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# Using social sciences to enhance the realism of simulation for complex urban environments


**THALES SOLUTIONS ASIA**
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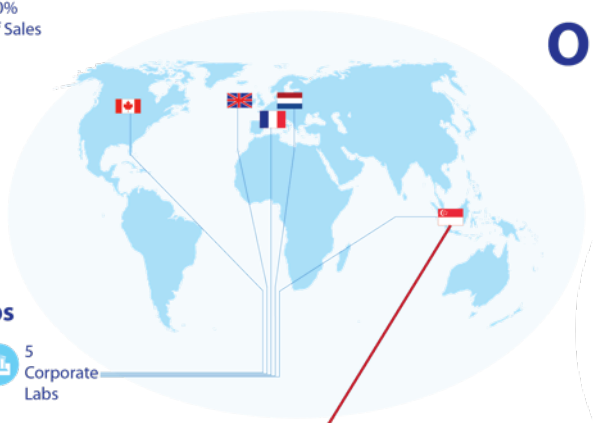
# Background – About us

## Research & Development Worldwide

24,000 People | >600 Experts | 15,000 Patents | 20% of Sales

Targeted Vertical Market Groups

Defence | Security | Avionics | Space | Transport



## The Thales Research & Technology Labs

400 Staffs | 50 PhDs | 10 Joint Labs | 5 Corporate Labs

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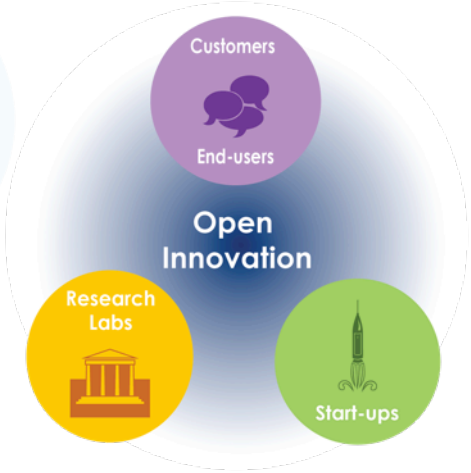
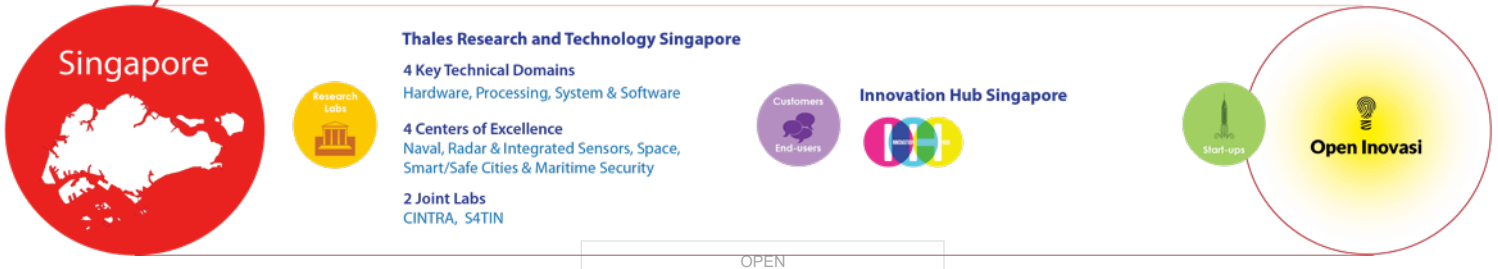
## Open Innovation




OPEN

# Background – Why this topic?

# Problem Statement

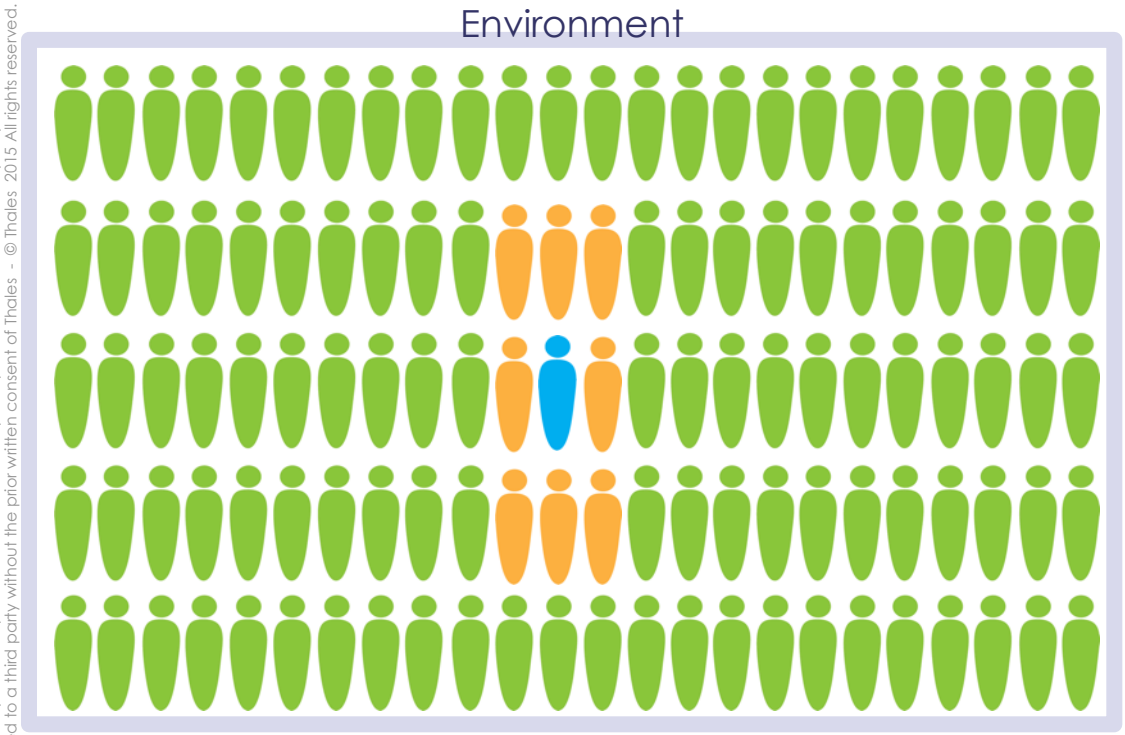
## Crowd Simulation

- full flexibility to conduct testing without affecting anyone in the real world
- interest
  - flow of crowd
  - crowd interaction with the environment

## Realism of the behavioral models?

- observation vs simulation
- context
- population

# Social Sciences




"**social scientists** have developed a number of **tools and approaches** that can **help technology builders** determine the effects of their work. **Links between engineers and social scientists** can go a long way toward developing an **understanding of context, visualizing where certain paths** might lead, and achieving the highest goal of engineering"

Wetmore, J. M.: The value of the social sciences for maximizing the public benefits of engineering. Bridge, 42(3) (2012), 40-45







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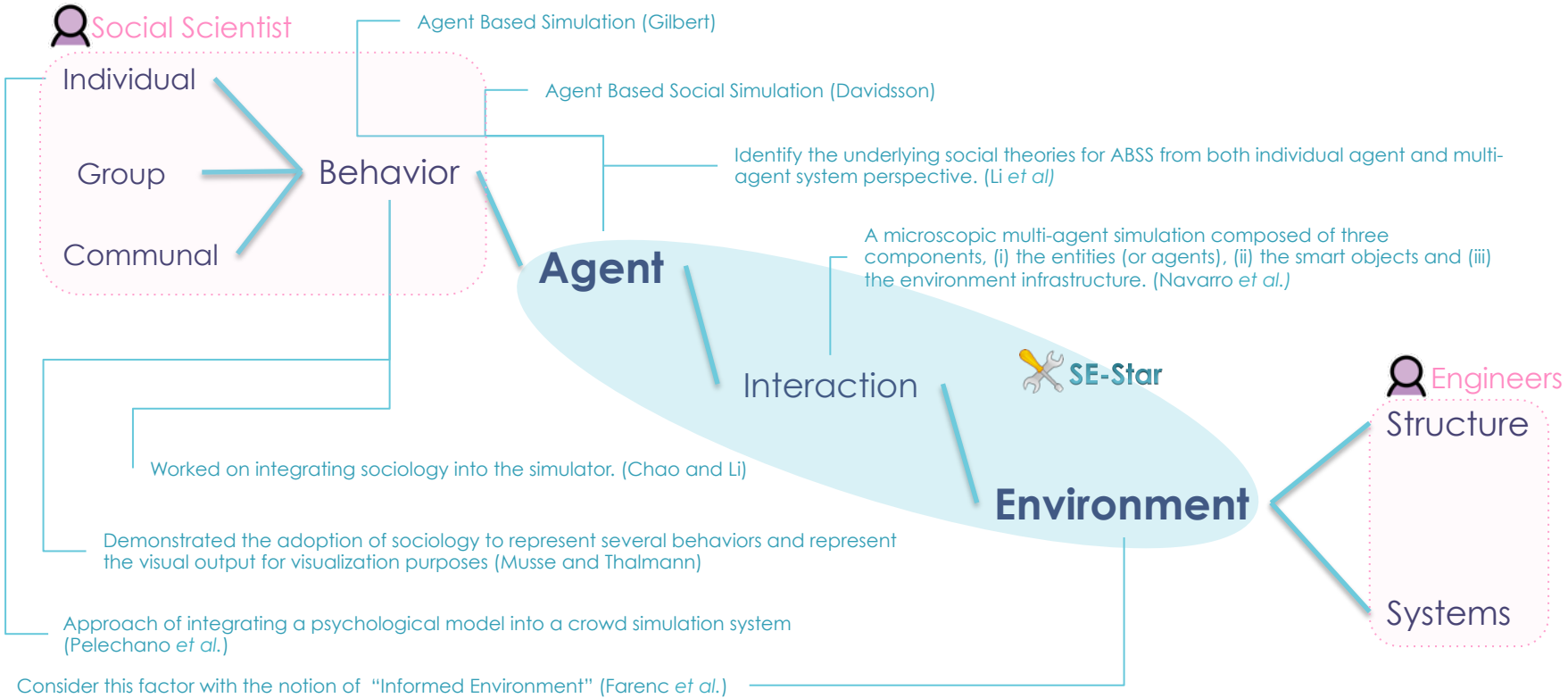
# Problem Space







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# Simulation Checklist

## Simulation Features Requirement

- Create social behaviors
- Integrate into virtual agents
- Capable of interacting with Environment

## Skills Requirement

- Social Scientists
  - Individual behavior (Psychology)
  - Social behavior (Sociology)
- Engineers
  - Coding simulation (Computer Engineering)
  - 3D Environment (Media Engineering)

# SE-Star

## Elements of Simulation

**Adaptive Agents**

**Intelligence**
Inspired by human brain

**Autonomous**
Non script based

**Unique personality**
Resembles crowd behavior in nature

**Context driven decision**
Motivational driven & opportunistic behavior

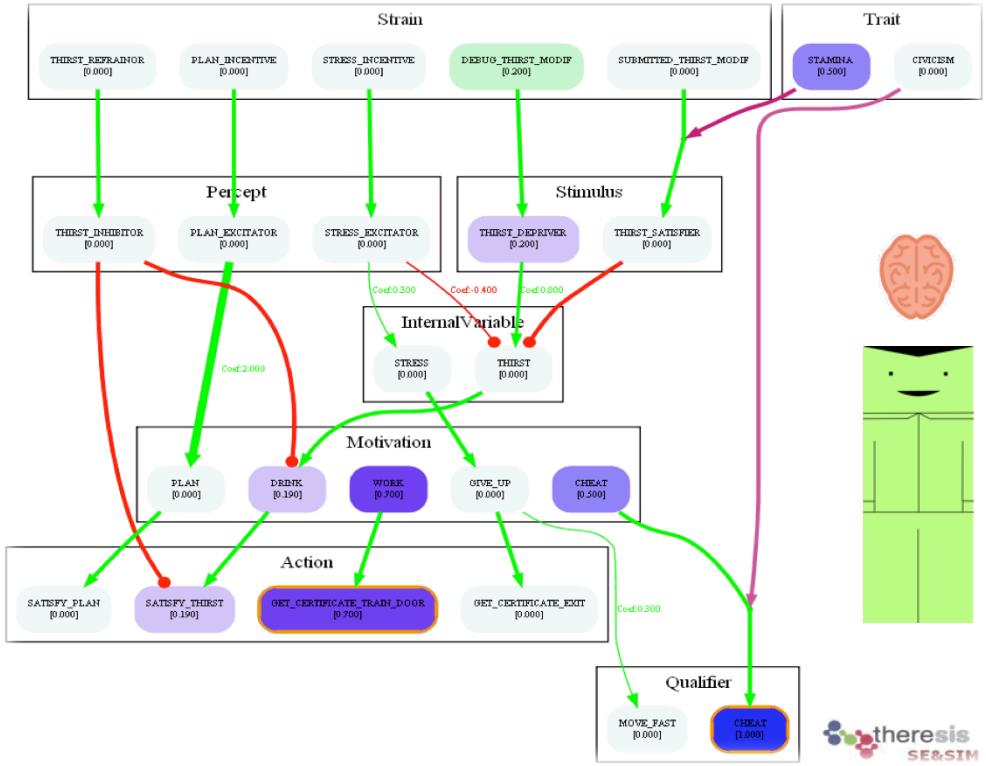
**Smart Objects**

**Service Provider**
Offers agents consumable services modeled from the real world.

**Automatic Chaining of Services**
Automatic integration of new services within the existing environment

**3D Environment**
Virtual model

## Free flow Hierarchy Motivational Tree Model







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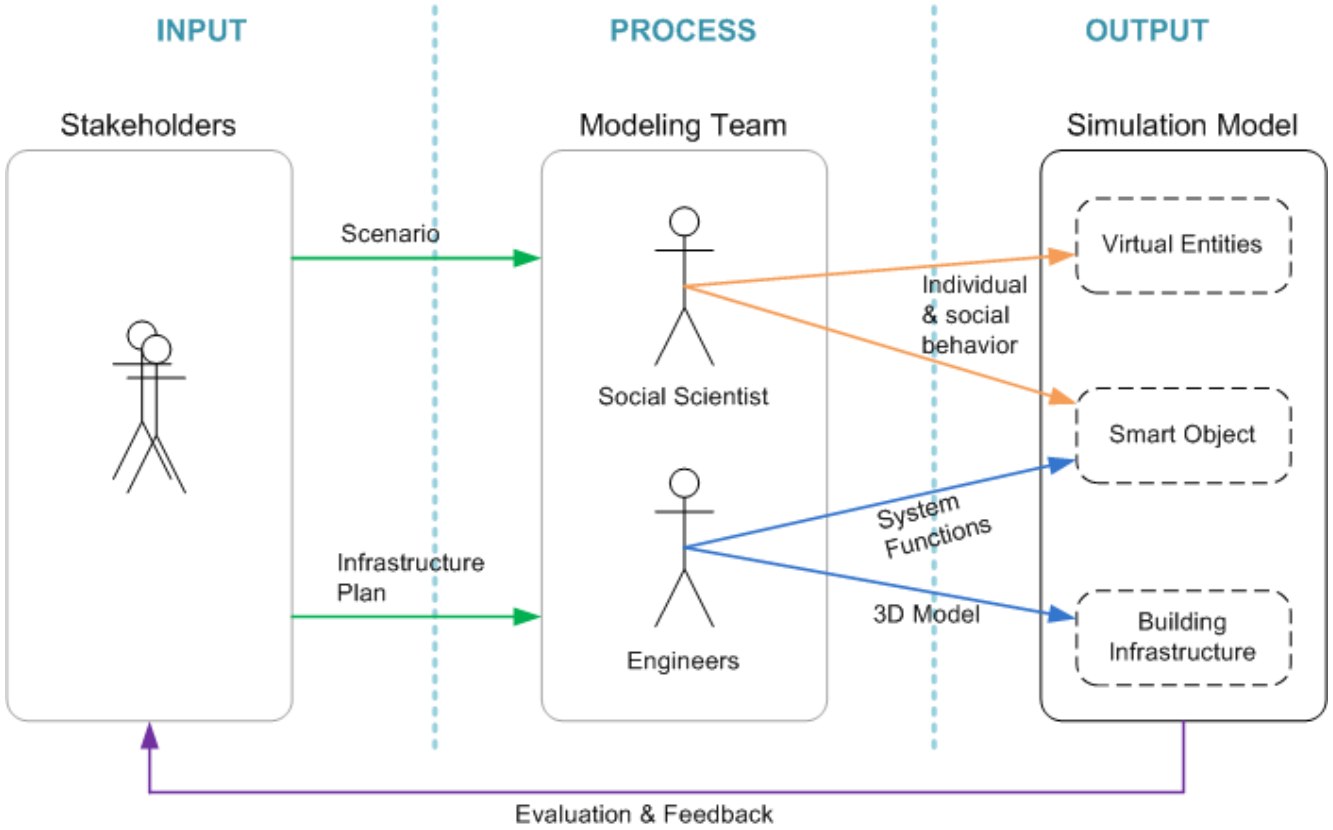
# Our Approach







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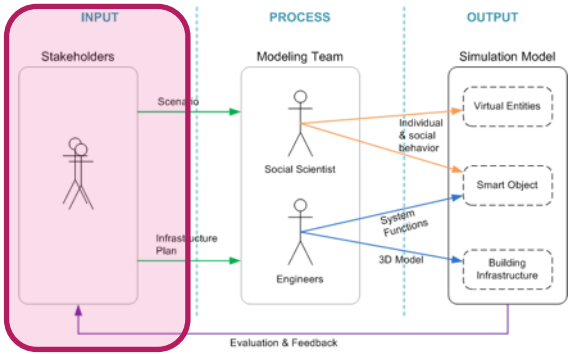
# Input

## Stakeholders

- provide the context of the simulation
- data and knowledge gathered through experience and observation
- provide feedback and validation of the model
- Bias?

## Reusable Behavioral Models

- based on established studies in Social Sciences
- reduces effort of defining behaviors
- improves the quality of the simulation model







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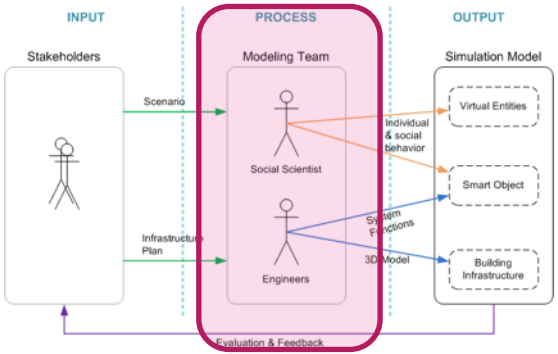
# Process

## Inputs are transformed into simulation models

- social scientists
  - analyze stakeholder input
  - conduct on-site studies
- engineers
  - construct 3D environment based on building or city plans
- both engineer & social scientists
  - model smart objects base on real system
  - actions and reactions of people interfacing with system

## Collaboration of engineers and social scientists

- differences in perspectives, backgrounds and skill sets
  - social scientists might find it hard to understand the computer language used to code the simulation models
  - engineers might find it hard to understand people







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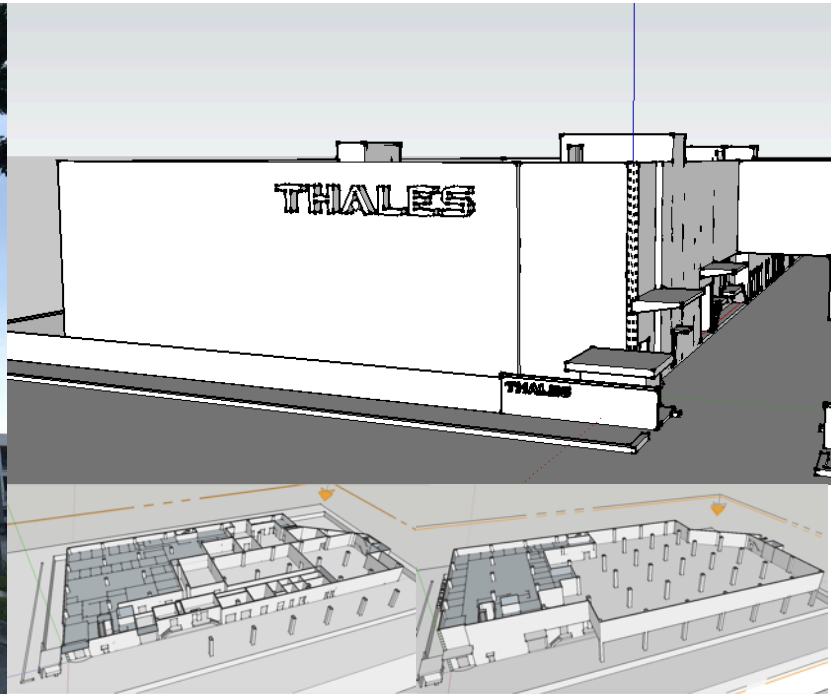
# Process - Environment Modeling

## 28 Changi North Rise





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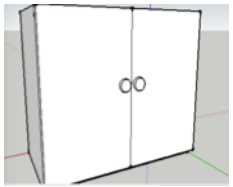
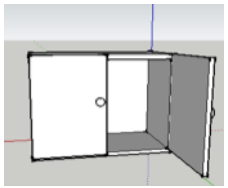
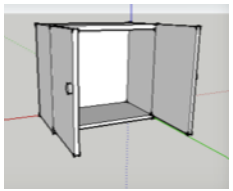
# Process - Smart Objects

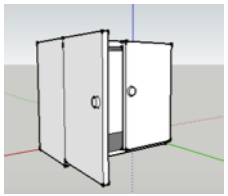
## Equipments / systems in the environment that agents can interact with

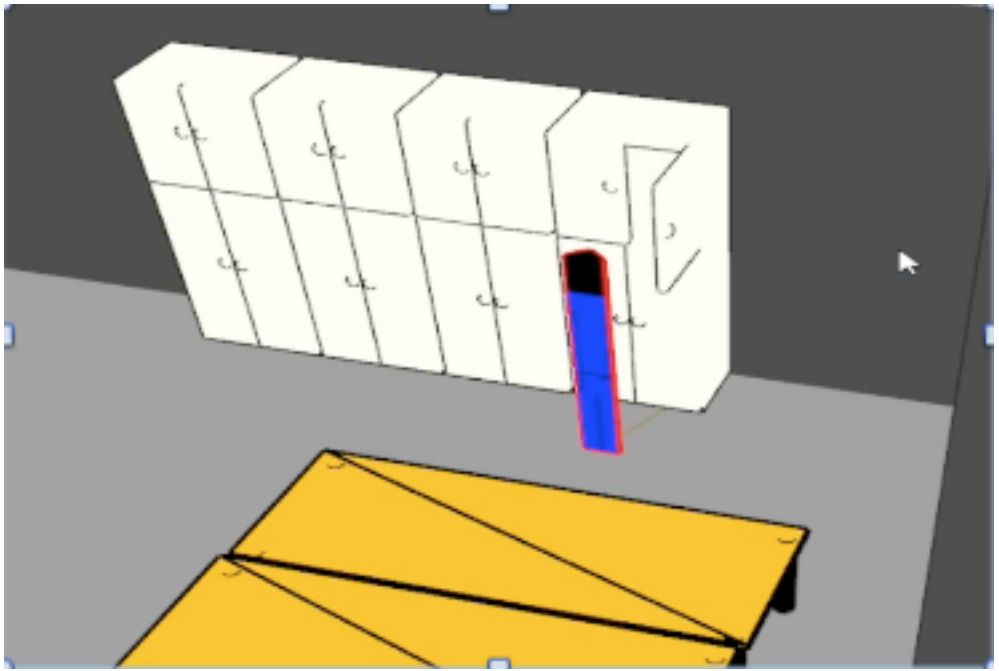
## Different states and Interaction









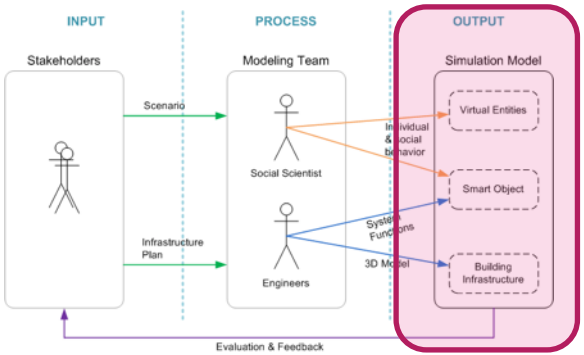


# Output

## Simulation models

- Entities
- Smart objects
- Environment
- Running the simulation model
  - link up all 3 components
  - assess the validity of the models
  - validation with the stakeholders

## The observations are compiled into a report







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# USE CASES

## USE CASE 1 – FIRE EVACUATION
## USE CASE 2 – CHOICE OF TRANSPORTATION

# Use Case 1 – Fire Evacuation

# Typical Fire Drill

# Use Case 1 – Output (Fire Drill –Side by side)








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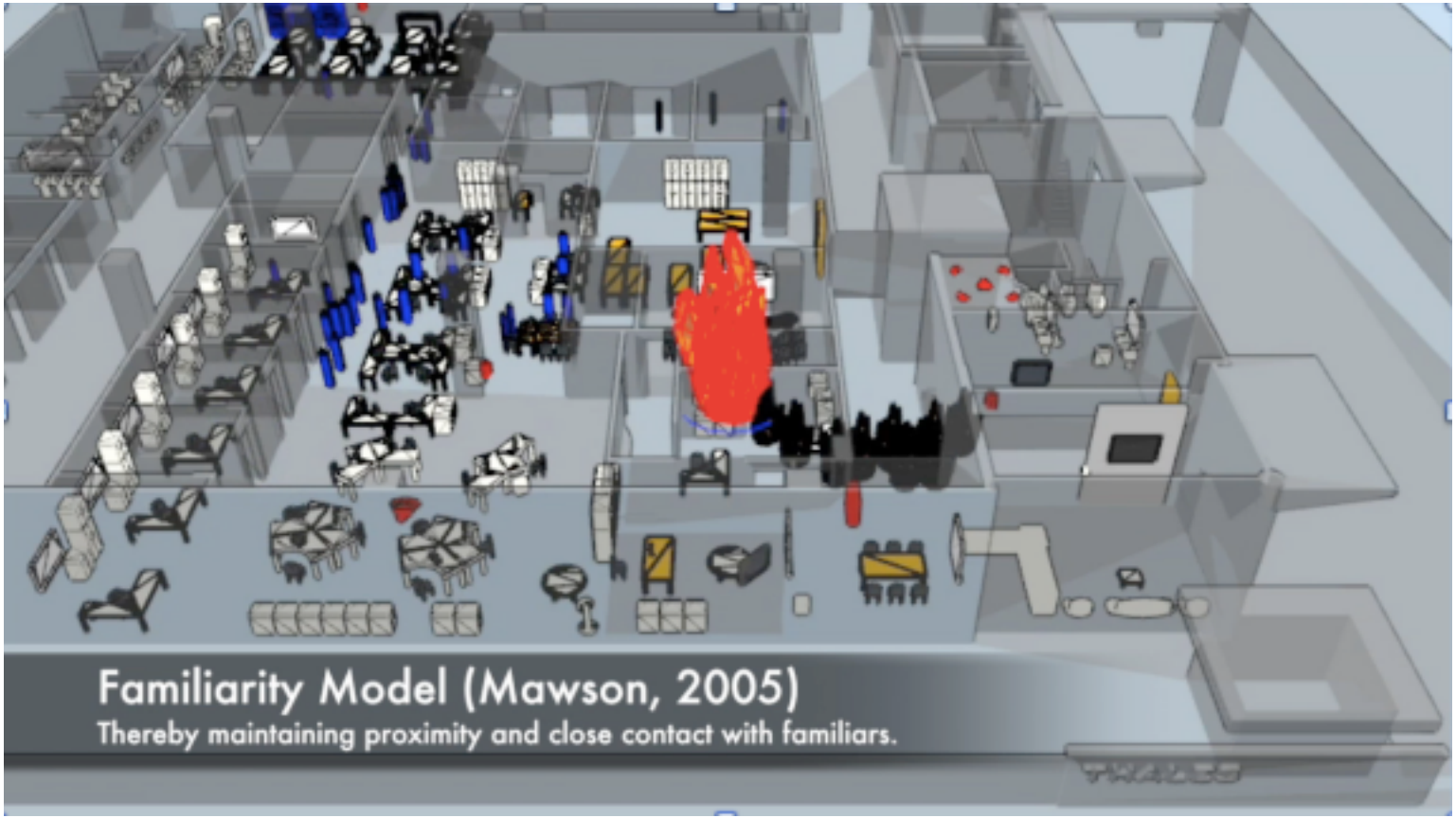
# Use Case 1 – Output (Fire Simulation with Social Behavior)







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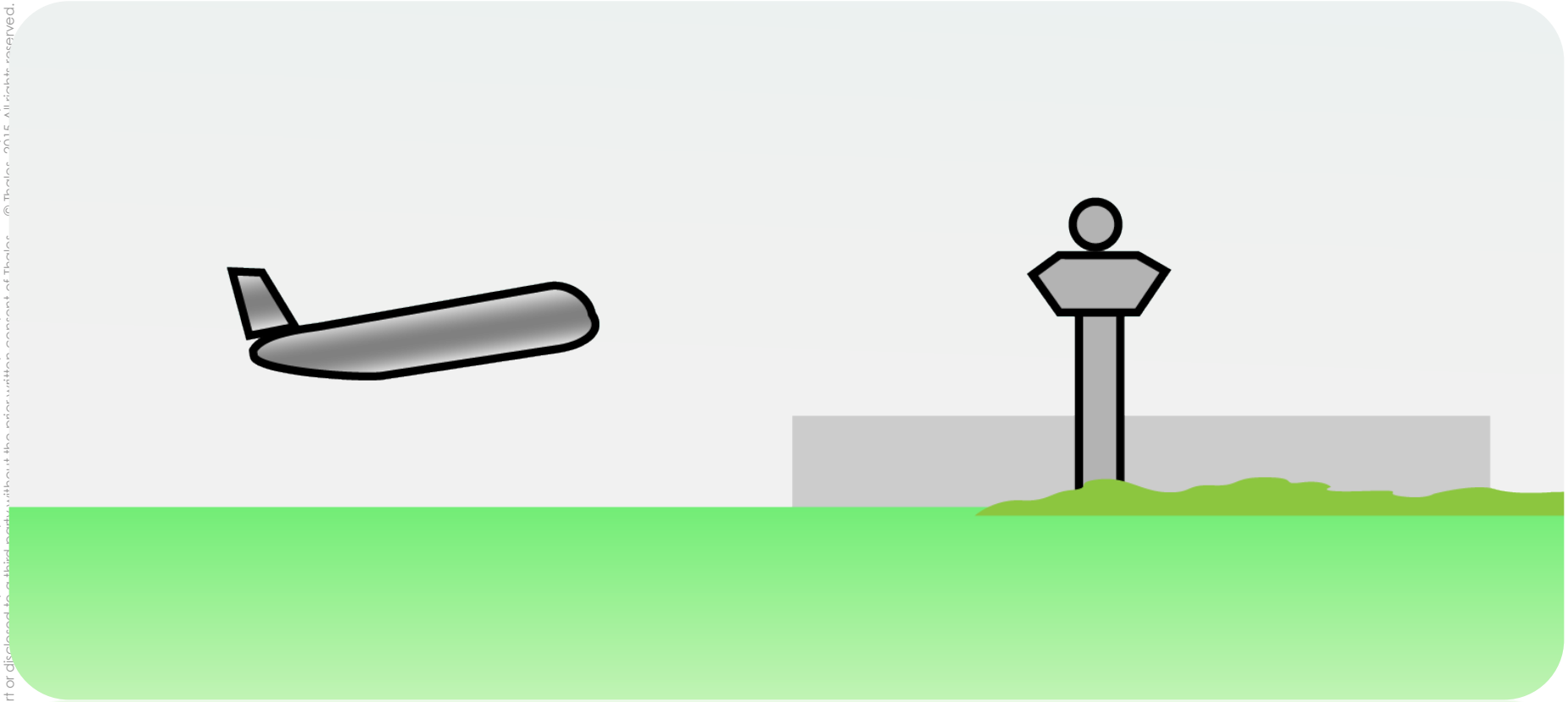
# Use Case 2 – Choice of Transportation



# Input References

## Translate research data into Motivational Tree Model

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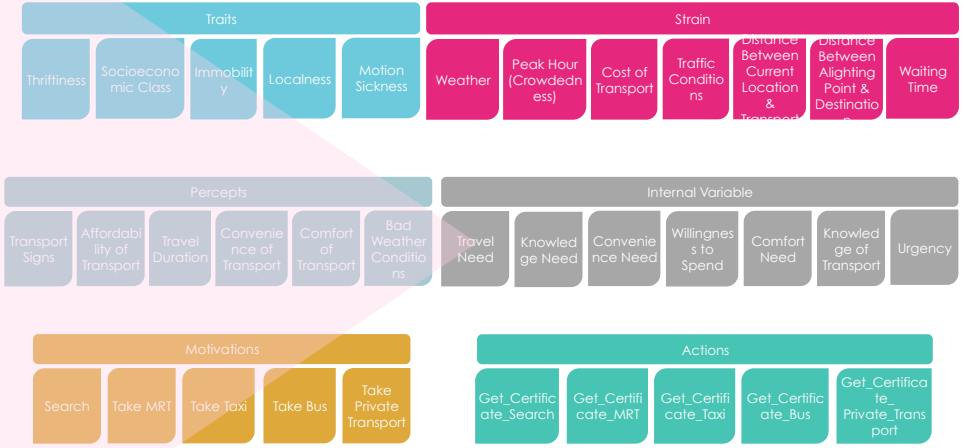








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# Use Case 2 – Arrival Hall Choice of Transportation








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# Future Work

## Social Sciences → Simulation

- valuable insights into the strength and weaknesses of our simulator
  - improving Group Behavior modeling
  - inter-entities communication could be further explored
- at a macro level, simulations should consider
  - social structures
  - implication of culture

## Simulation → Social Sciences

- Using simulation to study social behavior
  - On-going project with NTU

# Conclusion

## Approach of an integrated team of engineers and social scientists

- very effective in tackling complex problems
- contribute in their respective domains of expertise
- introducing new social behaviors into virtual entities

## Results of simulations produced using SE-Star

- some social sciences theories can indeed be implemented
- psychology models are easily adopted
- sociology models require modifications in simulation engine

**A reference to building more “humanistic” simulation models**

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## ENGINEERING

STEPHEN CHAI KHEH CHEW (THALES – SYS. ENG.)
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