Team:

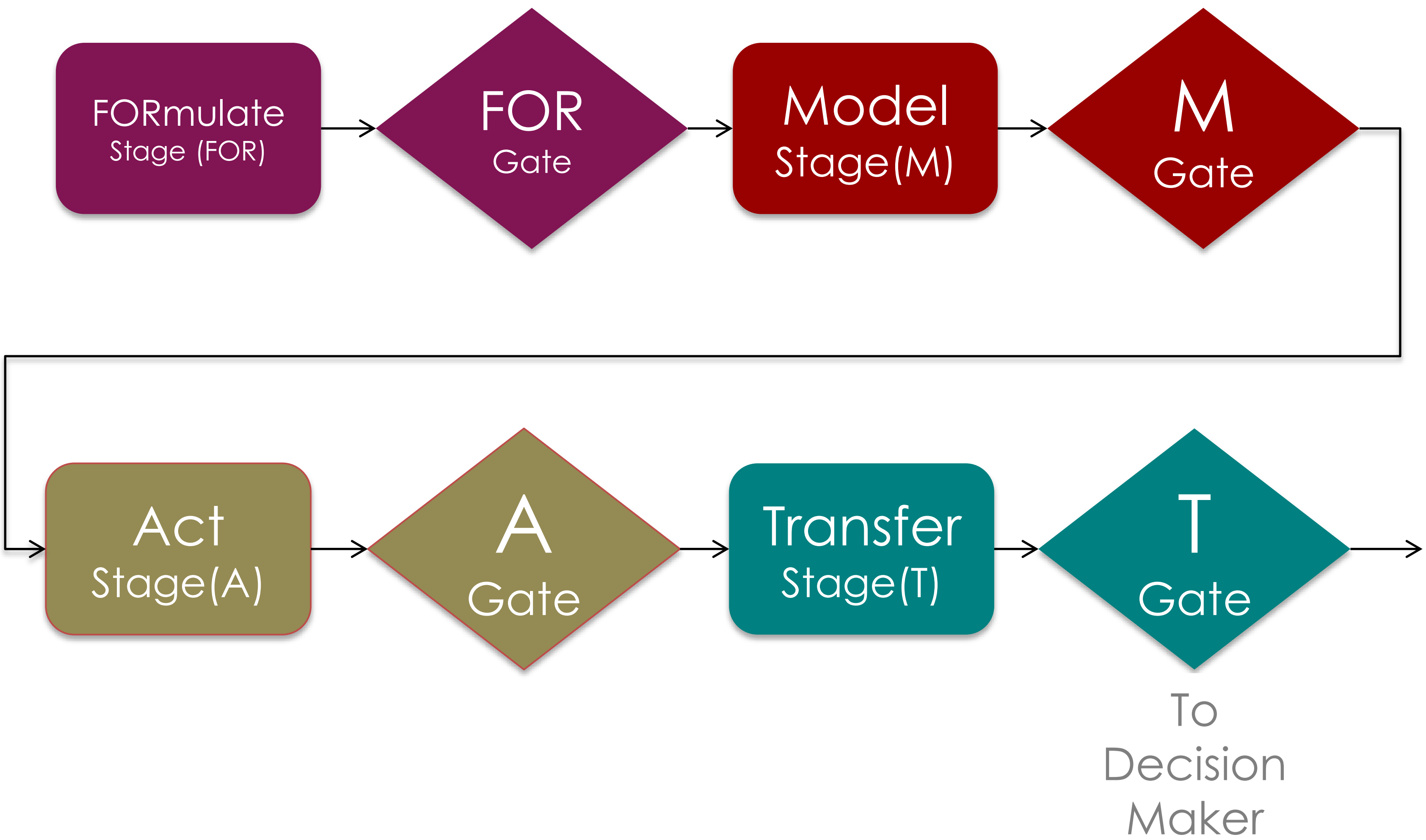
- Four person core team (FORMAT project developers),
- two Whirlpool experts,
- invited Whirlpool experts,
- supporting team (FORMAT project developers)

FORMAT
Forecast and Roadmapping for Manufacturing Technologies

Vacuum forming

Case Study

Please Note: not all steps of the FORMAT methodology were used for this study



Case study: Vacuum forming

Overview - Why are we forecasting Vacuum forming?

Vacuum forming equipment are

- expensive
- not flexible
- and have high-energy consumption.

Once bought they operate for up to 20 years.

These machines are due for renewal.

> “A huge, expensive, and long lasting investment”

Forecast questions

What will be the evolution of main parameters of polymers forming technologies in 10-20 years, (2013-2033) for Whirlpool refrigerators in Whirlpool factories in Western countries?

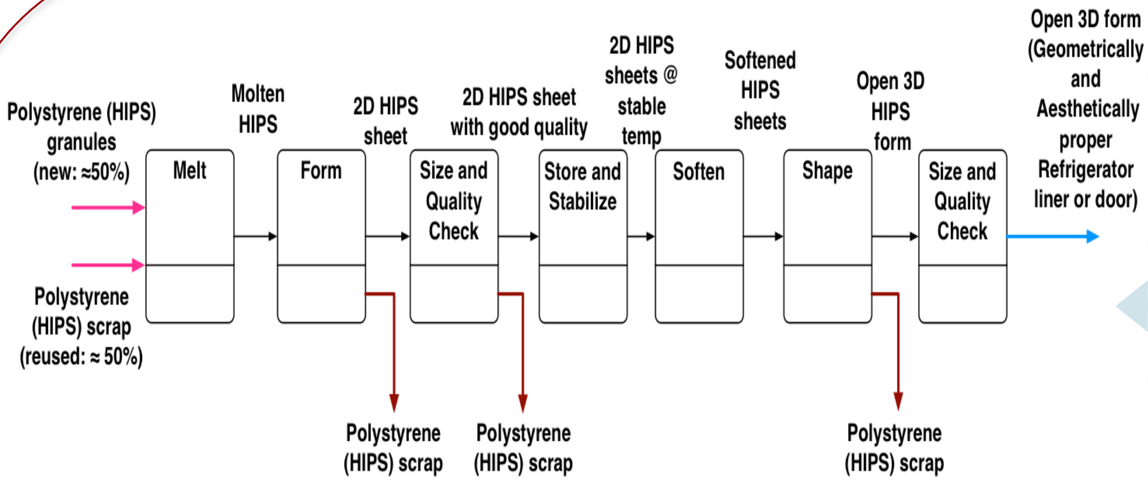
a) Will vacuum forming technologies be needed in 10 years, (2013- 2023) for Whirlpool refrigerators in Whirlpool factories in Western countries? **(Yes/No)**

b) What will be the most suitable polymer forming technologies in 10 years, (2013-2023) for Whirlpool refrigerators in Whirlpool factories in Western countries? (list of technologies)

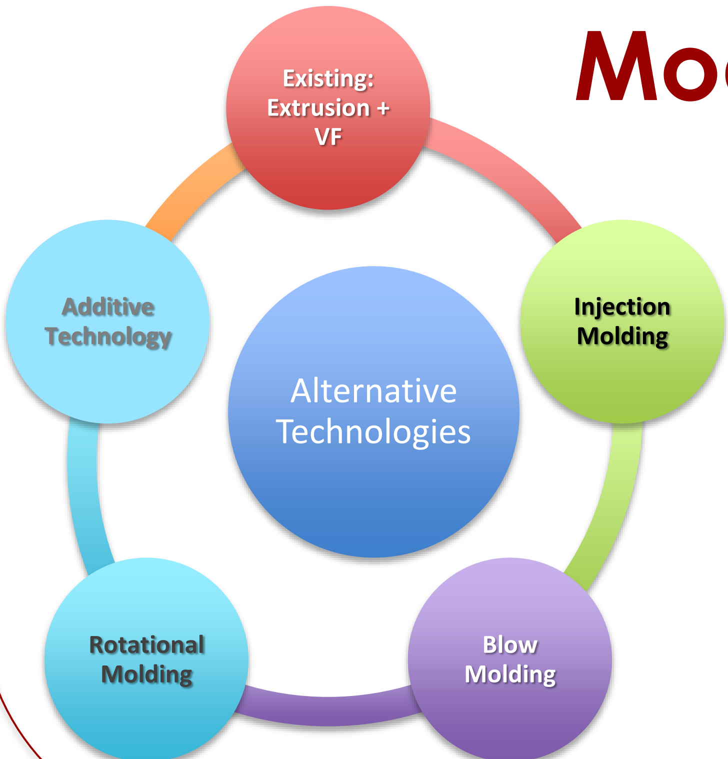
FORmulate Stage (FOR)

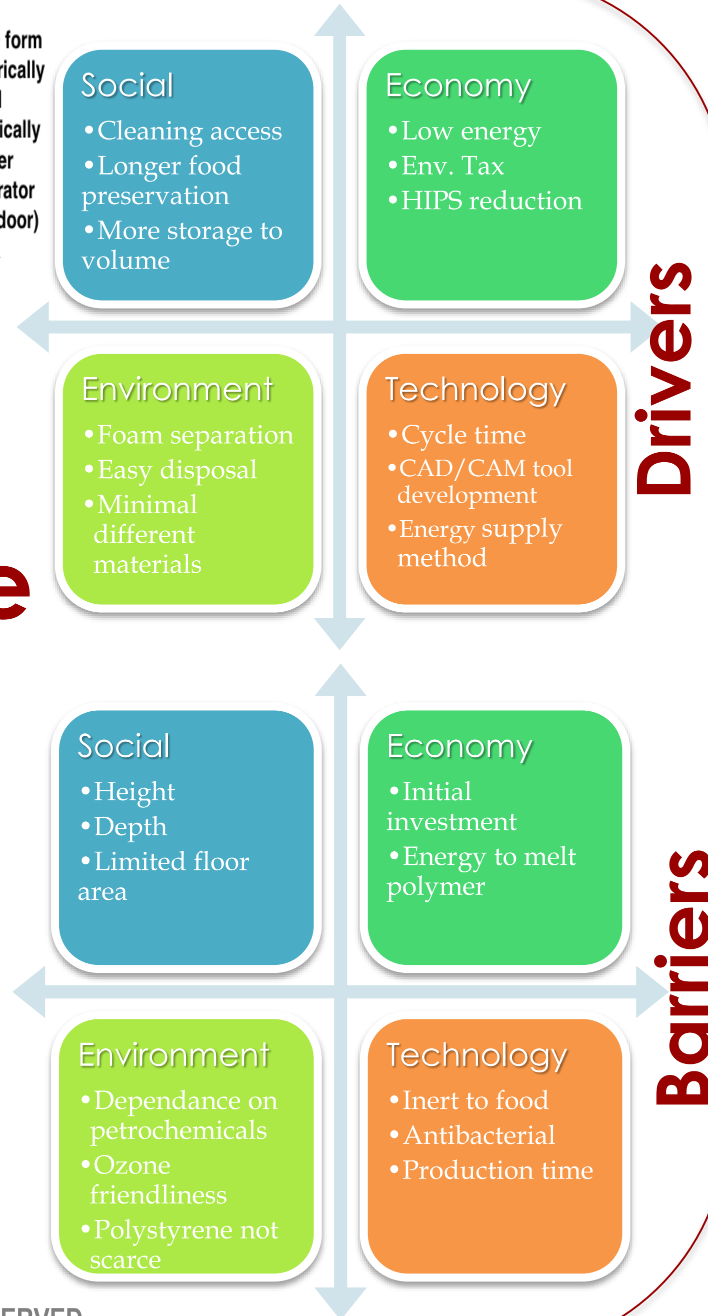
- ❑Main objectives of Forecast (Project) (Why?)
- ❑Definition of knowledge elements for the application of the forecasting results
- ❑INTERIM CHECK: Can we get the required results without Forecast?
- ❑Definition of Preliminary constraints for the project
- ❑List of Questions for Forecast (Questions to be answered at the end of study)
- ❑Plan of Project (How?)

FOR Gate



Model Stage (M)



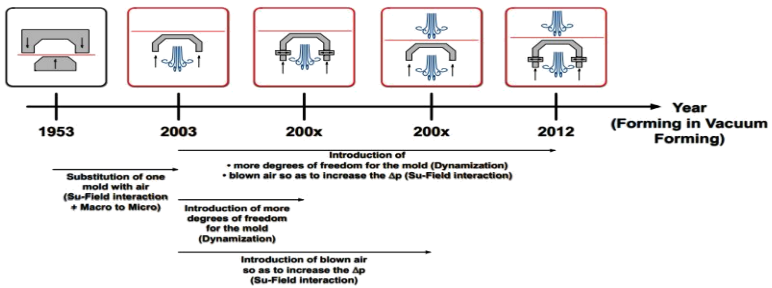


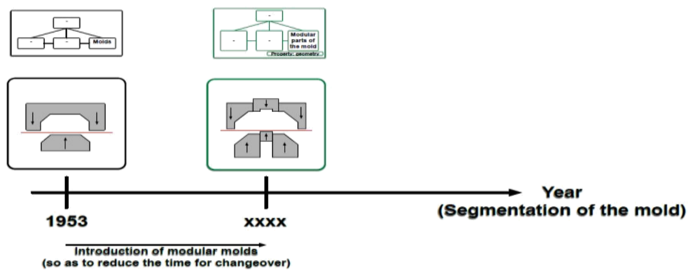
Case study: Vacuum forming

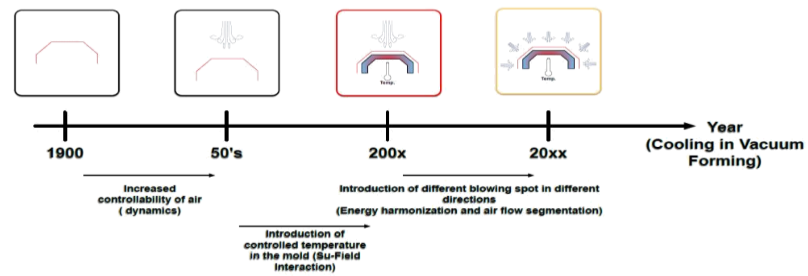
- Model of STF at the functional level
- Description of Competitive (Alternative) technologies (solutions)
- Measure of Performance & Expenses for STF and for Competitive Solutions
- Description for STF

M Gate

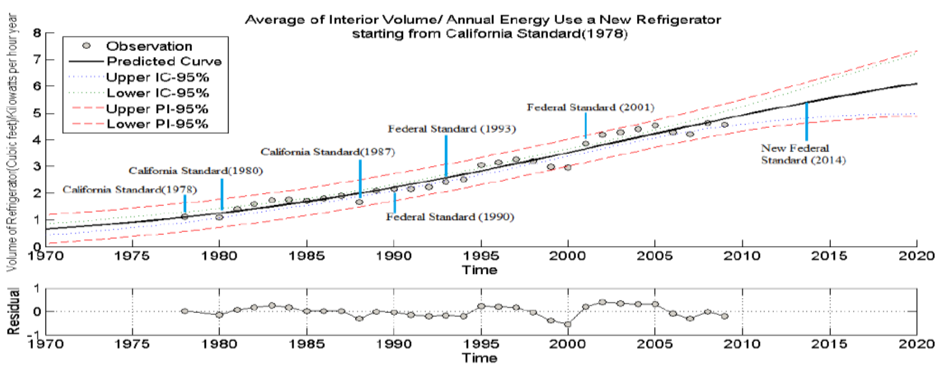
Qualitative Trends







Dynamization, segmentation and energy harmonization were applied to obtain qualititative forecasts



Quantitative Trends

Data based logistic curve regression analysis was applied to obtain predict trends in interior volume/annual energy consumption trends

Act Stage (A)

- ❑List of limiting resources
- ❑Directions of development of new solutions
- ❑Dynamics of parameter(s) measuring Performance & Expenses
- ❑Aggregated conclusions about future traits for STF

A Gate

Main Parameters of evolution
1. Complexity of mold will increase due to multi-part molds.
2. Maximal Productivity might increase (thanks to cooling time reduction) when minimal Productivity of MP will not change significantly.
3. Initial Investments into equipment will not increase significantly.
4. Attention to Energy consumption of manufacturing process (MP) will rise.
5. Amount of Materials to produce 3D shapes will decrease when cost might increase slightly.
6. Footprint of MP should decrease.
7. The degree of Automation of MP will increase.
8. The degree of Integration of MP with other phases of production will increase.

Vacuum Forming after 2023
Vacuum forming will be needed after 2033

Most suitable technology after 2023
Vacuum forming: very fast equipment option
Vacuum forming with extrusion and forming combined

Transfer Stage (T)

- ❑ Answer the Question to be Forecasted
- ❑ Executive summary
- ❑ Report
- ❑ Presentation

T Gate

Case Study Assessment

Strengths

Repeatability
Expertise
Modelling
Team
dynamics

Time taken
Lack of
access to
historical
data

Weakness