

# Clean Technology Startups Management Flight Simulator

**System Dynamics Conference 2009**

Joe Hsueh, David Miller and John Sterman  
MIT Sloan School of Management



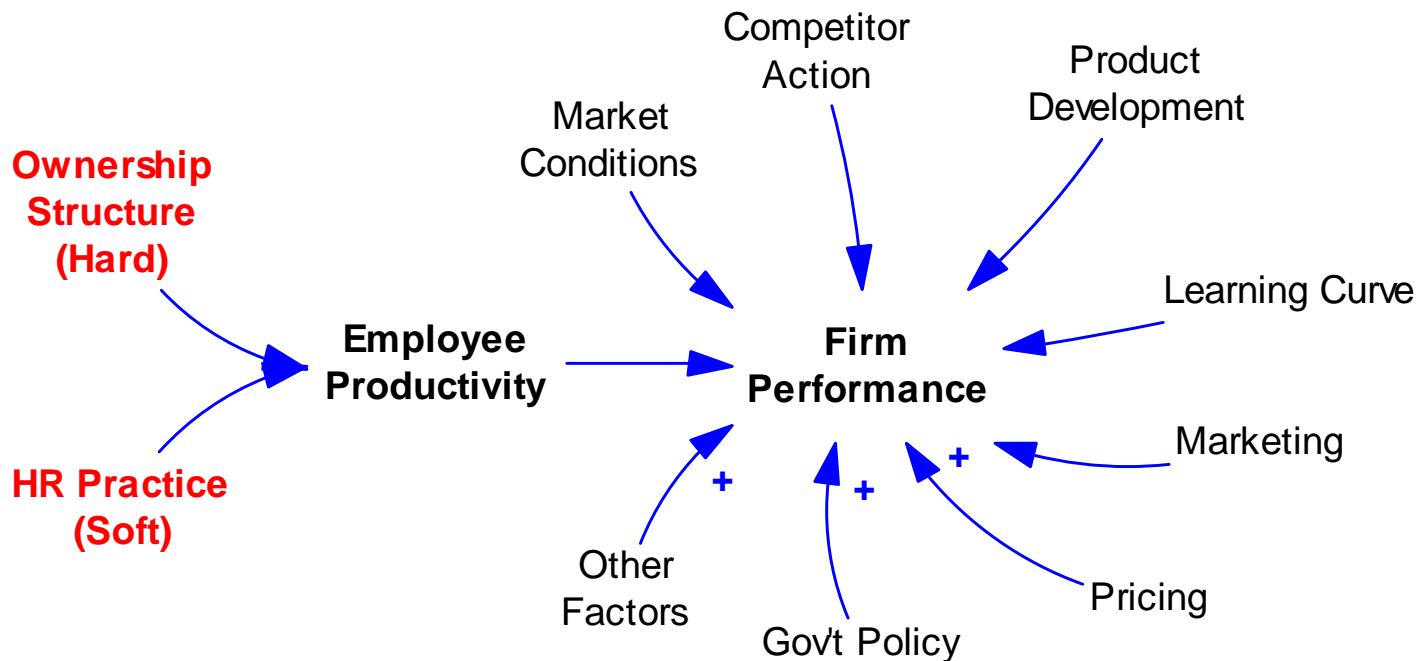
# Research Question/Teaching Purpose

---

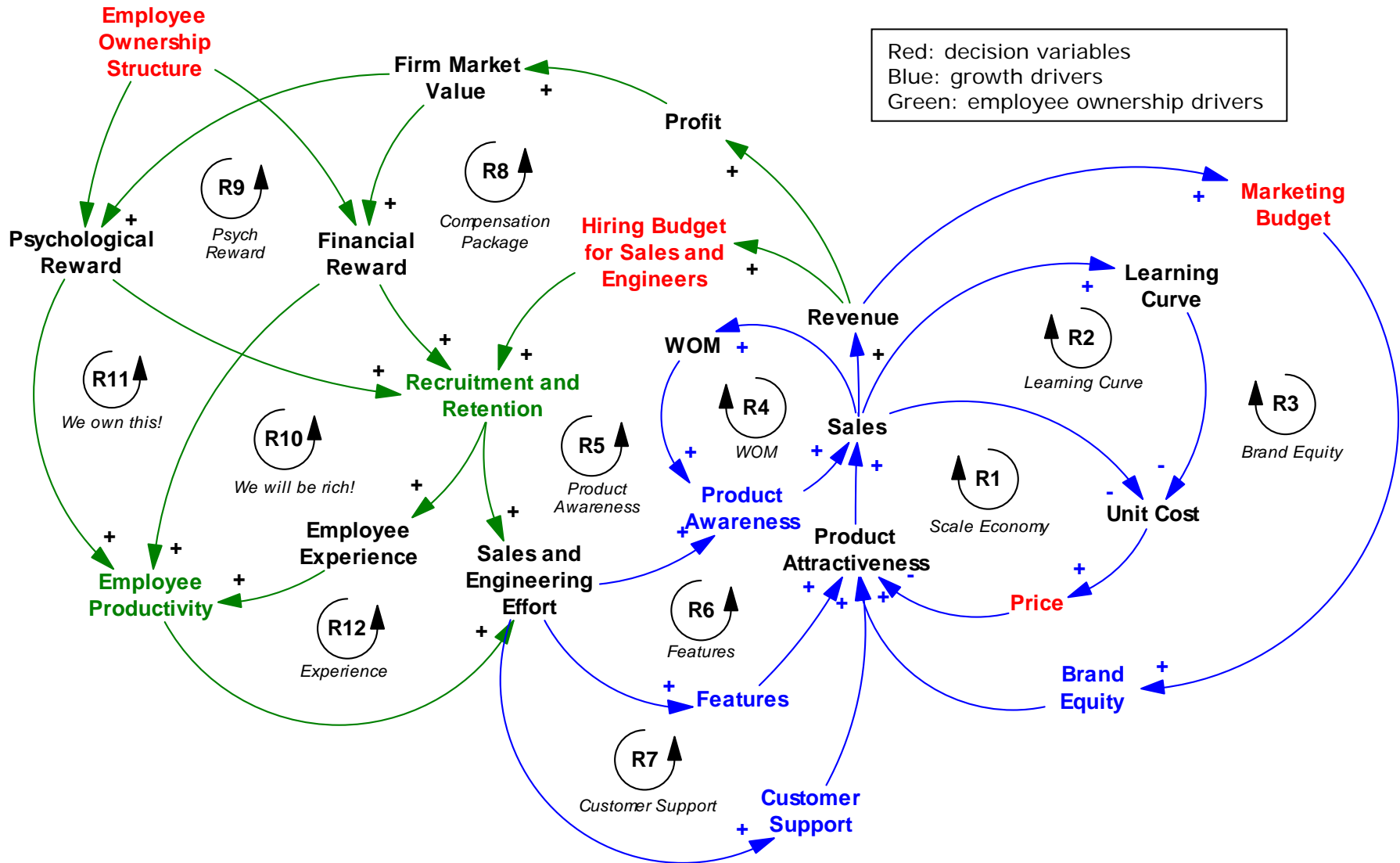
- What are the dynamics of green tech startups and how can their odds of success be improved?
  - Long sales cycles
  - Engineering vs. sales force focus
  - Valley of death
  
- How can different ownership structures affect employee behavior and firm performance?
  - Traditional external funding (e.g. VC financing)
  - Employee ownership (partial or full)
  
- More generally, under what conditions do various employee ownership structures lead to superior financial performance?

# Selected Determinants of Firm Performance

---



# Selected Reinforcing Loops of Employee Ownership Structure



DRAFT COPY

Note: these are selected reinforcing loops of the effects of employee ownership structure. Balancing loops that limit the effects are not shown.

# Starting point

---

- David Miller's (2007) PhD thesis on the dynamics of clean technology startup companies.
- Needed much more structure
  - Financial
  - Competition from other startups
  - Ownership structure
  - others

# What we have done...

---

- ❑ Expanded the **prospect chain** to track the flow of potential customers to potential prospects to prospects to hot prospects to adopter.
- ❑ Indexed firms to allow **multiple competitors**. Currently three: incumbent, startup1 and startup 2.
- ❑ Added **firm attractiveness** drivers to determine market share with multiple competitors.
- ❑ Expanded **human resource sector** to include rookie vs. experienced employees, and their respective experience and productivity.
- ❑ Indexed employees to track **sales force and engineers**.
- ❑ Added and integrated the **financial sector** from Oliva, Sterman and Giese (2003). It includes shares outstanding, stock options, financial market, balance sheet and income statement.
- ❑ Modified **job attractiveness** drivers to capture impact of financial rewards (including stock options) on employee retention.
- ❑ Added **operations and system costs of operating** the new product
- ❑ And more...

# Model Sectors

---

- Prospect Chain
  - Five stages from potential prospects to adopters
- Product Development
- Human Resource
  - Engineers vs. Sales force
  - Employee experience
  - Employee productivity and learning
  - Employee ownership structure (to be expanded)
- Financial Sector
  - Shares outstanding
  - Stock options
  - Financial market
  - Balance sheet
  - Income statement
- Competitors
  - Incumbent, Startup 1, Startup 2

# Management Flight Simulator:

## Case Scenario

---

- ❑ You are the CEO of a green technology startup company facing with competition from the existing incumbent and another startup.
- ❑ You have developed a superb technology that may cost more than the existing technology up front, but saves energy costs in the long run.
- ❑ You need to promote your product to customers through your sales force, while keep up product development by hiring, motivating and retaining engineers.
- ❑ You face resistance from potential clients who are unfamiliar with such technology
- ❑ You face competition from other startups and from the incumbent utility/energy provider, which may enter your market
- ❑ You have initial funding of \$x million to grow the company successfully from startup to success.
  
- ❑ To succeed, you need to make the following decisions...

# Management Flight Simulator: Decision Variables

---

- ❑ Employee hiring: headcount growth rate
- ❑ Employee allocation: engineers vs. sales
- ❑ Financing options: VC Financing, Employee Ownership
- ❑ Employee ownership structure: ESOP, options, stock grants?
  
- ❑ Tradeoff between transparency, usability and model complexity/realism, number of decisions people can make

# Management Flight Simulator: Game Interface

---

- ❑ Next few slides are screen shots of the beta version of the Clean Technology Startup Management Flight Simulator for illustration purpose.
- ❑ The first is the decision making screen followed by a reporting screen.
- ❑ We aim to use it for teaching at the Sustainability Lab (S-Lab) course at MIT Sloan School of Management.

## Decisions

Headcount 6 Mo.  
Growth Rate (%)
 ?
% of Employees  
As Engineers
 ?

VC Financing (\$)

 ?
Options as % of  
Compensation

Price Markup (%)

Quicksave Last Run as Run#:

## Simulate

Run 6 Months

Run to End

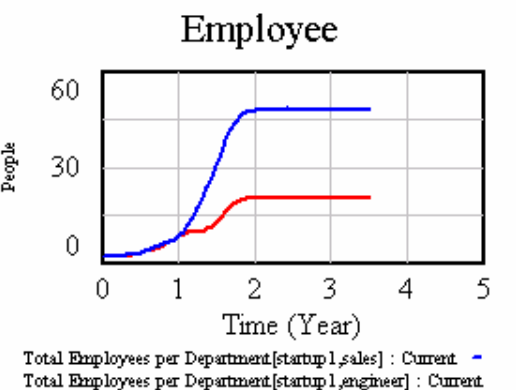
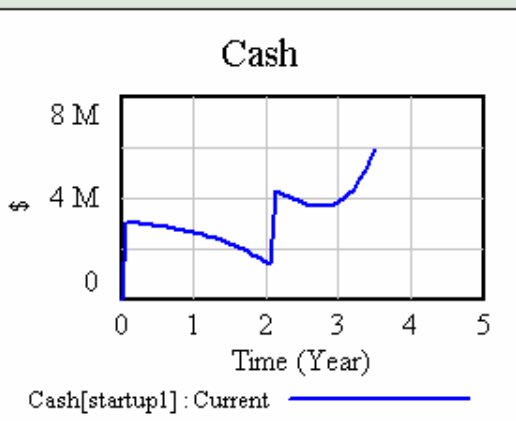
Backup

Restart

Main Menu

Change Scenario Settings

Print



## Overview

Startup1

Startup2

Incumbent

Cash (\$)	5.918 M	0	0
Burn Rate (\$/Year)	0	0	0
Runway (Year)	0	0	0
Annual Sales (Unit/Year)	182	0	0
Annual Revenue (\$/Year)	15.48 M	0	0
Annual Net Income (\$/Year)	426,678	0	0
NPV Cumulative Profit (\$)	-3.270 M	0	0
Features Rel to Incumbent	2.08	2.00	1.00
Price (\$/Unit)	79,173	120,000	120,000
Unit Cost (\$/Unit)	65,978	100,000	100,000
Sales Force (People)	48	1	1
Engineers (People)	20	1	1
Market Capitalization (\$)	479.53 M	0	0
Shares Outstanding (Share)	1.660 M	1 M	1 M
Founders Ownership (%)	60	100	100
VC Ownership (%)	32	0	0
Employee Ownership (%)	8	0	0
Public Ownership (%)	0	0	0

## Reports

Income Statement

Human Resource

Cash Flow

Product Development

Shares Outstanding

Sales

Compare Runs

View Scenario Settings

Analyze Runs

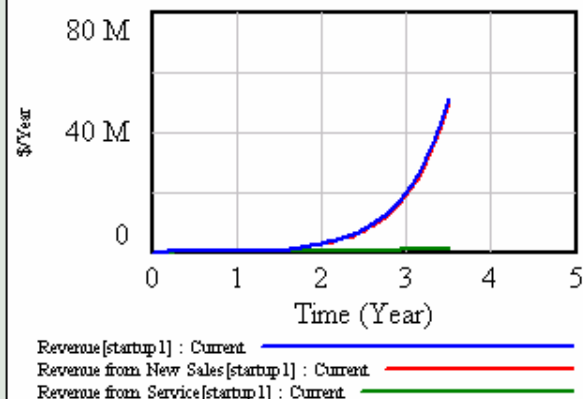
Sensitivity Analysis

# Annual Income Statement

Year: 4

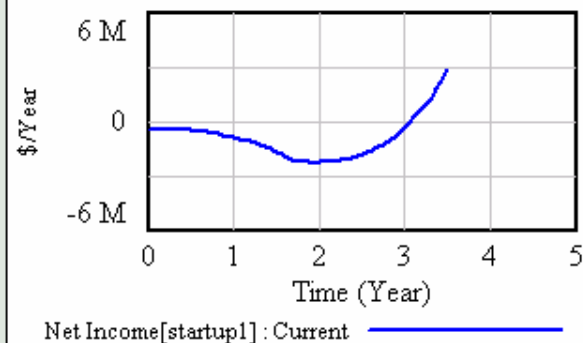
	Startup 1 (\$/Year)	Startup 2 (\$/Year)	(\$/Year)
Revenue	15.48 M	0	0
Cost of Goods Sold	12.58 M	0	0
<b>Gross Profit</b>	<b>2.901 M</b>	<b>0</b>	<b>0</b>
Salary Expense	1.392 M	0	0
General & Administrati	52,637	0	0
Marketing Expense	1.029 M	0	0
Depreciation	0	0	0
<b>Operating Income</b>	<b>426,678</b>	<b>0</b>	<b>0</b>
Extraordinary Charges	0	0	0
Tax	0	0	0
<b>Net Income</b>	<b>426,678</b>	<b>0</b>	<b>0</b>
Cumulative Profit (\$)	-3.483 M	0	0
NPV of Profit (\$)	-3.270 M	0	0
Consumer Price (\$)	79,173	120,000	120,000
Unit Direct Cost (\$)	65,978	100,000	100,000
Gross Margin (Rev Fraction)	0.18	0.00	0.00
Return on Sales (Rev Fraction)	0.03	0.00	0.00
Annual Purchases	182	0	0

Revenue

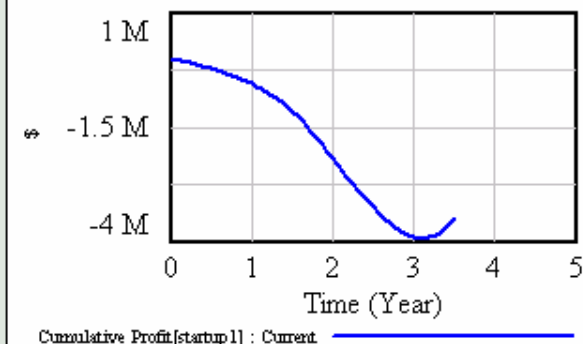


Print

Net income



Cumulative Profit



Return

# Shares Outstanding