A gentile introduction to Automatic Control

Faculty of «Electronic Engineering for Intelligent Vehicles»

Nicola Mimmo

Departiment of Electrical, Electronics and Information Engineering «G. Marconi»

Contents

- What are we talking about?
- Why automatic controls?
- Automatic control architecture: humans revealed!
- Automatic control theory: a live coach
- Automatic control design: the best compromise
- Conclusions

Contents

What are we talking about?

We have an inherent desire to bend life to our wills

What are we talking about?

We have an inherent desire to bend life to our wills

- Meeting friends
- Having beers
- Swimming
- Travelling
- …

My life

Me
(before the marriage)

What are we talking about?

We have an inherent desire to bend life to our wills

My wife
(before the marriage)

A husband
- doing housework
- At her disposal 7/24/365
- Funny
- Intelligent
- Strong
- …

Her wishes

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- [illegible]eting friends
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- …

My life

What are we talinkg about?

More formally

system

in British English

(ˈsɪstəm)

NOUN

1. a group or combination of interrelated, interdependent, or interacting elements forming a collective entity; a methodical or coordinated assemblage of parts, facts, concepts, etc
   a system of currency
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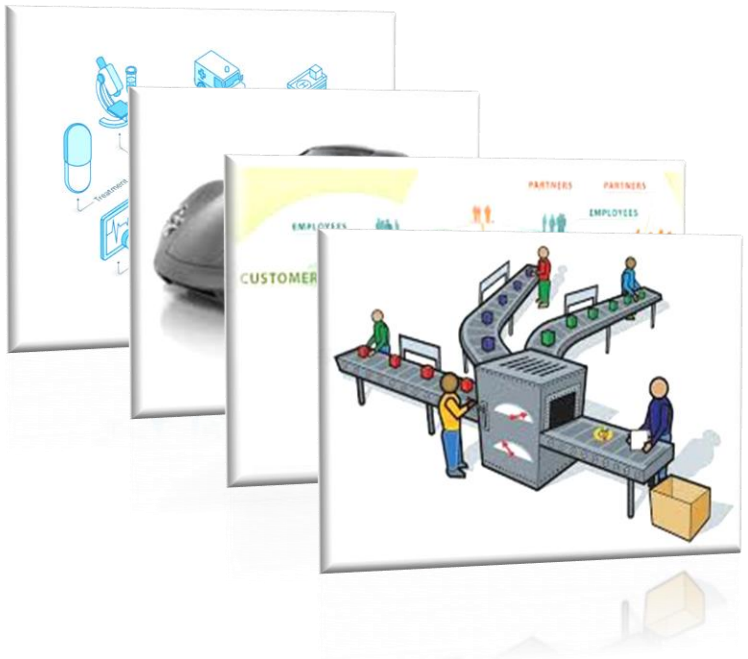

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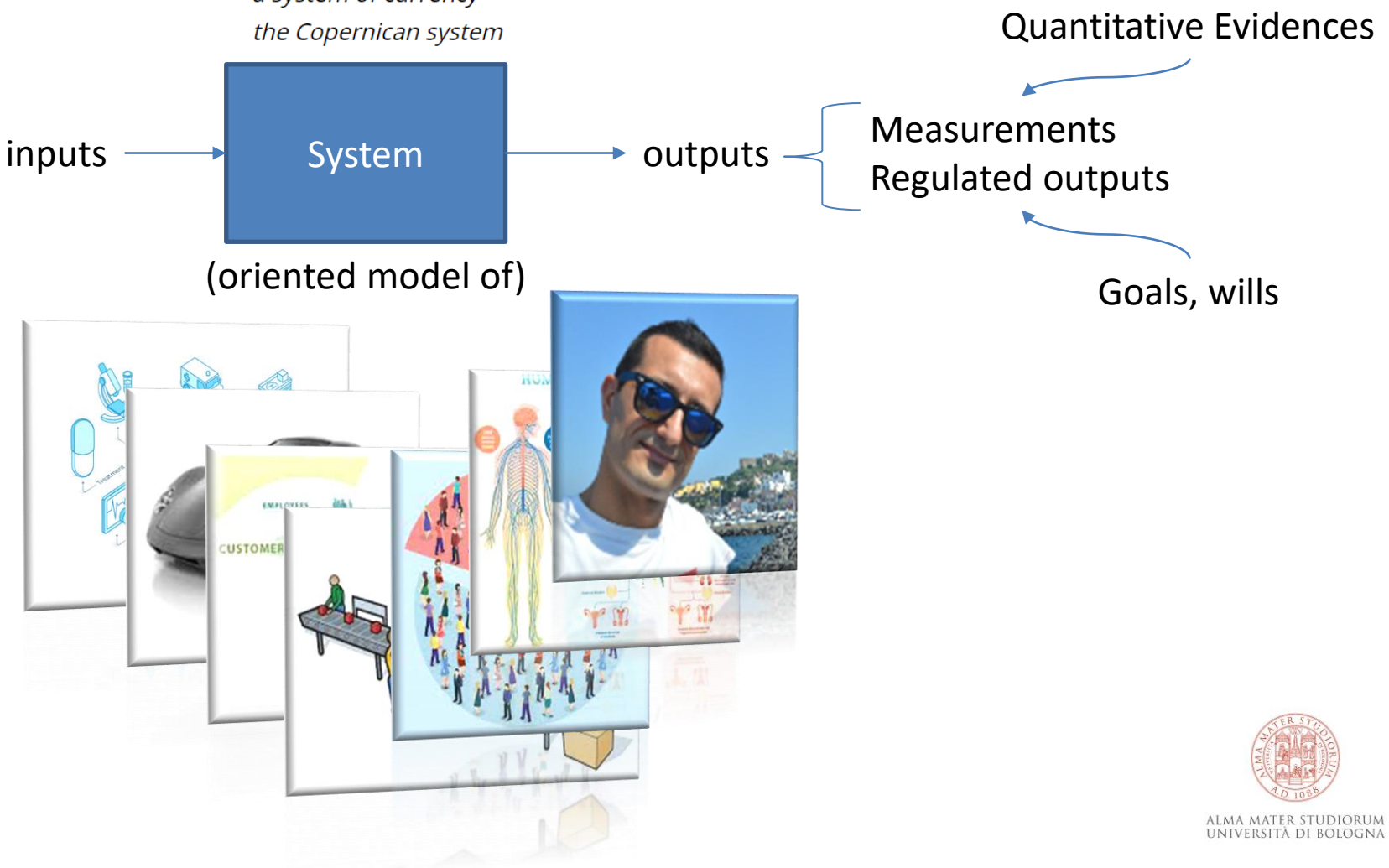

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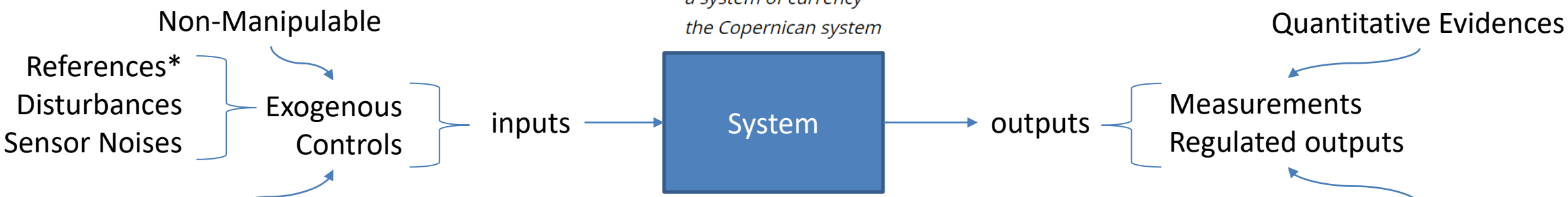

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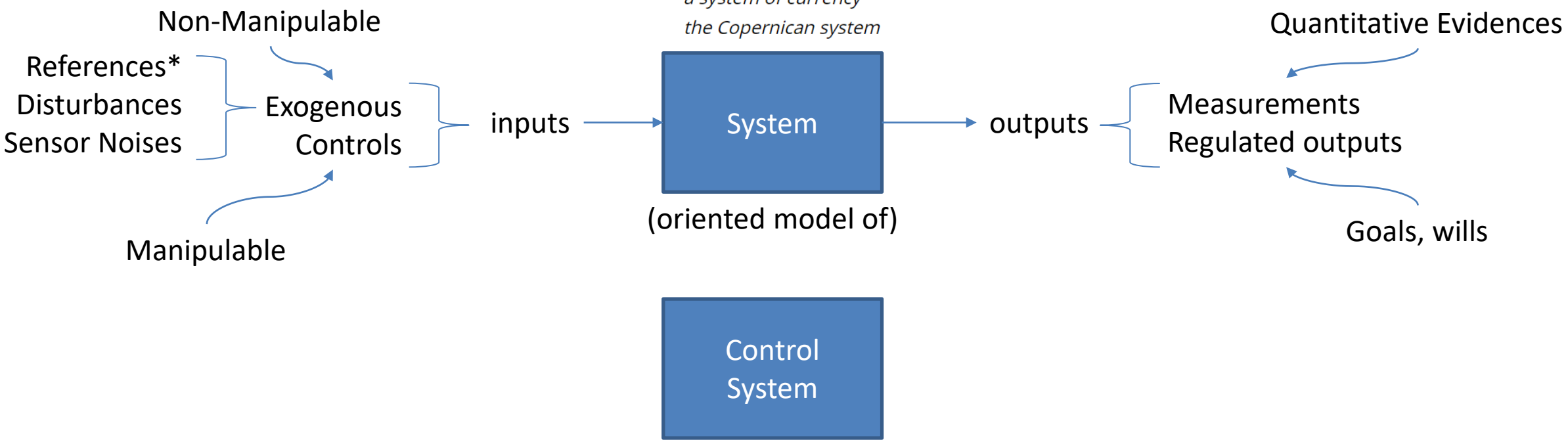

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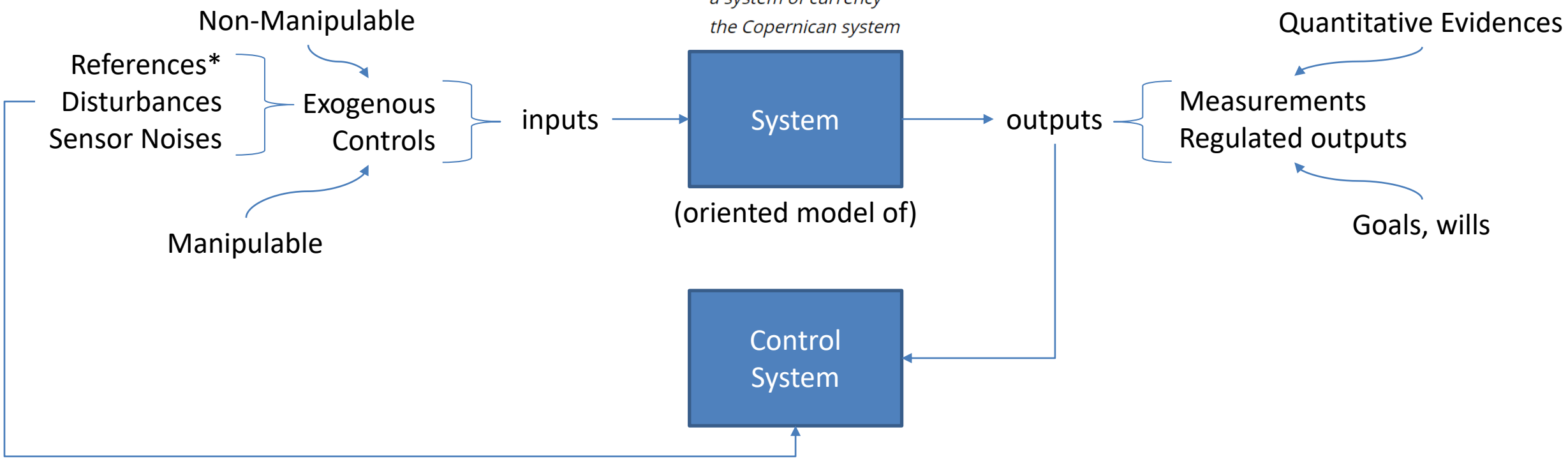

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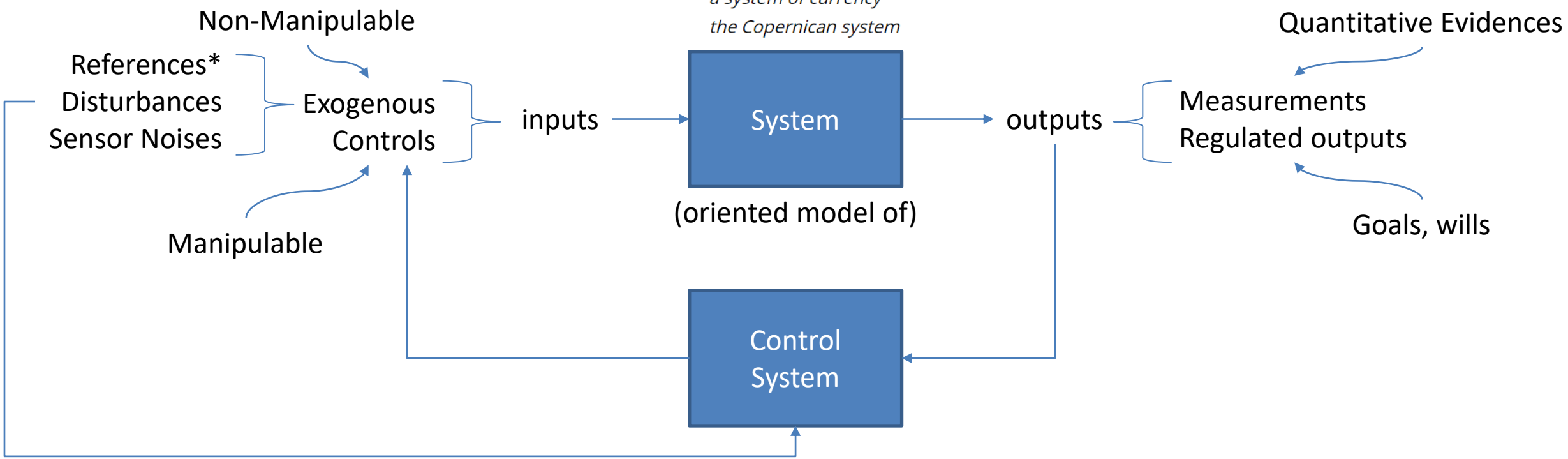

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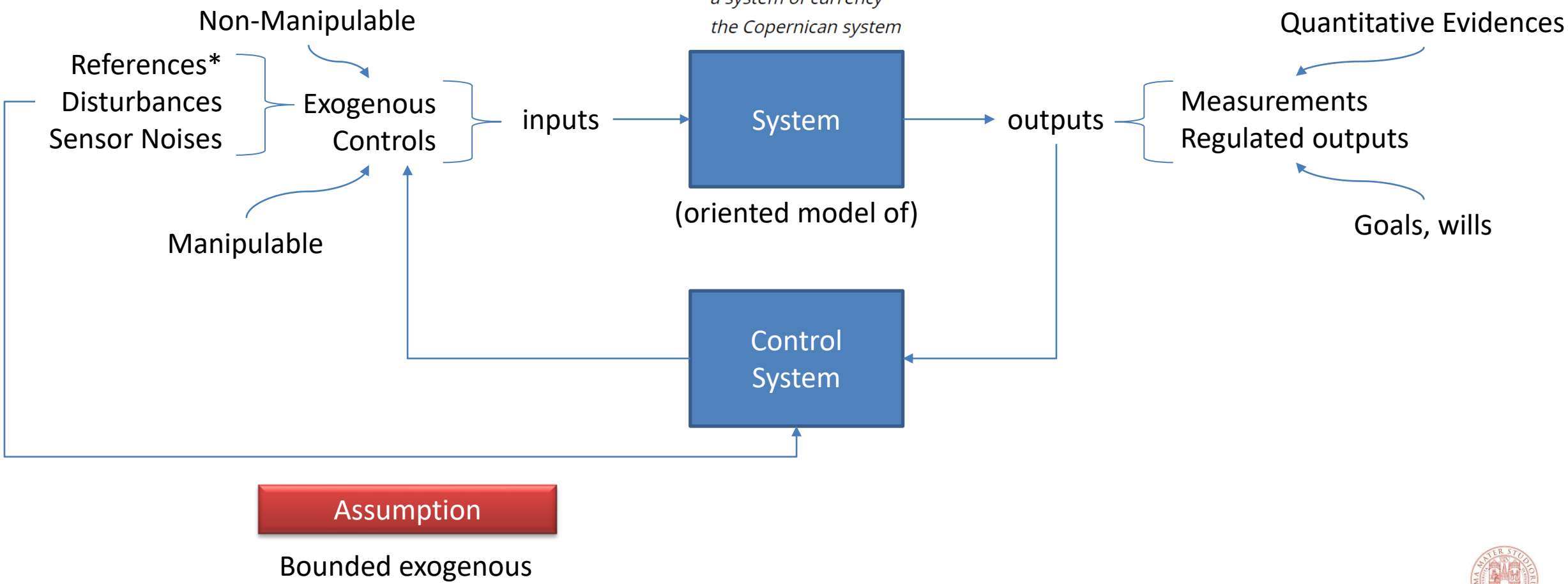

Assumption

Bounded exogenous

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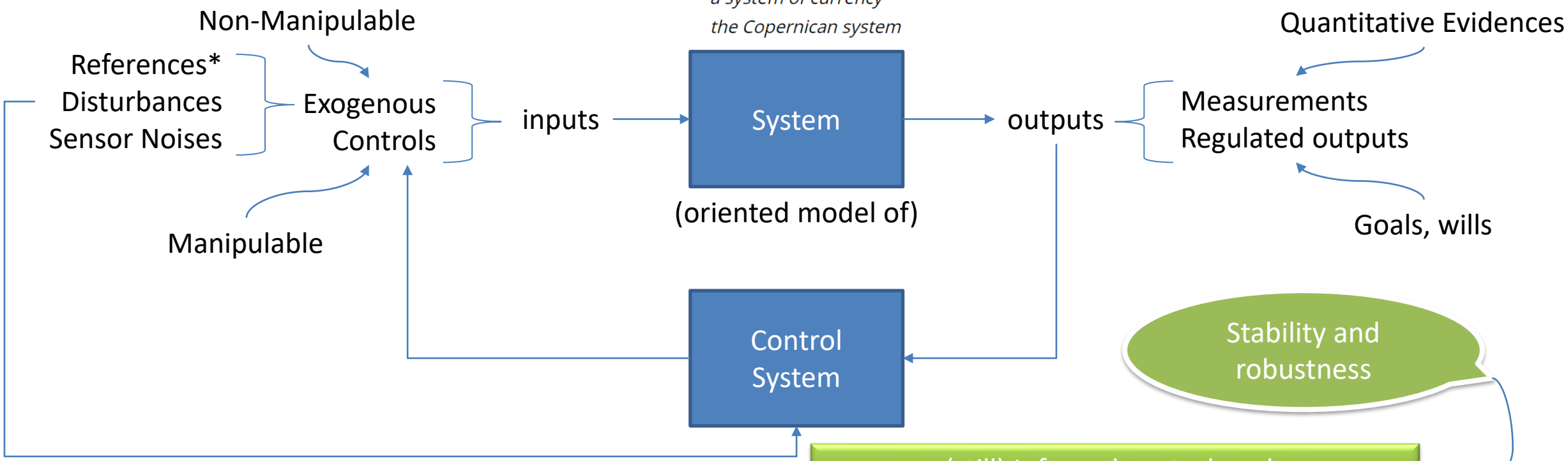

Assumption

Bounded exogenous

(still) Informal control goals

1) **Boundedness**: through a bounded control law keep bounded all the remaining signals
2) **Performance**: let the regulated outputs behave as the references

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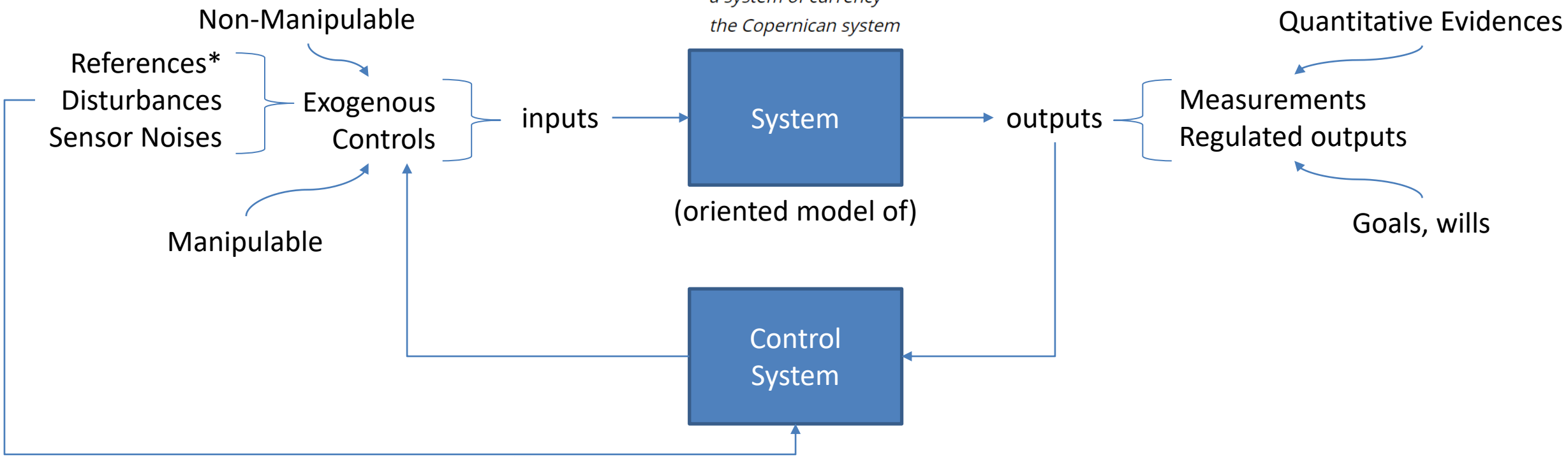

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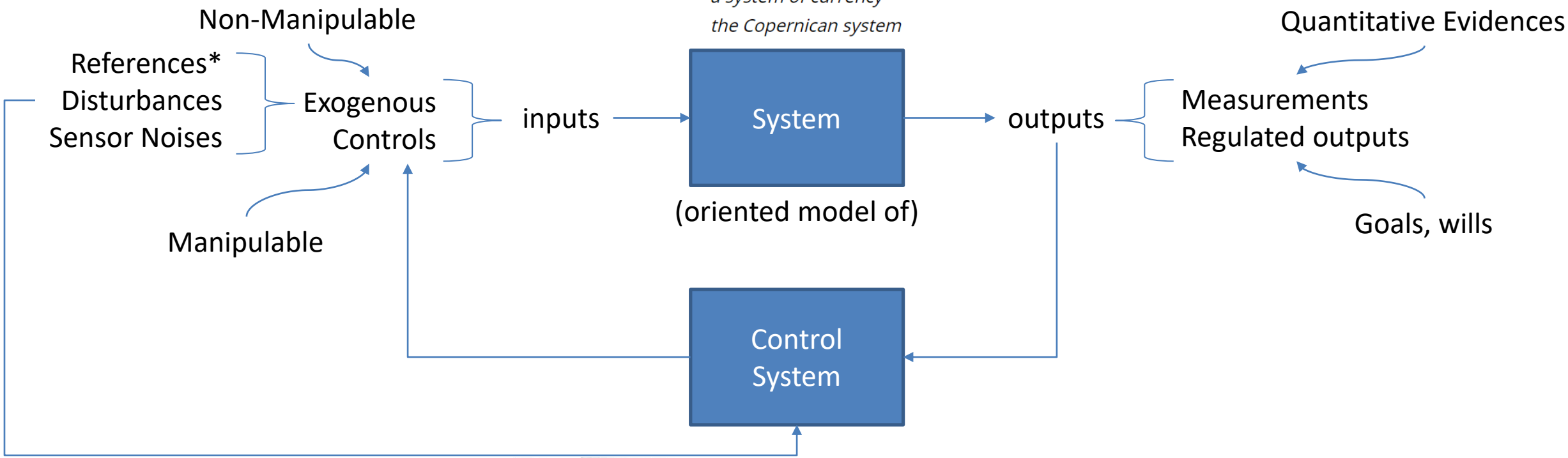

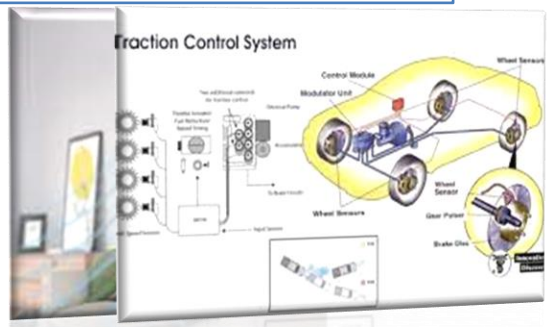

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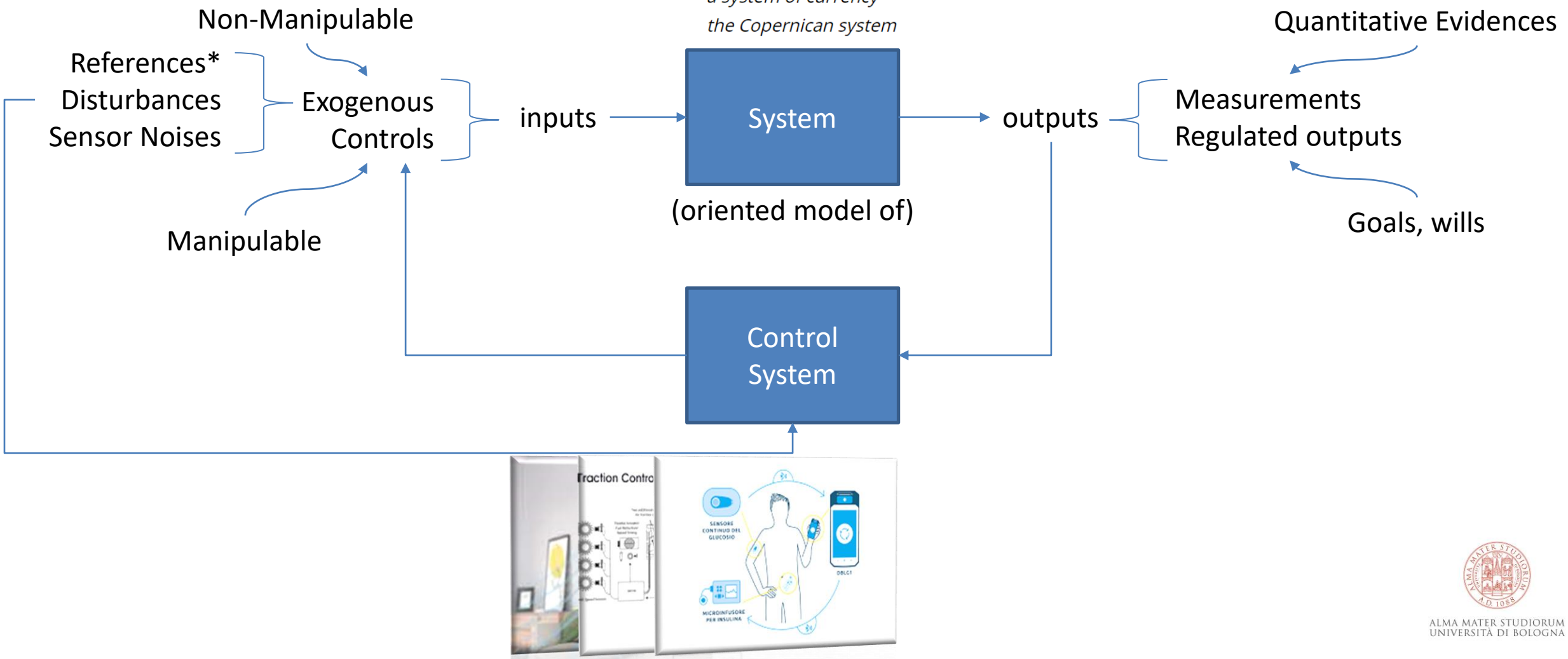

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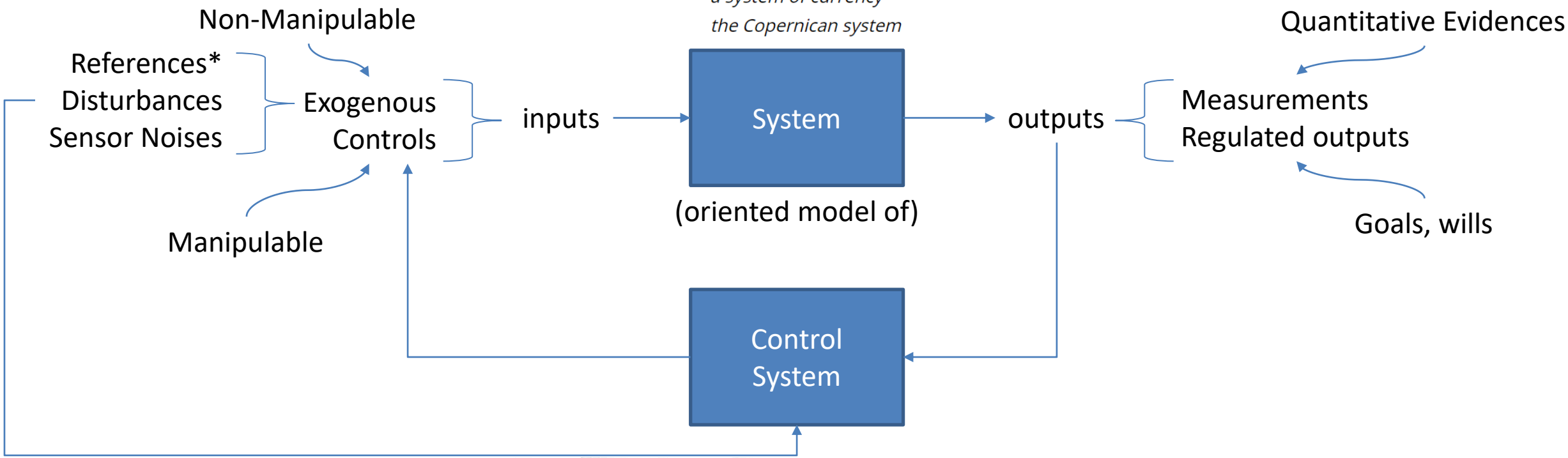

ALMA MATER STUDIORUM
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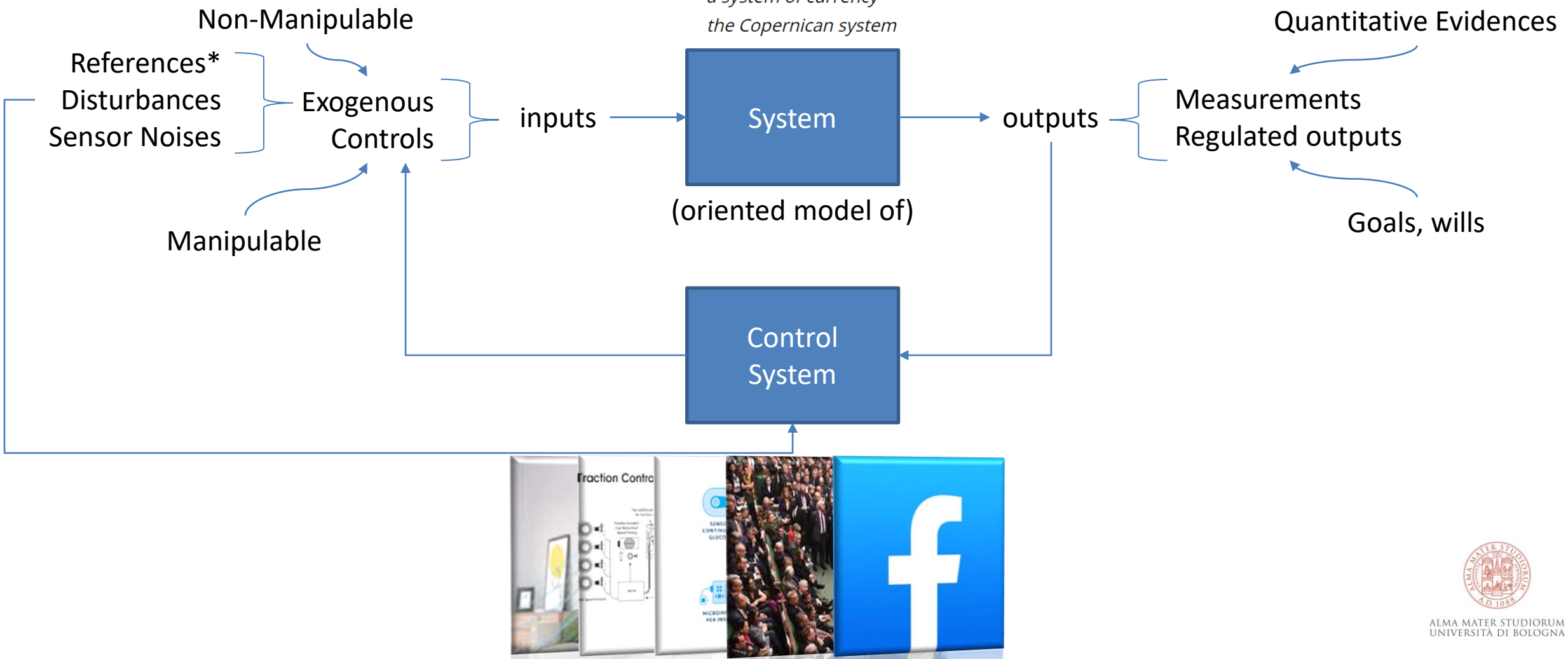

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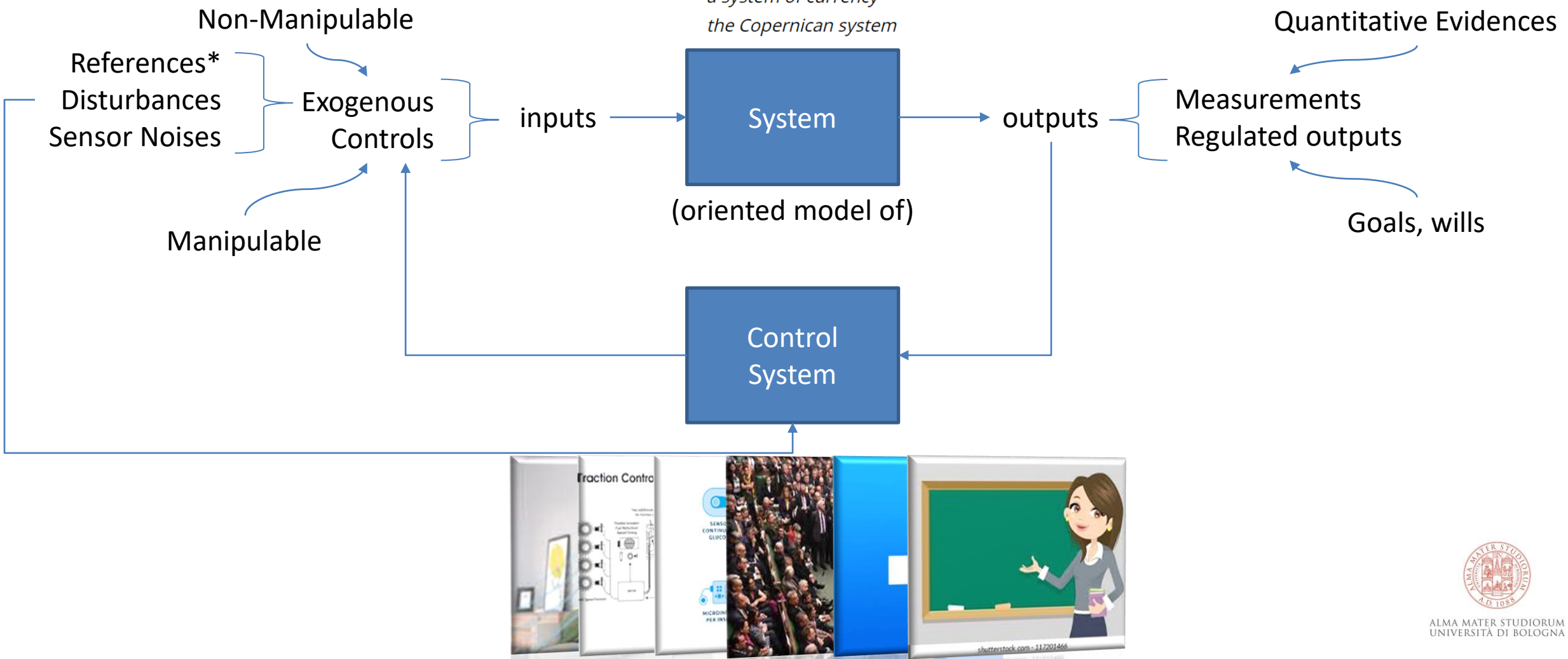

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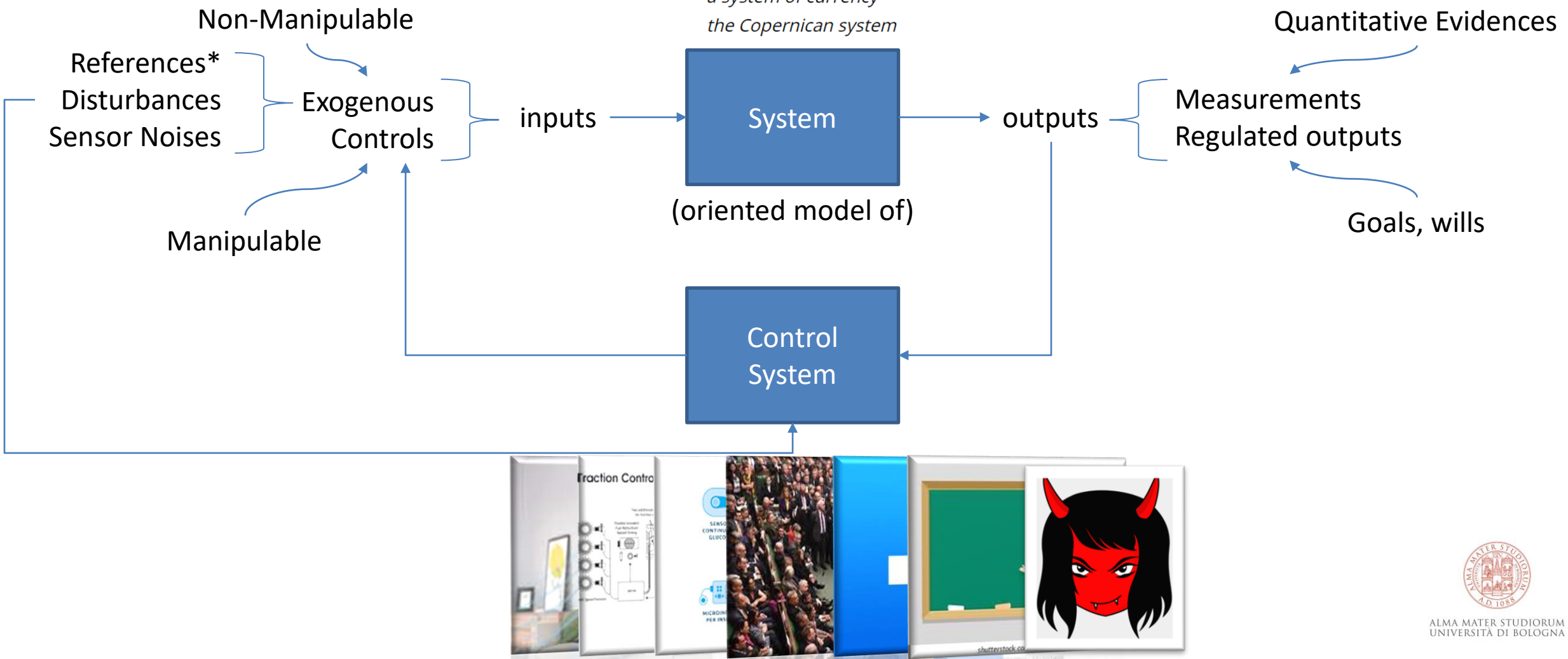

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Why automatic controls?

Help humans

- Support in heavy and repetitive tasks

Why automatic controls?

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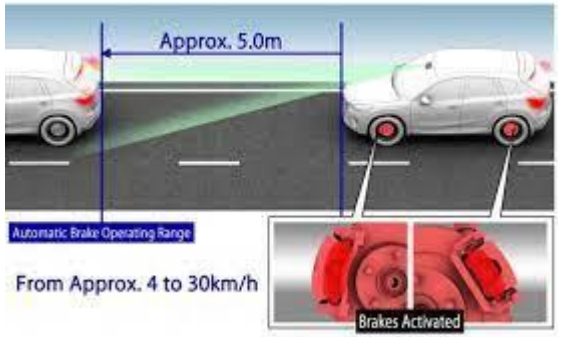

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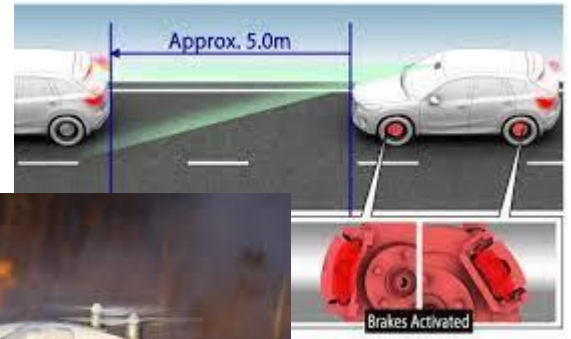
Substitute Humans

- Precision tasks



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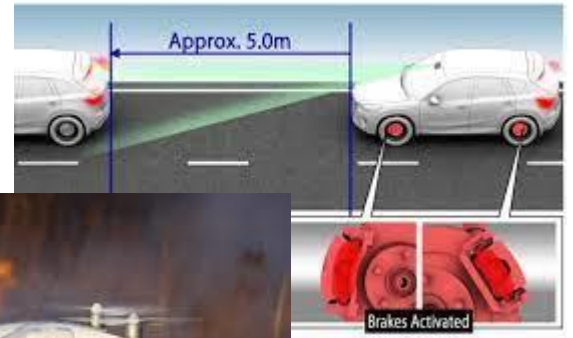

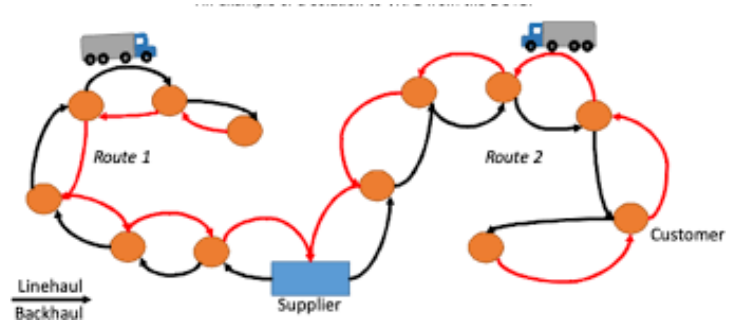

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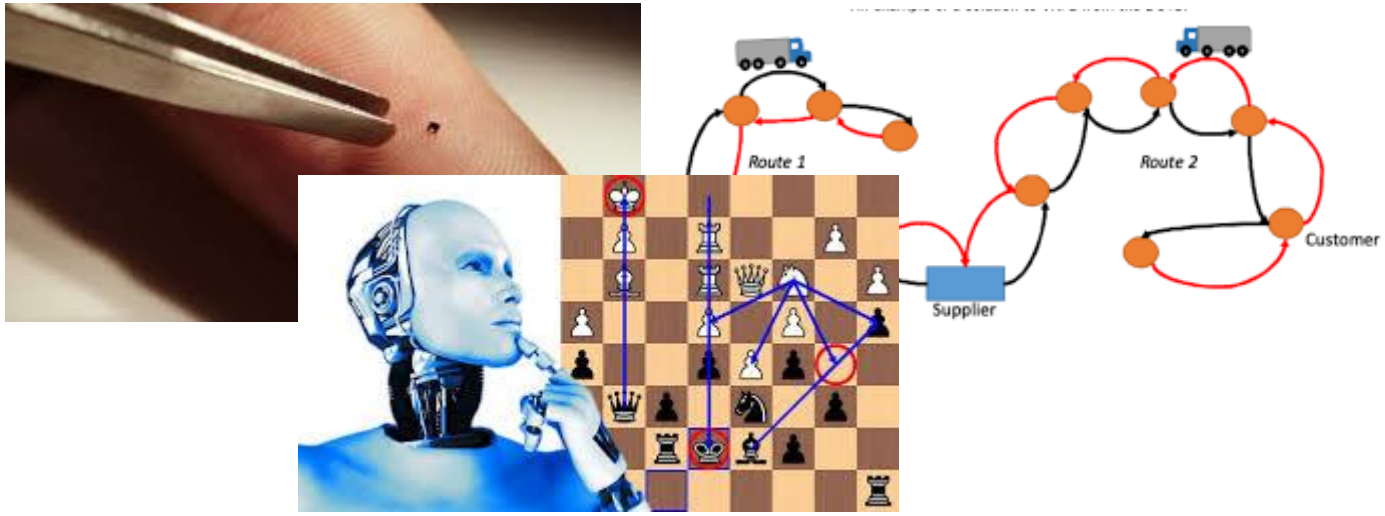

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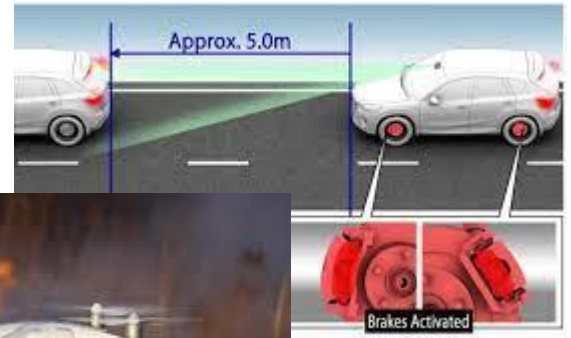

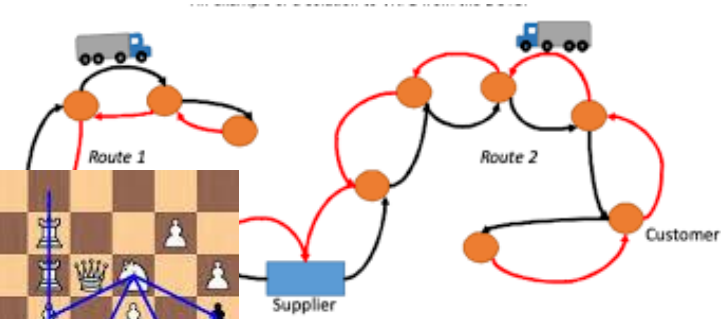

Curiosity

Nowadays, the majority of automatic control systems are implemented through electronics.

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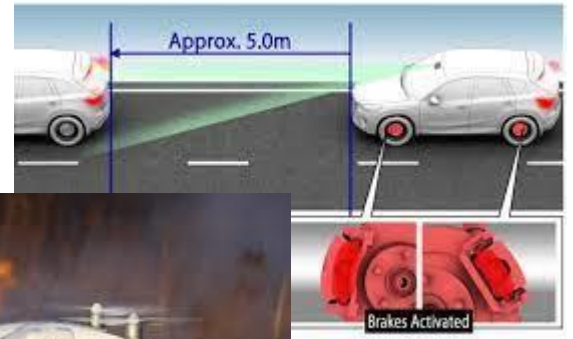

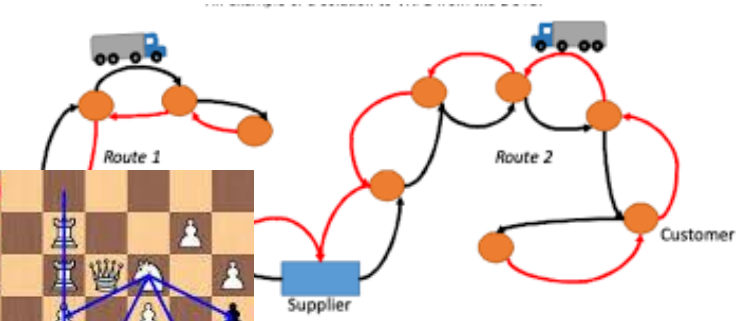

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Nowadays, the majority of automatic control systems are implemented through electronics.

So, no electronics, no party!

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Automatic control architecture: humans revealed!

Let's experimentally build it together

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Let's experimentally build it together: catch a fly!

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1st step: identify the oriented model of the system

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1st step: identify the oriented model of the system

inputs → System
muscles + hand + fly + eye → Fly's and hand's position
Distance = 0

Quantitative Evidence → Fly's and hand's position

Goal → Fly's and hand's position

Automatic control architecture: humans revealed!

Let's experimentally build it together: catch a fly!

1st step: identify the oriented model of the system

Non-Manipulable

Fly's trajectory

Electrical stimuli

Manipulable

System

muscles + hand + fly + eye

Quantitative Evidence

Fly's and hand's position

Distance = 0

Goal

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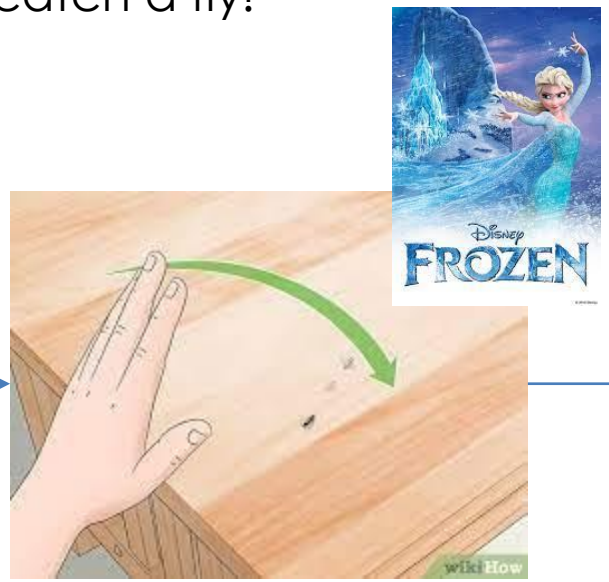
Let's experimentally build it together: catch a fly!

1st test: frozen fly

Non-Manipulable

Fly's trajectory
Electrical stimuli

Manipulable



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Hand's position

Feed-back

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Automatic control architecture: humans revealed!

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2nd test: lazy fly

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Let's experimentally build it together: catch a fly!

2nd test: lazy fly

0.75 speed

Non-Manipulable

Fly's trajectory
Electrical stimuli

Manipulable

System
muscles + hand + fly + eye

Quantitative Evidence

Fly's and hand's position
Distance = 0

Goal

Bounded computational speed

Hand's position

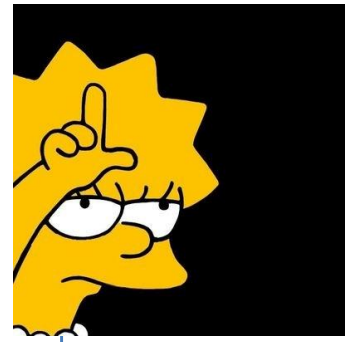
Feed-back

Fly's position

Automatic control architecture: humans revealed!

Let's experimentally build it together: catch a fly!

3rd test: normal fly



Automatic control architecture: humans revealed!

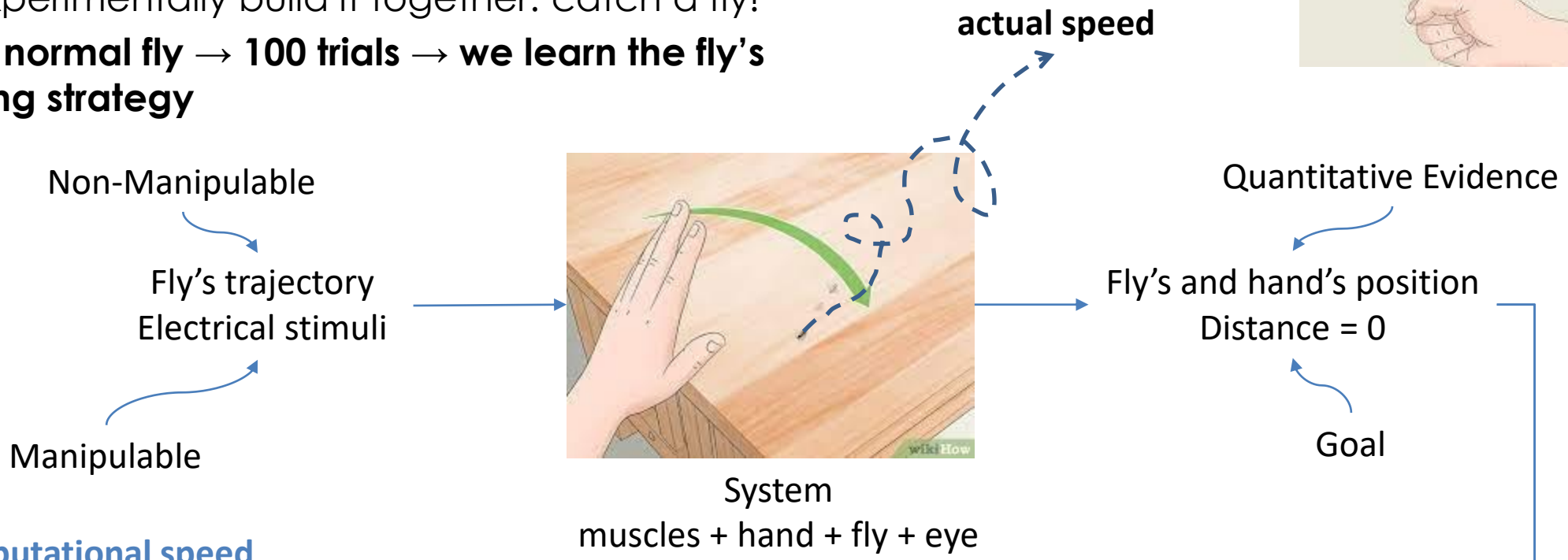
Let's experimentally build it together: catch a fly!

4th test: normal fly → 100 trials

Automatic control architecture: humans revealed!

Let's experimentally build it together: catch a fly!

4th test: normal fly → 100 trials → we learn the fly's escaping strategy



Automatic control architecture: humans revealed!

Let's experimentally build it together: catch a fly!

4th test: normal fly → 100 trials → we learn the fly's escaping strategy → we foresee the future

Non-Manipulable

Fly's trajectory
Electrical stimuli

Manipulable

actual speed

System
muscles + hand + fly + eye

Quantitative Evidence

Fly's and hand's position
Distance = 0

Goal

Bounded computational speed

Hand's position

Feed-back

Fly's position

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Performance

Feed-forward

Stability & Robustness

Feed-back

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Fly's position

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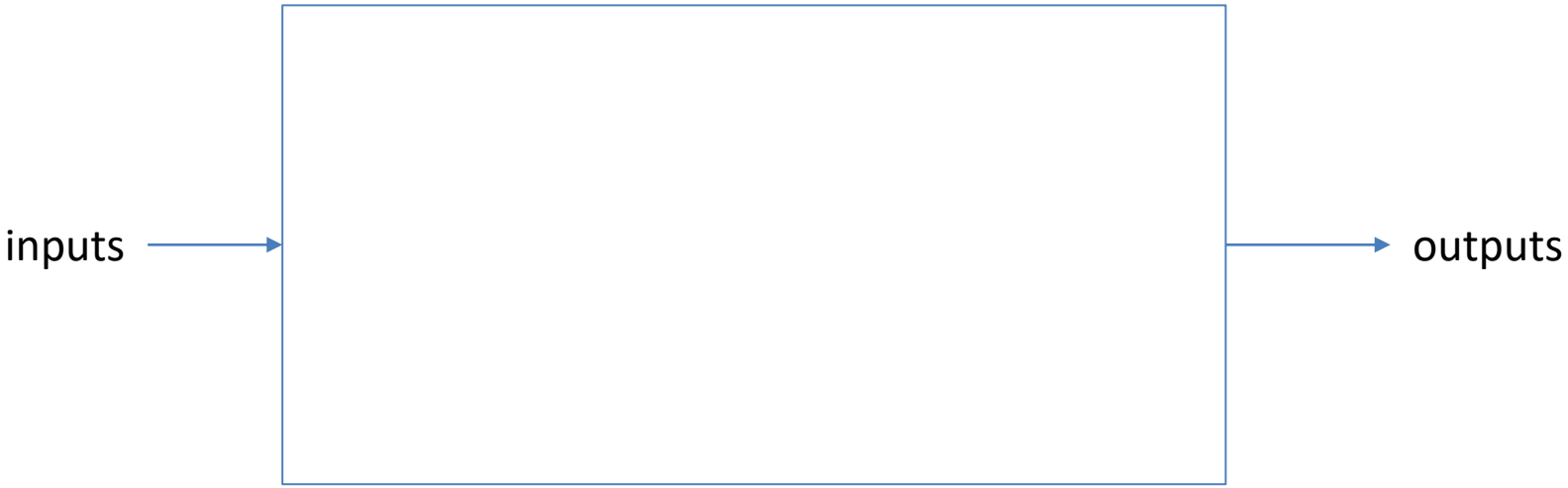
Automatic control theory: a live coach

Can we always reach our goals?

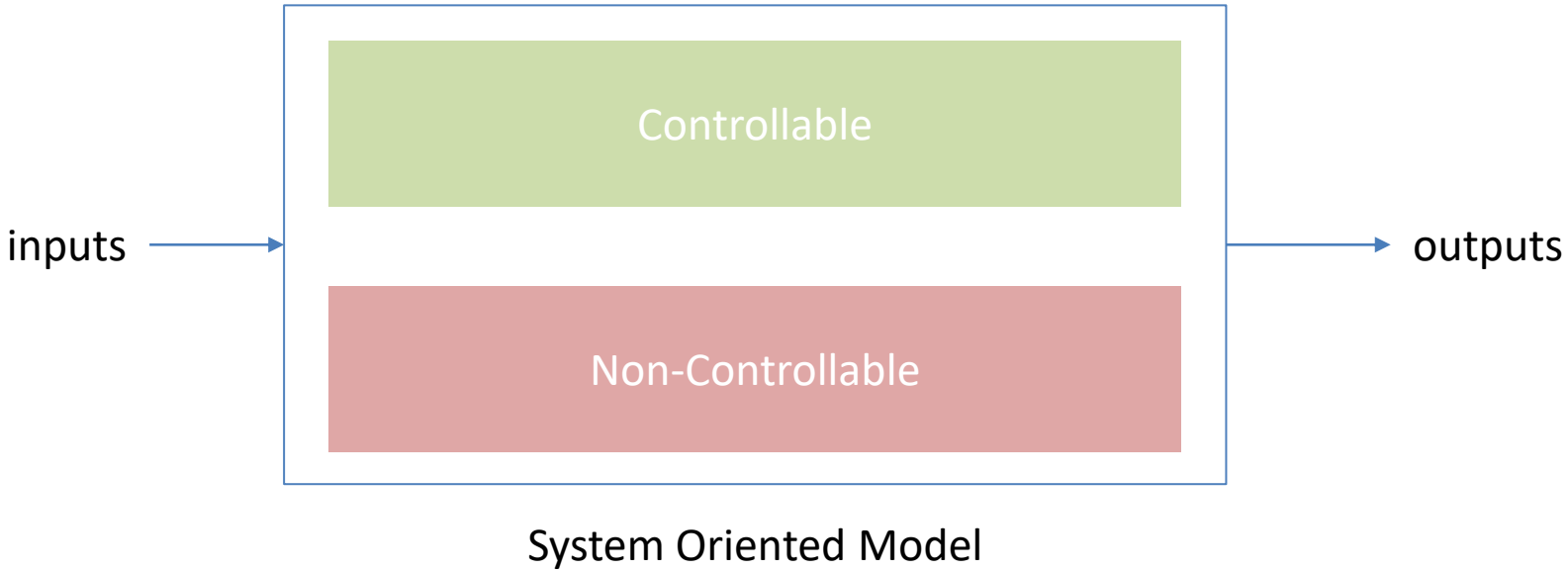


System Oriented Model

Automatic control theory: a live coach

"You can't control everything"

Can we always reach our goals?



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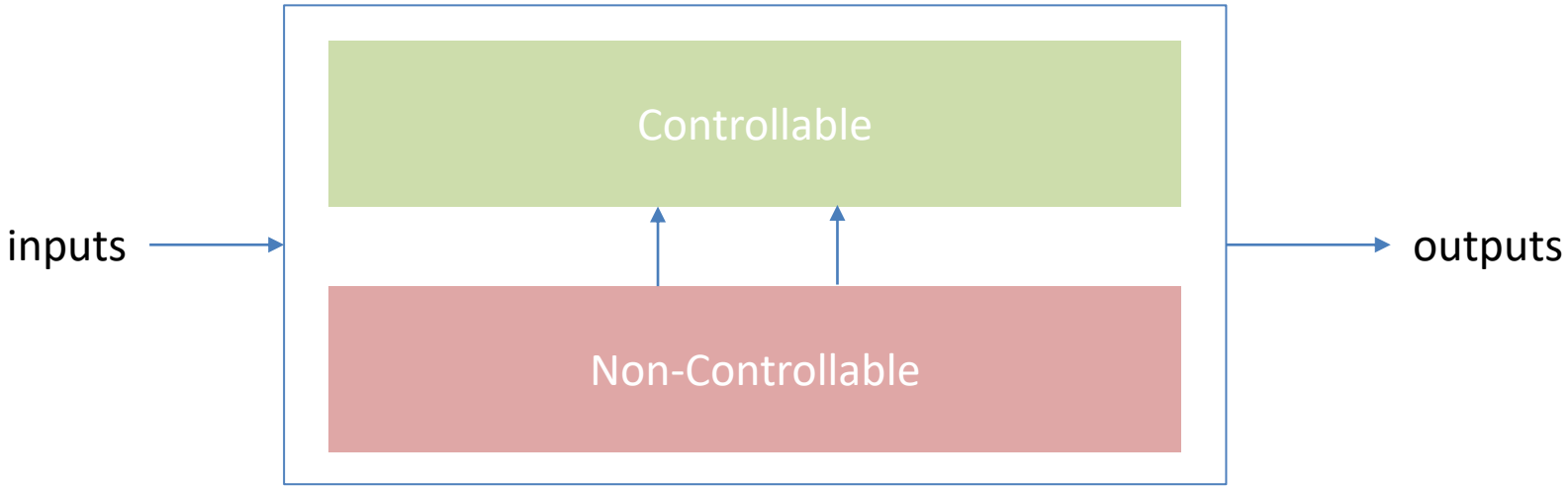

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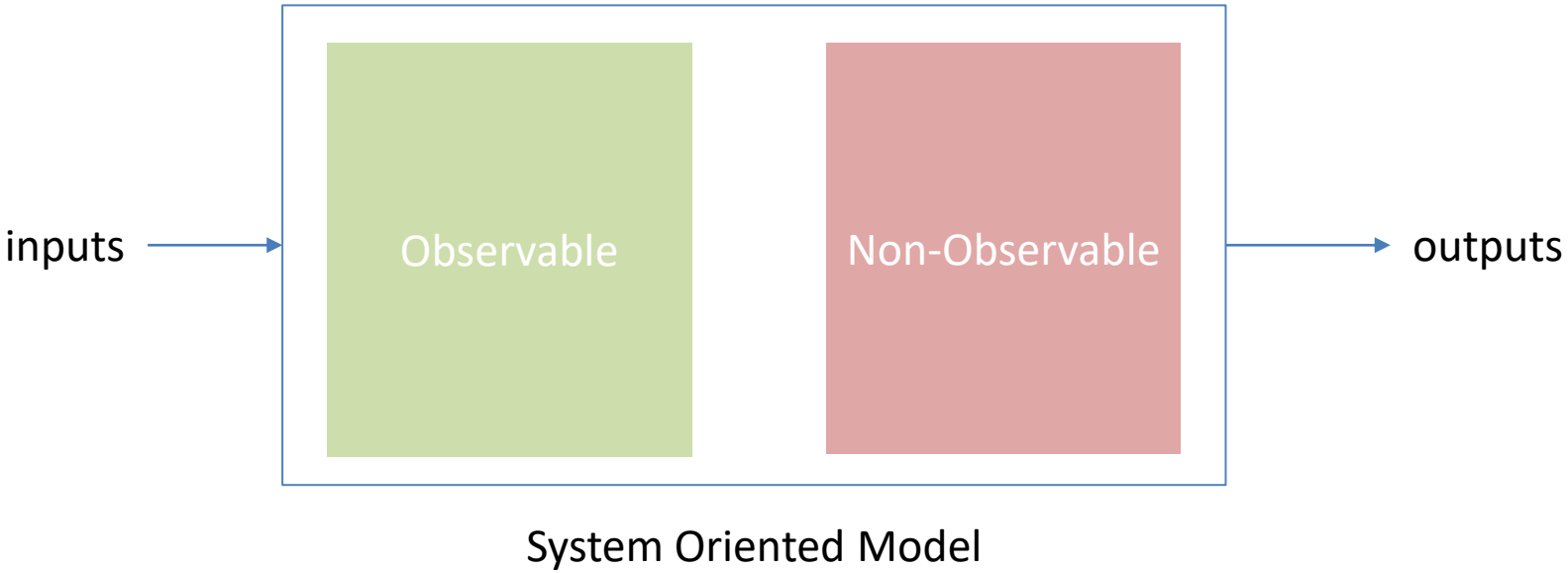

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"There are phenomena you don't know"

Automatic control theory: a live coach

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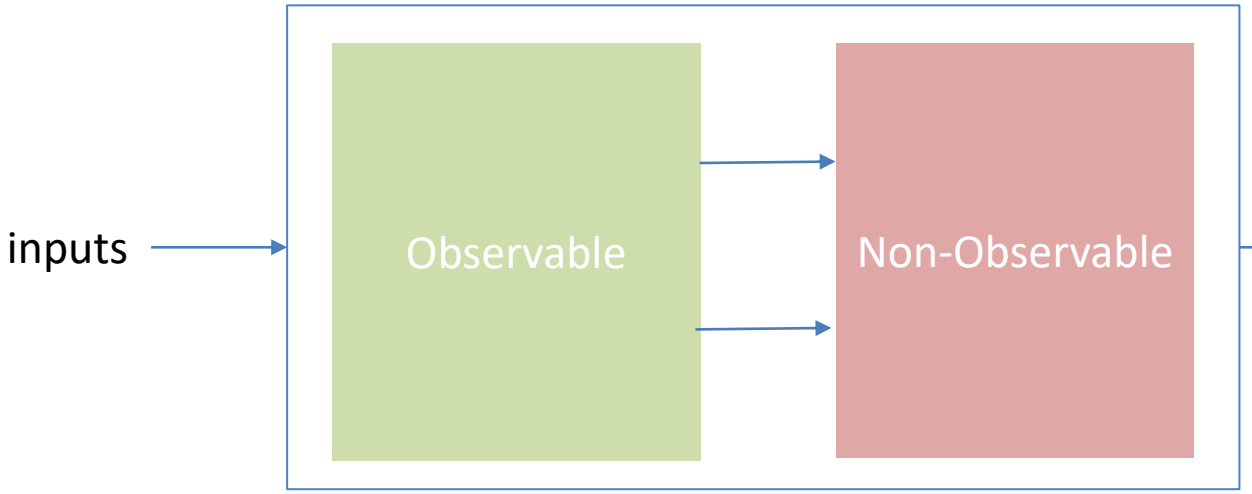

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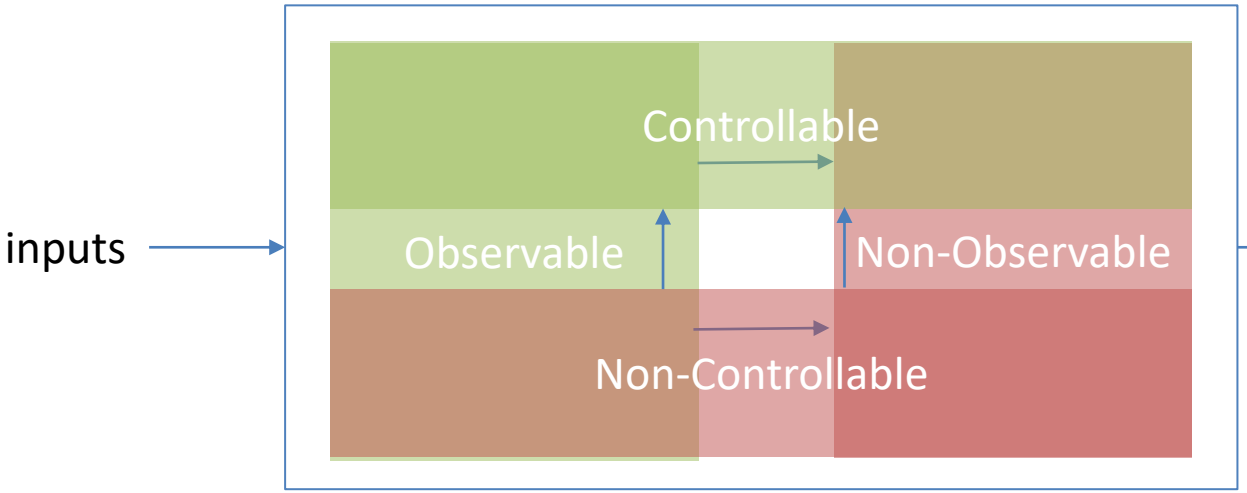

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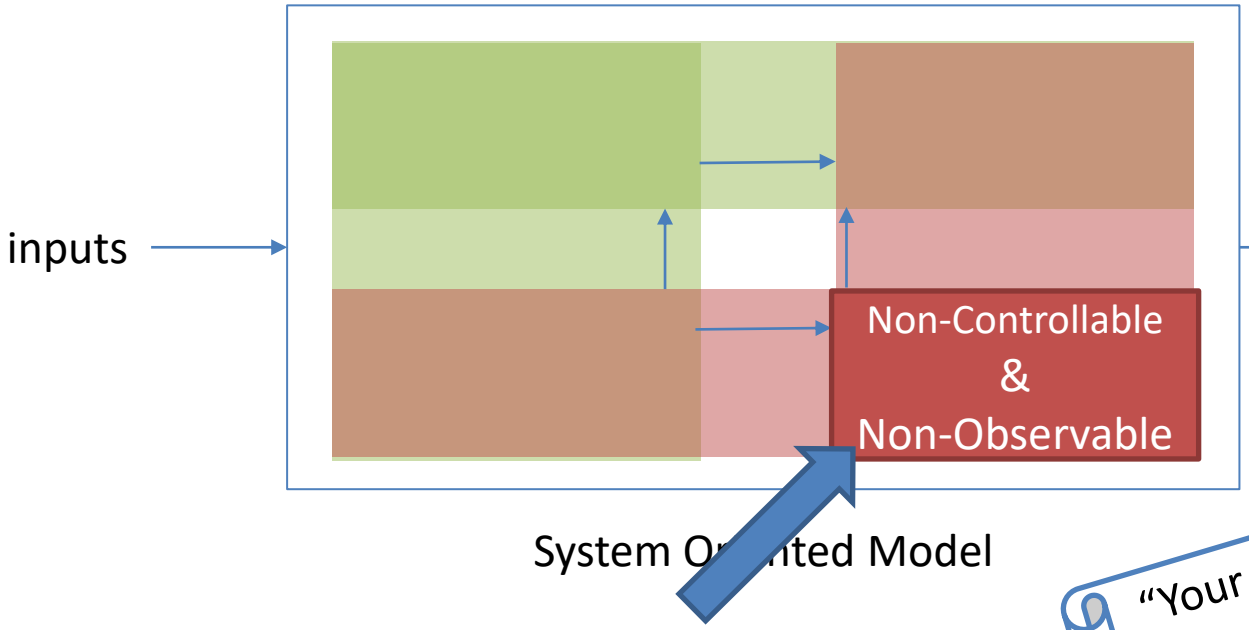

"Your actions may have consequences you don't see"

"There are phenomena you don't know"

You don't know there is a problem and you can not solve it. just don't care!

Automatic control theory: a live coach

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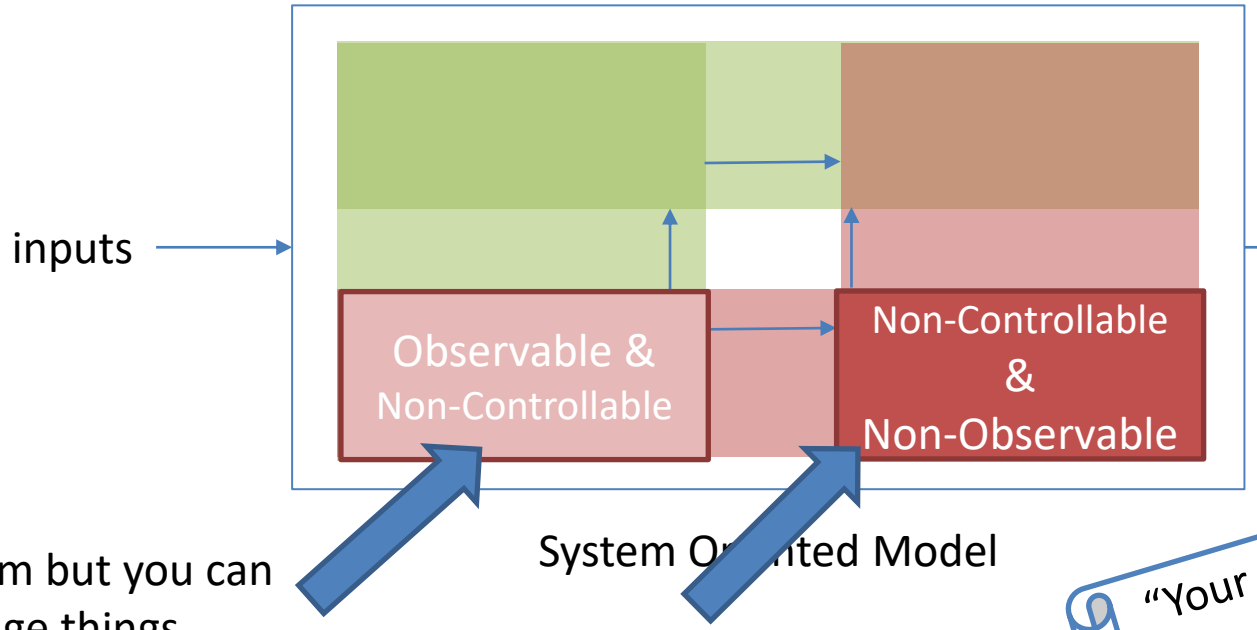
"You can't control everything"

"There is always somebody disturbing you"



You see the problem but you can do nothing to change things.
Just don't care!

You don't know there is a problem and you can not solve it.
just don't care!

"Your actions may have consequences you don't see"

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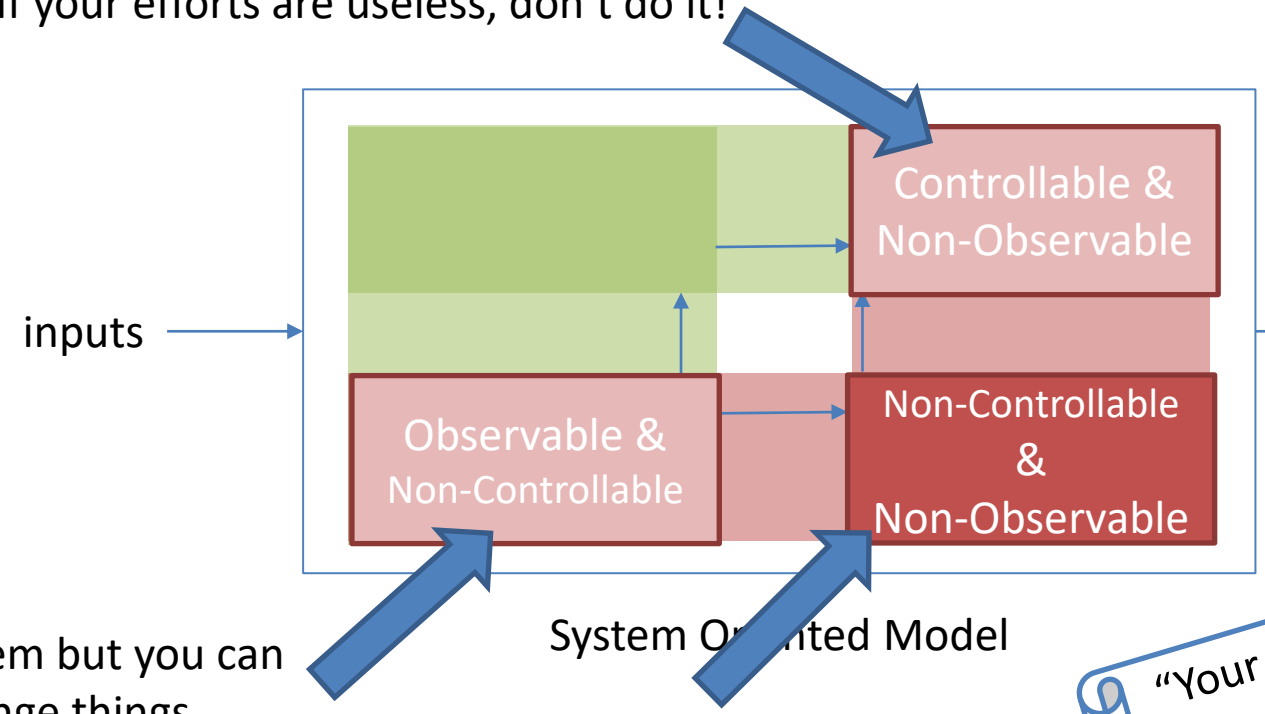
Can we always reach our goals?

If your efforts are useless, don't do it!



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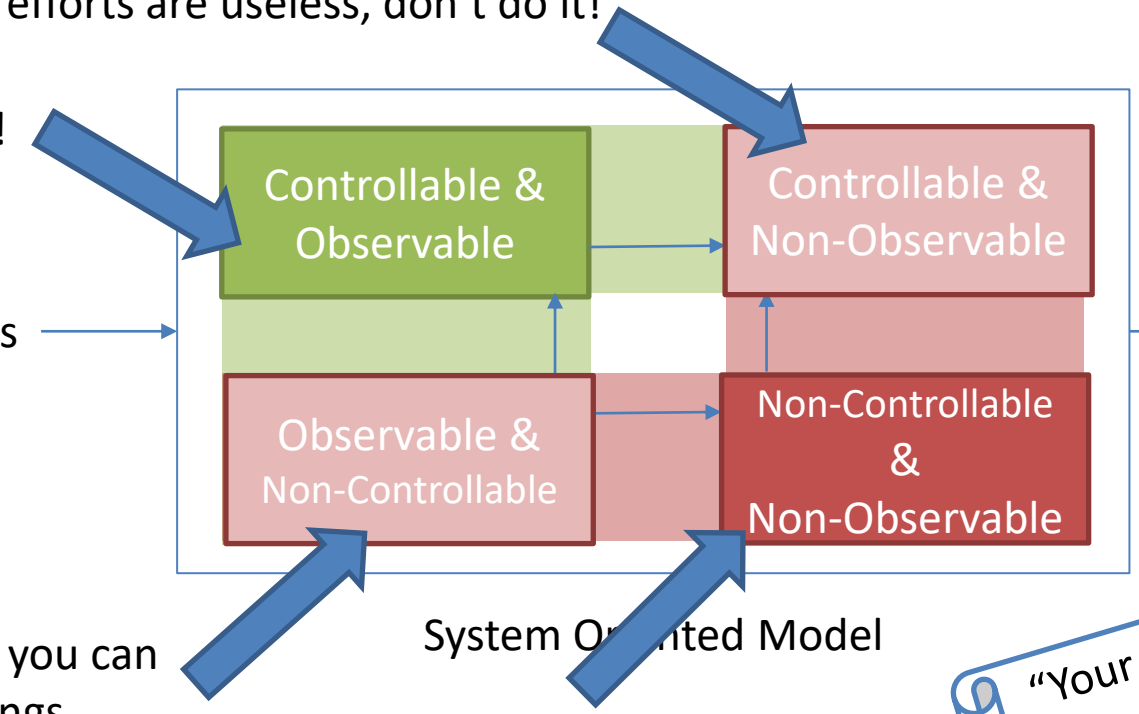
The best we can do!



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Automatic control design: the best compromise

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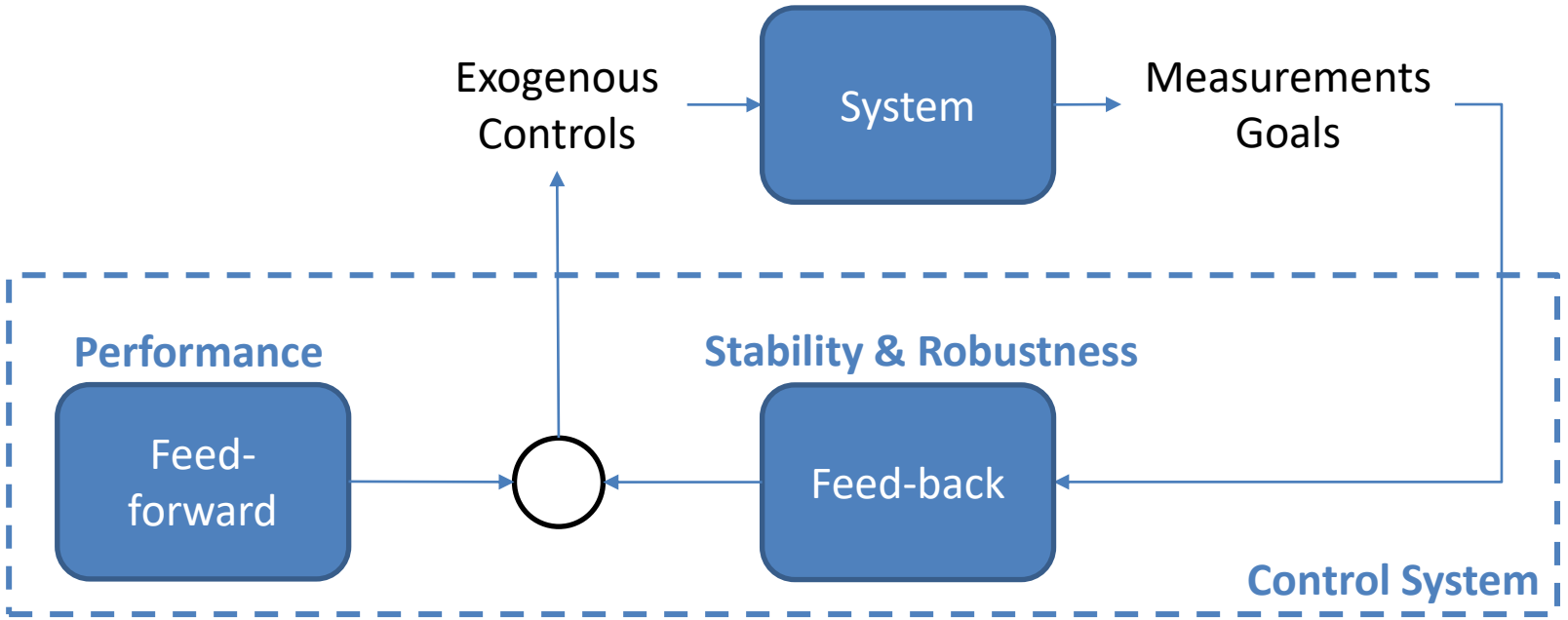

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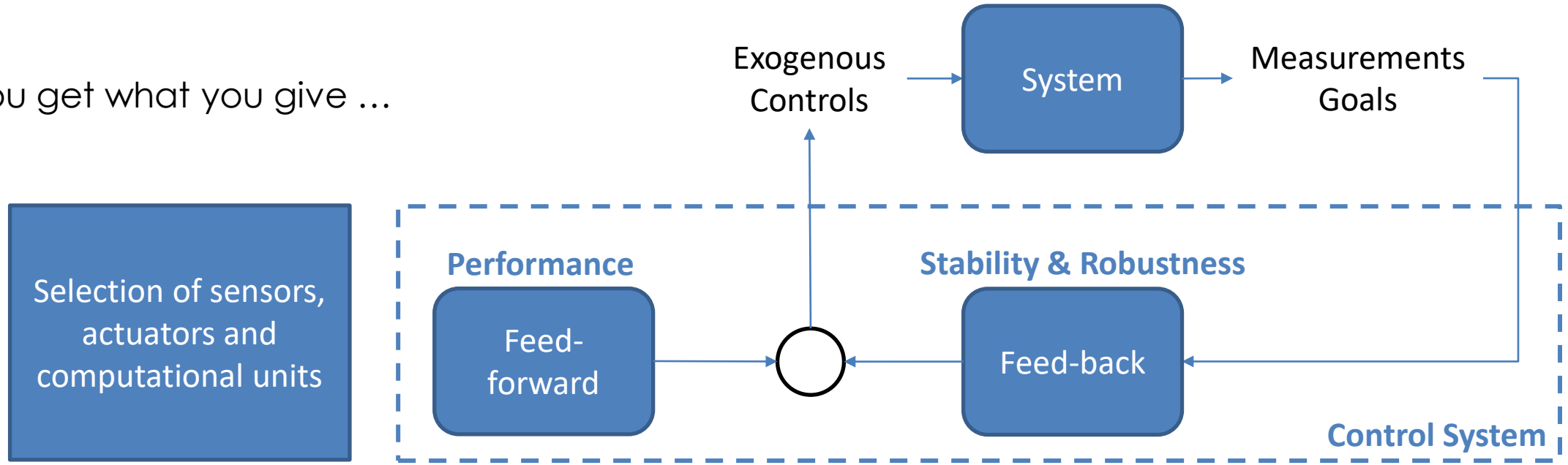

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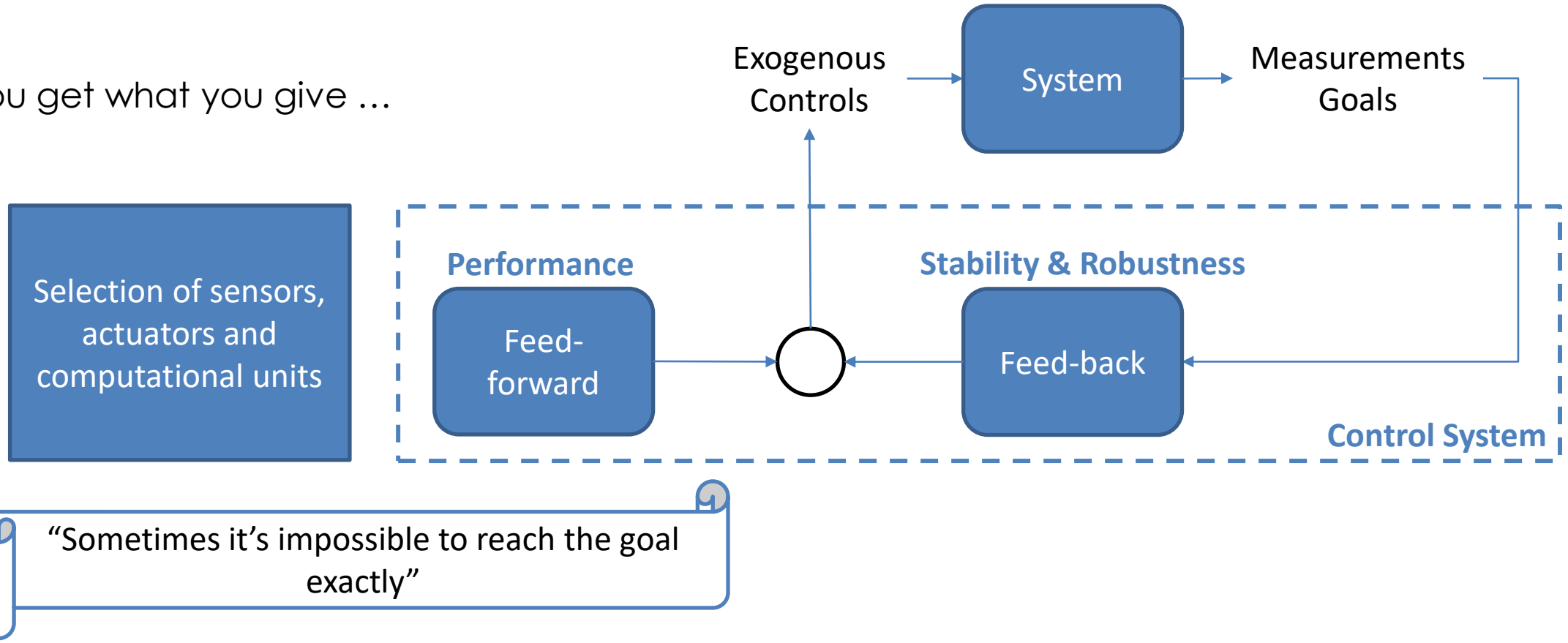

"Sometimes it's impossible to reach the goal exactly"

Automatic control design: the best compromise

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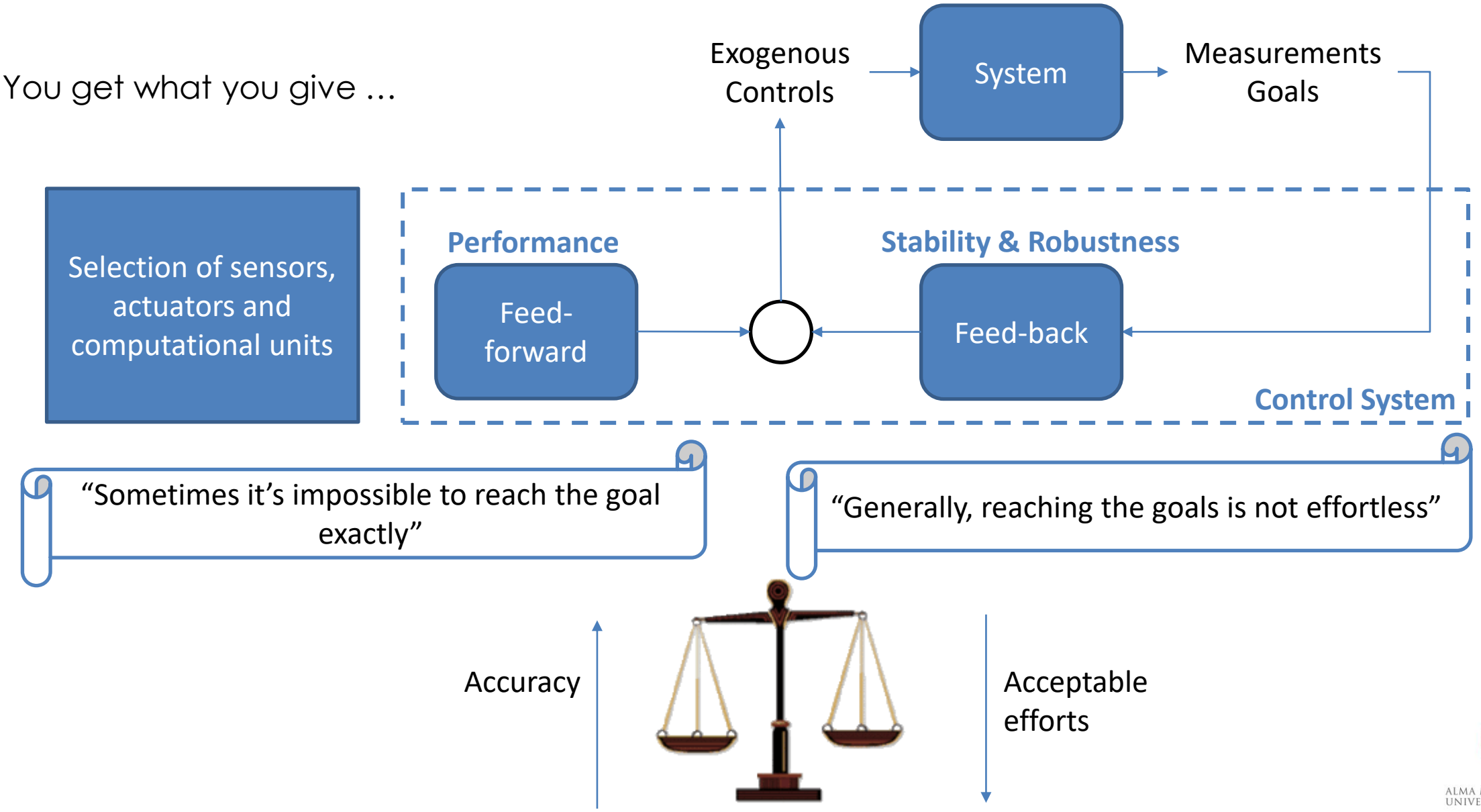

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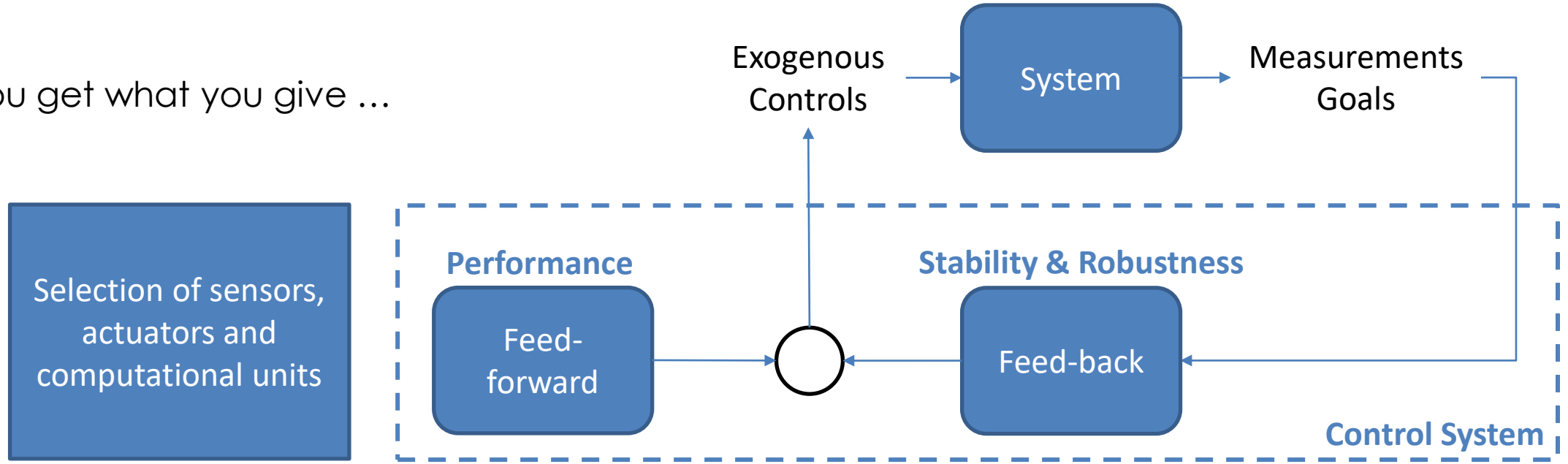

"Sometimes it's impossible to reach the goal exactly"

"Generally, reaching the goals is not effortless"

Accuracy

Acceptable efforts

Automatic control design: the best compromise

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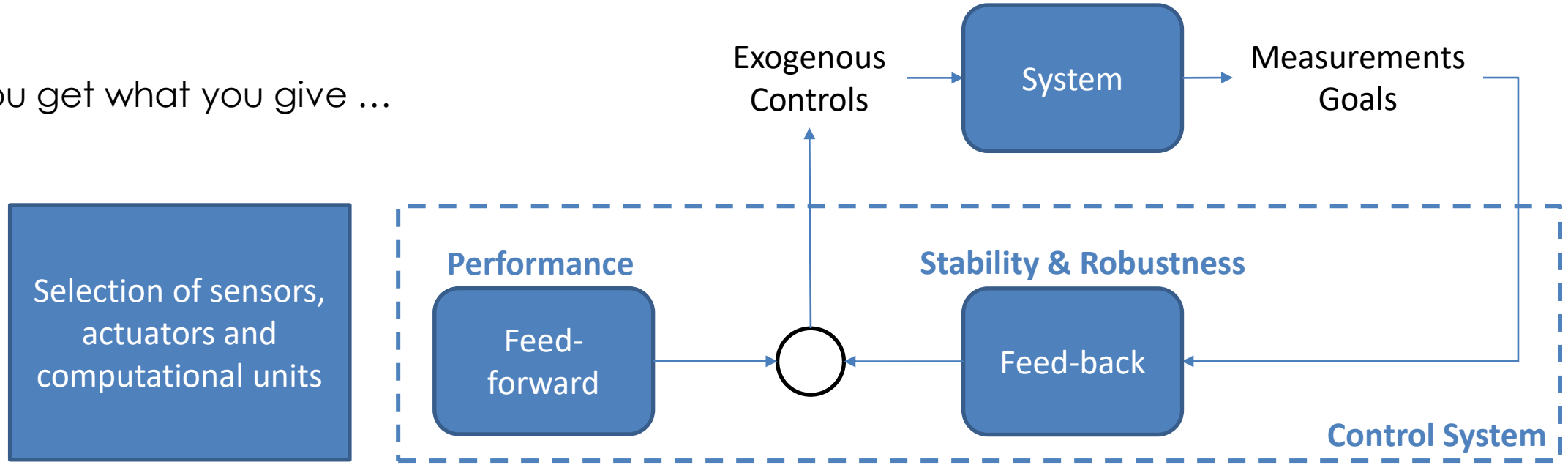

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- Were motivated by human needs
- Are applicable in any context
- Their structure represents the way we reason and act
- They tell us what we can do and when no efforts are needed
- Their components depend on a life-inspired compromise

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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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Department of Electrical, Electronics and Information Engineering «G. Marconi»

nicola.mimmo2@unibo.it