"What's Model Rocketry Got to Do with Tech Startups in Silicon Valley"

By: John F. C. Cheong, Ph.D.

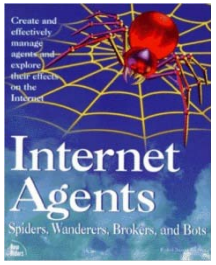
Rev.2016.0414

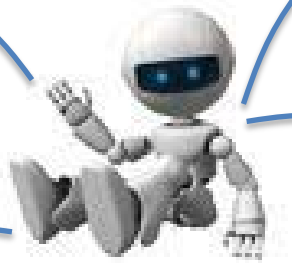
Feedback and comments to: johnc@spacemachine.net

My Silicon Valley Adventures

4 "FinTech" Blogger, Advisor, Trader

Researcher, Author, Angel 1





Entrepreneur "GPS+Map" 2

3 "EdTech" Co-founder + Investor

KidSpring

簡単取り付け!
3ステップで

使いやすいナビ機能!
行きたい場所を見つけやすい。

超薄! 超軽量!

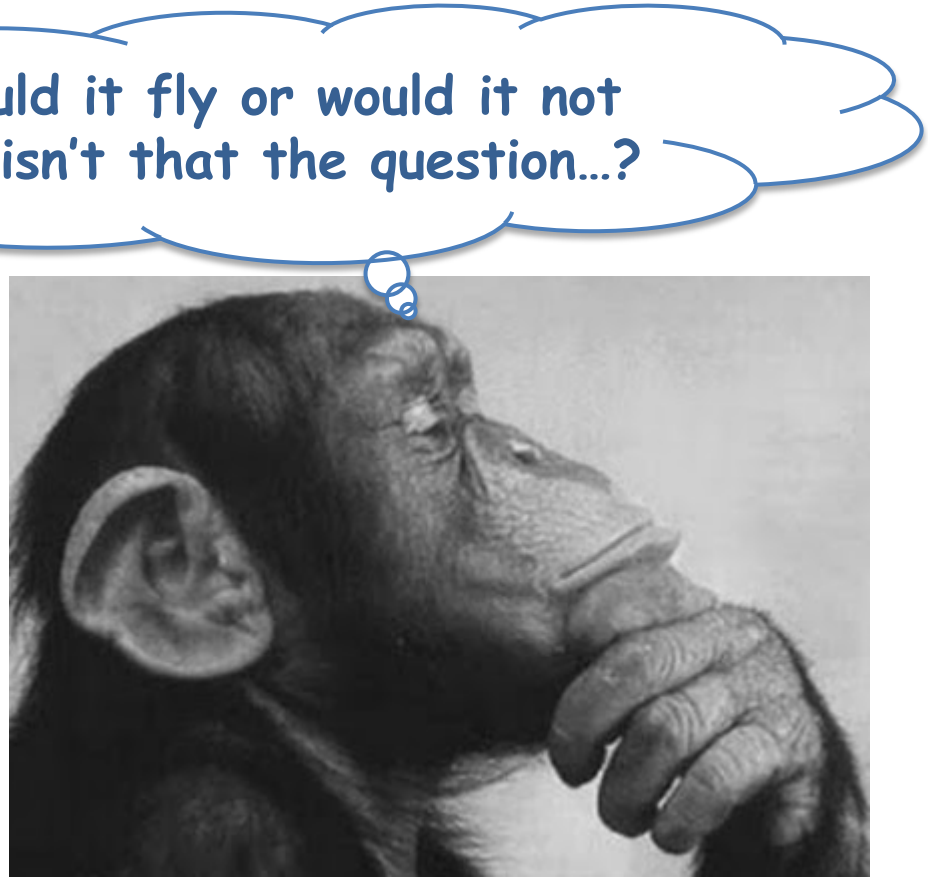
豊富なデータベース:
住所検索: 約 3,500万件
電話番号検索: 約 980万件
ジャンル検索: 約 420万件

充実の地図表示:
マップスケール: 50m～200km (12段階)
※ ZENRIN全国版道路地図を搭載しております。

Q: Do I Have "**Skill**"? Or Was I Just "**Lucky**"?

"**Spray & Pray**"

vs.



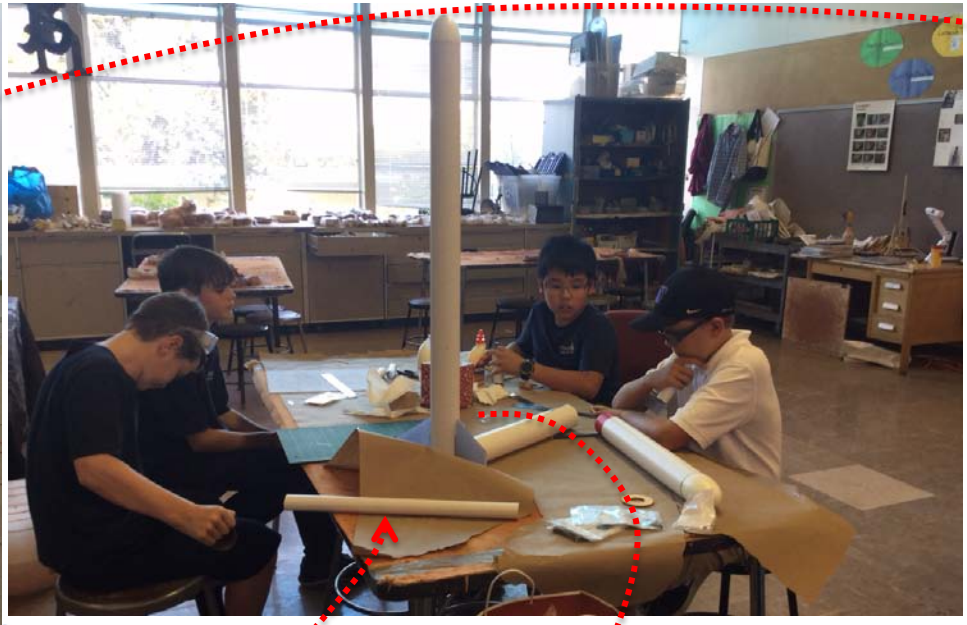
Ansatz (/'ænsæts/): an **educated** guess that is later verified by its results.

Alternatively: "Was I just **unlucky**, or did I really **screw up**?"

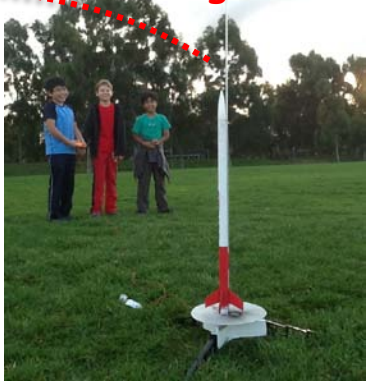
Just One Question: "Would it fly? Or Would it not fly?"

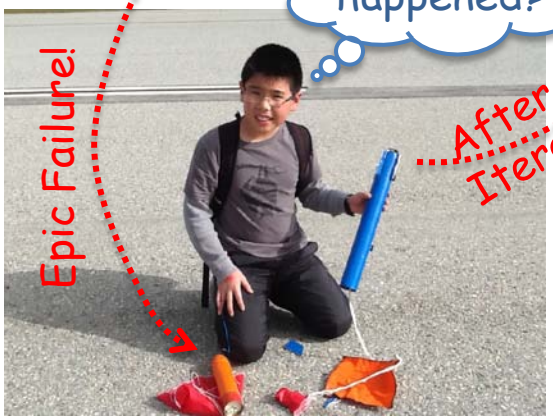
Not sure… but we'll keep **iterating** until we get it right!

How 12-Year-Old Rocketeers Learn to Overcome Challenges in the Field and Recover from Failures.

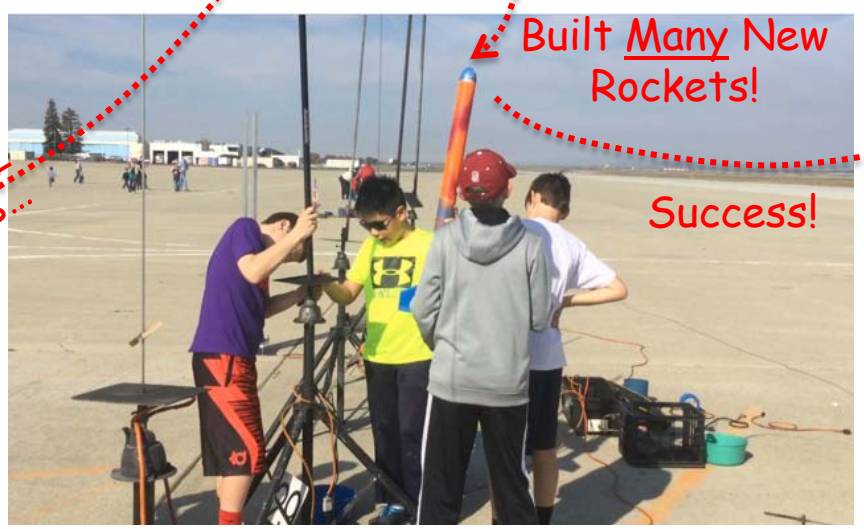


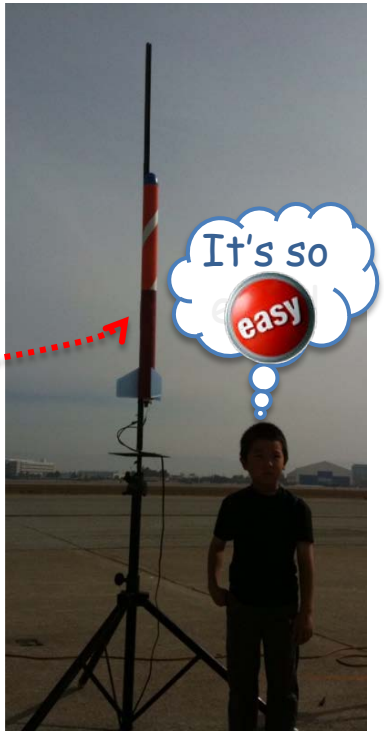
Recruiting Demo



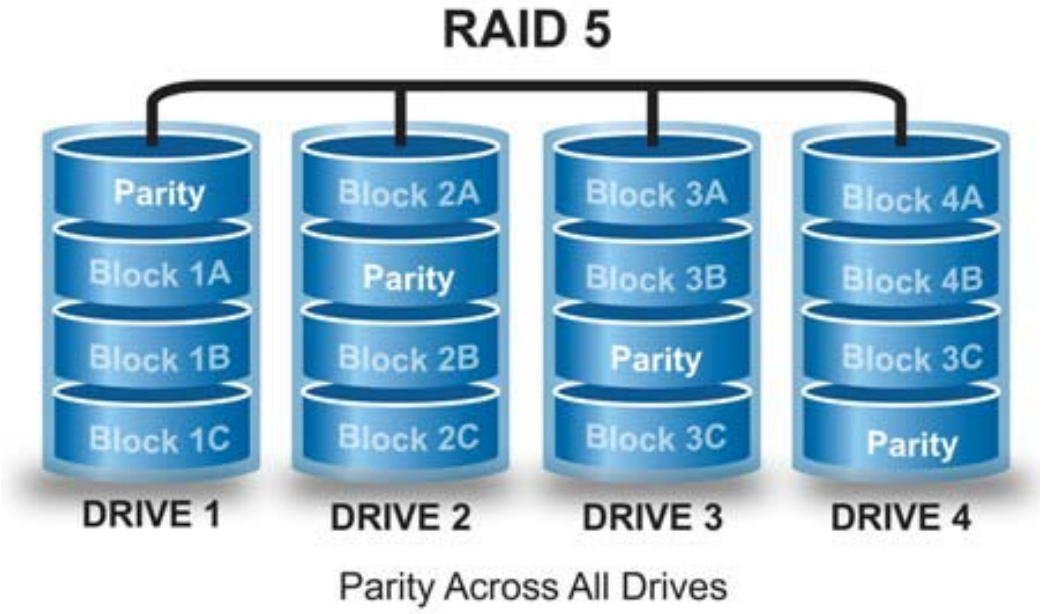


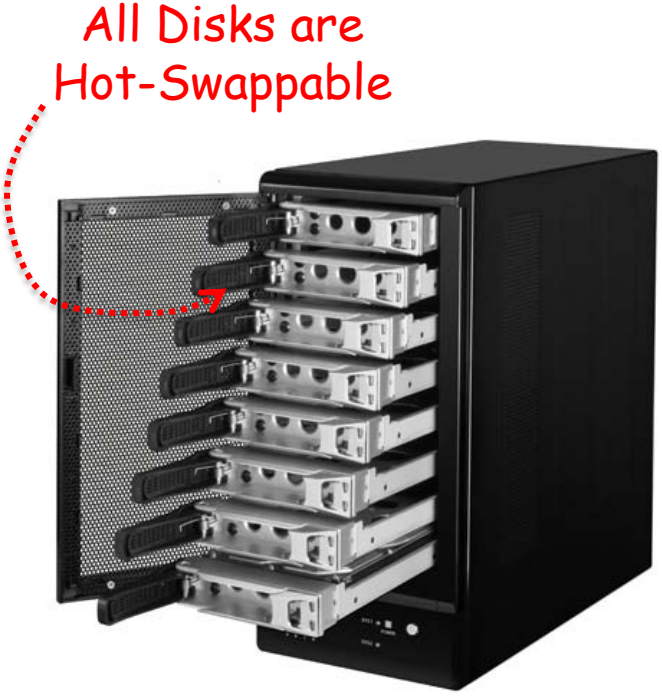
After Many Iterations...





A Source of Inspiration:
"Redundant Array of Inexpensive Disks" (RAID).



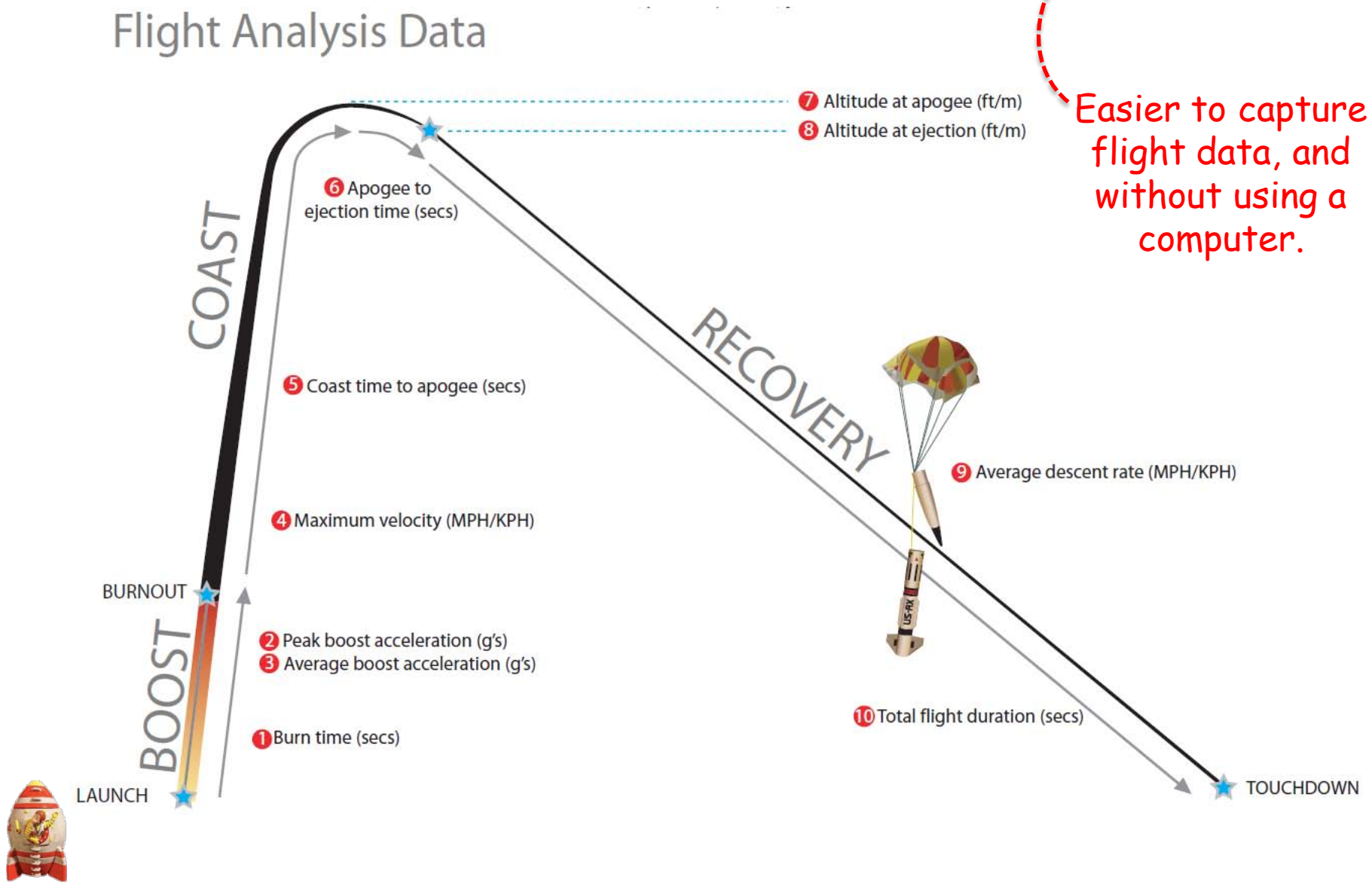


New ideas do not appear out of nowhere. The **SLED** vs. **RAID** idea can also be traced even further back to **CISC** vs. **RISC**.

How "**Assembly in Field**" can be Made a Lot Easier:

- Use simple modular designs so parts can be easily swapped
- Choose single-use motors that do not require assembly
- Use pre-slotted body tubes to minimize human errors
- Make payload section 9" long and booster section 18" long or vice-versa or both 18" (to fit BT-80 body tubes length of 18")
- Design rockets to have just 3 fins (instead of 4 fins)
- Have lots of 3D-printed fins prepared ahead of time (easier if each fin does not require cutting or sanding)
- Use quick-dry glue that does not dry too quickly (e.g., Epoxy)
- Is painting really necessary? Flying with bare body tubes OK?
- Label all rocket parts and organize them inside one big box
- **Keep It Super Simple**... and **Practice, Practice, Practice**!

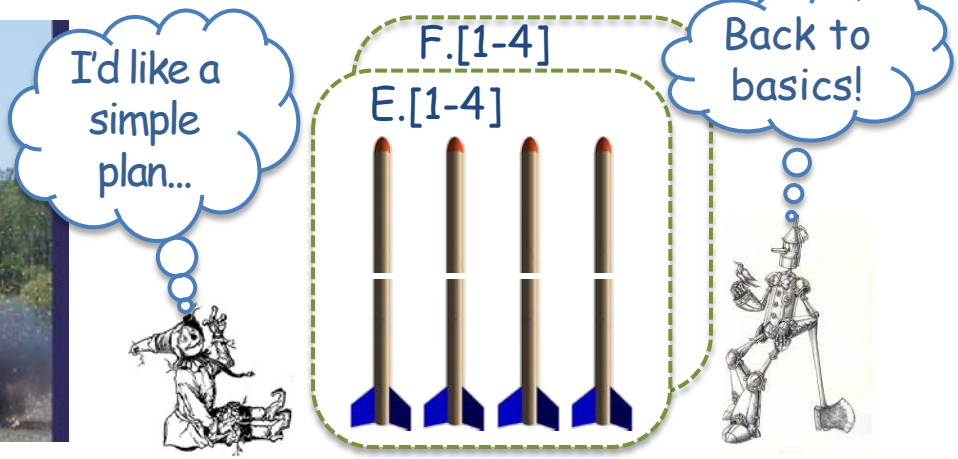
Flight Data Recording (Based on "Altimeter Two")



Easier to capture flight data, and without using a computer.

How Middle Schoolers Learn to "Battle Giants": Borrowing a Page from the "David and Goliath" Playbook.

team america rocketry challenge



"Advanced" Rocket(s) (e.g., Primary + Backup)

Sophisticated Large Expensive Rocket (SLER)

- Flight duration control is done onboard.
- Slow turnaround, takes longer to prep.
- Harder to fix when things go wrong.
- Backup may not fly the same as Primary.
- Physical rocket embodies the design.
- Variability (and noise) is costly.
- Division of labor by specialization.

VS.

"Just-A-Bunch-Of-Rockets" (JBOR)

Redundant Array of Almost Identical Rockets (RAAIR)

- Flight duration calibrated by humans.
- Fast turnaround, rapid field iteration.
- Easy to repair or replace any parts.
- All rockets basically fly the same way.
- Rockets are just instances of design.
- Variability can be harnessed with data.
- Addition of "build-fly-mod" capacity by all.

TARC 2016 "**Build-Fly-Mod**" Workflow: Venues, Times and Dates (Updated: 2016.0324)

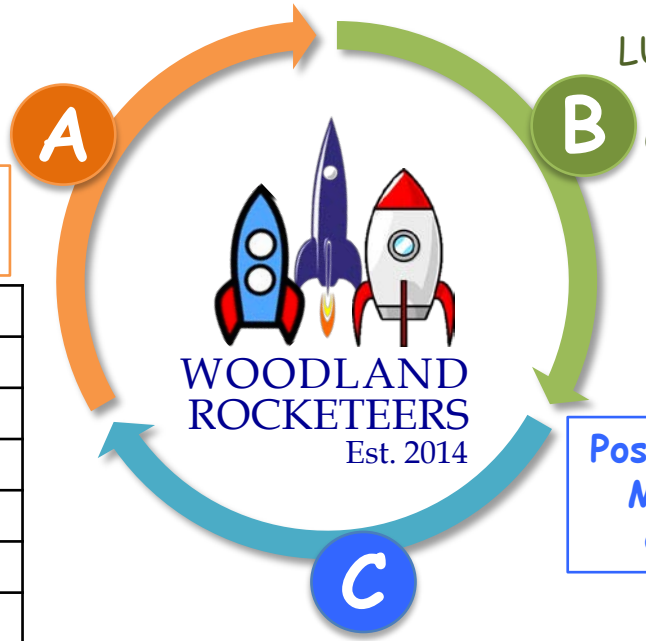
"Build Sessions"

Open Studio @ Woodland School
(Wed. 3:30pm-5:00pm)
Rocket "E": Oct 14 & 21;
Rocket "F": Nov 18;
Prepare Poster: Dec 2.

Assemble, Paint, Repair or Modify Rockets

2015.0926	"Kickoff" Meeting #1	✔
2015.1014	Build Session #1	✔
2015.1021	Build Session #2	✔
2015.1024	**Fly Session #1**	✔
2015.1031	"Post-Flight" Meeting #2	✔
2015.1118	Build Session #3	✔
2015.1121	**Fly Session #2**	✔
2015.1202	Build Session #4	✔
2015.1205	"Demo Day" Meeting #3	✔
2015.1219	~~**Fly Session #3**~~ **(rain!)**	×
2016.0116	~~**Fly Session #4**~~ **(rain!)**	×
2016.0123	"Pre-Flight" Meeting #4	✔
2016.0220	**Fly Session #3**	✔
2016.0227	"Pre-Qual" Meeting #4	✔
2016.0319	**Fly Session #4 (Qual!)**	✔

Fly Rockets and Record Flight Data



"Fly Sessions"

LUNAR Launches @ Moffett Field
(Sat. 9:00am-1:00pm)
Oct 24, Nov 21, ~~Dec 19~~, ~~Jan 16~~,
Jan 28, Feb 4, Feb 11, Feb 20,
Mar 3, Mar 10, Mar 16,
Mar 19 & **Mar 26** (Last Call!).

Post-Flight Analyses, Model Calibration or Design Mods

"Rocketeer Meetings"

Big Room @ Belmont Library
(Sat. 1:00pm-2:30pm)
Sept 26, Oct 31,
Jan 23, **Feb 27**.

D

"Demo Day"

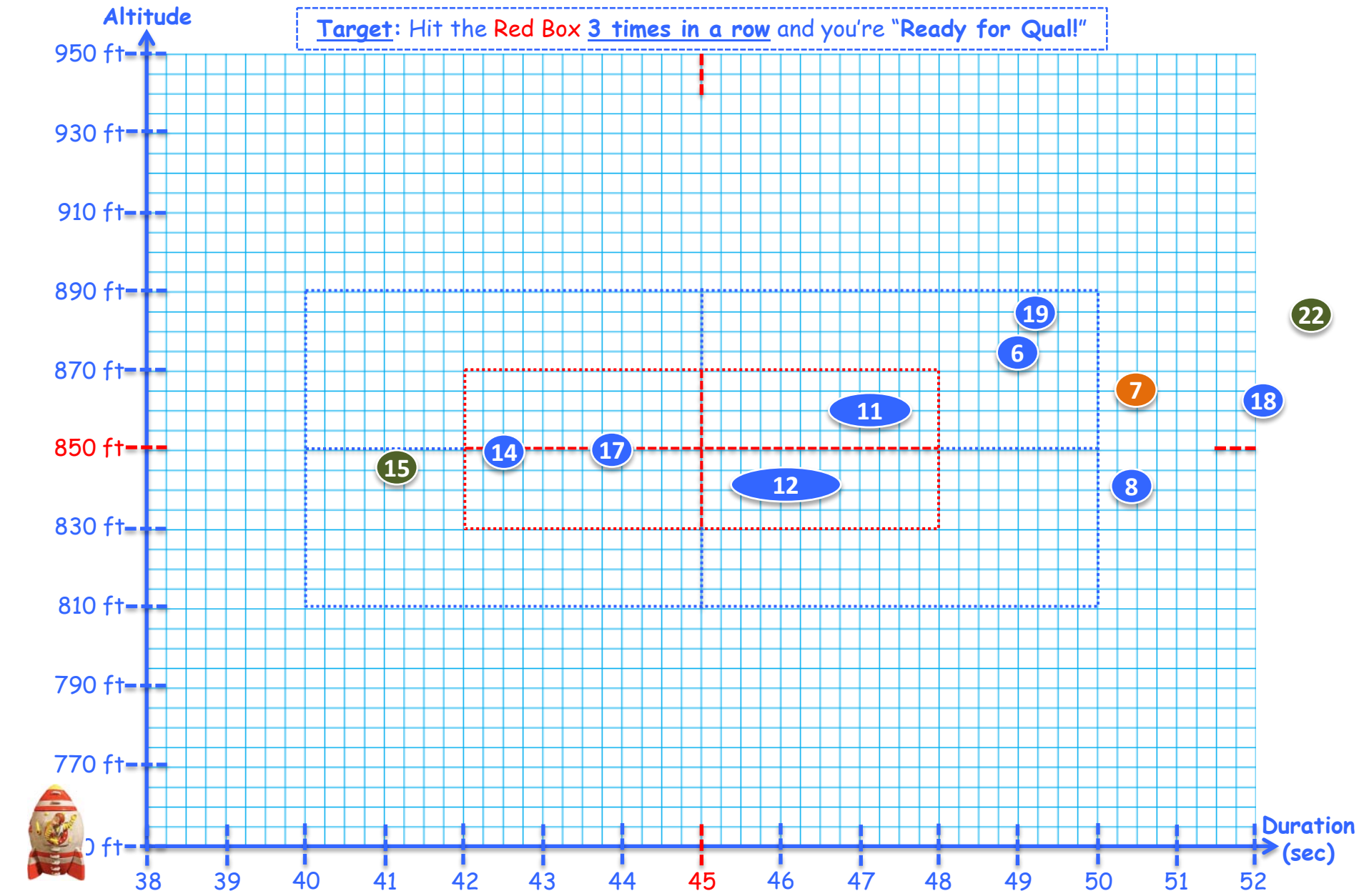
Open House @ Woodland School
(Sat. 10:00pm-12:00pm)
Dec 5, 2015.

Note: Get ready for qual. on **Mar 19**... And (last chance) **Mar 26**!
Build 2 new rockets ("F.5", "F.7") and repair current "F.3".

TARC 2016 LUNAR Launches @ Moffett Field

2015.10.24			1	2		3	4		
2015.11.21			5			6	7		
2015.12.19	Cancelled due to rain…								
2016.01.16	Cancelled (again!) due to rain								
			8 mph wind						
2016.02.20			7						
2016.03.19			15				16		
2016.03.26		19	20		21	22			

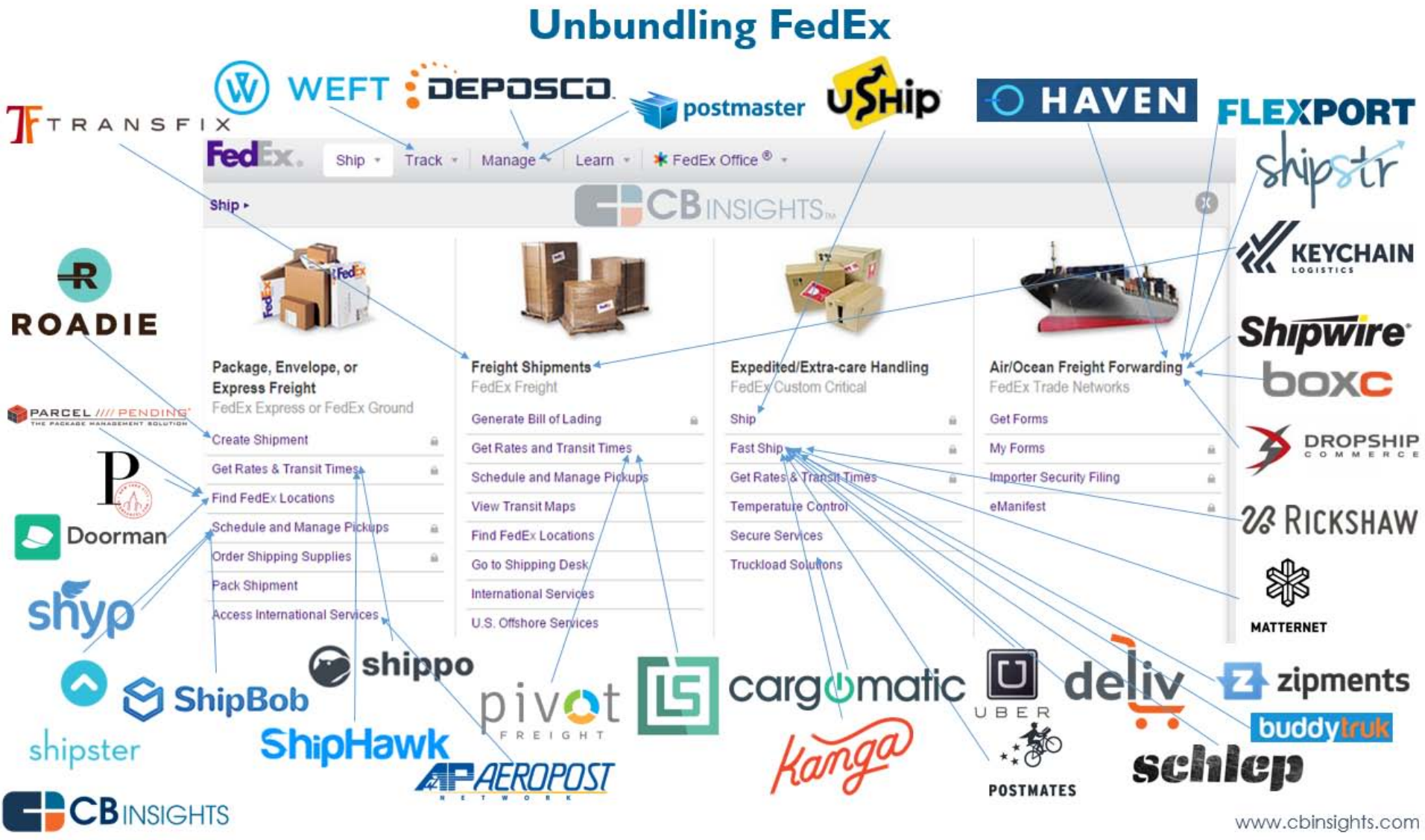
Woodland Rocketeers **Score Graph** (Last: 2016.03.26):



Pick A Good Arrow, Keep Calm and **Streeeeetch**...

... and try to qualify by March 26, 2016.

"Death by a Thousand Arrows": The Startups Unbundling FedEx, UPS and the Logistics Industry.



Taking on the Banking Behemoths: FinTech Startups Unbundling Wells Fargo, Citi and Bank of America.

Lean Startup Changes Everything!

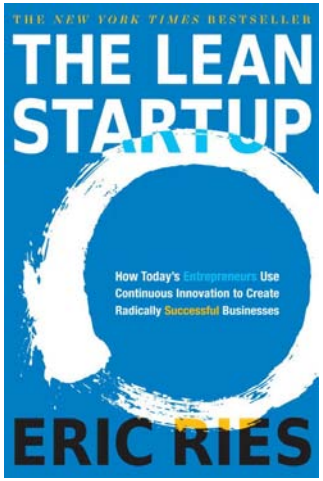
"It is easier than ever to start a new company. Buy a domain name (NameCheap or GoDaddy or dozens of others), spin up a website (SquareSpace or WordPress), have a logo crowd-sourced (99designs or Fiverr), do the legal paperwork to register a corporation (Legalzoom or RocketLawyer), and for under $1K you've got a company. Start an online store (Shopify or BigCommerce) or get your brick-and-mortar operation up and running (Square or PayPal). Amazon will rent you just about any part of their business, from hosting to warehousing to transaction processing. You can even raise investment capital online with a whole crop of crowd-funding startups of various stripes (AngelList, CircleUp, IndieGoGo, Kickstarter, Tilt, LendingTree, Kabbage). You can build products using 3D printing, or use Alibaba to source manufacturers in China. It is hard to imagine businesses that are immune to small scale competition — airplane manufacturing, perhaps. Or pharmaceuticals, although even in drug manufacturing trends toward personalized medicine make the current hegemony likely to be short-lived." — Nicco Mele

"The competitive advantages of scale are being commoditized. Minimum efficient scale is getting *smaller and smaller*." — Maxwell Wessel

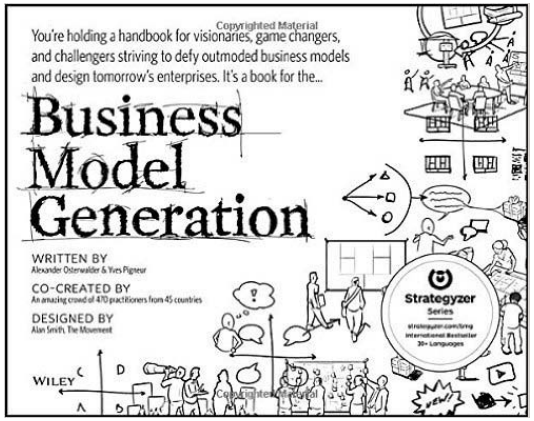
Tech Startup Guides:

(You Probably Have Too Many So Here's How to Organize!)

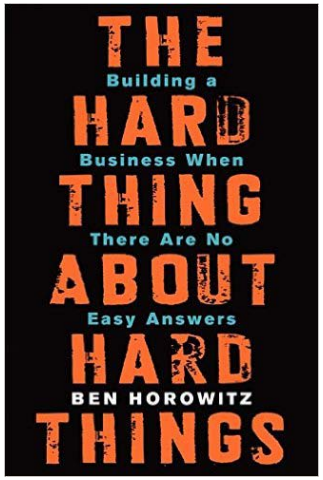
1 Your starter book: "Must read"!



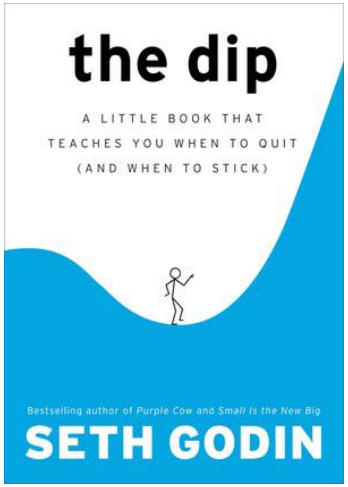
2 Language of business model: "Got to have"!



3 Going gets tough?

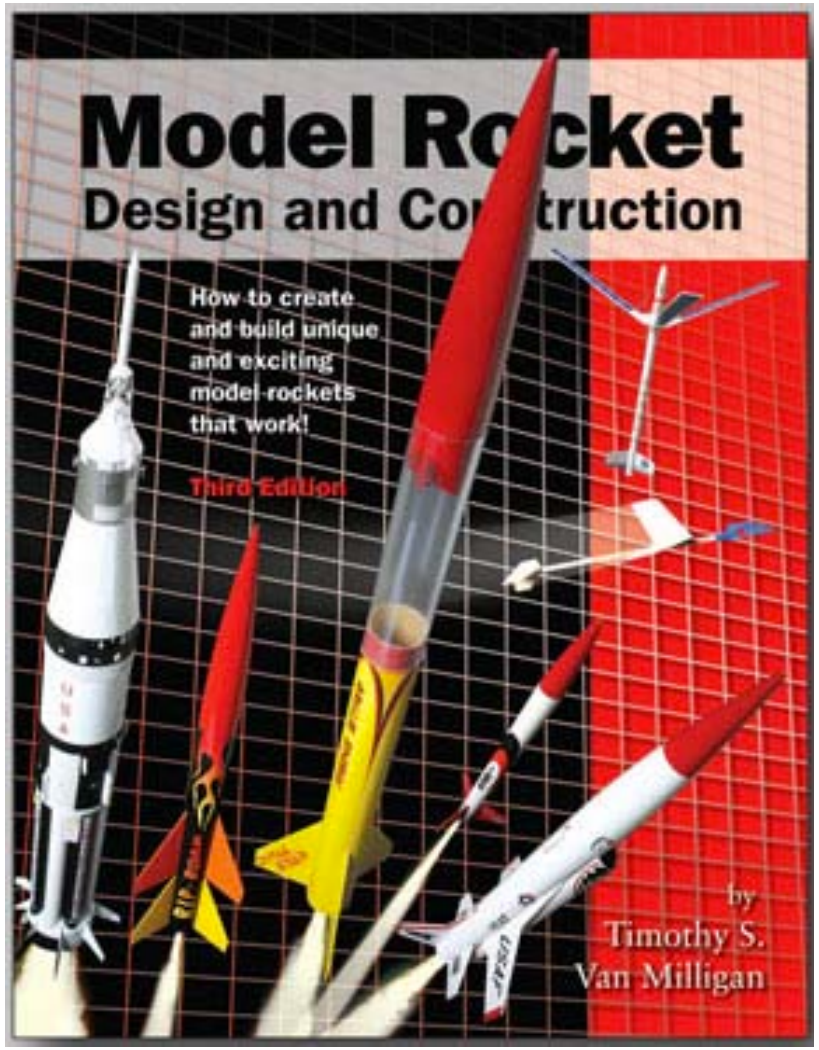


4 Which way out?



And go read these books… so you can actually make sense of this new dialect!

Model Rocket Resources:

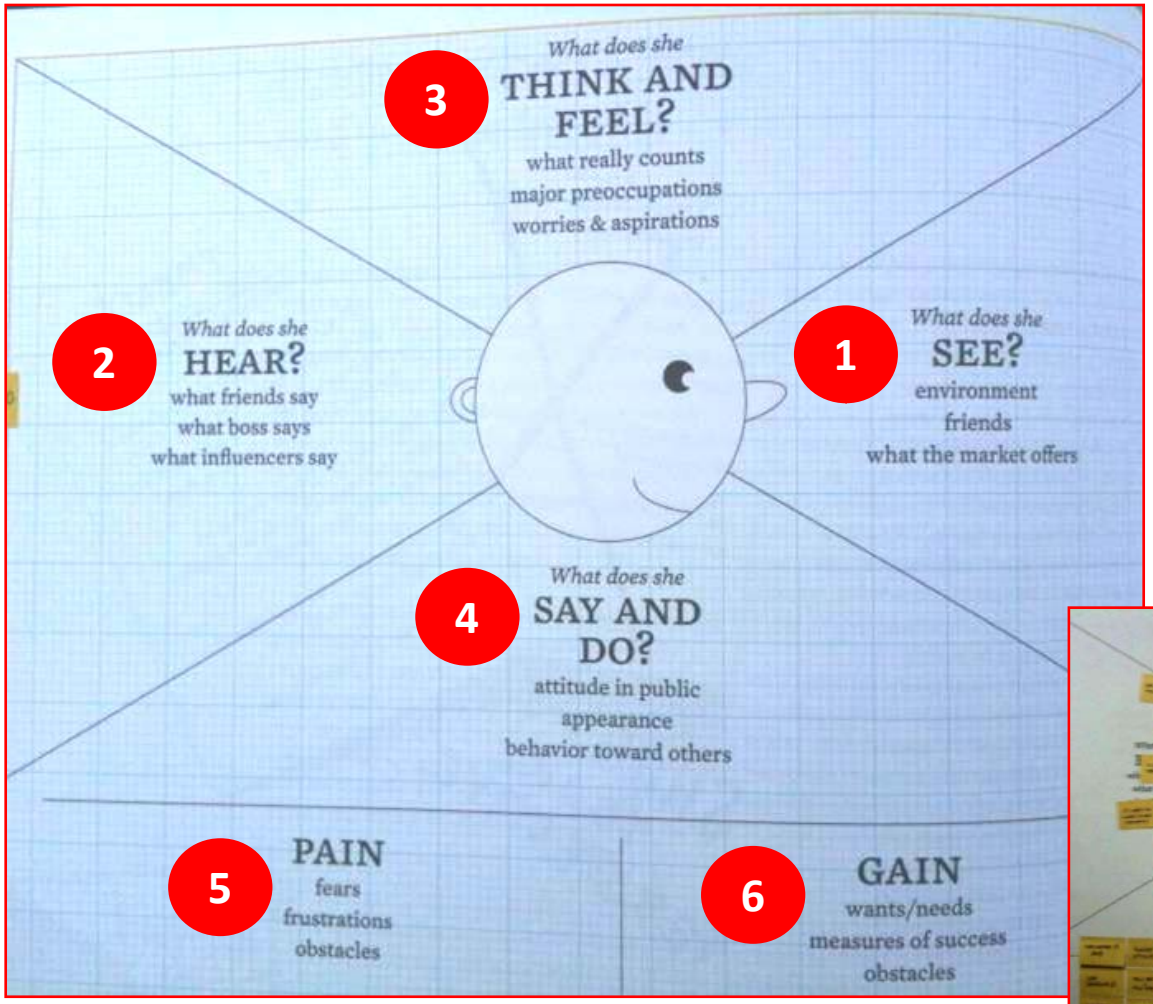


So You Want to be a Rocketeer Videos:
Video #1: Design and Construction
Video #2: Stability
Video #3: How (Not) to Fly

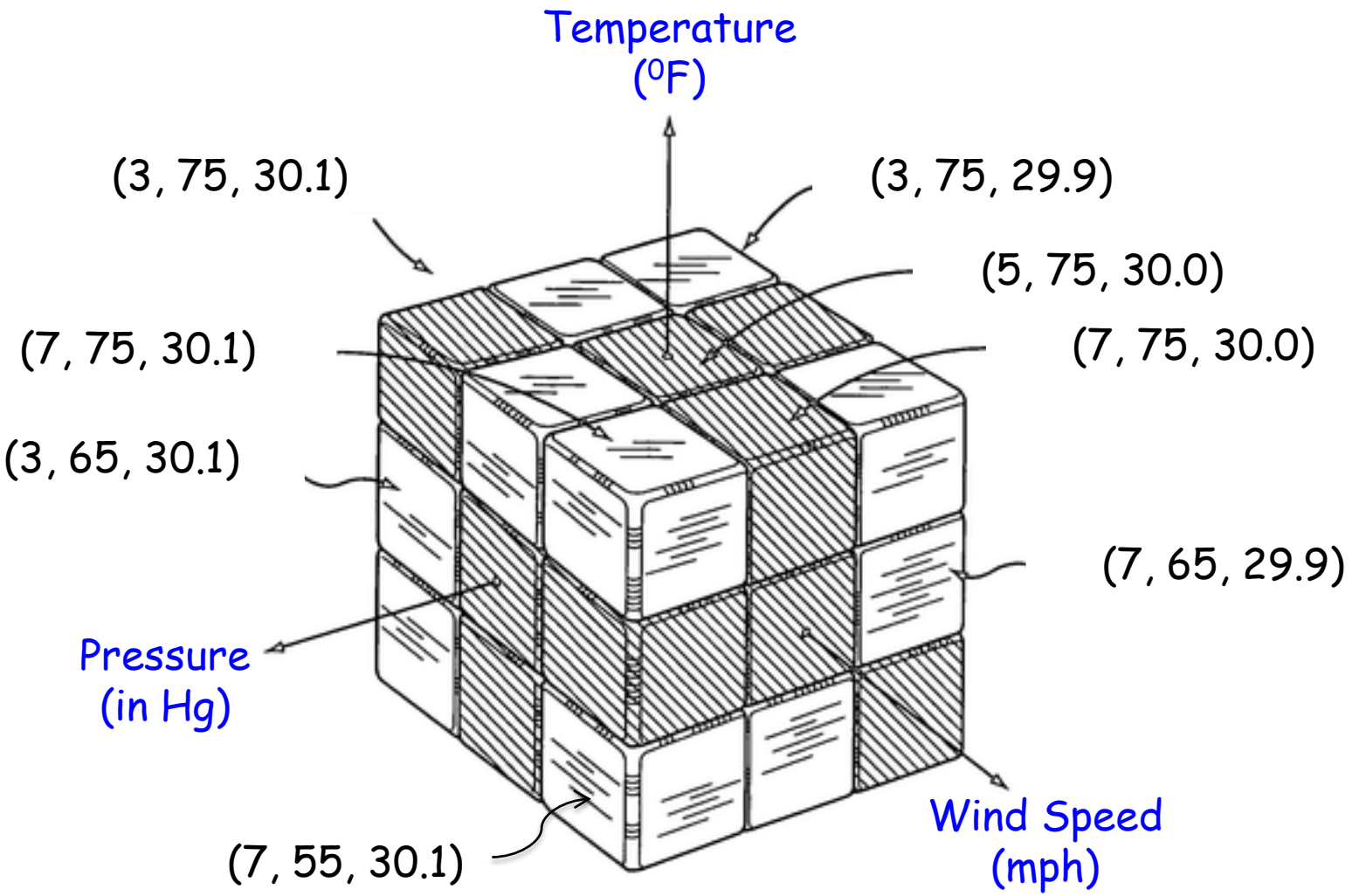
TARC: www.rocketcontest.org
NAR: www.nar.org
Estes: www.esteseducator.com
Apogee: apogeerockets.com
Quest: www.questaerospace.com
Hobby: www.hobbylinc.com

This is Rocketry (NAR Introduction)
2016 Team Handbook (must read!)
Student TARC Handbook (must read!)
Lesson #LD02 The Model Rocket
Lesson #LD03 Laws of Motion
Lesson #LD04 Aerodynamics
Lesson #LD05 Rocket Stability
Model Rocketry Curriculum (it's all here!)
Adventures in Rocket Science (NASA)

Know Your Customer (First Hand!) & "Never Delegate Understanding"



"Weather Cube" Specified

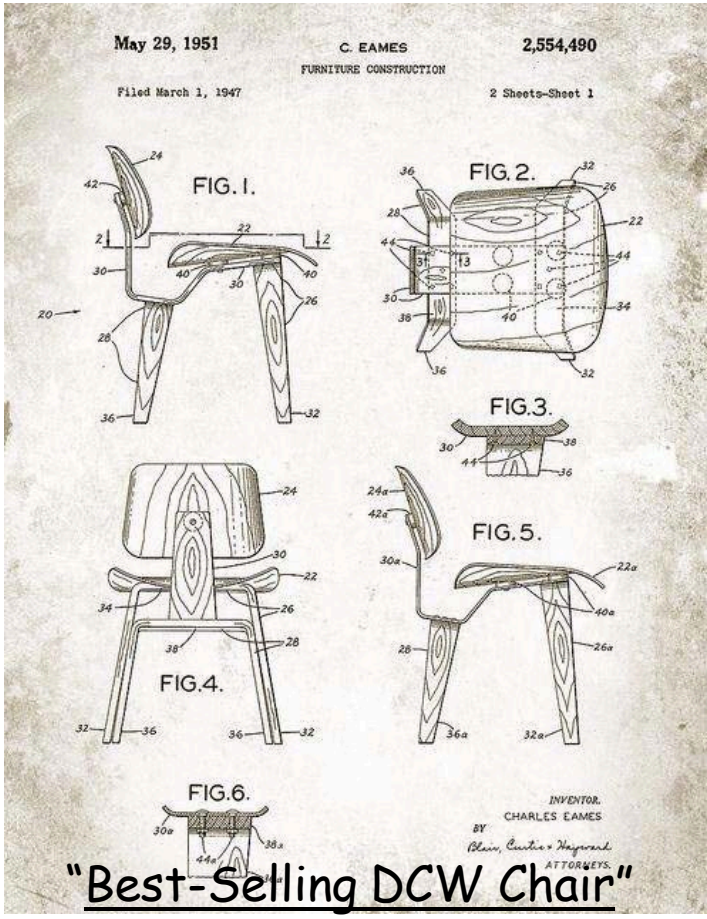


How Does One Go About Making Design Choices? A Design Contest Case Study.

"Eames-Saarinen Chair"

The winning trick? Work through 3,000 studies of the components of your problem; **twice**. It might be a trick, but it sure isn't a shortcut!

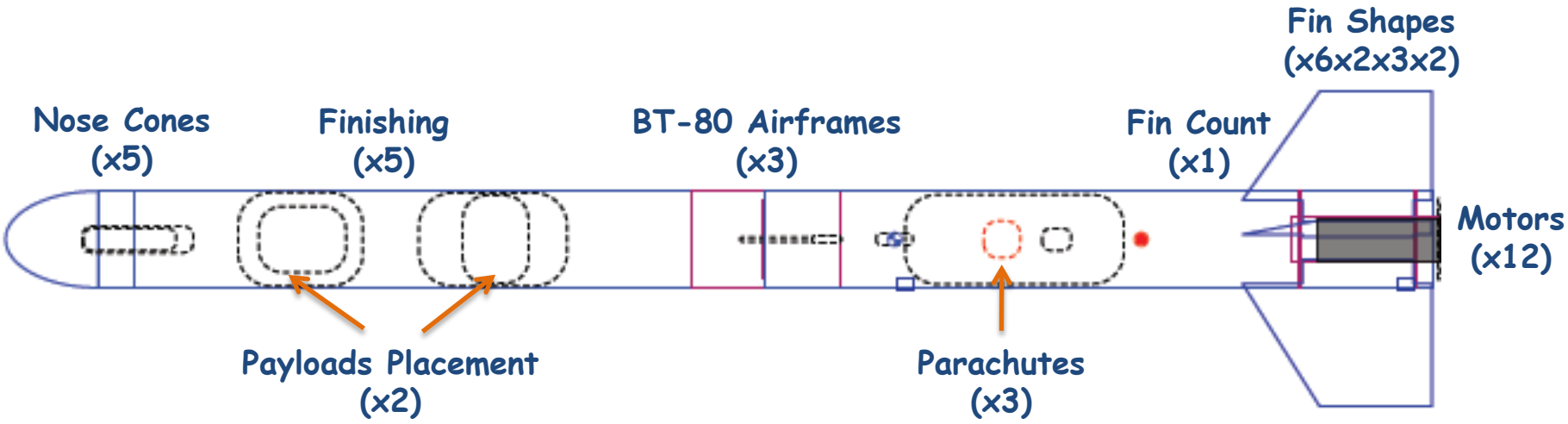
But the winning design was too complex and too expensive to manufacture. The designers Charles Eames and Eero Saarinen learned their lessons. Charles later built a successful design firm with his wife, Ray.



"Best-Selling DCW Chair"

Their Secret? "**Never Delegate Understanding**" (e.g., to tools like Open Rocket!). Whether encountering a new technology, a new material, or a new idea, Charles and Ray Eames **explored its constraints deeply themselves** before bringing it into the office where others joined in.

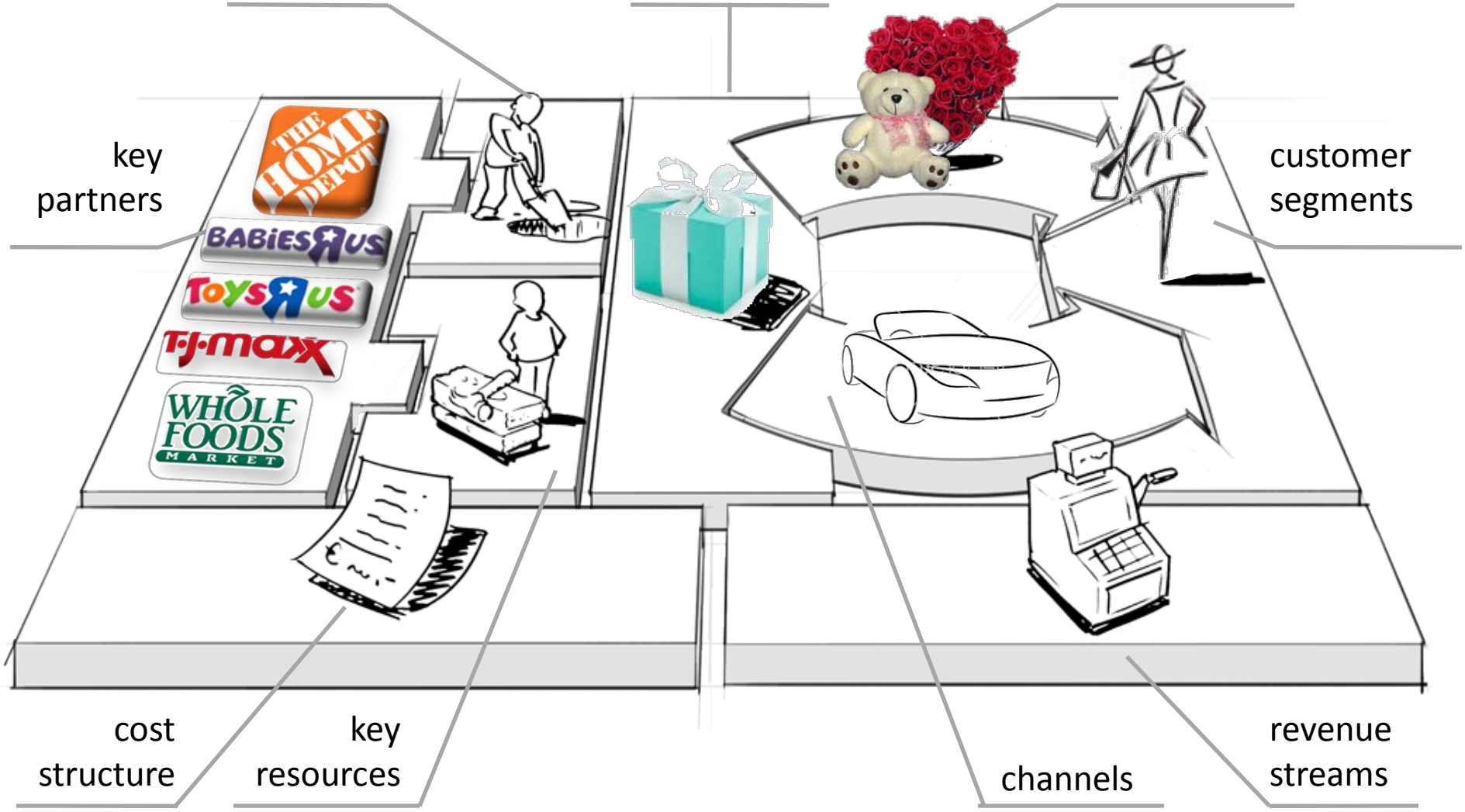
So…, What are the Design Choices for Just A "**Basic**" Rocket? Let's Count Them **All**:



Fin Shapes = { Rectangular, Swept, Tapered Swept, Clipped Delta, Trapezoidal, Elliptical }
X { Straight, Canted } X { Symmetrical, Cambered, Spin-Tabbed } X { Wedged, Airfoiled }
Fin Count = { 3 }
Nose Cones = { Conical, Ogive, Elliptical, Parabolic, Sears-Haake }
Airframes = { 18-9, 9-18, 18-18 }
Motors = { F10, F15 } U { F25, F26 } U { F20, F23, F27, F42, F50 } U { F30, F32, F44 }
Payloads = { Stand-Sleep, Sleep-Stand }
Parachutes = { 15", 18", 24" }
Finishing = { None, Nose Only, Top-Half, Nose & Bottom-Half, Full-Body }

Q: How many total design combinations? **Answer: 388,800.**
Let's not also forget about fin and nose cone dimensions, materials (e.g., density, structure, infill and shells, etc.) and finishing.

Business Model Design = 9 "Building Blocks"



Business Model = "Short Version" of a Business Plan

BUSINESS PLAN: *The "Full Story"*

EXECUTIVE SUMMARY

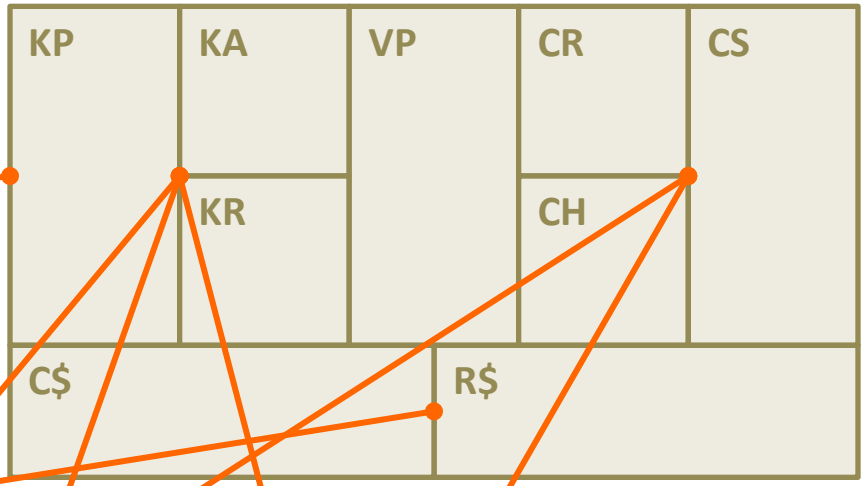
1. THE TEAM
- Management Profile
- Why We Are a Winning Team

2. THE BUSINESS MODEL
- Vision, Mission, and Values
- How Our Business Model Works
- Value Proposition
- Target Markets
- Marketing Plan
- Key Resources and Activities

3. FINANCIAL ANALYSIS
- Breakeven Analysis
- Sales Scenarios and Projections
- Capital Spending
- Operating Costs
- Funding Requirements

4. EXTERNAL ENVIRONMENT
- The Economy
- Market Analysis and Key Trends
- Competitor Analysis
- Competitive Advantages of Our Business Model

BUSINESS MODEL: *The "Short Story"*



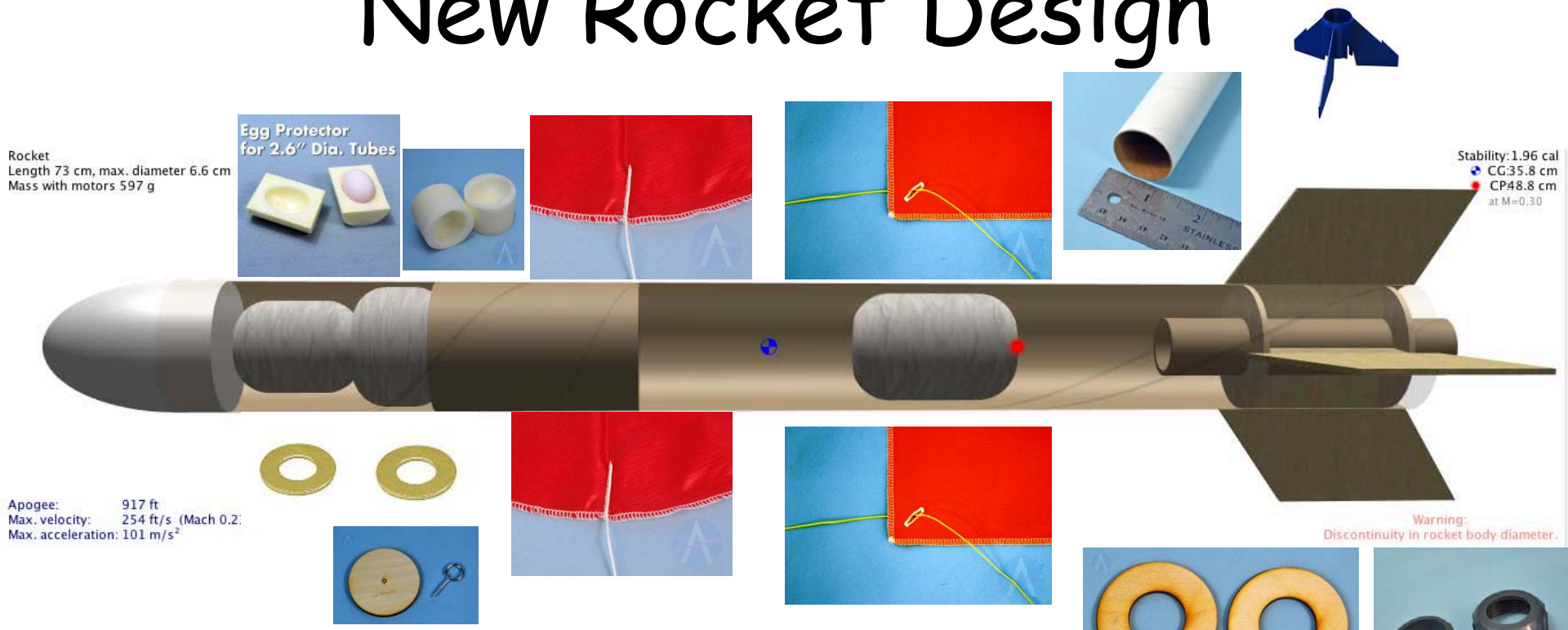
5. IMPLEMENTATION ROADMAP
- Projects
- Milestones
- Roadmap

6. RISK ANALYSIS
- Limiting Factors and Obstacles
- Critical Success Factors
- Specific Risks and Counter-measures

CONCLUSION

APPENDIX

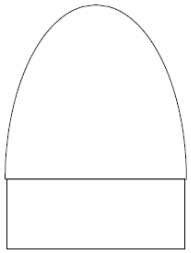
New Rocket Design

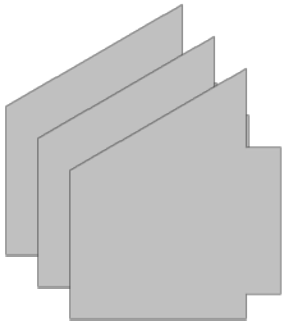


New Design Features:

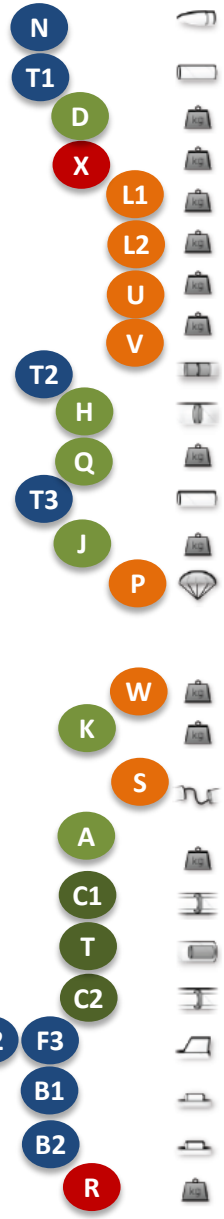
- Two 15-inch parachutes for a smoother descent
- Pre-slotted body tubes allowing less chance of human error
- Stronger F42-8T motors to push extra weight
- 2 parachute protectors to prevent burning the parachutes
- Brass washers as ballast for more flexibility adjusting range of altitude

Rocket "F" Parts + F50-9T Motor ("Dense Air, Windy")





Spin-Tabbed Airfoil
(aka "Spinneron")
12% in-fill @ 3 shells



Nose Cone	Styrofoam (generic EPS) (0.02 g/cm³)	Ellipsoid	Len: 6.35 cm	Mass: 4.58 g
Payload Section	Cardboard (0.68 g/cm³)	Diain 6.5 cm Diaout 6.6 cm	Len: 45.7 cm	Mass: 32 g
Altimeter Sled		Diaout 1.8 cm		Mass: 5 g
Altimeter (Pnut)		Diaout 1.5 cm		Mass: 7.4 g
Egg A		Diaout 4.5 cm		Mass: 60 g
Egg B		Diaout 6 cm		Mass: 60 g
Egg A Protector		Diaout 6.4 cm		Mass: 19.5 g
Egg B Protector		Diaout 6.35 cm		Mass: 23 g
Tube Coupler	Cardboard (0.68 g/cm³)	Diain 6.4 cm Diaout 6.5 cm	Len: 10.2 cm	Mass: 7 g
Bulkhead	Plywood (birch) (0.63 g/cm³)	Diaout 5.4 cm	Len: 0.2 cm	Mass: 2.89 g
Eye Bolt		Diaout 0.3 cm		Mass: 5 g
Booster Section	Cardboard (0.68 g/cm³)	Diain 6.5 cm Diaout 6.6 cm	Len: 45.7 cm	Mass: 32 g
Snap Swivel #5		Diaout 0.5 cm		Mass: 1 g
Parachute (Booster)	Ripstop nylon (67 g/m²)	Diaout 45.7 cm	Len: 2.5 cm	Mass: 14 g
Shroud Lines	Braided nylon (2 mm, 1/16 in) (1 g/m)	Lines: 6	Len: 50 cm	
Reusable Wadding		Diaout 6.1 cm		Mass: 24 g
Snap Swivel #7		Diaout 0.5 cm		Mass: 1 g
Shock Cord	Elastic cord (flat 19 mm, 3/4 in) (1.2 g/m)		Len: 152 cm	Mass: 1.83 g
Shcok Cord Anchor		Diaout 0.8 cm		Mass: 2 g
Centering Ring (Fore)	Plywood (birch) (0.63 g/cm³)	Diain 3 cm Diaout 6.5 cm	Len: 0.2 cm	Mass: 3.29 g
Inner Tube (Motor)	Cardboard (0.68 g/cm³)	Diain 2.9 cm Diaout 3.1 cm	Len: 10.2 cm	Mass: 6.51 g
Centering Ring (Aft)	Plywood (birch) (0.63 g/cm³)	Diain 3 cm Diaout 6.5 cm	Len: 0.2 cm	Mass: 3.29 g
Trapezoidal Fin Set (3)	ABS (0.6 g/cm³)	Thick: 0.476 cm		Mass: 106 g
Rail Button (Fore)	PVC (1.39 g/cm³)	Diain 0.61 cm Diaout 0.81 cm	Len: 1.14 cm	Mass: 2.7 g
Rail Button (Aft)	PVC (1.39 g/cm³)	Diain 0.61 cm Diaout 0.81 cm	Len: 1.14 cm	Mass: 2.7 g
Motor Retainer		Diaout 5.5 cm		Mass: 11.1 g

High-Thrust Motor

M

Mass: 84g

F50-9T Motor

Rocket "F"

435g + 84g => 519g

Mass (with motor): 514 g

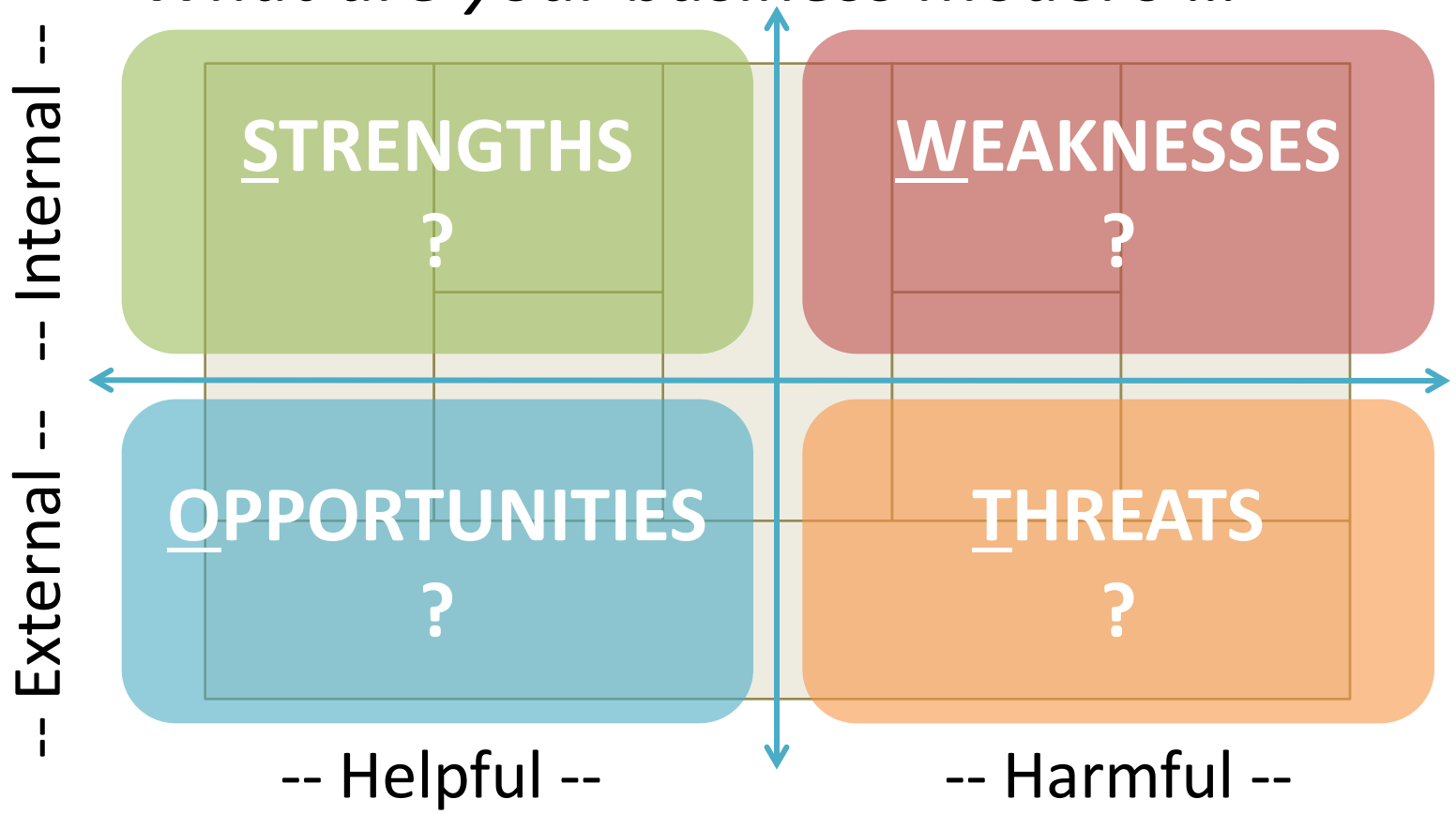
Stability: 2.56 cal

CG: 61 cm

CP: 77.9 cm

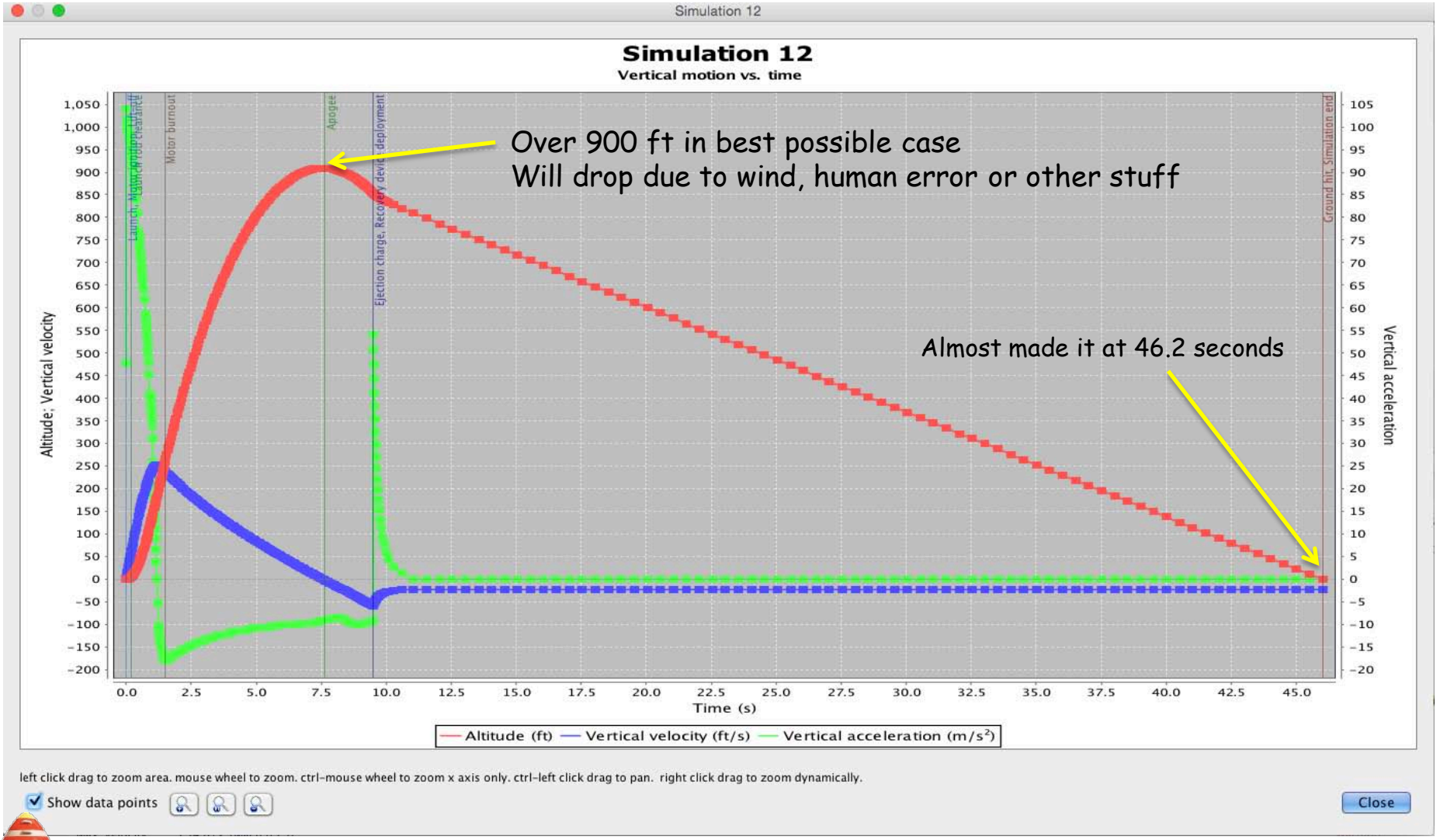
How SWOT Analysis Tool Can be Used to Evaluate Business Models Methodically

What are your business model's …

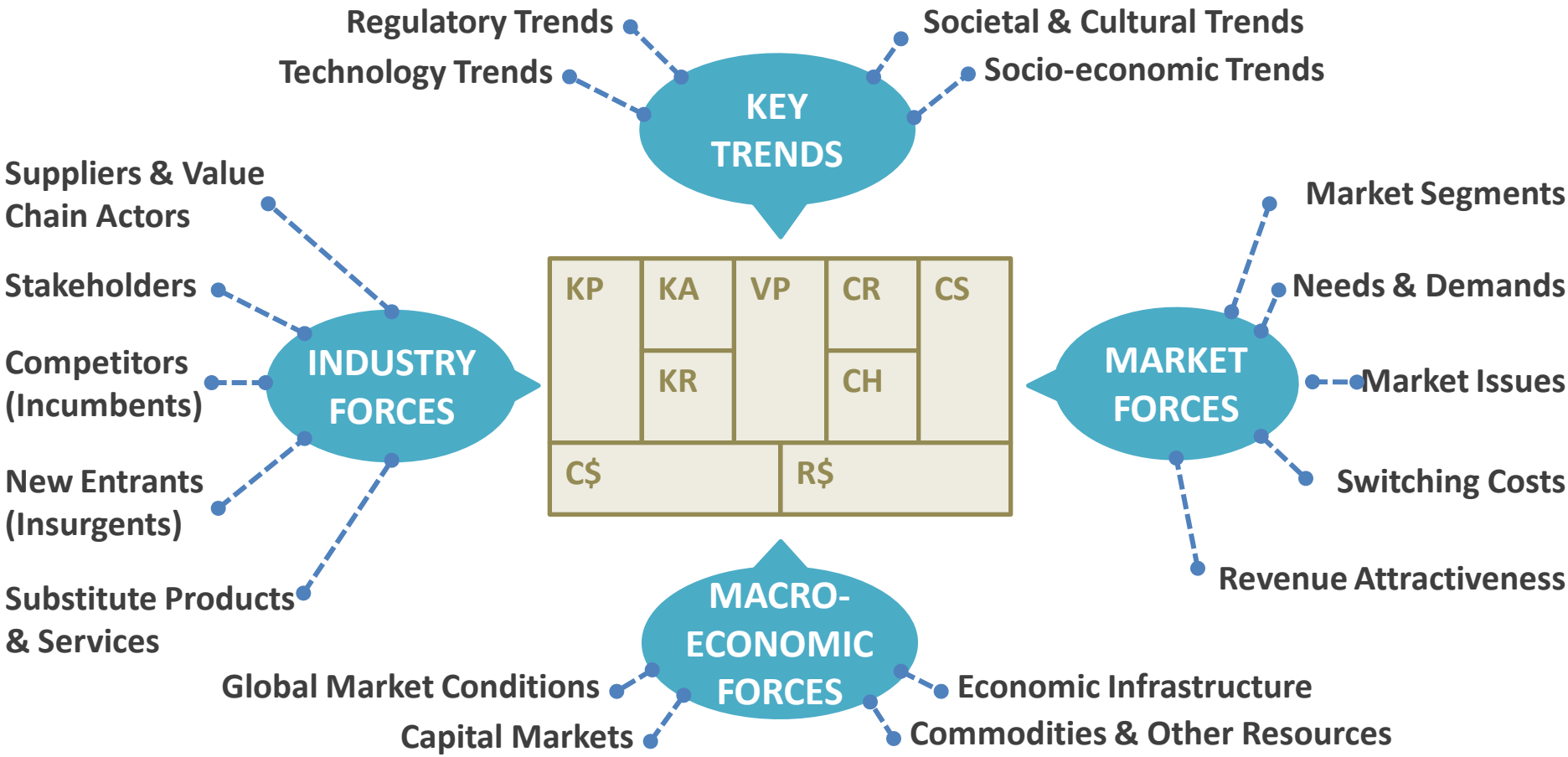


SWOT analysis is like a questionnaire that provides a focused assessment of the business model and each of its 9 Building Blocks by asking 4 sets of simple questions around: Strengths, Weaknesses, Opportunities & Threats.

Preliminary Simulation Results from OpenRocket:



Business Models Evolve to Adapt to Changing External Environments



Business models are designed and executed in specific environments. So the external environment is like a "design space" for business models.

Model Rockets Must Similarly Adapt to Changed Weather Conditions on Qualification Day!

WEATHER UNDERGROUND | Maps & Radar | Severe Weather | News & Blogs | Photos & Video | Activities | More

Popular Cities: New York, NY 60.6 °F Clear | London, UK 55 °F Clear | Chicago, IL 55 °F Clear | Boston, MA 48.9 °F Partly Cloudy | Houston, TX 75.8 °F Overcast | San Francisco, CA 59.4 °F Partly Cloudy

Moffett Field, CA
Moffett Federal Air Field

Forecast | History | Calendar | Rain / Snow | Health

Weather History for KNUQ - March, 2016

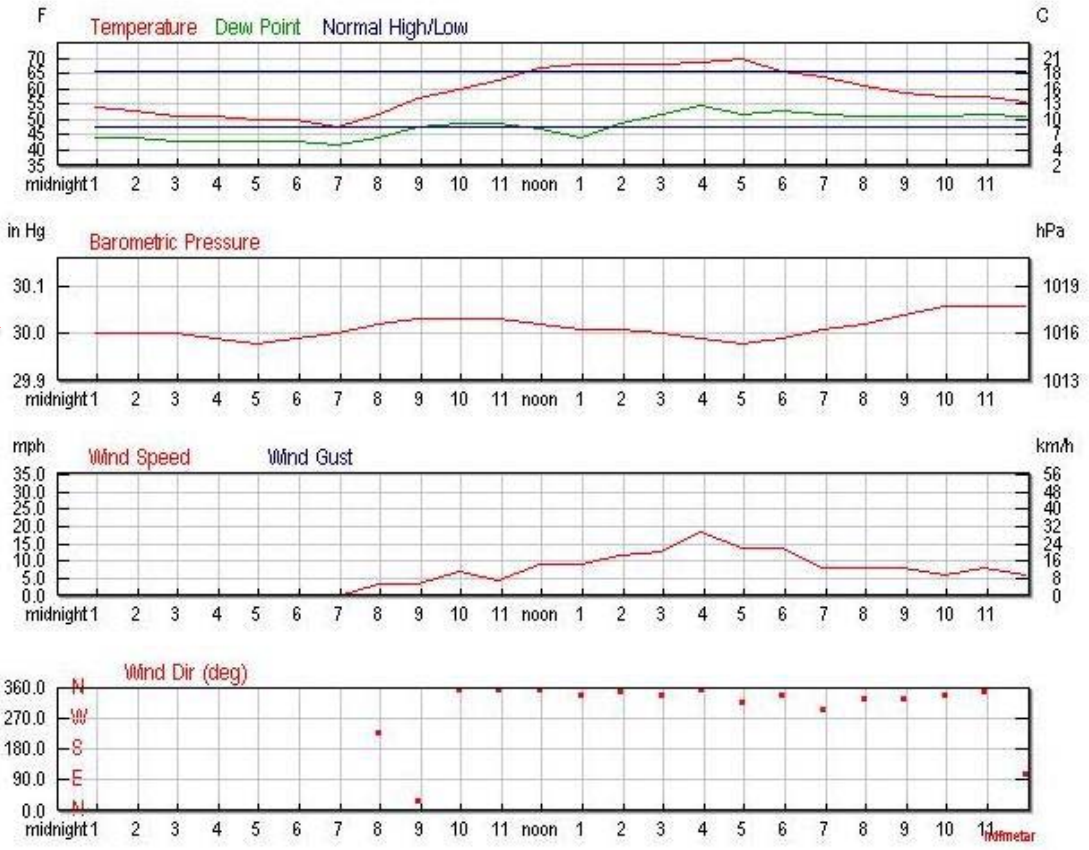
Change the Weather History Date: March 26 2016

Saturday, March 26, 2016

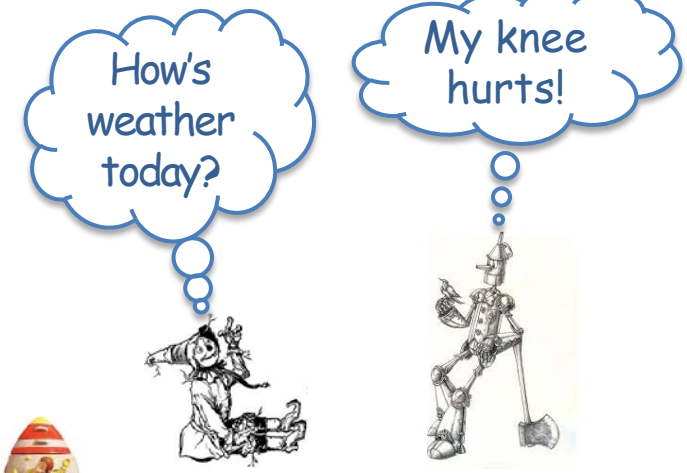
« Previous Day

Daily | Weekly | Monthly | Custom

Daily Weather History Graph

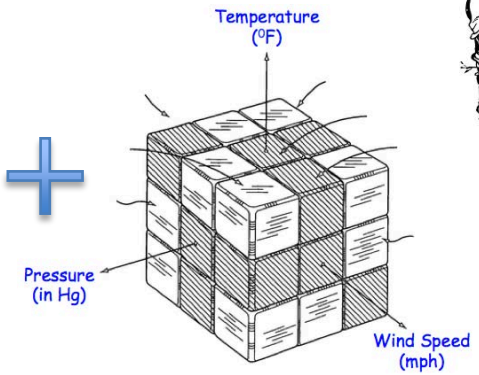


Low Pressure!



A Method for Calibrating to Weather Conditions and Matching to Rocket Builds in the Field based on Flight Data:

Rocket Design Completed



"Weather Cube" Specified

Open Rocket

Straw-man	OK?
#1	OK
#2	OK
#3	OK
. . .	OK
#26	OK
#27	OK
Min	OK
Max	OK

Simulate Design w/ "**Strawman**" Model

Test Flight

Flight	OK?
#1	DQ
#2	DQ
#3	OK
. . .	OK
#7	DQ
#8	OK

Record Flight Data

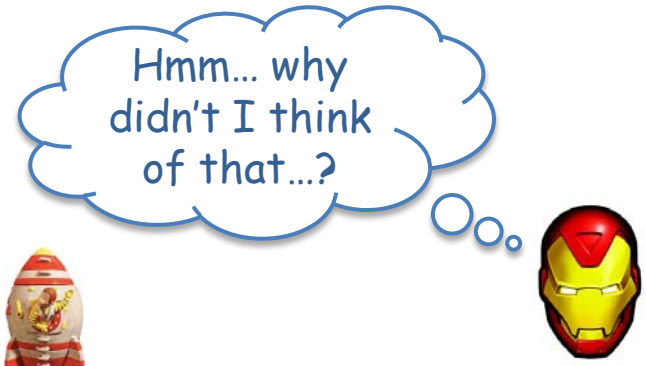
Find Matching Builds

Open Rocket

Tin-man	OK?
#1	OK
#2	OK
#3	OK
. . .	OK
#26	OK
#27	OK
Min	OK
Max	OK

Adjust to Improve "**Tinman**" Model(s)

Calibration



Remember: Rapid **iteration** **in the field** is key (because no design is ever "bullet-proof").

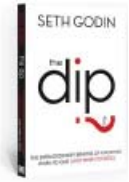
When to *Quit, Stick* or *Pivot*?

> *"Many of life's failures are people who did not realize how close they were to success when they gave up."*
>
> — Thomas Edison (1847-1931)

> *"Quitters never win and winners never quit."*
>
> — Vince Lombardi (1913-1970)

> *"If at first you don't succeed, try, try again. Then quit. There's no point in being a damn fool about it."*
>
> — W.C. Fields (1880-1946)

> *"Winners quit all the time. They just quit the right stuff at the right time."*
>
> — Seth Godin, "The Dip" (2007)



> *"The people who are the best in the world specialize at getting really good at the questions they don't know."*
>
> — Seth Godin, "The Dip" (2007)

> *"Being able to persist is not the most important thing – the ability to start over is."*
>
> — F. Scott Fitzgerald (1896-1940)

> *"The greatest accomplishment is not in never failing, but in rising again after you fall."*
>
> — Vince Lombardi (1913-1970)

Just One More Thing: Remember to "**Stretch**"!

You learn best when you're stretching yourself… beyond your previous level of comfort:

"You want to be stretched to the edge of your ability sometimes. It needs to be hard and uncomfortable. That's how your brain grows. We learn when we're in our discomfort zone.

"When you're struggling, that's when you're growing stronger and smarter. The more time you spend there, the faster you learn. It's better to spend an extremely high quality ten minutes growing, than it is to spend a mediocre hour running in place.

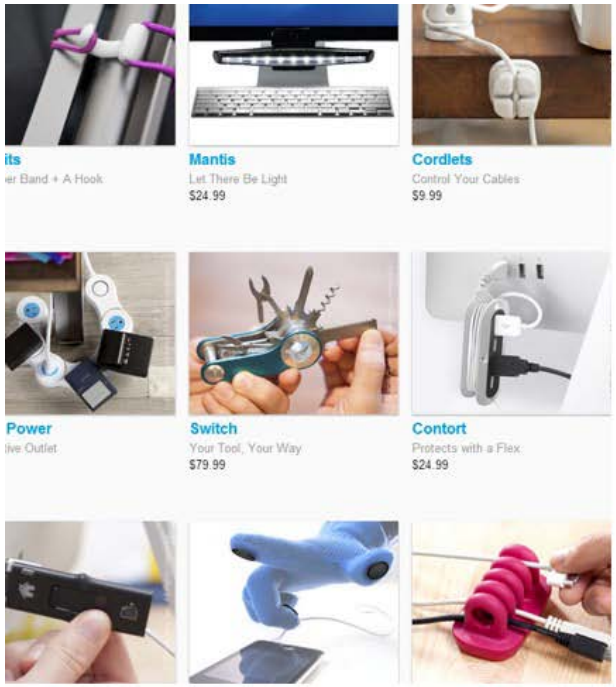
"You want to practice at the point where you are on the edge of your ability, stretching yourself over and over again, making mistakes, stumbling, learning from those mistakes and stretching yourself even farther.

— Excerpted from: marc & angel HACK LIFE

Case Study: The Curious Case of "Quirky"

Quirky: 4,000 ideas a week, 1 million inventors on board => many products. But Quirky never iterated over its products.

A good company builds one product, learns from the field, and iterates to make that product exceptional. E.g., GoPro's HERO.



VS

After many iterations…

Lesson: "Lack of iteration" can be fatal, even with good designs and great teams!


That's all Folks!