



Team:

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

Special thanks to Whirlpool invited experts: Tiziano Mici, Fabrizio Sella, Marco Signa.



Vacuum forming

Final presentation

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

”

The main question

What will be the evolution of Main Parameters of **polymers forming** technologies in 10-20 years, (2013-2033) for WHRIT Refrigerators* in WHRIT factories in Western** countries?

- a) Will vacuum forming technologies be needed in 10 years, (2013-2023) for WHRIT Refrigerators* in WHRIT factories in Western countries**? **(Yes/No)**
- b) What will be the most suitable polymer forming technologies in 10 years, (2013-2023) for WHRIT Refrigerators* in WHRIT factories in Western countries**? (list of technologies)

Answers to the main question

What will be the evolution of Main Parameters of **polymers forming** technologies in 10-20 years, (2013-2033) for WHRIT Refrigerators* in WHRIT factories in Western** countries?

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.

Answer to sub-questions

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

Yes (no strong alternative has been identified)

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

Vacuum forming: very fast equipment option (frequent molds changeover and setup consume time that need to be gained by very fast equipment).

Vacuum forming – with following upgrades: integration of extrusion and forming, variable thickness within one sheet, improved cooling, complicated molds, increased automation, decreased footprint, decreased energy consumption.

Where forecasting results will be used? ^{1/2}

- It will be used in the WOCE Department & Refrigeration Factories (in EMEA) for deciding about investments into new equipment, human resources
- Communicate to Advanced Manufacturing (global) to shape research activities and funds distribution.

Stripe built out of side by side linked photos of Whirlpool refrigeration products app. 6, even better if they show interior.

Where forecasting results will be used? 2/2

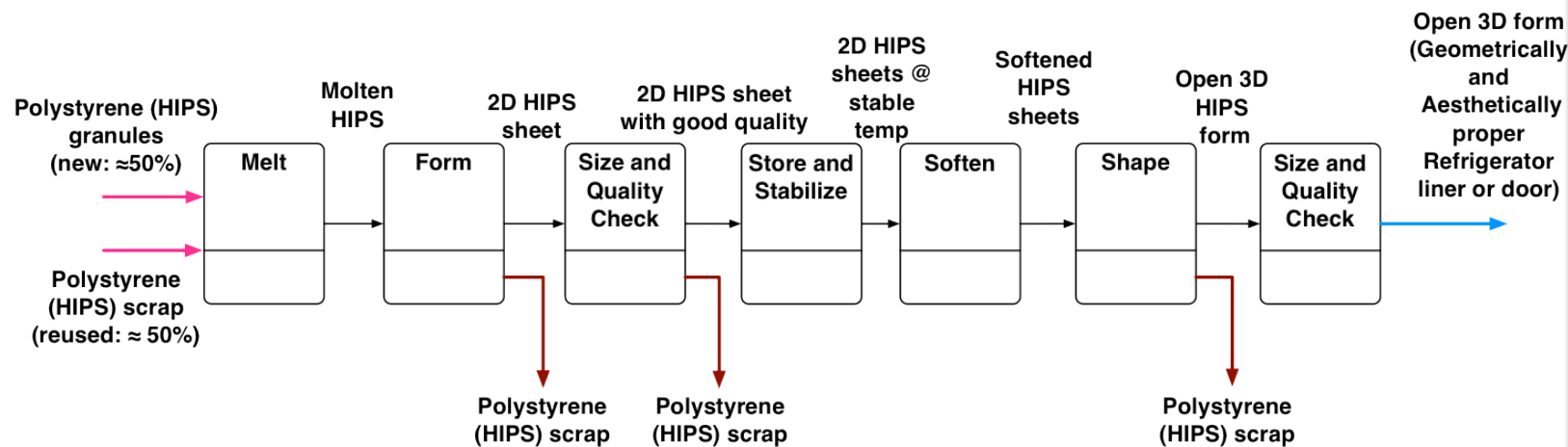
- To share for making impact to product development roadmap.
- To facilitate changes in the WH for improving competitiveness;
- To prove decisions (fact based decisions)

(the same stripe – order of products may be changed slightly)
Stripe built out of side by side linked photos of Whirlpool refrigeration products app. 6, even better if they show interior.

How was this study prepared?

Traits in context space of the manufacturing system

- 1 Reduction of cycle time in cabinet MP (sec)
- 2 Reduction of energy consumption (for refrigerator; and for cabinet MP) (kWh)
- 3 Increase in importance of Process for Recycling the inner part of refrigerator (kg)
- 4 Increase of food preservation time, (days)
- 5 More elements of fridge system will be integrated into inner-liner (number)
- 6 Increase in automation for cabinet MP (man*h)



How was this study prepared?

Problems study was constructed around:

- 33 identified problems

- 7 features critical-to-MP¹

Features critical to evolution, development, operation, life of MP

- 7 top problems

They will be addressed 1st in order to evolve MP.

Evolution study:

- 8 envisioned directions for MP evolution

¹ MP – manufacturing process

How was this study prepared?

Mapping of the future charts for VF (1 of 3)

Equipment selection criteria

	Cycle time [s]	Productivity [pcs/shf]	Thickness [mm]	Changeover [min]	Scrap [%]	Number of equipment [#]
Top problems to be solved						
Distance between rollers = Initial thickness of 2D sheet	5	3	7	0	3	2
Distance between heater and sheet	4	0	0	0	4	2
Temperature profile inside of mix	0	2	0	0	2	0
Dependence on crude oil of a raw material	0	0	1	0	0	0
<Thermal pattern> on 2D sheet	0	0	3	0	0	2
Setups' frequency	0	5	0	10	0	0
Cooling equipment complication in MP	10	7	0	0	0	3
Dimension of 3D form (thickness)	5	5	7	0	0	0
<Temperature profile (of 2D sheet in the pallet)>	6	0	0	0	6	7