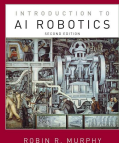
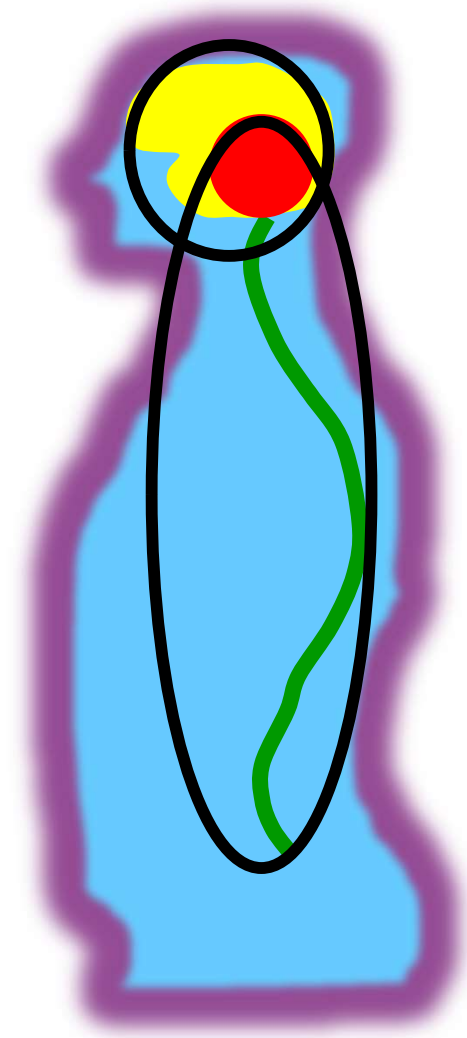
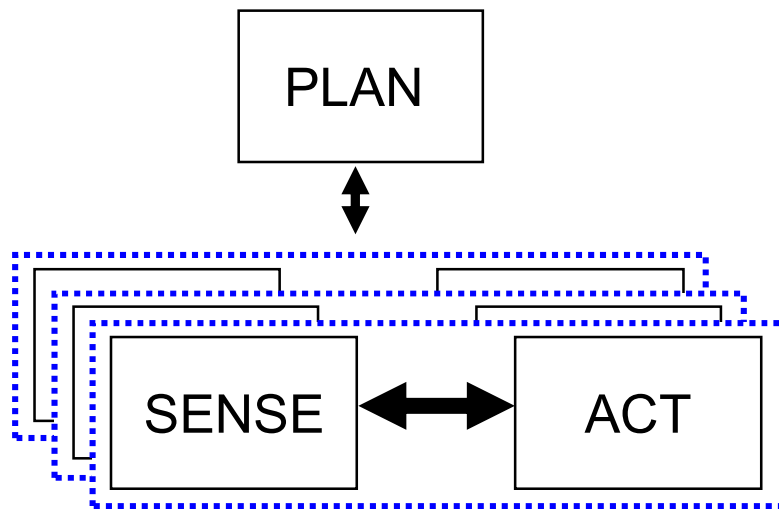


# 4b

## Hybrid Deliberative/Reactive (1990)

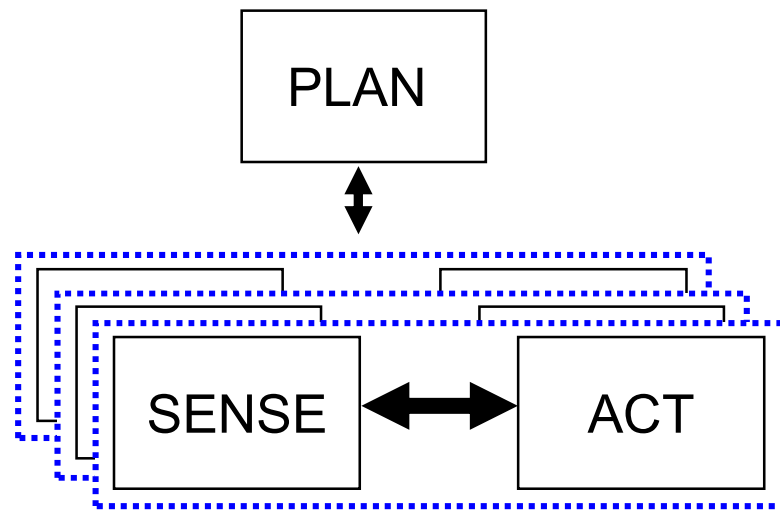
Objectives  
Review  
**System Arch**  
- 5 Subsystems  
- **Paradigms**  
- Hierarchical  
- Reactive  
- **Hybrid**  
Technical Arch  
- evaluating



# 4b

## Hybrid Deliberative/Reactive (1990)

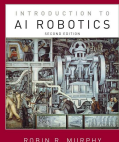
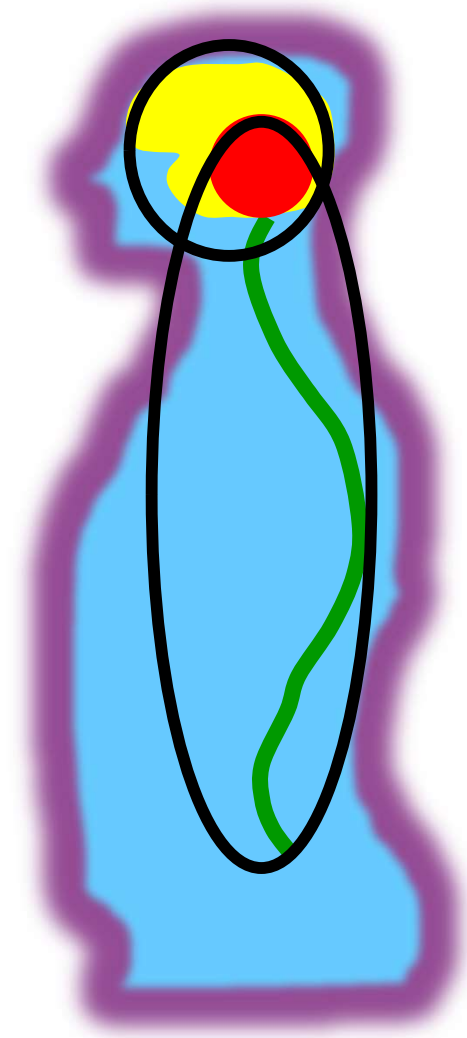
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- evaluating



Control people hated it because no models at the lowest level, but are getting over it

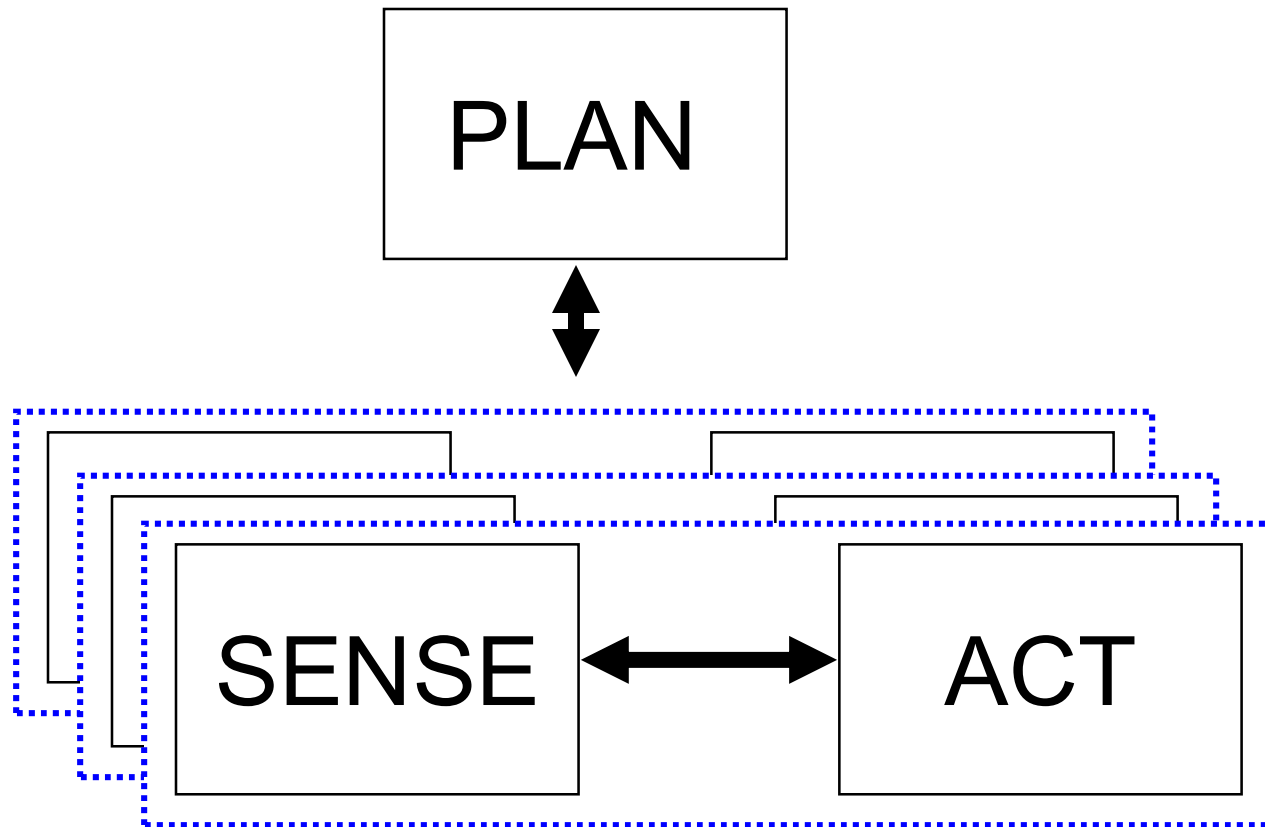
AI people loved it

Users loved it



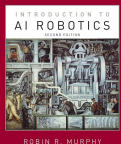
# 4b

## Hybrid Deliberative/Reactive: Plan, then Sense-Act



*Plan, then sense-act until task is complete or need to change;  
Note movement towards event-driven planning rather than continuous*

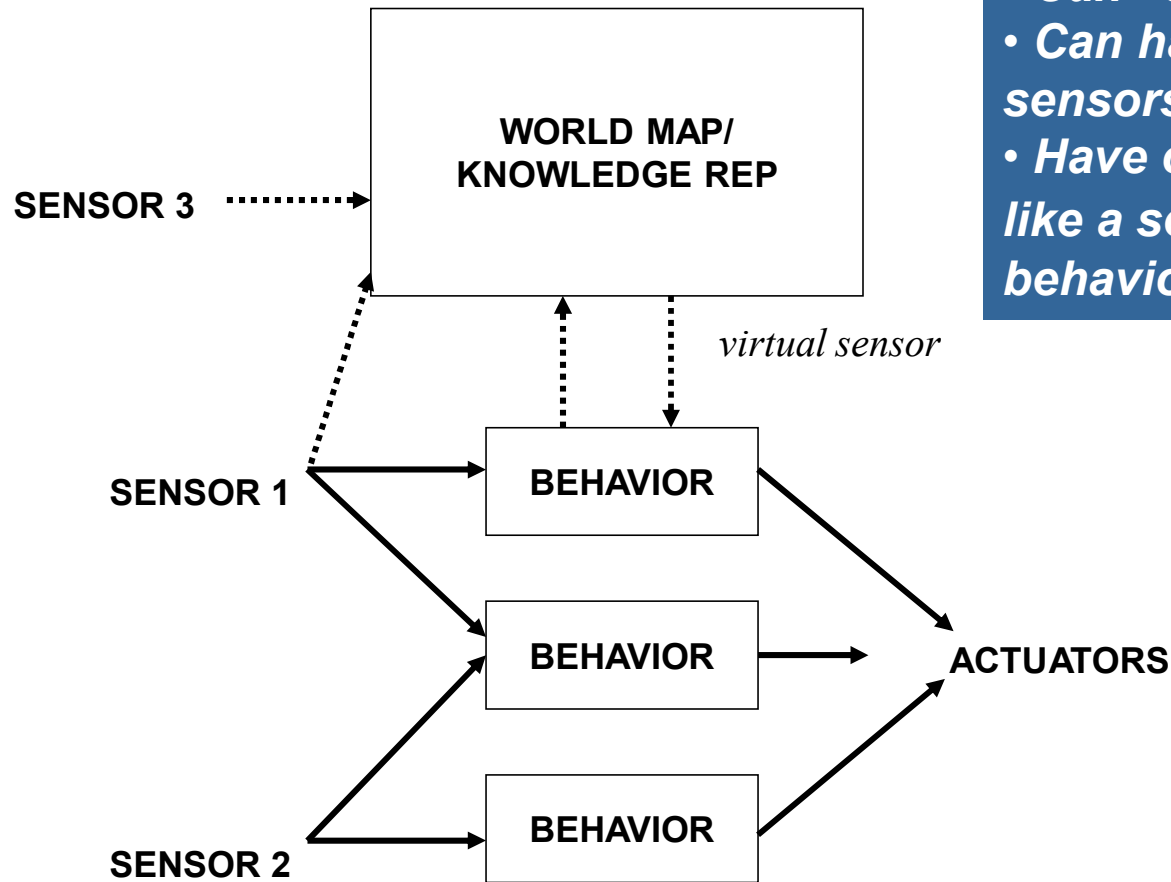
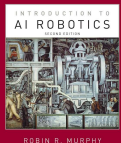
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# 4b

## Hybrid Paradigm: Sensing Organization is Shared

Objectives  
Review  
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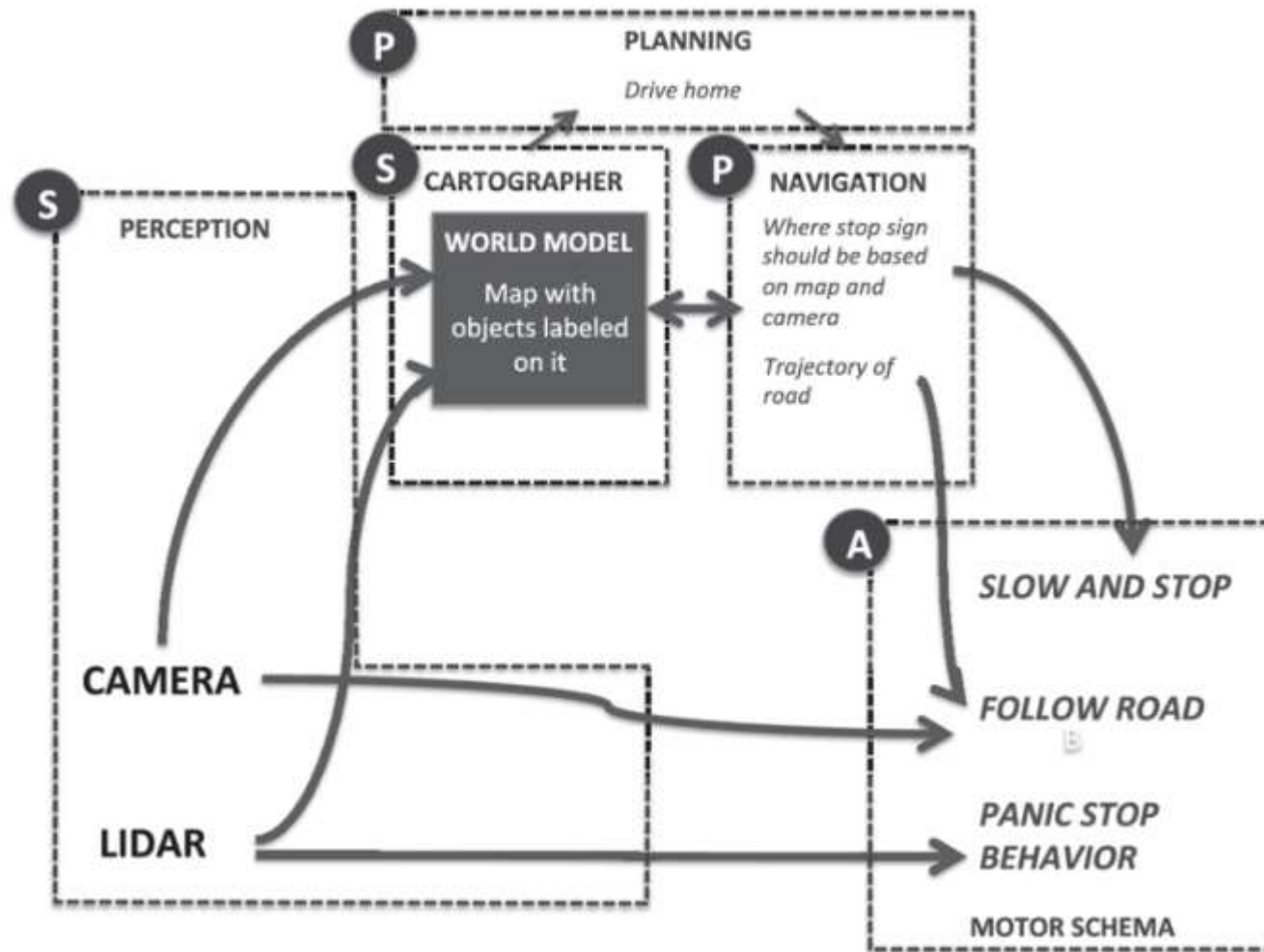
### Deliberative functions

- Can “eavesdrop”
- Can have their own sensors
- Have output which looks like a sensor output to a behavior (virtual sensor)



# 4b

## Example of a Hybrid Systems Architecture for a driverless car.

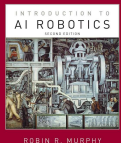


# 4b

## Systems Architecture

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Technical Arch  
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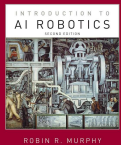
- Systems architectures have evolved around functions (subsystems) and around paradigms
- The hybrid deliberative/reactive paradigm “won” the paradigm wars
  - Most extensible and reusable
  - More modular
- Hierarchical systems are still favored by DoD and NASA because of perceived efficiency and deterministic



# 4b

Objectives  
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**Technical Arch**  
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## WHAT GOES INTO THE TECHNICAL ARCHITECTURE?



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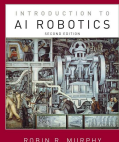


# 4b

## Technical Details...

Objectives  
Review  
System Arch  
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- Hierarchical  
- Reactive  
- Hybrid  
**Technical Arch**  
- evaluating

- Algorithms such as Hough transforms, genetic algorithms, neural networks, path planning, fuzzy logic, scheduling, resource allocation
- Data structures such as potential fields, perceptual spaces, polar plots
- Algorithms for coordination and control of software modules such as island driving, vector summation, subsumption, voting, production rules
- Displays and interfaces such as natural language, gestures



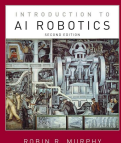


# 4b

## Evaluating the Technical Architecture

- *support for modularity:*
  - decomposition by functionality specified by the systems architecture
- *niche targetability:*
  - Can be adapted to domains
- *ease of portability to other domains:*
  - Infrastructure code should be reusable
- *robustness:*
  - Often neglected beyond reactive system tendency to “do the right thing”

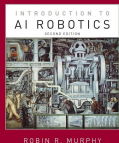
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# 4b

Objectives  
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## SUMMARY AND ADDITIONAL THOUGHTS



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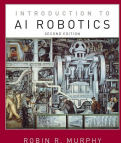


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## Summary: Architectures

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Technical Arch  
- evaluating

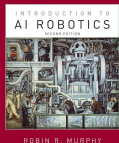
- An architecture is the Big Picture of how to program an intelligent robot.
- “Architecture” in AI robotics is often refers to
  - The *operational architecture* which captures the functionality
    - Three layers
      - Reactive
      - Deliberative
      - Interface
  - The *system architecture* developed by a researcher or research group
    - Three paradigms for the *system architecture*
      - Hierarchical
      - Reactive
      - Hybrid deliberative/reactive
  - The *technical architecture*, usually a novel technique such as potential fields



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## Summary

- The operational and system architecture influences the technical architecture
- What are the subsystems in a system architecture?
  - Navigation (Generating)
  - Cartographer, World Model, World Map (World Model)
  - Planning (Generating mission, Implementing, Selecting, Monitoring)
  - Motor Schemas, Behaviors (executing motor commands)
  - Perception, Sensing, Perceptual Schemas (executing sensor input)
  - *BUT THIS IS NOT ALL THAT IS NEEDED OR POSSIBLE*
- What goes into a technical architecture?
  - Specific algorithms, control/coordination, knowledge structures



# 4b

## Next Lecture

- So far- AI is good with symbols (deliberative) and good with skills (reactive) and has ignored people (interface) - it's the conversion of sensor data "in the middle" that is holding up progress
- Telesystems
  - How do we put people "in the loop" to compensate for the problems in converting sensor data to symbols, i.e., telesystem as a workaround?
  - How intelligent does a robot need to be for people who want to work remotely through it, such as for telecommuting, telemedicine, surveillance, etc., i.e., telesystem for remote presence?

