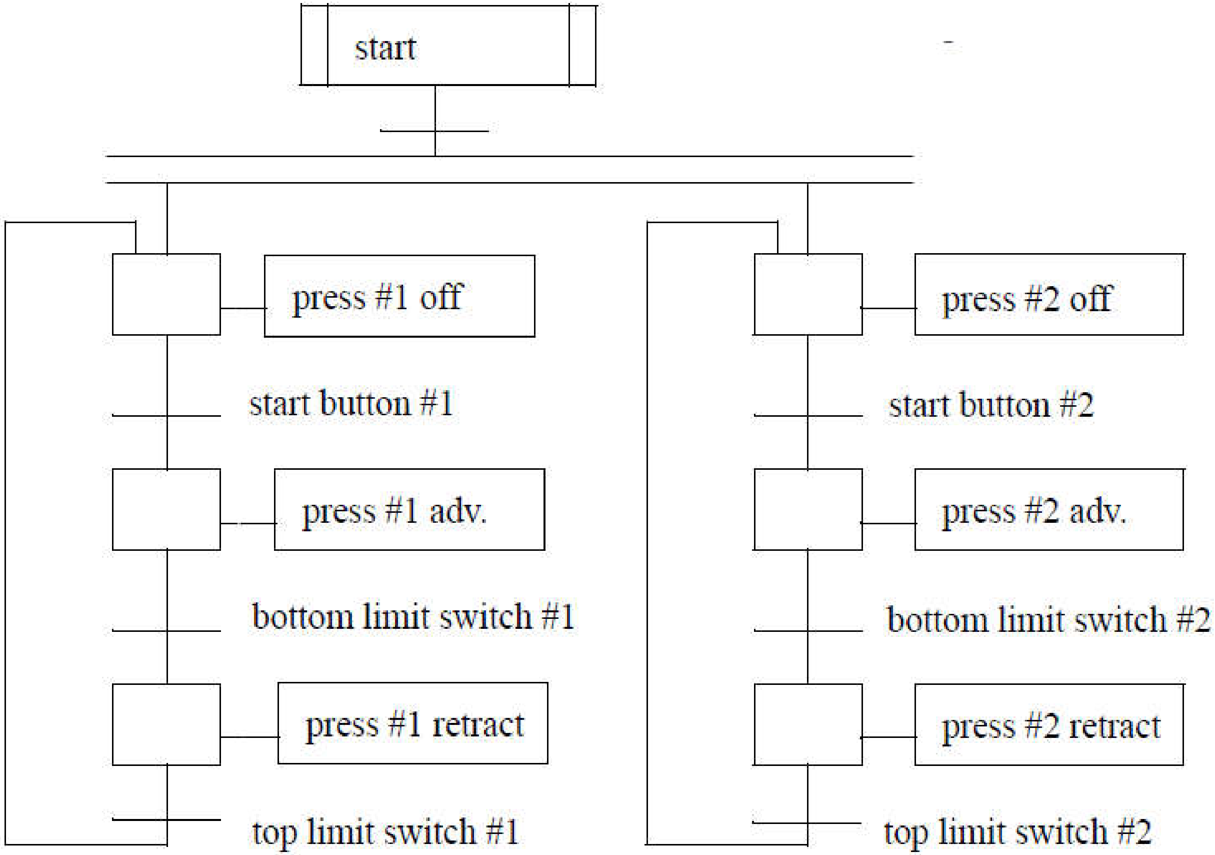
Further study: discuss the advantages of using SFC as compared with using Ladder in this problem.



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]

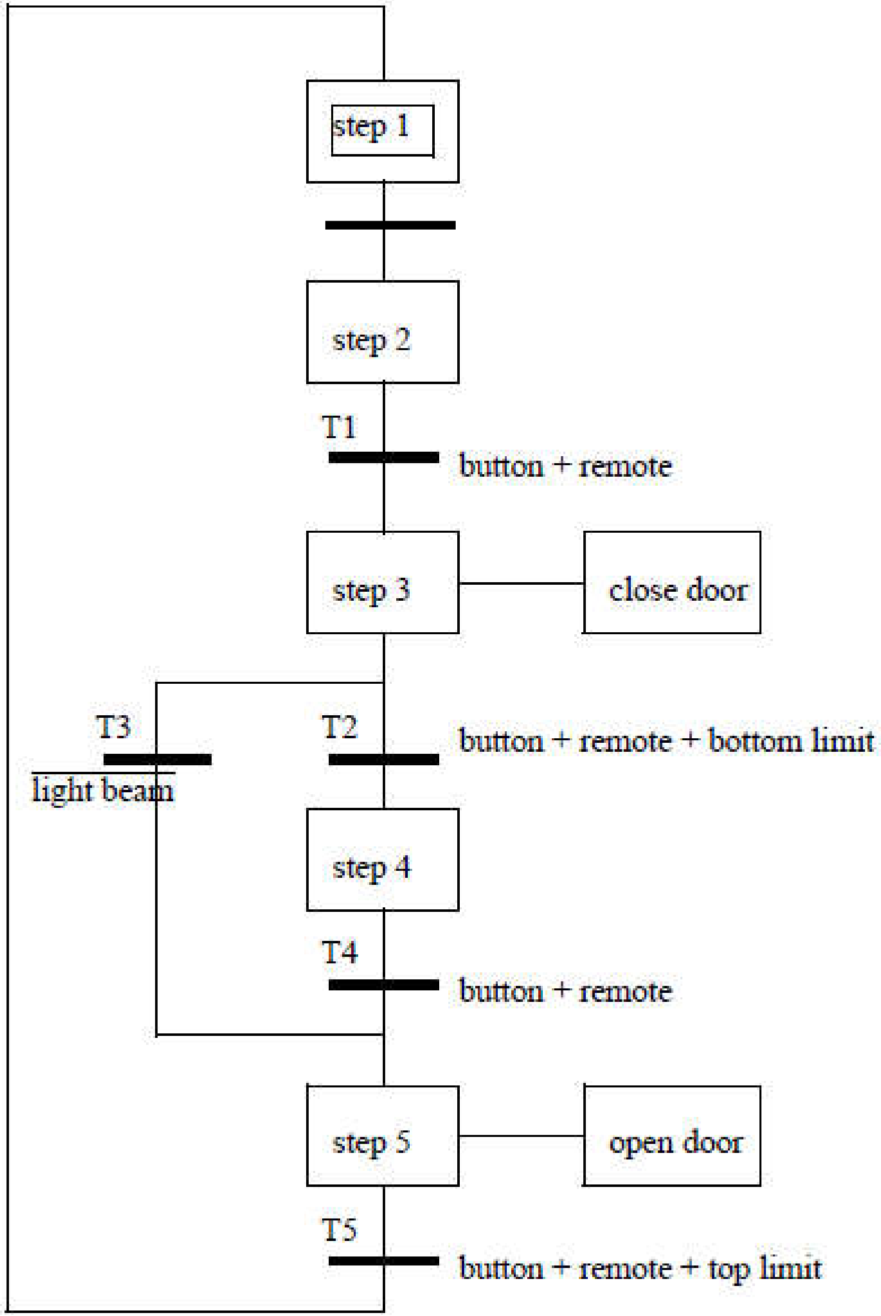
GRAFCET Practice Problem 3

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]