# Technology transfer to industry
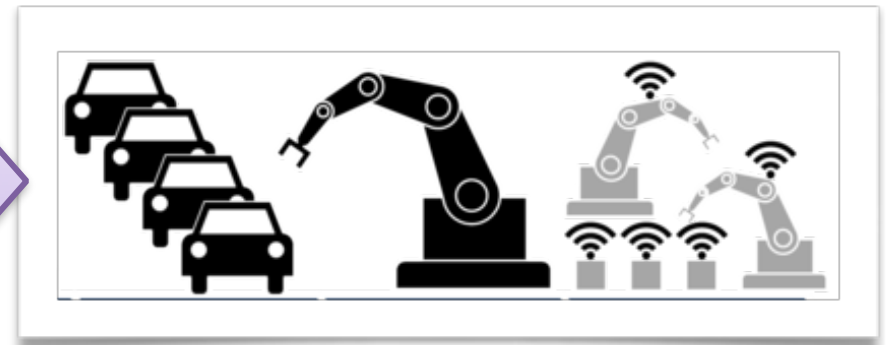
One of the key concerns in academia

*How to develop and deploy technology in industry*

## Academia 4.0?

## Industry 4.0

# Industry point of view

- Needed **characteristics** of a technology:
  - Adaptability
  - Robustness
  - Maturity
  - Readiness
- **Relevance** is an issue, **acceptance** is another, connected one

# Industry's point of view

- (Perceived) Relevance in industry, e.g.,
  - Meeting business goals
  - Meeting needs of organisation and people
  - Enhance processes and systems
  - Enhance job quality and performance

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# Industry's point of view

- Technology Acceptance
- Perceived **easy-of-use**
  - Degree at which use of technology will be free of effort
- Perceived **usefulness**
  - Degree at which use of technology would enhance user's job performance

# Industry's point of view

- **Not a proof of concept or prototype**
  - Academia typically develops **prototypes and proof-of concepts**
  - Industry needs **full working products** that can be used with **no help from the researchers**
  - Academia cannot be a **competitor** of industry on the market

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# Academia's point of view

- **Academia is called for rigor and generalisation**
    - **Methods and processes** for development and deployment together with evaluations
    - Extensions of the industry problems to **researchable and generalisable research topics**

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# Knowledge exploitation

*How to exploit domain knowledge to overcome the above challenges of technology transfer?*

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# Design Science

*Improve the environment by introducing new and innovative artefacts and the processes for building them*

Simon, 1996

# Design Science

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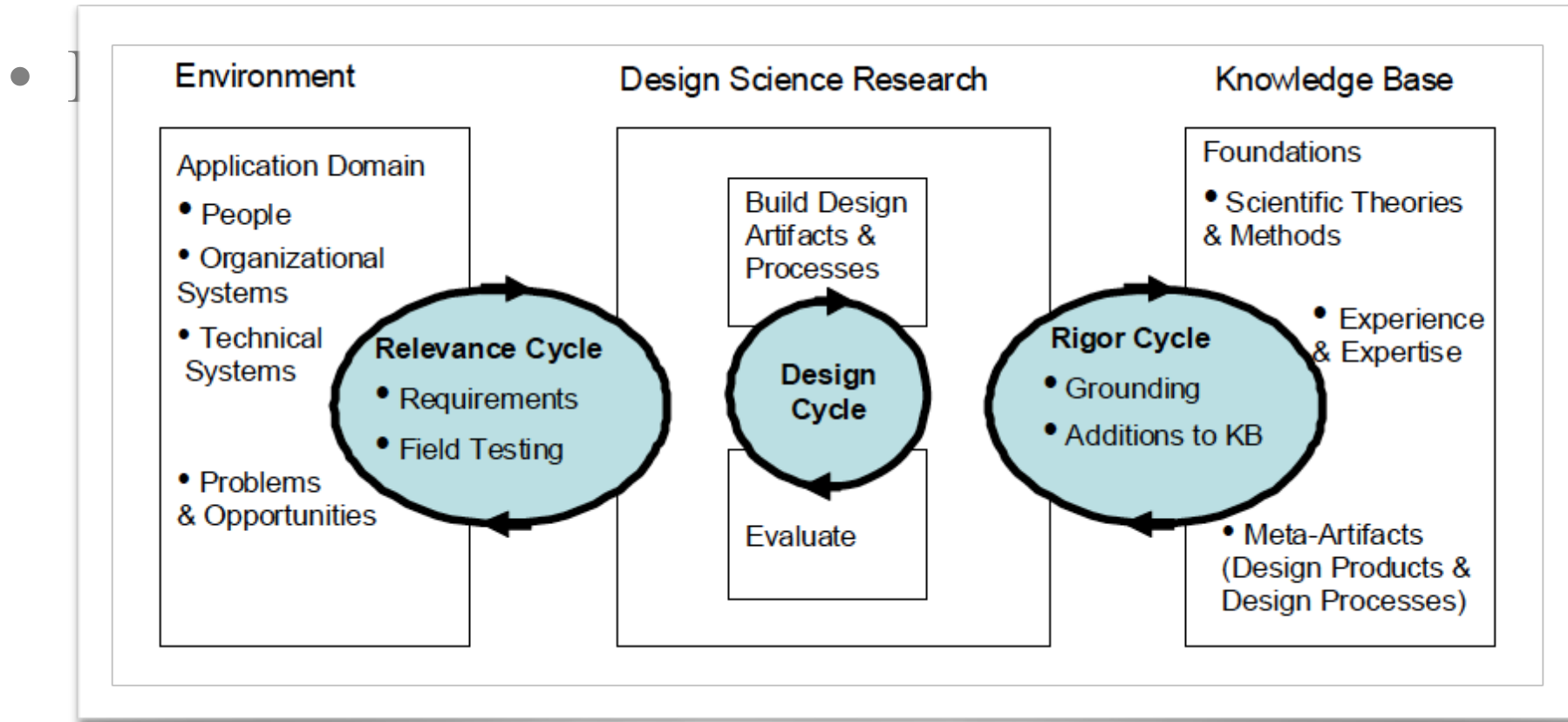


Hevner, 2007

# Design Science

- **Relevance.** Identify and represent problems in industry that can have **research potentiality**

- **Rigor.** Provide foundations to the problem with **theories and engineering principles**

- **Design. Construction and evaluation of an artefacts** that meet relevance and rigor balancing between effort for construction and evaluation

# Technology Transfer Model
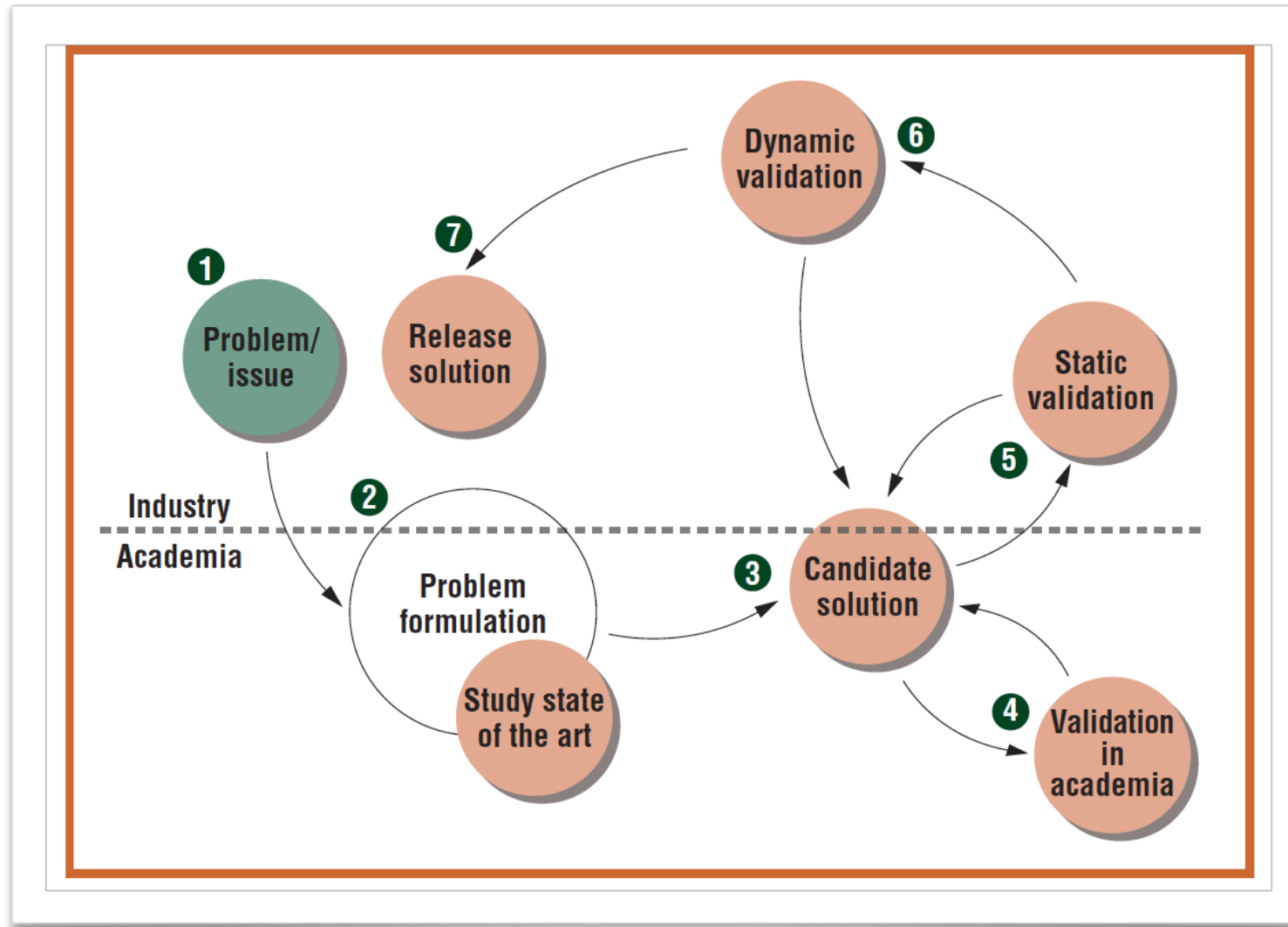


Gorschek, 2015

# Major types of research

- **Theoretical Research** is hypothetical and draws upon / integrates theoretical framework to explain a phenomenon. Typically, top down

- **Empirical research** builds theories from data and tests the feasibility of a solution using empirical evidence. Typically, bottom up

- They can be basic or applied

# Empirical Research

**This-year focus**

# Empirical research

- Gain knowledge by means of direct and indirect **observation or experience**

- Perform **quantitative or qualitative** analysis

- Start with clearly defined **empirical questions** (answerable with the evidence collected)

- Use **research design** according to the questions being investigated

# The de Groot's Empirical Cycle

- **Observation**: Collecting and organising empirical facts

- **Induction**: Formulating hypotheses

- **Deduction**: Deducing consequences of hypotheses as testable predictions

- **Testing**: Testing the hypotheses with new empirical material

- **Evaluation**: Evaluating the outcome of testing

# Example



- Empirical question:
- Is the iPhone XS user friendly?
- **Observation**: Collecting and organising empirical facts:
- *Select a sample of subjects that have an iPhone*
- *Interview them on the user friendliness of the smartphone*
- *Analyse the responses and organise them by the characteristics of the subjects (e.g., technical skills).*

# Example



- **Induction**: Formulating hypotheses:
- *User friendliness of iPhone XS depends on technical skills of the users*
- **Deduction**: Deducing consequences of hypotheses as testable predictions:
- *Subjects that have already used a smartphone (mimimal technical skill) consider the iPhone XS user friendly*

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# Example



- **Testing**: Testing the hypothesis with new empirical material

- *Verify the hypothesis against the consequences on a new sample compounded of two groups: subjects that have and the ones that have not used a smartphone before.*

- **Evaluation**: Evaluating the outcome of testing

- *Interview each group on user friendliness and measure the gap*

# Exercise

- Is the iPhone XS user friendly?

- **Compare Shneiderman' method and de Groot's methods for the testable hypothesis:**

- User friendliness of iPhone XS depends on technical skills of the users

  - *Subjects that have already used a smartphone consider the iPhone XS user friendly*

Replication

# Let's compare de Groot's and Shneiderman's theories

- **Observation**
- **Induction**
- **Deduction**
- **Testing**
- **Evaluation**

- Start with a practical problem & existing theory
- Write a lucid & testable Hypothesis
- Alter a small number of independent variables (treatment)
- Select & assign subjects
- Control other variables
- Measure small number of dependent variables
- Apply statistical test
- Solve problem, refine theory, produce guidance for future researchers

# Let's compare de Groot's and Shneiderman's theories

- de Groot's cycle starts from the observation to identify a practical problem; but a problem can be found in other ways

- In de Groot's cycle, hypotheses are derived by induction (from observations)

- Both models assume that there is cause and an effect; but there are other types of research for example simply descriptive

# Let's compare de Groot's and Shneiderman's theories

- Sheinederman's model considers testing as measurement and statistical test; but there are other types of testing like expert opinion

- Shneierman's model includes recommendations for researchers