

Strategic Decision Making in the 3D Printing Industry

A Robust Decision Making (RDM) analysis

Pedro Nascimento de Lima Maria I. W. M. Morandi
Daniel Pacheco Lacerda

GMAP Research Group, UNISINOS University, RS, Brazil

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Introduction

Motivation - DMDU and Business Decisions

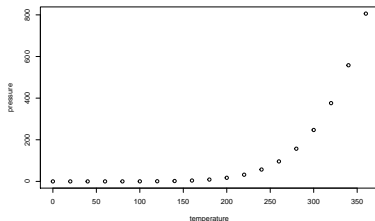
- Decision Makers in Business are faced with uncertainty, but. . .
- Testing quotation: (Lima 2018), (Gong et al. 2017), (Wholers 2016).

Key Features of 3D printing

- 3D printing allows us to manufacture parts with unprecedented **complexity**, in **low volume**;
- By doing so, entire manufacturing industries might be disrupted by AM, presenting challenges to . . .

Two Column Layout

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Why 3D Printing?

3D Printing is an emergint technology, but decision makers face uncertainty:

Positive Evidence:

- 3D printing Industry has seen two digits growth consistently in the last few years;
- 3D printing is already reshaping supply chains across industries (e.g.: prothesis, aerospace, etc.).

Negative Evidence:

- Major players have been observing declining profitability (e.g.: Stratasys, 3D Systems);
- Estimates of 3D printing growth diverge.

Shaping Events and Factors in the 3D Printing Industry

- Patent Dynamics & Patent Expiration: (e.g. FDM Patent);
- R & D
- Strong Competition:
- After the 3D printing Bubble, major players refocused their operations on industrial-grade printers;

XLRM

New Product Diffusion Models

There is a broad range of models portraying new product diffusion and technological substitutions, beyond the basic Bass Diffusion Model (Bass 1969):

- New Product Launch Strategy and timing between successive Product Generations (Mahajan and Muller 1996);
- Social Factors (e.g. Reference Users and Opinion Leaders - GE in the case of AM) (Dattée and Birdseye Weil 2007);
- Competition Among Players and Substitution Between Product Generations (Maier 1998);
- Market Uncertainty (Cui, Zhao, and Ravichandran 2011);
- Competition, Learning Curves, diffusion dynamics, Pricing and Capacity Strategies (Stermann et al. 2007).

What's the Problem

- Most of these models are employed with a **consolidative** approach, some of them using Sensitivity Analysis to explain under which conditions one might choose a different strategy based on thresholds of uncertain parameters.

Sterman et. al (2007) Model

- We choose (Sterman et al. 2007) model as a bed-rock for our analysis, since it:
- Captured competition among players;
- Was focused on ...

X - Uncertainties

L - Levers

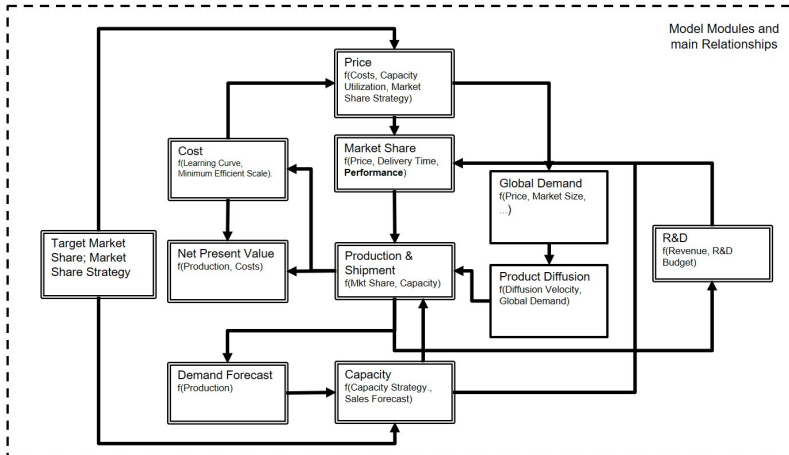
R - Relationships

M - Metrics

Model Boundaries

Outside the
Scope of the
model

- 3D Printers models disaggregation;
- 3D Printing market disaggregation;
- Mergers and Acquisitions;
- Patent Licensing;
- Disaggregated New Entrants;
- Competition w/ competing Technologies (e.g.: machining);
- 3D printing service industry;
- 3D Printing supplies sales;
- Interactions with non-professional 3D printing Market;



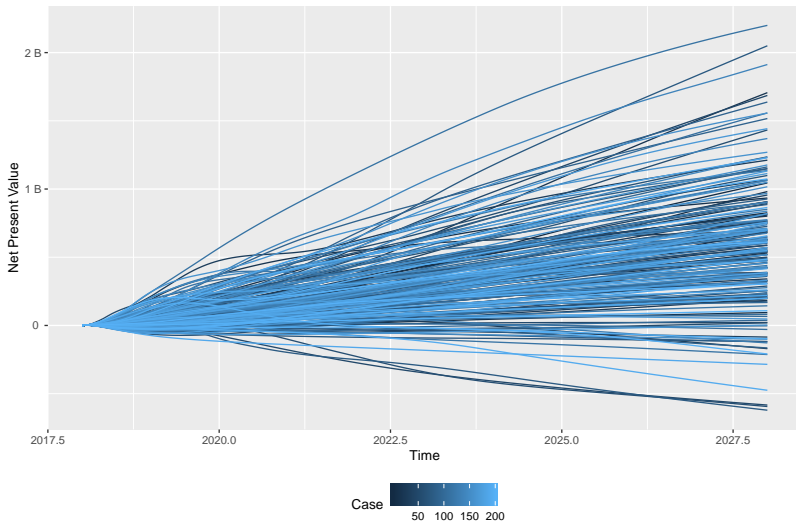
Case Generation

Design of Experiments

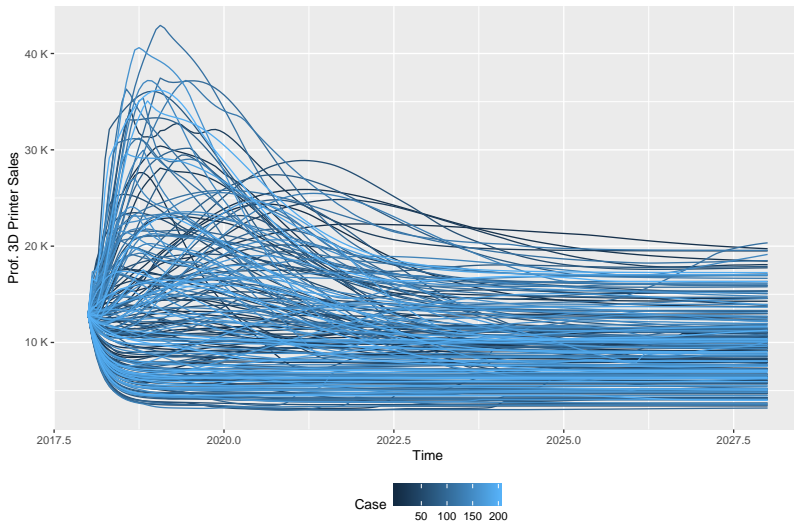
- Full factorial design of these variables, resulting in 54 strategies:

Variable	Meaning	Levels
S_1	Market & Pricing Strategy. Defines whether the player pursue an aggressive marketing strategy to gain market share (by cutting prices and accepting excess capacity), or pursue a conservative strategy,	Aggressive (1); Conservative (2)
S_1^{max} or S_1^{min}	Desired Market Share. For a Conservative Strategy, the player adopts the S_1^{max} and	20%; 30%; 40%

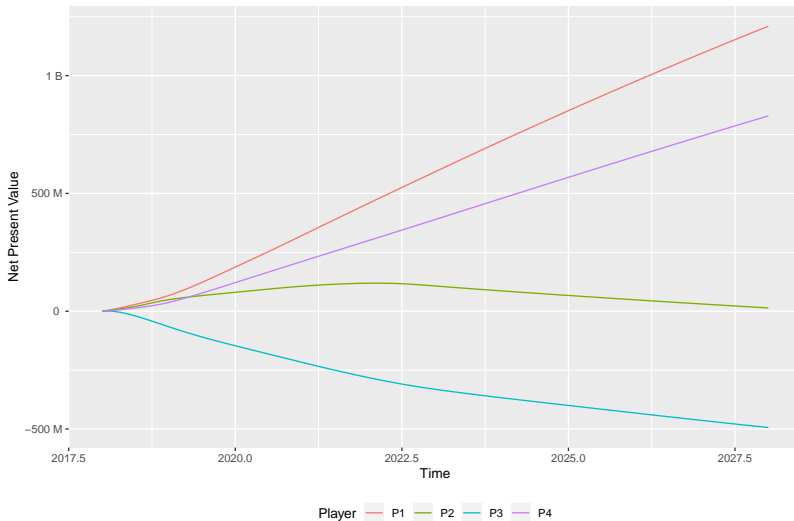
Candidate Strategy NPV across scenarios



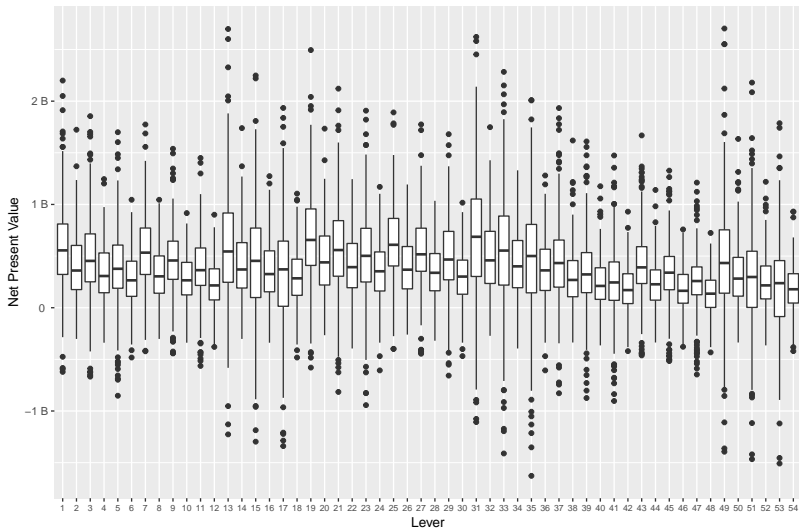
Global Demand across scenarios



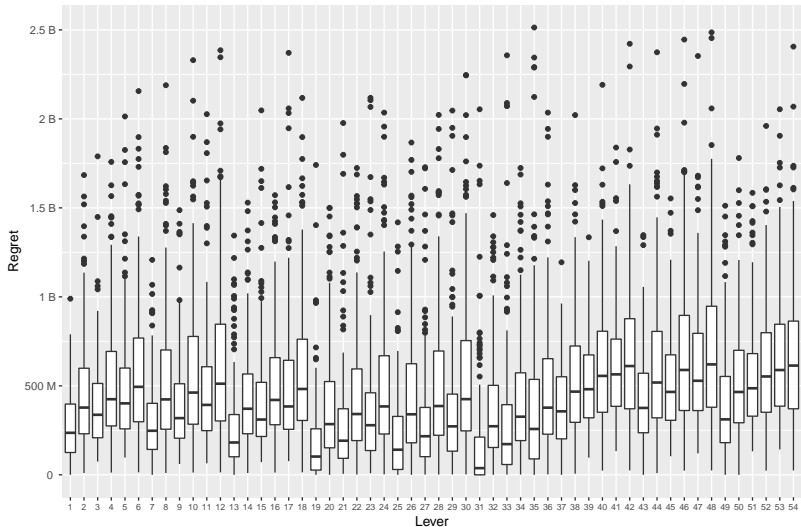
4 Players Net Present Value in a given scenario



Net Present Value across strategies and Scenarios



Regret across strategies and Scenarios



Ranking Strategies by Regret

Scenario Discovery

Conclusions