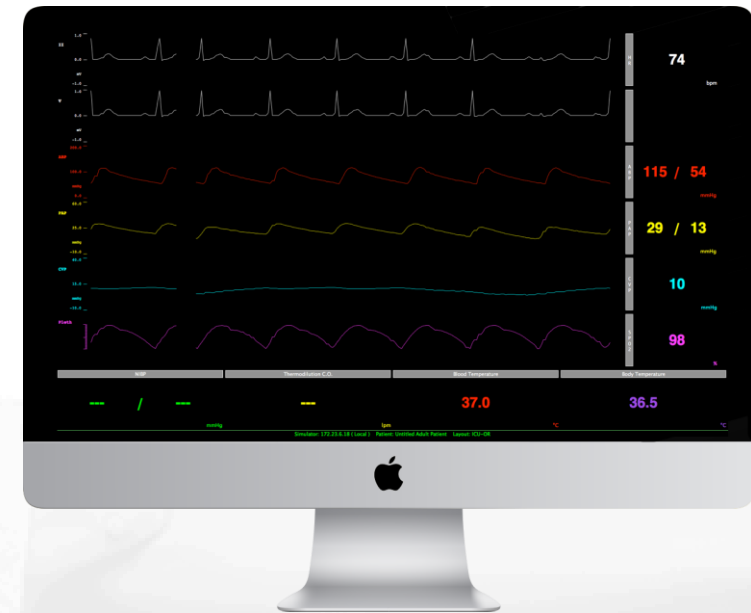


NON-LINEAR ASYNCHRONOUS SIMULATION



Valeriy Kozmenko, MD
Associate Professor, University of South Dakota, Sanford School of Medicine

HFS – CONVENTIONAL USE



Valeriy Kozmenko, MD
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SCENARIO – CONVENTIONAL USE

STATE 1



STATE 2



STATE 3

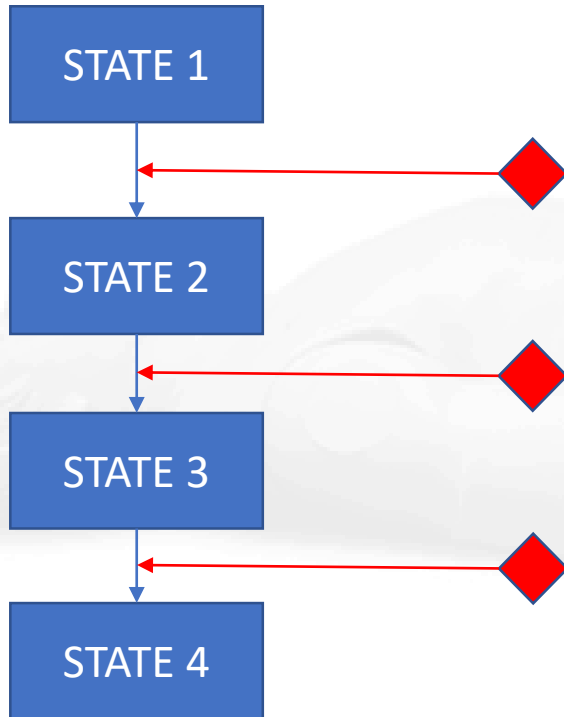


STATE 4



BP	120/70 mm Hg
HR	75 bpm
RR	12 bpm
SpO2	98%
Temp	36.7C
Rhythm	NSR
Eyes	Blinking (both)
EtCO2	38 mm Hg

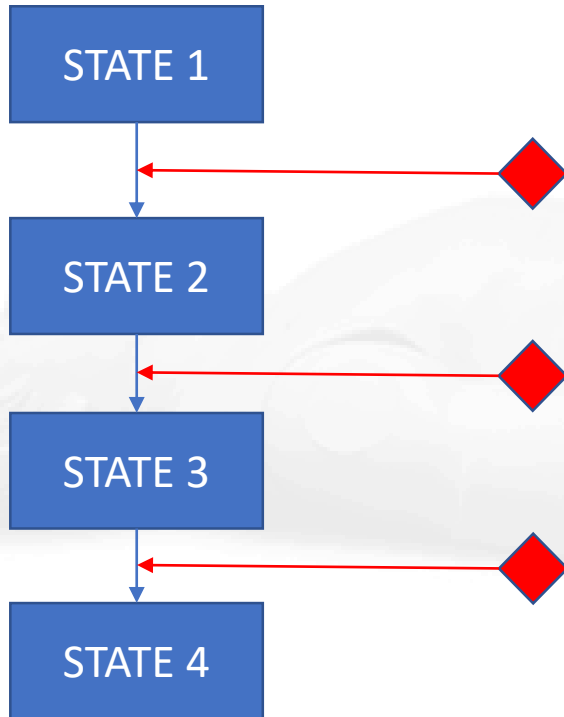
SCENARIO – CHF with pulmonary edema



MONA protocol

1. Morphine
2. O₂
3. Nitroglycerine
4. Aspirin
5. Furosemide (Lasix)

SCENARIO – CHF with pulmonary edema

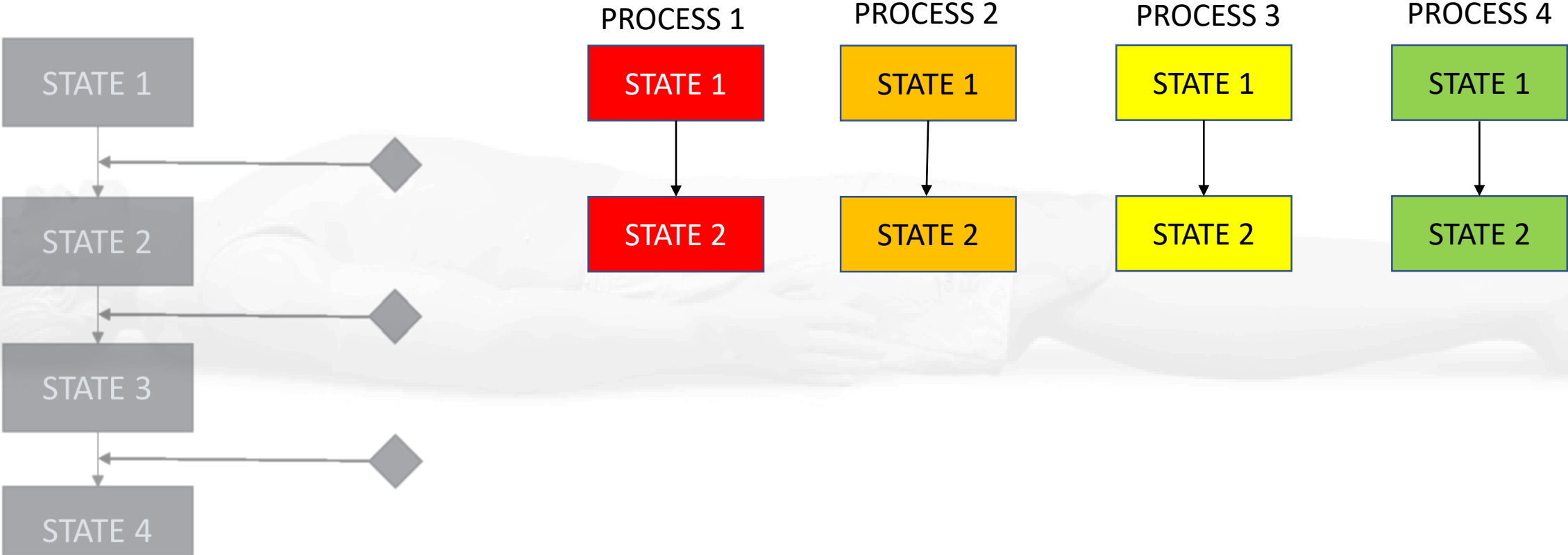


Challenges

1. Correct medications could be given in a different order
2. Correct medication, wrong dosage
3. Wrong medication
4. Unanticipated intervention (intubation, defibrillation etc)

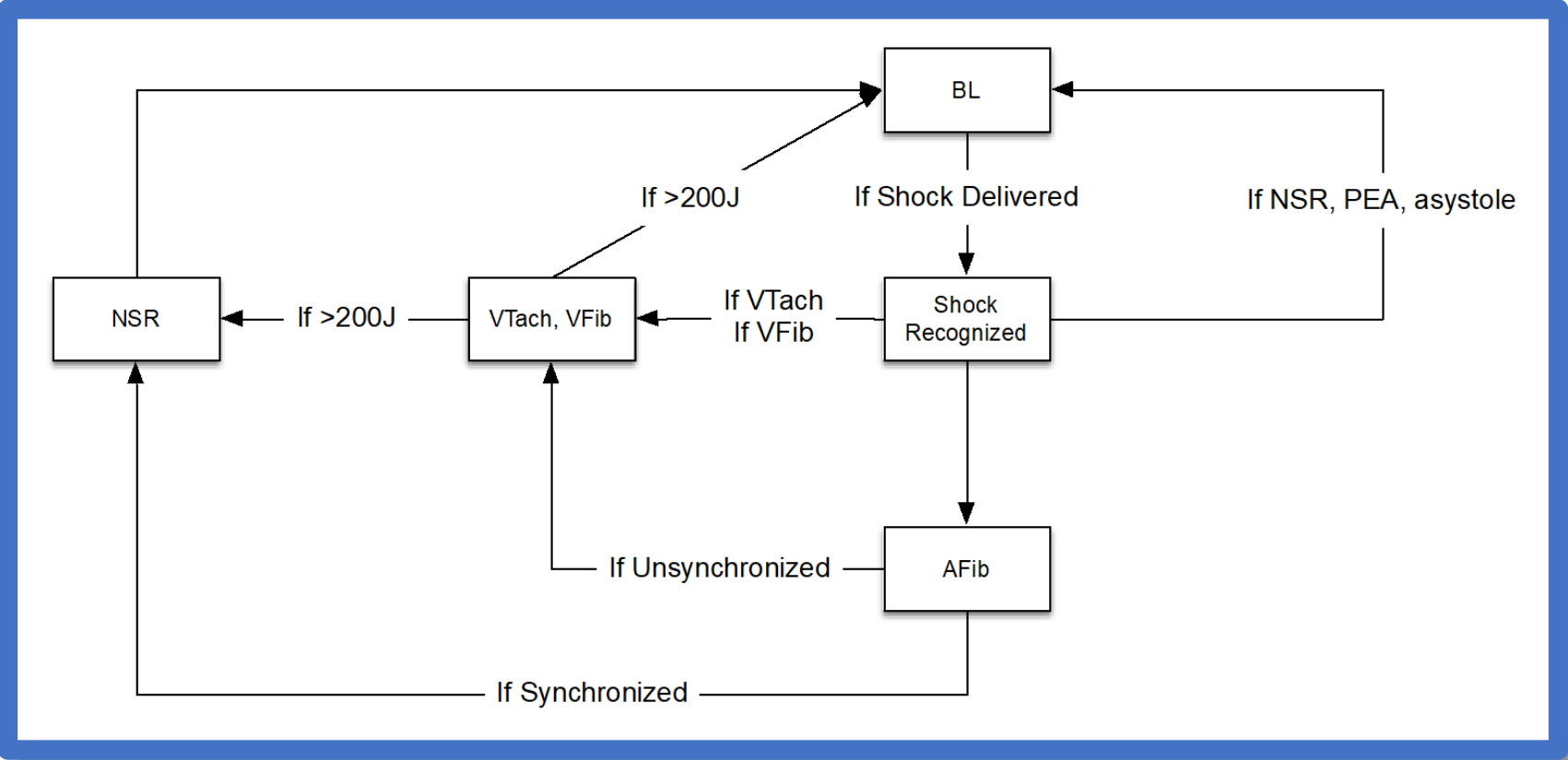
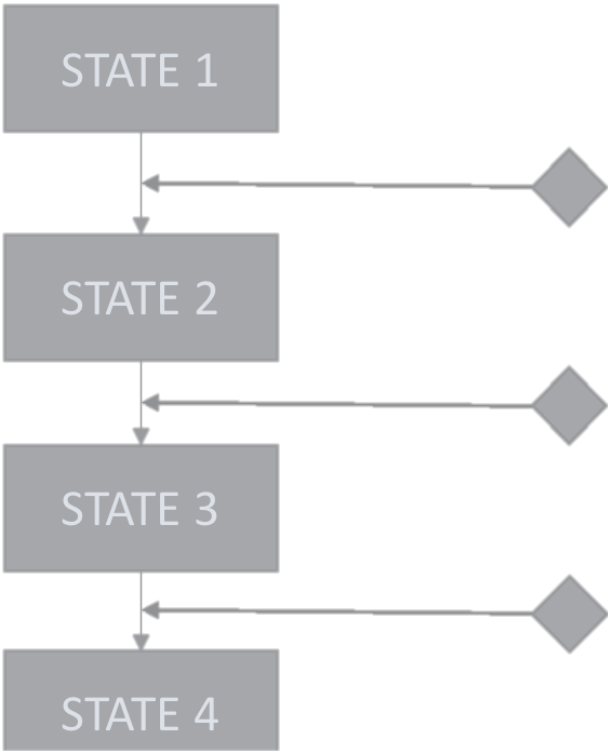
SCENARIO – CHF with pulmonary edema

NON-LINEAR ASYNCHRONOUS



SCENARIO – CHF with pulmonary edema

NON-LINEAR ASYNCHRONOUS CYCLIC



IMPLEMENTATION – CAE simulators

1. Using one "scenario" per process
2. Assigning and using custom variables
3. Effective using transitions



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IMPLEMENTATION – CAE simulators

Parameters:

1. Cardiac Rhythm	NSR
2. LV contractility Factor	0.5
3. RV contractility Factor	0.5
4. Oxygen consumption	0.5
5. Venous Capacity	2.0
6. Custom Variable 1 (user defined)	1

Transitions:

1. If [Parameter x] equals [...], then go to State [...]

IMPLEMENTATION – CAE simulators

Untitled Adult Patient (1) @ localhost

00:02:24 Patient Time

Save Stop Logs Detach Tab Recorder Disconnect Connections

Simulation Scenario Condition Drugs Fluids Cardiovascular Respiratory

No photo available

METI™

Untitled Adult Patient

Name, Age, and Gender:

History of Present Illness:

Past Medical History:

Past Surgical/Anesthetic History:

Review of Systems:

Current Medications:

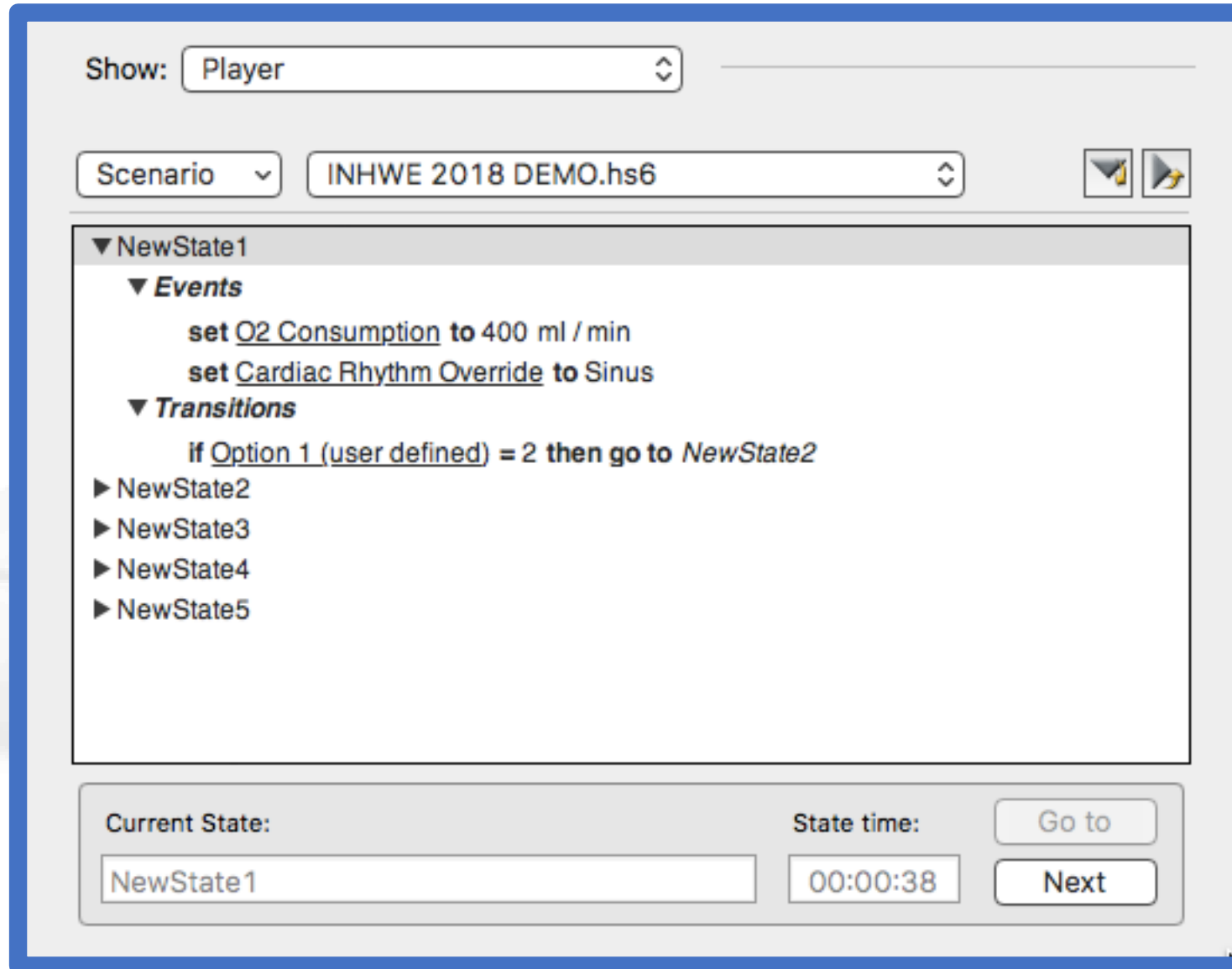
HR	MAP	C.O.
73	79	6.0
SpO2	Hct	Isch. Idx.
98	42.30	1.69
ABP	PAP	CVP
118/53	30/17	10

Left Vol.	Right Vol.	Spont.VT
1346	1346	859
PACO2	PAO2	Spont.RR
39.8	98.2	15
Alv. N2O	Alv. Iso.	Alv. Sevo.
0.0	0.0	0.0
Alv. Halo.		Alv. Enf.
0.0		0.0
PaCO2	pH	PaO2
39.7	7.44	94.2
PvCO2		PvO2
44.6		43.3
TBody	Weight	TBlood
36.5	70.0	37.0

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IMPLEMENTATION – CAE simulators



The screenshot displays a software interface for configuring a state machine. At the top, there is a 'Show:' dropdown menu set to 'Player'. Below it, a 'Scenario' dropdown is set to 'INHWE 2018 DEMO.hs6'. The main area is titled 'NewState1' and contains the following configuration:

- Events**
 - set O2 Consumption to 400 ml / min
 - set Cardiac Rhythm Override to Sinus
- Transitions**
 - If Option 1 (user defined) = 2 then go to *NewState2*

Below the transitions, a list of states is shown with expandable arrows: NewState2, NewState3, NewState4, and NewState5.

At the bottom of the interface, there are two status fields: 'Current State:' with a dropdown menu showing 'NewState1', and 'State time:' with a digital display showing '00:00:38'. To the right of these fields are two buttons: 'Go to' and 'Next'.

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IMPLEMENTATION – CAE simulators

The screenshot shows a software interface for a CAE simulator. At the top, there is a 'Show:' dropdown menu set to 'Player'. Below it is a 'Scenario' dropdown menu set to 'INHWE 2018 DEMO.hs6'. The main area displays a tree view for 'NewState1' with the following structure:

- ▼ **Events**
 - set O2 Consumption to 400 ml / min
 - set Cardiac Rhythm Override to Sinus
- ▼ **Transitions**
 - if Option 1 (user defined) = 2 then go to *NewState2*
- ▶ NewState2
- ▶ NewState3
- ▶ NewState4
- ▶ NewState5

At the bottom, there are controls for the current state and time:

- Current State:
- State time:
- Buttons: 'Go to' and 'Next'

Parameters:

1. Cardiac Rhythm	NSR
2. LV contractility Factor	0.5
3. RV contractility Factor	0.5
4. Oxygen consumption	0.5
5. Venous Capacity	2.0
6. Custom Variable 1 (user defined)	1

Transitions:

1. If [Parameter x] equals [...], then go to Sate [...]

IMPLEMENTATION – CAE simulators

Louisiana State University was awarded an international patent for this innovation in 2013

<https://patents.justia.com/inventor/valeriy-v-kozmenko>

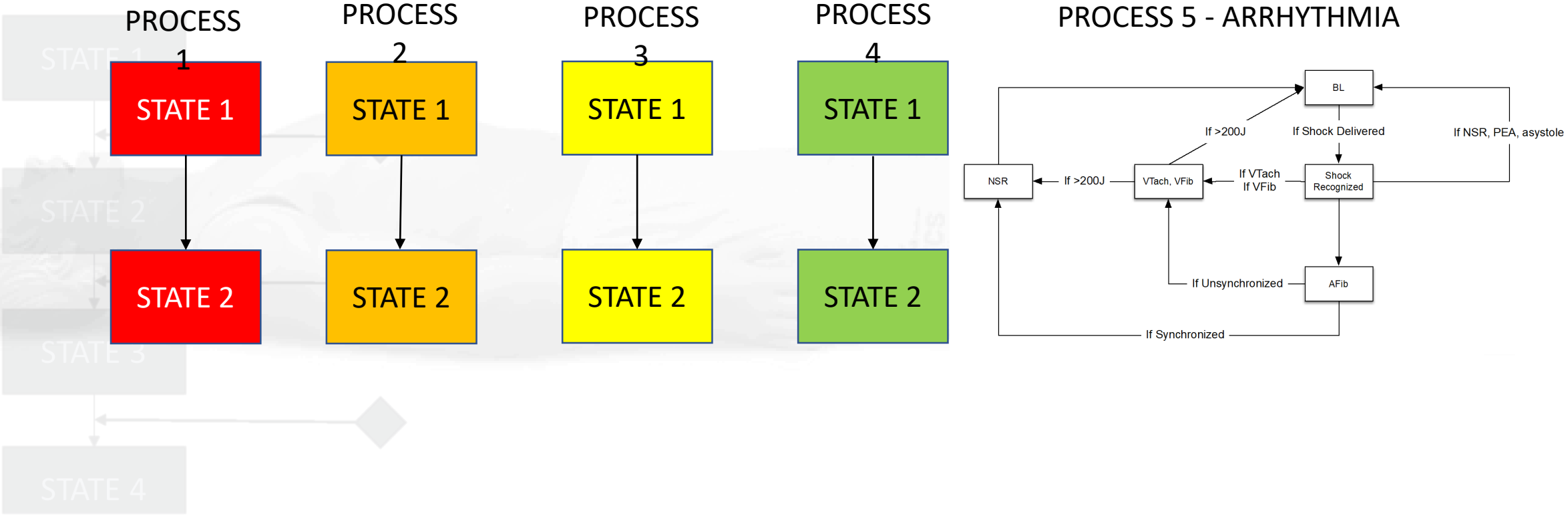
Valeriy Kozmenko and Charles Hilton were the inventors

Valeriy Kozmenko, MD

Associate Professor, University of South Dakota, Sanford School of Medicine

SCENARIO – CHF with pulmonary edema

NON-LINEAR ASYNCHRONOUS



IMPLEMENTATION – Laerdal

The HUB technique was developed at USD Sanford School of Medicine and received an award for technological innovation by the Society for Simulation in Healthcare at the annual meeting in New Orleans in 2015.



Valeriy Kozmenko and Brian Wallenburg were the inventors

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NON-LINEAR ASYNCHRONOUS PROGRAMMING ENHANCES REALISM OF HEALTHCARE SIMULATION



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