Plant description

We want to realize a pyrolytic oven (self-cleaning oven) by means of the following modules.

1. A program selector that allows to select a program among cooking and pyrolysis. Such a module imposes that no program is selected in its initial state. Once a program has been selected, such a module Only allows to deselect it.

2. A start/stop button to start or stop the oven. In its initial state the oven is OFF, whereas Once started (the oven is ON) such a module Only allows to stop the oven.

3. A door that can be either open or closed. In its initial state the door is closed and thus it can Only be opened. Conversely, Once the door is open it can Only be closed.

Assignments:

A1) Define a finite state automaton for each component above.

Solution:

In this section, I design automation for each part of the question by hand and ESCET tool. I have designed a simple SVG to visualize the result of simulation for each plant. Each part of the solution contains the designed automaton and simulation result in ESCET.

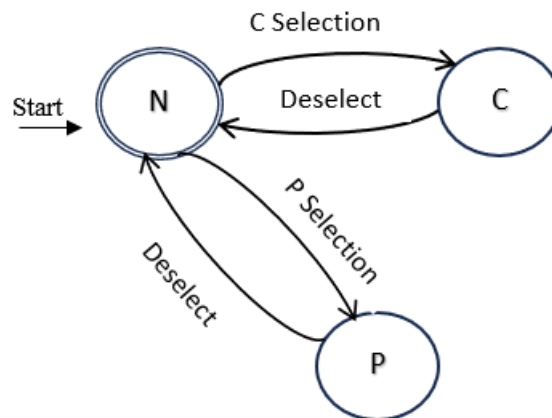All plants and requirements are implemented in ESCET.

I.   States:
- N: No Program **(Initial State)**
- C: Cooking program selected.
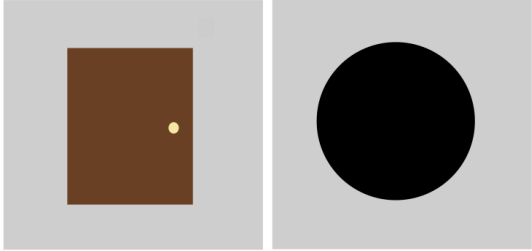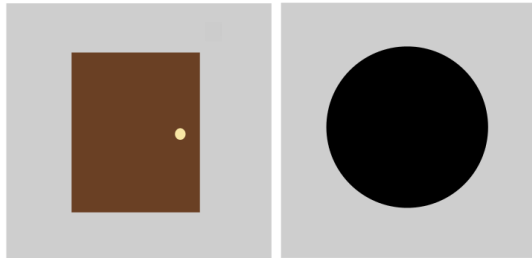- P: Pyrolysis program selected.

II.   Events:
- C Selection: select cooking program (N to C transition).
- P Selection: select pyrolysis program (N to P transition).
- Deselect: deselect pyrolysis program (P to N transition).
- Deselect: deselect cooking program (C to N transition).
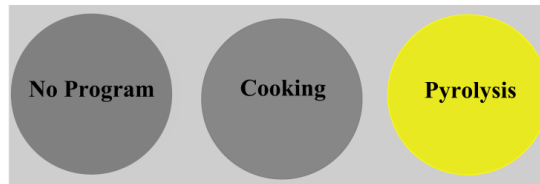
III.   Automaton:

IV. Simulation Result:

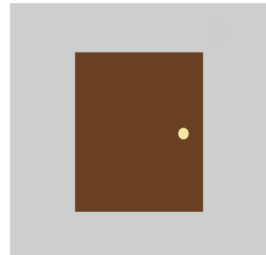| GUI Input	SVG Visualizer
At the first step we can select either cooking or pyrolysis program. And after selecting each of them we only can deselect them and come back to initial state.	

Program Selector

Program Selector

Program Selector

Cselection ▼	
Deselect ▼	
DoorClosing ▼	
DoorOpening ▼	
OvenOFF ▼	
OvenON ▼	
Pselection ▼	
time delay ▼	
reset ▼	
undo (3) ▼	

No Program   Cooking   Pyrolysis

Door   **Oven**

I. **States:**
- OFF **(Initial state)**
- ON
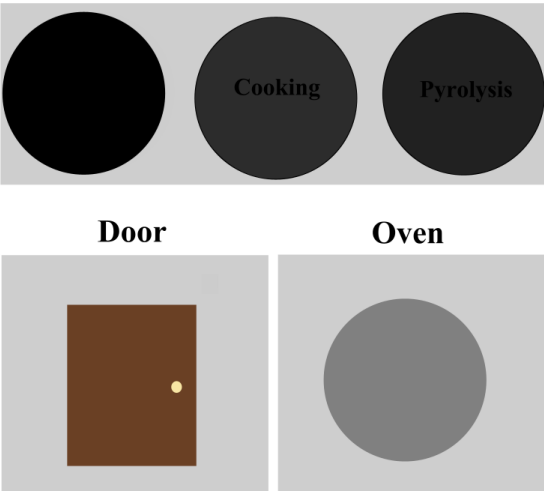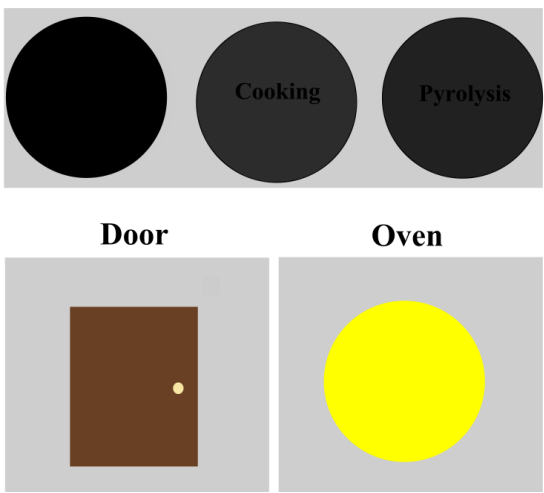
II. **Events:**
- Oven ON: Turning ON oven (OFF to ON transition)
- Oven OFF: Turning OFF oven (ON to OFF transition)

III. **Automaton:**

V. Simulation Result:

GUI Input	SVG Visualizer
At the first step the oven is OFF, and we can only turn it ON. After that, we can only turn the oven OFF again.	

Program Selector

Door **Oven**

Program Selector

Door **Oven**

4. A door that can be either open or closed:

I. States:
- Closed **(Initial state)**
- Open
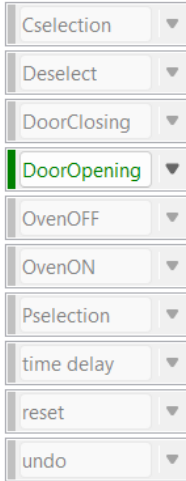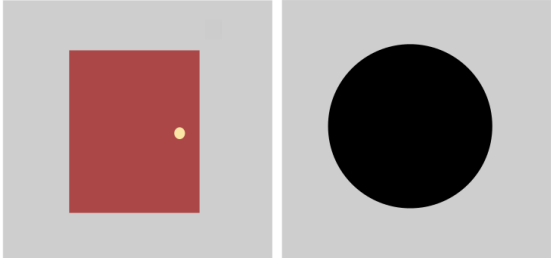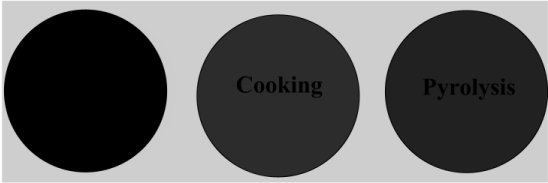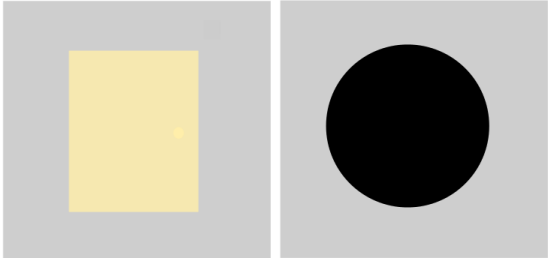
II. Events:
- Door opening: Opening the door (Closed to Open transition).
- Door closing: Closing the door (Open to Closed transition).

IV. Automaton:

V. Simulation Result:

GUI Input	SVG Visualizer
At the initial state, the door is closed, and we can only open it. After that we can only close door again.	

Program Selector

| Cselection ▼ |
| Deselect ▼ |
| DoorClosing ▼ |
| DoorOpening ▼ |
| OvenOFF ▼ |
| OvenON ▼ |
| Pselection ▼ |
| time delay ▼ |
| reset ▼ |
| undo ▼ |

Cooking   Pyrolysis

Door   **Oven**

Program Selector

| Cselection ▼ |
| Deselect ▼ |
| DoorClosing ▼ |
| DoorOpening ▼ |
| OvenOFF ▼ |
| OvenON ▼ |
| Pselection ▼ |
| time delay ▼ |
| reset ▼ |
| undo (1) ▼ |

Cooking   Pyrolysis

Door   **Oven**

A2) Define a finite state automaton for each of these requirements.

      R1) The oven can be started only if a program has been selected.

I.   States:

- {N, OFF}: Oven is OFF, and no program is selected **(Initial state).**
- {C, OFF }, {P, OFF }: Oven is OFF, cooking or pyrolysis has been selected.
- {C, ON} , {P, ON }: Oven is ON, cooking or pyrolysis has been selected.

II.   Events:

- C Selection-OFF: Cooking program selection oven is OFF. {N, OFF} to {C, OFF}
- P Selection-OFF: Pyrolysis program selection oven is OFF. {N, OFF} to {P, OFF}
- P Selection-ON: Pyrolysis program selection oven is ON. {P, OFF} to {P, ON }
- C Selection-ON: Cooking program selection oven is ON { C, OFF} to {C, ON }
- C Selection-OFF: Cooking program selection oven is OFF { C, ON} to {C, OFF}
- P Selection-OFF: Pyrolysis program selection oven is OFF. { P, ON} to {P, OFF }
- Deselect-OFF: Deselect cooking oven is OFF { C, OFF} to {N, OFF}
- Deselect-OFF: Deselect pyrolysis oven is OFF { C, OFF} to {N, OFF}

III.   Automaton:
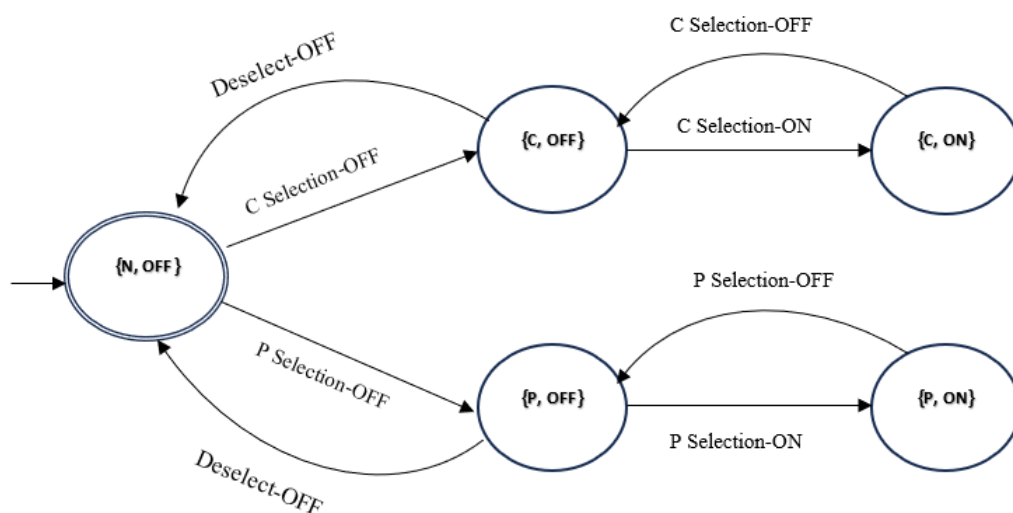
VI.   Simulation:

For this requirement[1], only program selector and oven are considered[2].

For this requirement, we could only apply the condition of selecting the program to turning on the oven with the below requirement. But, using this requirement can lead to a state in which the oven is ON, and no program is selected, and it can cause a conflict with the primary condition.

```
import "../Plant/Events.cif";

requirement R1: // Oven ON When Program Is Selected

  location NoProgramSelected:
    initial; marked;
    edge Cselection goto ProgramSelected;
    edge Pselection goto ProgramSelected;


  location ProgramSelected:
    edge Deselect goto NoProgramSelected;
    edge OvenON;

end
```

Because of this reason, I merge the requirement R1 and R2.

```
import "../Plant/Events.cif";


requirement R1: // Program can be deSelected only if oven is off

  location NoProgramSelected:
    initial; marked;
    edge Cselection goto ProgramSelected;
    edge Pselection goto ProgramSelected;


  location ProgramSelected:
    edge Deselect goto NoProgramSelected;
    edge OvenON goto OvenOFFNecessity;

  location OvenOFFNecessity:
    edge OvenOFF goto ProgramSelected;

end
```

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[1] R1.cif

[2] Using "Build_Program_Oven_Plant.tooldef"

GUI Input	SVG Visualizer

At the first step only, a program can be selected.

Program Selector

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo	▼

No Program   Cooking   Pyrolysis
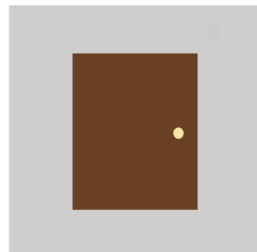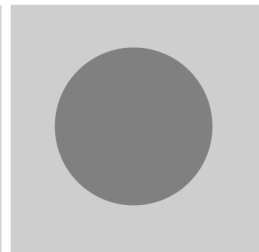
Door   **Oven**

After selecting a program, it can be deselected, or the oven can start.

Program Selector

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo (1)	▼

No Program   Cooking   Pyrolysis
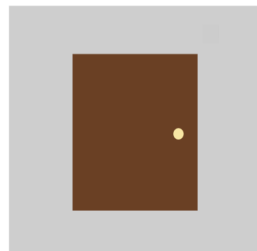
Door   **Oven**
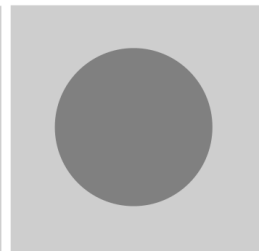
When Oven turns ON, the program can be deselected until it turns OFF again.

Program Selector

Cselection	▼	
Deselect	▼	
DoorClosing	▼	
DoorOpening	▼	
OvenOFF	▼	
OvenON	▼	
Pselection	▼	
time delay	▼	
reset	▼	
undo	(2) ▼	

No Program   Cooking   Pyrolysis

Door   **Oven**
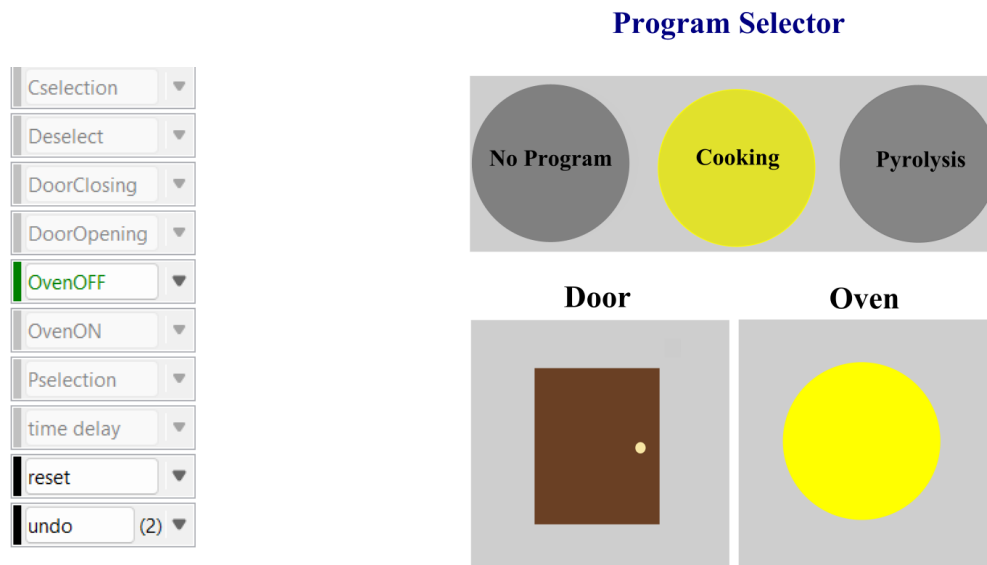
Only after turning OFF the oven, the selected program can be deselected.

Program Selector

Cselection	▼	
Deselect	▼	
DoorClosing	▼	
DoorOpening	▼	
OvenOFF	▼	
OvenON	▼	
Pselection	▼	
time delay	▼	
reset	▼	
undo	(3) ▼	

No Program   Cooking   Pyrolysis

Door   **Oven**
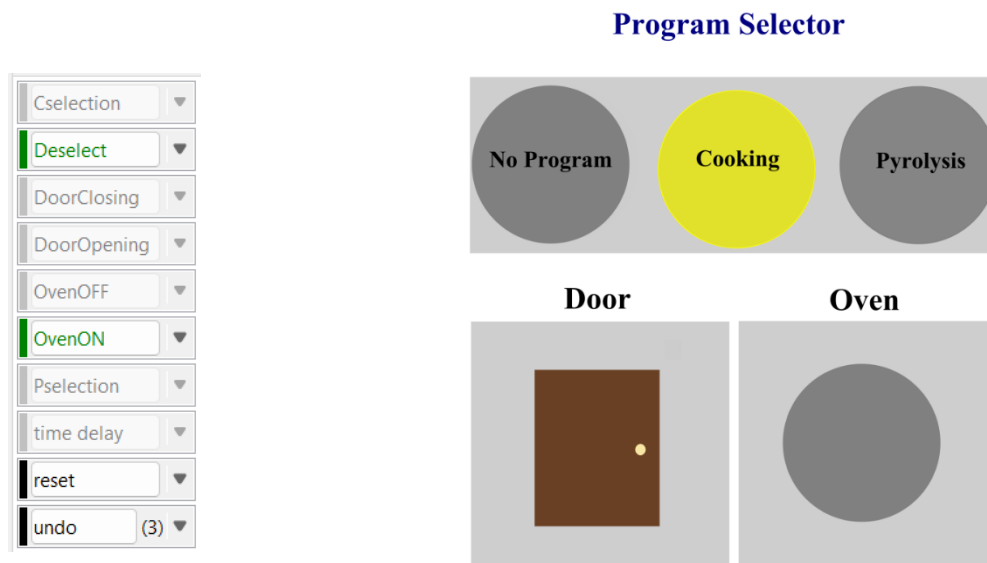
R2) A selected program can be deselected Only if the oven is OFF.

Solution:

This requirement is considered in the previous requirement (R1).

R3) If pyrolysis has been selected, then the oven can be started only if the door is closed.

Solution:

I. **States:**
- { N, OFF, Closed }: No program selected, oven OFF, door closed (**Initial state**).
- { N, OFF, Open }: No program selected, oven OFF, door open.
- { C, OFF, Closed } , { P, OFF, Closed }: Program Selected: Program selected, oven OFF, door closed.
- { C, ON, Closed } ,{ C, ON, Open }, { P, ON, Closed } Oven ON: Program selected, oven ON, door closed.
- { C, OFF, Open }, { P, OFF, Open } : Program selected, oven OFF, door open.
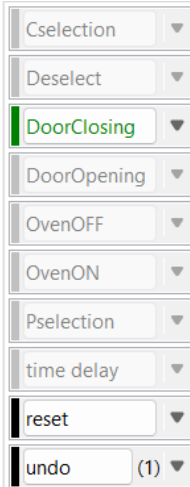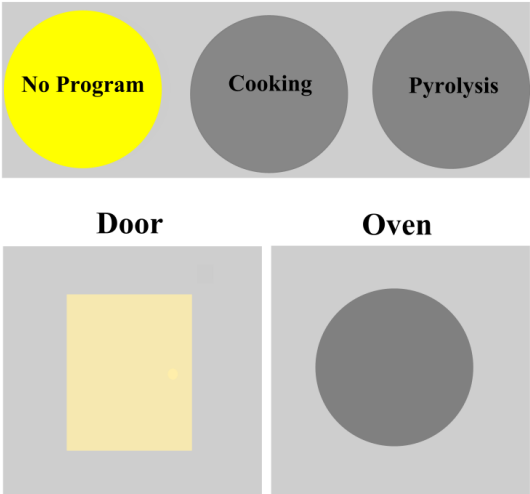
II. **Events:**
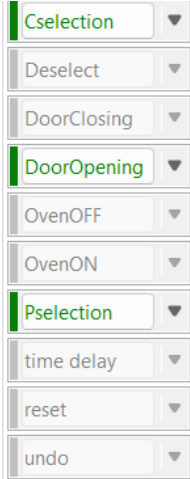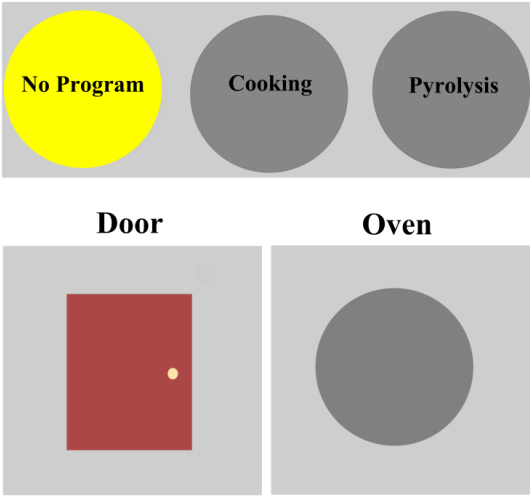- Select cooking or pyrolysis program:
  - C-OFF-Closed: {N, OFF, Closed } to { C, OFF, Closed } transition.
  - P-OFF-Closed: {N, OFF, Closed } to { P, OFF, Closed} transition.

- Oven starts If program selected with One exception. If the Pyrolysis program is selected, as per the new requirement Oven is started if door is closed:
  - C-ON-Closed: {C, OFF, Closed } to { C, ON, Closed } transition.
  - P-ON-Closed: { P, OFF, Closed } to { P, ON, Closed} transition.
  - C-OFF-Open: { C, OFF, Open } to { C, ON, Open} transition.

- Deselect the program (oven must be OFF):
  - N-OFF-Closed: { C, OFF, Closed } to { N, OFF, Closed} transition.
  - N-OFF-Closed: { P, OFF, Closed } to { N, OFF, Closed} transition.

- Open the door:
  - N-OFF-Open: { N, OFF, Closed }to { N, OFF, Open} transition.
  - C -OFF-Open: { C, OFF, Closed}to { C, OFF, Open} transition.
  - P -OFF-Open: { P, OFF, Closed}to{ P, OFF, Open} transition.
  - C- ON-Open: {C, ON, Closed } to { C, ON, Open} transition.

- Close the door:
    - N-OFF-Closed: { N, OFF, Open} to { N, OFF, Closed} transition.
    - C-OFF-Closed: { C, OFF, Open} to { C, OFF, Closed} transition.
    - P -OFF-Closed:{ P, OFF, Open} to { P, OFF, Closed} transition.
    - C-ON-Closed:{ C, ON, Open} to { C, ON, Closed} transition.

- Oven stops:
    - C-OFF-Closed: {C, ON, Closed} to {C, OFF, Closed} transition.
    - C-OFF-Open: {C, ON, Open} to {C, OFF, Open} transition.
    - P-OFF-Closed: {P, ON, Closed} to {P, OFF, Closed} transition.

III.   **Automaton**
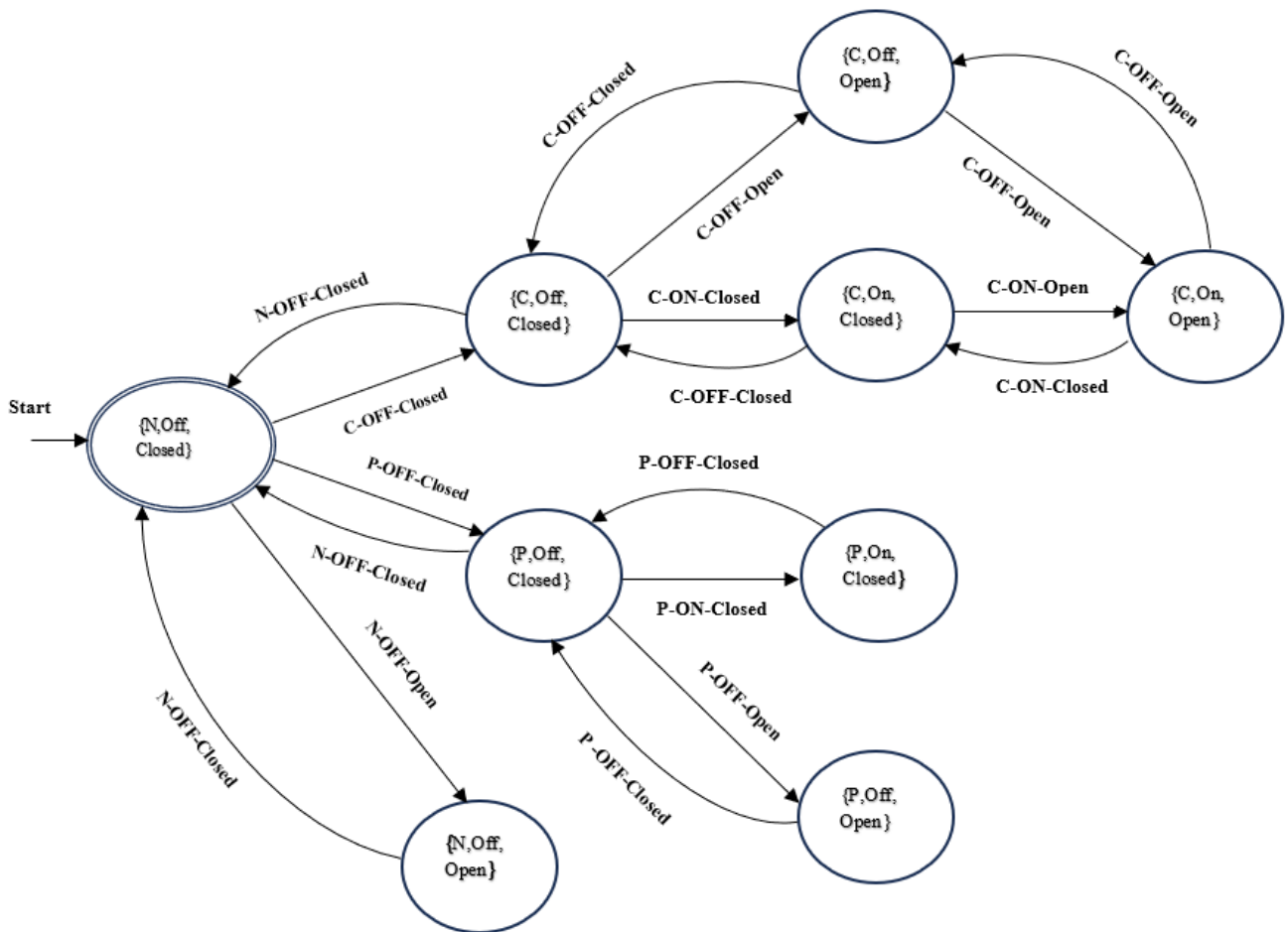
VII. Simulation Result

GUI Input	SVG Visualizer

At the first step, a program can be selected, or the door can be opened.

Program Selector

Cselection
Deselect
DoorClosing
DoorOpening
OvenOFF
OvenON
Pselection
time delay
reset
undo

No Program   Cooking   Pyrolysis

Door   **Oven**

If the door opened, it can only be closed.

Program Selector

Cselection
Deselect
DoorClosing
DoorOpening
OvenOFF
OvenON
Pselection
time delay
reset
undo (1)

No Program   Cooking   Pyrolysis

Door   **Oven**

If cooking has been selected, either door can be opened, or oven can turn ON without limitation. At this step the program can also be deselected.

Program Selector

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo	(1) ▼

No Program   Cooking   Pyrolysis

Door   **Oven**
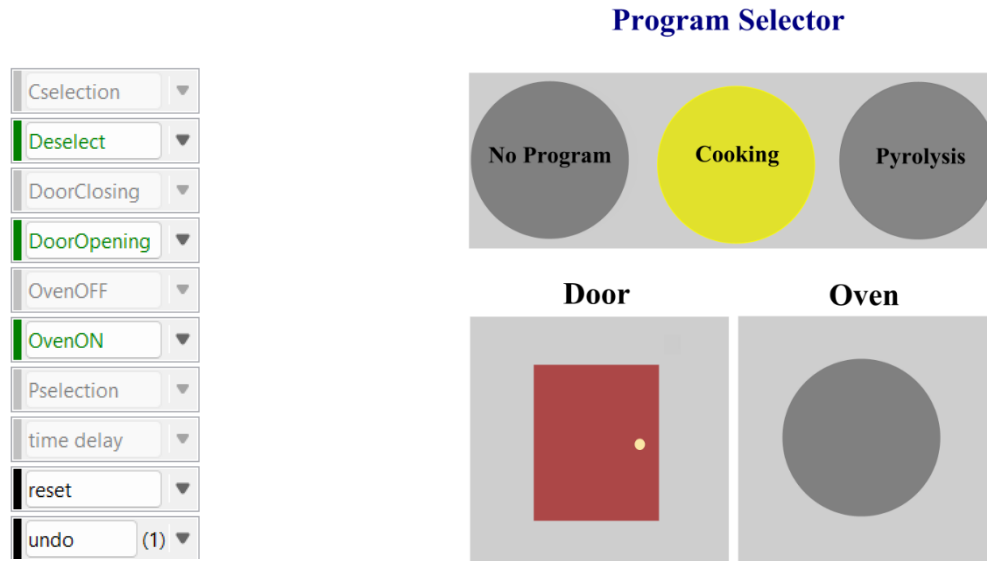
When cooking is selected and oven turns ON, the door can be opened without limitation. But, the cooking can be deselected only if the oven turn OFF again.

Program Selector

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo	(2) ▼

No Program   Cooking   Pyrolysis

Door   **Oven**
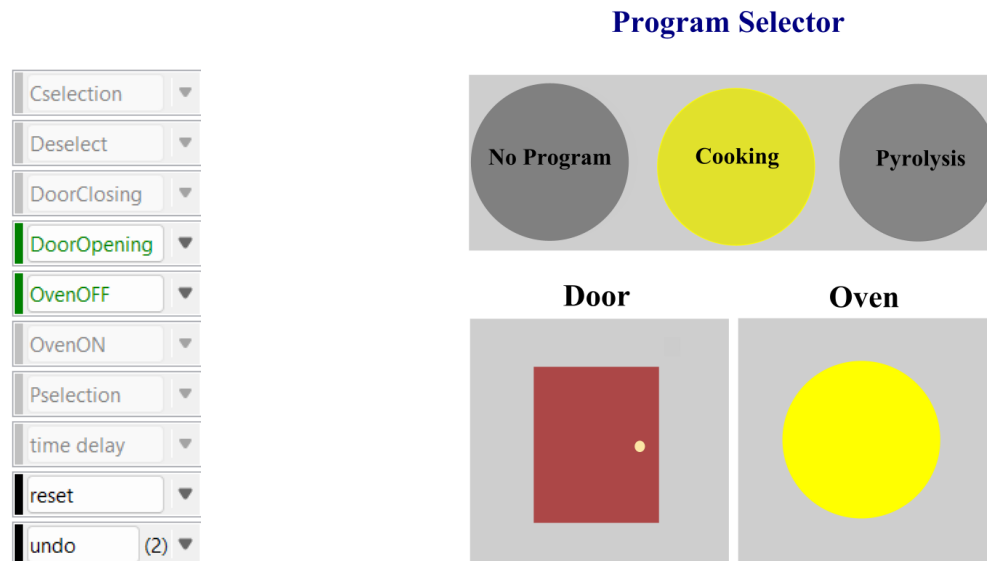
If the pyrolysis program is selected, the door can be opened or the oven can turn ON.

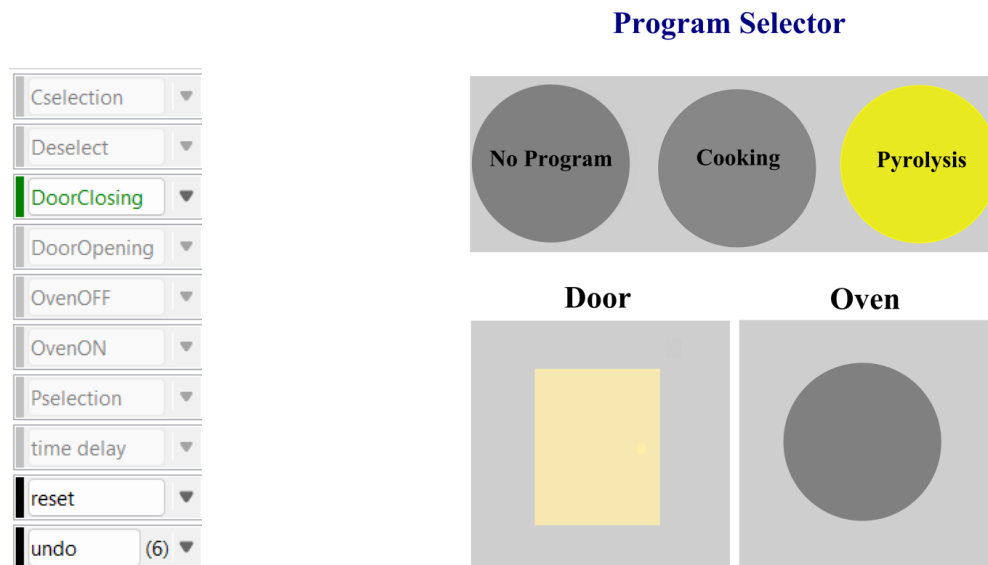**Program Selector**

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo (5)	▼

No Program   Cooking   Pyrolysis

Door   Oven
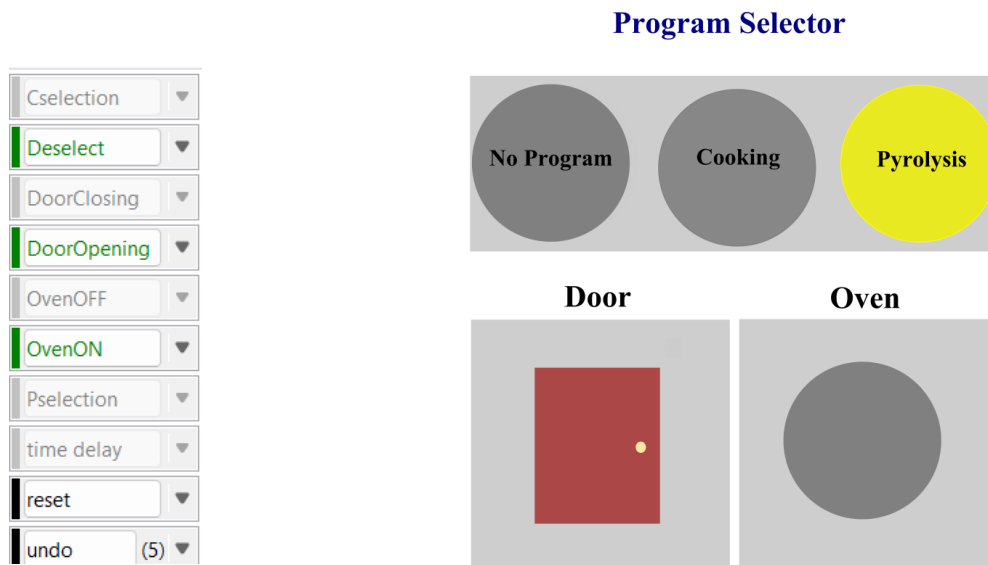
When the pyrolysis program is selected and door is open, the oven cannot turn ON until the door closes again.

Program Selector

Cselection	▼
Deselect	▼
DoorClosing	▼
DoorOpening	▼
OvenOFF	▼
OvenON	▼
Pselection	▼
time delay	▼
reset	▼
undo (6)	▼

No Program   Cooking   Pyrolysis

Door   Oven

And finally, as long as the oven is ON, the selected program can not be deselected.

Program Selector

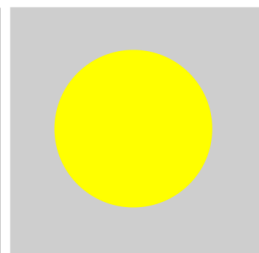|		
No Program	Cooking	Pyrolysis

Cselection ▼
Deselect ▼
DoorClosing ▼
DoorOpening ▼
OvenOFF ▼
OvenON ▼
Pselection ▼
time delay ▼
reset ▼
undo (8) ▼
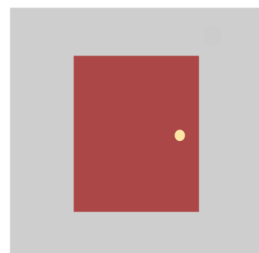
Door

Oven

*R*4) If pyrolysis has been selected and the oven has been started, then the door cannot be opened until the oven is switched OFF.

This requirement is already satisfied in the R3 automaton since there are no transitions allowing the door to be opened during pyrolysis.