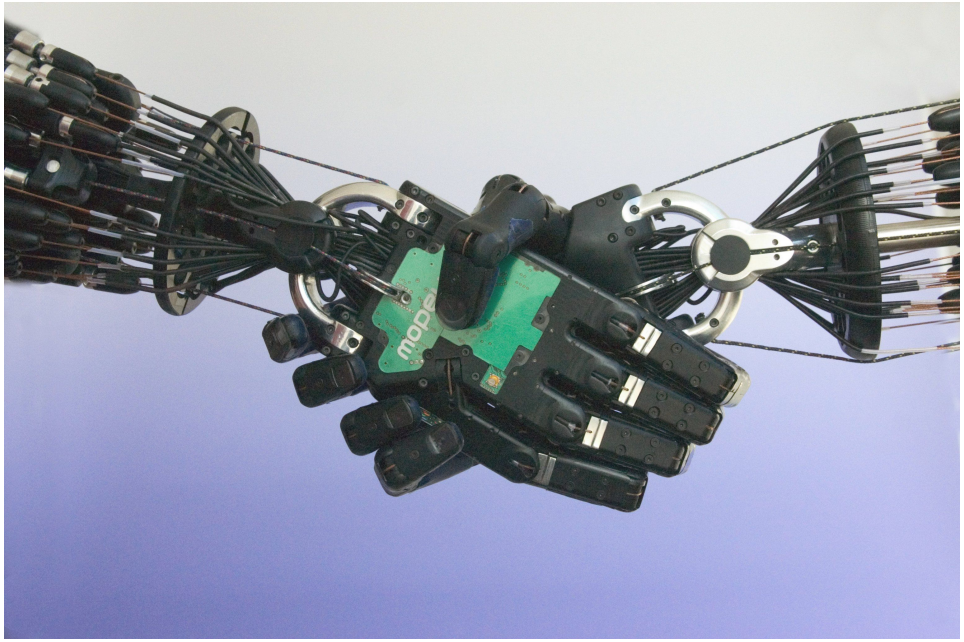
Innovation and Robotics



Rich Walker

Managing Director

rw@shadowrobot.com

Shadow: developer of robot hands for manipulation systems.

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Structure of the talk

- Introduction to Shadow. Why do we care about innovation?
- Product lifecycle and markets
- Which new products?
- Canvasses for development
- Funding R&D
- Next steps with our technologies

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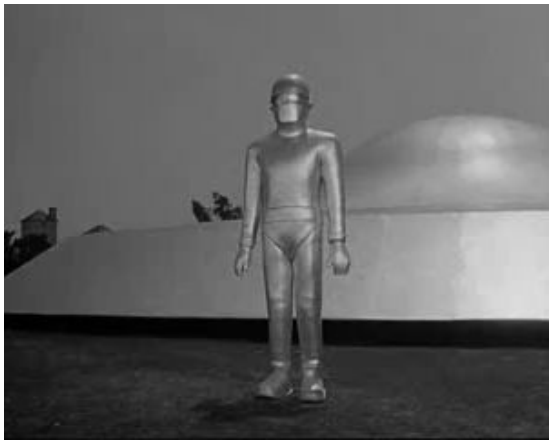
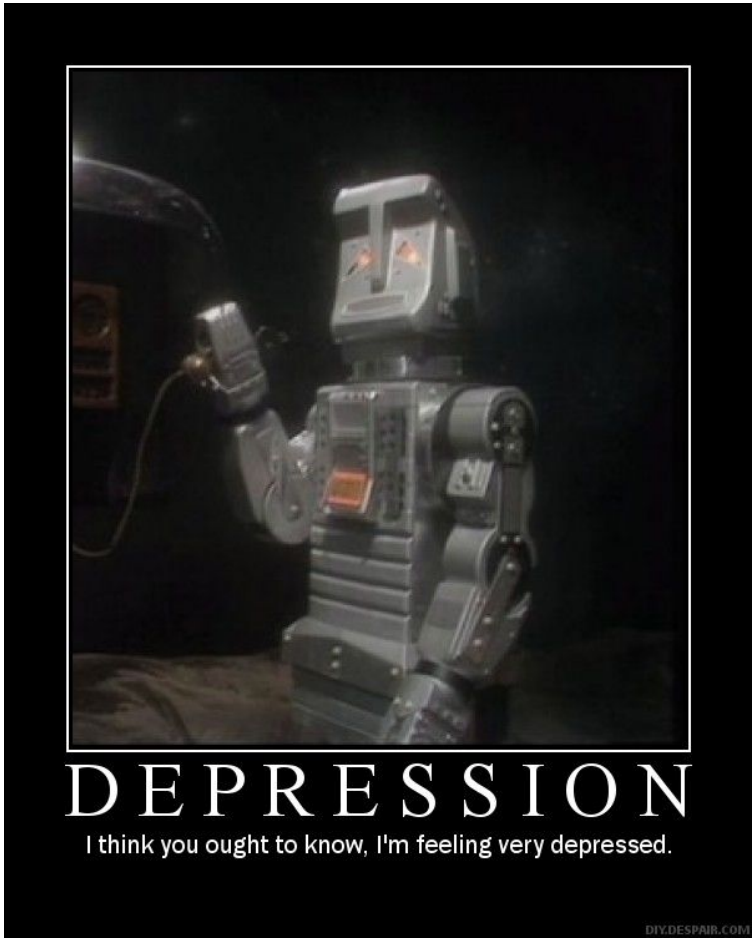
Shadow's Influences...





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Objective: Build useful robots

How does a robot get around the house?

1987-1995: The Shadow Biped
14 movements
Air Muscle actuation
Stood up using Fuzzy Logic, and the Alexander Technique

14 position sensors, 28 force sensors, 28 pressure sensors, 3 accelerometers, 10 load cells.

Then the first Honda bipeds appeared...

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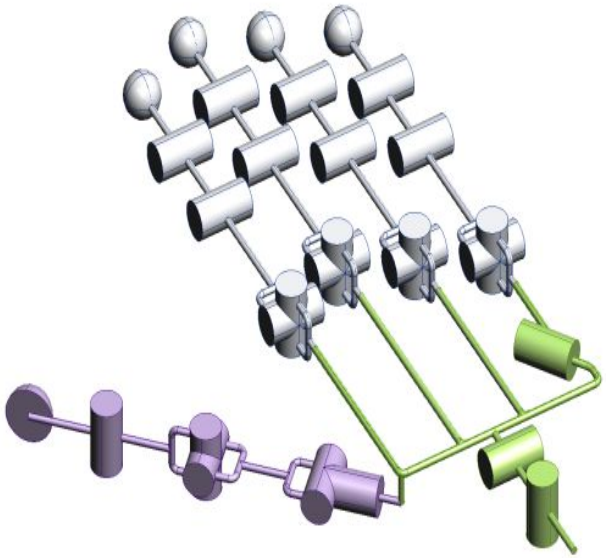
Dexterous Hand

A useful robot needs to interact with the world. How do we do it?



20 brushless DC motors

40 strain gauges

40 tendons

24 joints

24 position sensors

25 temperature sensors

5 pressure sensors

26 microcontrollers

2 CANbus interfaces

1 EtherCAT interface

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Hand as a product

- It sold by itself
- We had no idea why
- We optimised it for our early adopter
- We didn't understand what could be done with it.

A recipe for disaster!

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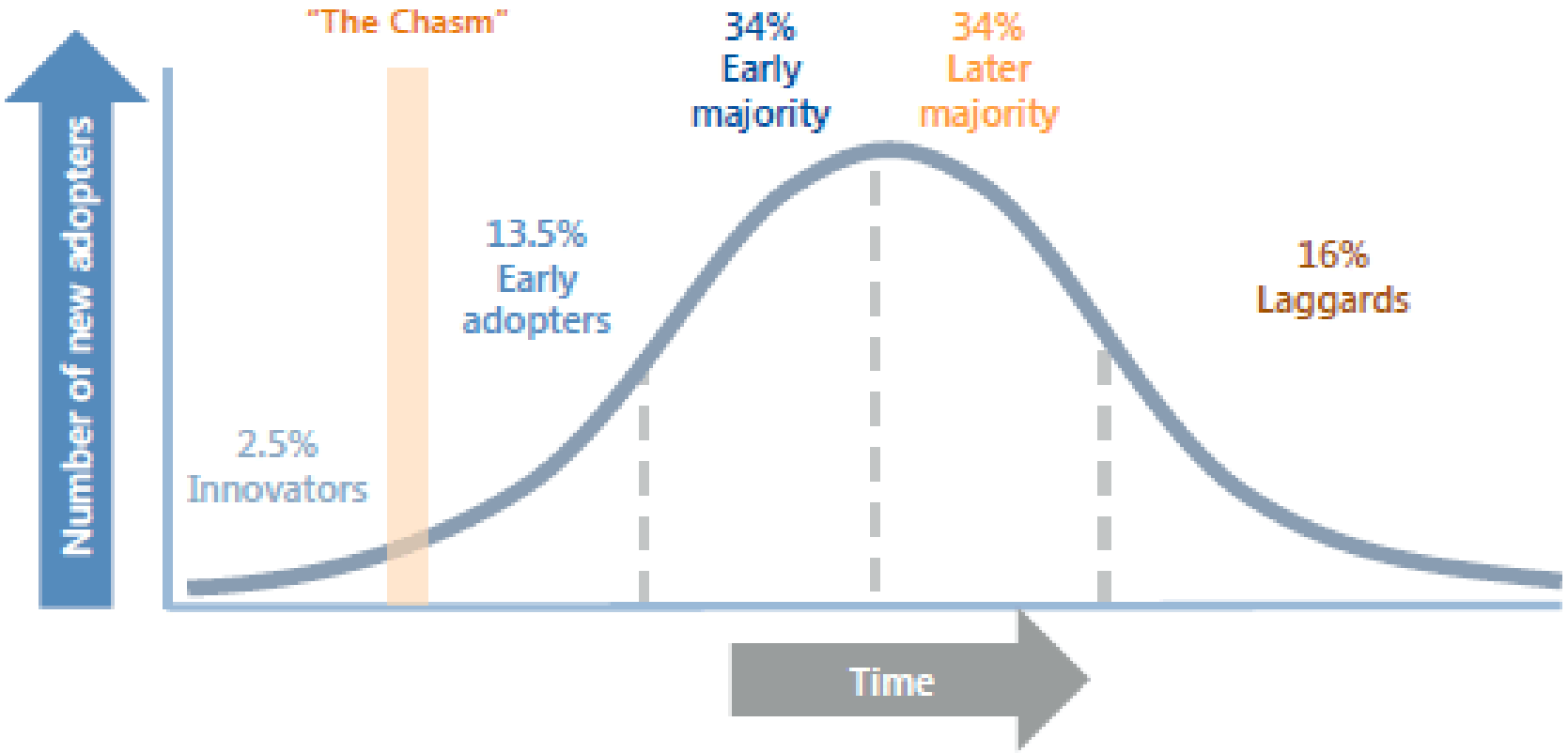
What didn't we know?

- Product lifecycles:



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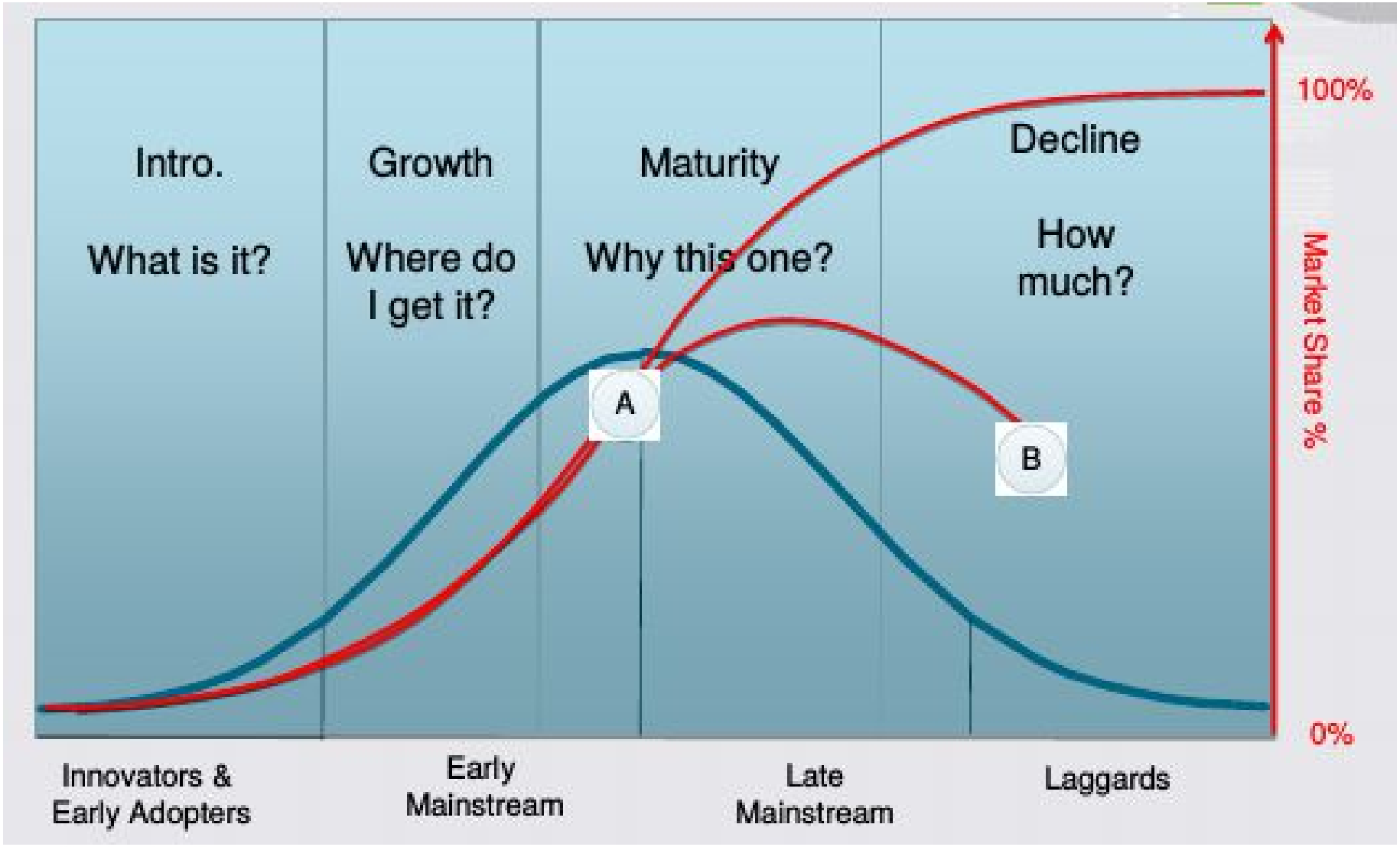
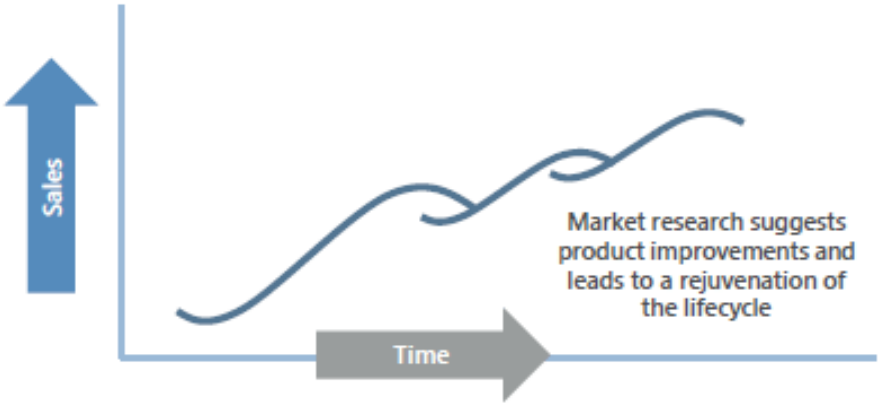
Geoffrey Moore, Crossing the Chasm

Why is that important?



Suicide Leaps

	Old Market	New Market
Old Product	Existing product – Grow by sustaining innovation	Understand new customer needs and create new company profile. Adapt product.
New Product	Build on market position and customer understanding to create new revenue streams	Visionary leap.



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Looking around - STEEPLED

- Societal
- Technological
- Economic
- Environmental
- Political
- Legislative
- Ethical
- Demographic

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Trends we consider

- Health and Safety – more stringent safety rules
- Nuclear renaissance and decommissioning
- Global energy transition – travel more expensive?
- Aging society and demographic slump
- Increasing urbanisation
- More bandwidth to everywhere
- Computing is free
- Cameras/sensors are everywhere
- ROS!

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What else is a Hand good for?

- Research
- EOD
- Nuclear
- Biomedical
- Remote maintenance
- Remote presence
- Other people's robots
- Flexible automation

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What else is a Hand good for?

Research – existing market, “easy” sustaining innovation

- EOD – high barriers to entry
- Nuclear – high barriers to entry
- Biomedical – research focussed customers
- Remote maintenance – credibility and systems gaps
- Remote presence – cost gap
- Other people's robots – evolve product into component
- Flexible automation – real market, real challenges

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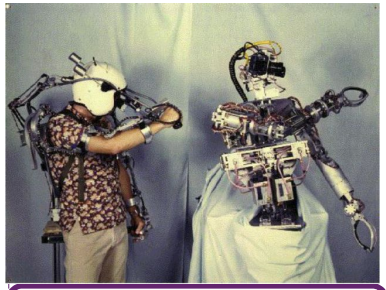
Manipulation Lattice



Greenman Teleoperator

Dexterous Hand

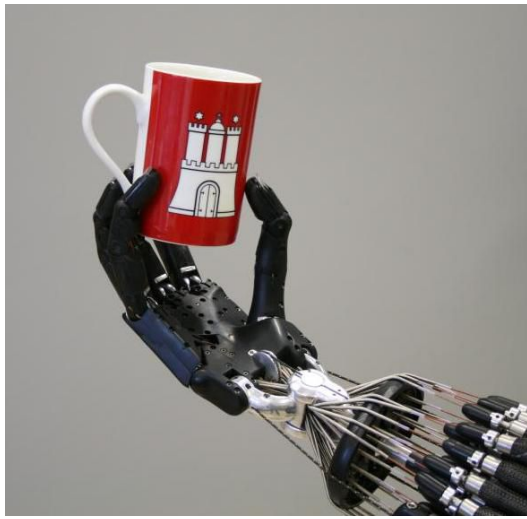
Teleoperation

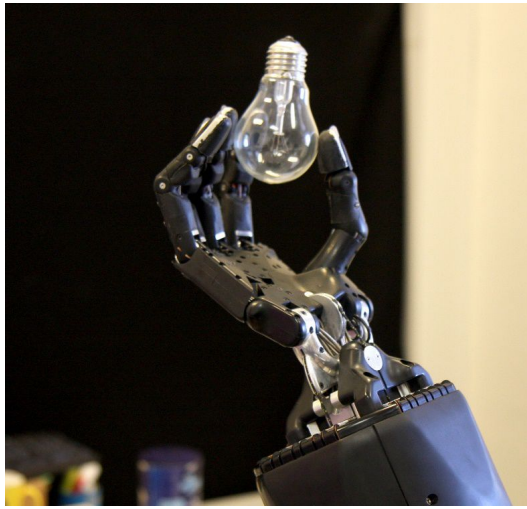
Autonomous manipulation

Intelligent, personalized, bimanual telemanipulation

Current Capabilities

- Core Dexterous Hand
- Stable grasps of known objects
  - By demonstration
  - Generalisation
- Motion planning with objects
- Task oriented grasping
  - Hold for use
  - Regrasp in limited cases





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D/D/D Tasks

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Chasing the wrong money

- High-value targets
- Big-ticket projects
- High profile
- All “Visionary”
- One-offs with no followup
- Wasted half a decade!

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Barriers to entry

- Inertia
- Risk aversion
- Performance
- Availability
- Capability
- Whole System
- Environment

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Barriers to entry – 7 W's

- Inertia - “we never did that!”
- Risk aversion - “who else does that?”
- Performance - “what if it doesn't?”
- Availability - “where else can we buy it?”
- Capability - “what does it do?”
- Whole System - “what else do we need?”
- Environment - “washing it down?”

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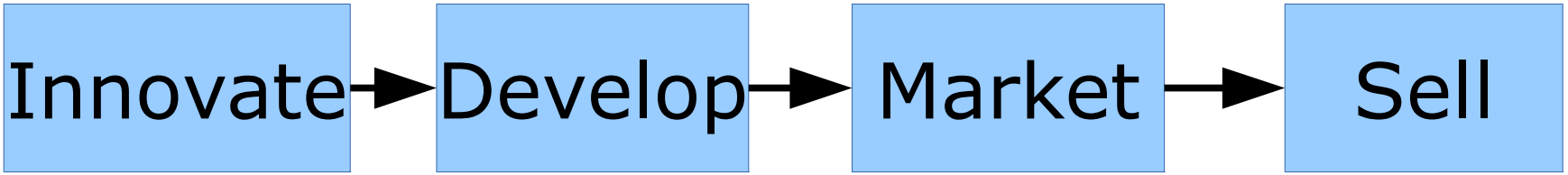
How to look for markets?



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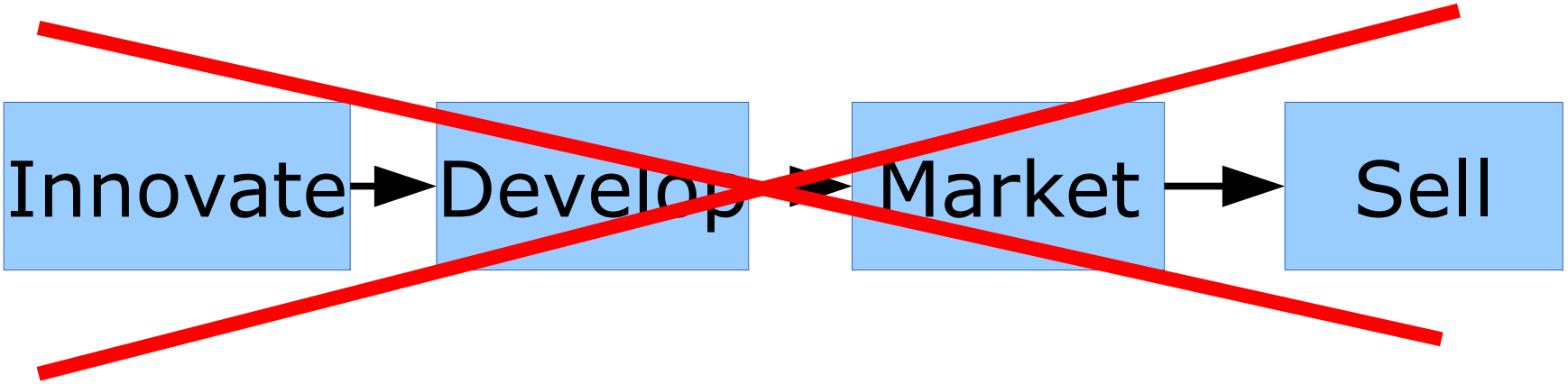
How to look for markets?



With apologies to the E++ KPI mechanisms, which are for project management not innovation!

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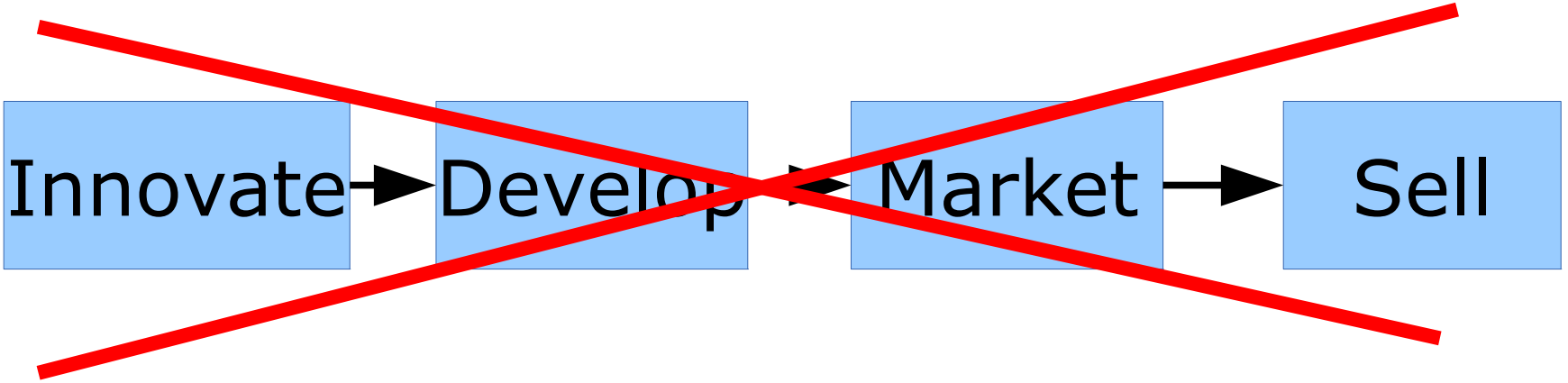
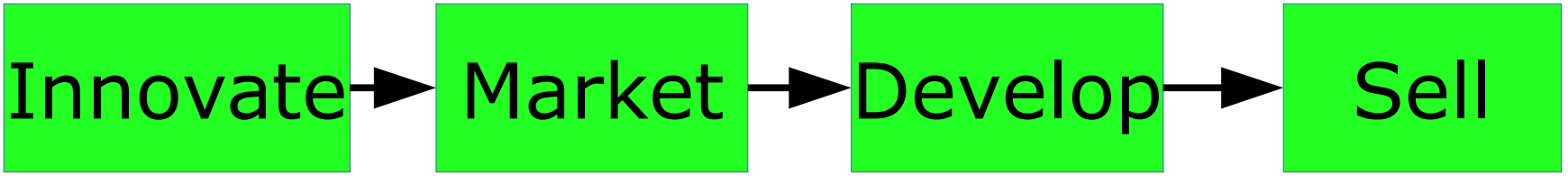
How to look for markets?





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The Business Model Canvas

Designed for:

Designed by:

On:

Iteration:

Key Partners

Who are our Key Partners?
Who are our key suppliers?
Which Key Resources are we acquiring from partners?
Which Key Activities do partners perform?

Key Activities

What Key Activities do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue streams?

Key Resources

What Key Resources do our Value Propositions require?
Our Distribution Channels? Customer Relationships?
Revenue Streams?

Value Propositions

What value do we deliver to the customer?
Which one of our customer's problems are we helping to solve?
What bundles of products and services are we offering to each Customer Segment?
Which customer needs are we satisfying?

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?
Which ones have we established?
How are they integrated with the rest of our business model?
How costly are they?

Channels

Through which Channels do our Customer Segments want to be reached?
How are we reaching them now?
How are our Channels integrated?
Which ones work best?
Which ones are most cost-efficient?
How are we integrating them with customer routines?

Customer Segments

For whom are we creating value?
Who are our most important customers?

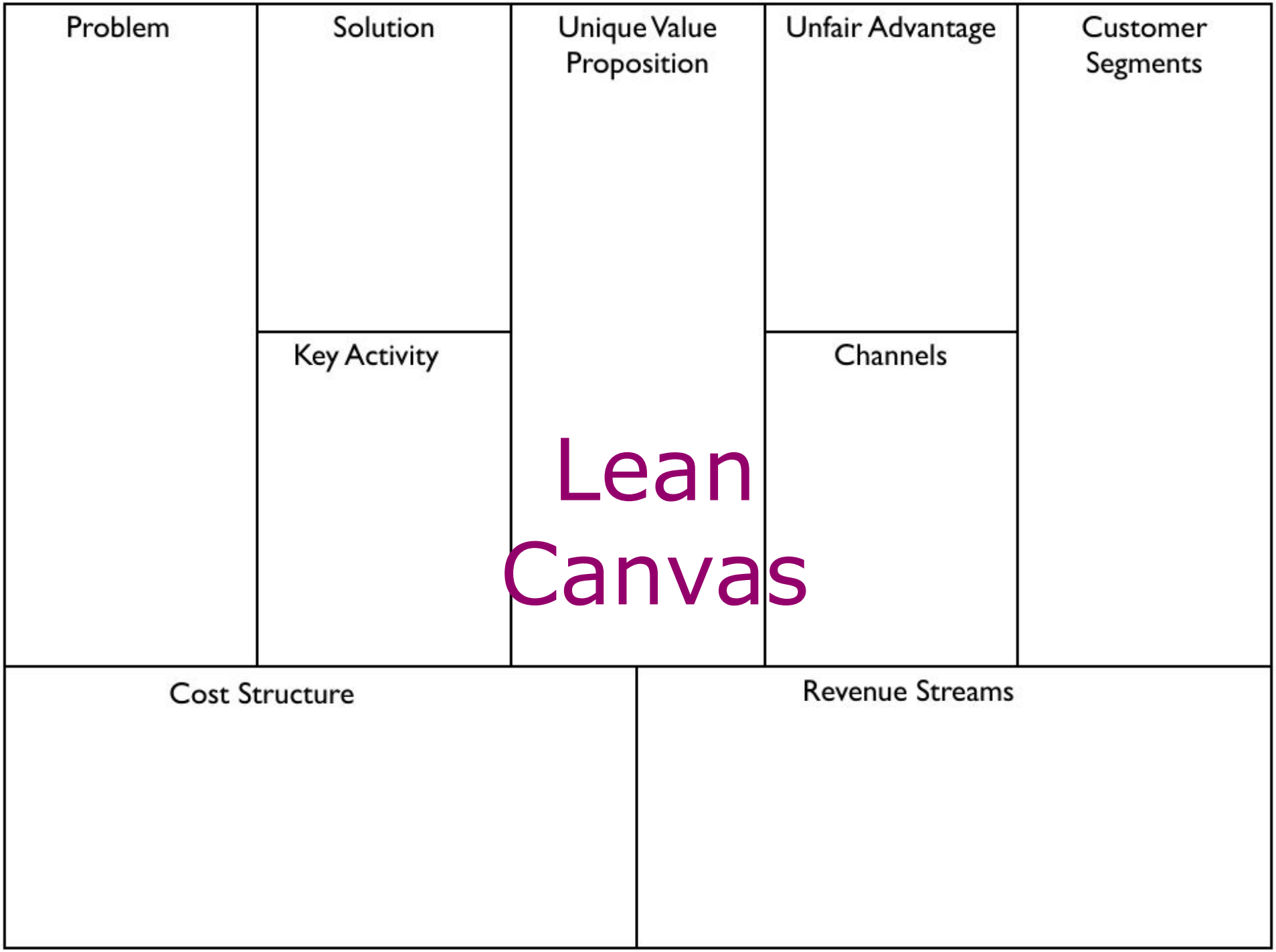
Cost Structure

What are the most important costs inherent in our business model?
Which Key Resources are most expensive?
Which Key Activities are most expensive?

Revenue Streams

For what value are our customers really willing to pay?
For what do they currently pay?
How are they currently paying?
How would they prefer to pay?
How much does each Revenue Stream contribute to overall revenues?

www.businessmodelgeneration.com


Problem
Solution
Unique Value Proposition
Unfair Advantage
Customer Segments
Key Activity
Channels
Lean Canvas
Cost Structure
Revenue Streams

How do we use this?

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Helping Robot Builders

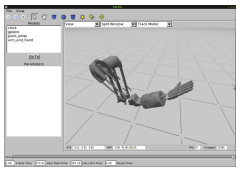
Developers

SWRI

Fraunhofer

Shadow

Any Robot Designer!



Distribution

Topic

Simulator

Cluster

Package

ROS

Model

Service

Parameters

Node

Robots

Components

Integration

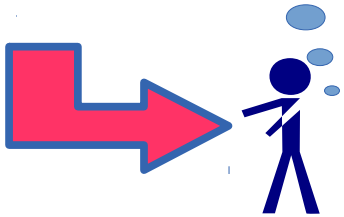
SLAM

MoveIt

Navigation

Kinematics

Robot Idea



Electric → Fuerte → Groovy → Hydro → Indigo

Roadmap

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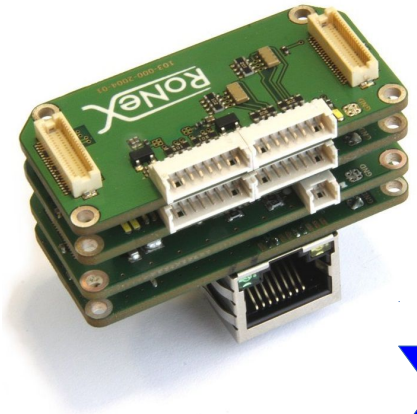
Robots made Easy...



ROS

RoNeX

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Lean Canvas – Shadow RoNeX

Problem	Solution	Unique Value Proposition	Unfair Advantage	Customer Segments
-Hard to connect ROS to new hardware. -Realtime deterministic IO is hard -Robots need lots of IO -High spec expansion is bulky/costly -System designers must change between prototype and product -Different bits of development can be hard to integrate	-..Modules with good ROS drivers - Scalable rich i/o modules - Ethernet->ethercat good ..drivers - Smaller, cheaper per pin, dense - production ready modules. - Licensable designs, proto. friendly design tools **Key Activity/Metric** Clicks on RNX page from -google -media conversions -shop visit -purchase -addn. Purchase -sales-revenue	-Trivial to conect robot parts to ROS -Labview for robot hackers connect hw to sw quickly, simply and efficiently -Spinal cord for robots. -Simple scalable fast i/f between AI and mech eng. Nor more hacking electronics. -Solves interfacing problems with simple modular scalable robot I/O building blocks Gateway to ROS for device builders Gateway to hardware for software builders. Low level control without micro-controller. Easy solution for standardising interfaces in your project Enables easier collaboration.	Physical Build Stiff-flop – R&D … Shadow Brand ROS experts Decades of robot devel experience IPR momentum **Channels** Gaitech Educational supplies Direct sales to profs/techs conferences quora/linkedin social marketing bio... adwords/word of mouth ec/h2020	Educational labs using ros to teach Robot designers in companies/startups Company/suppliers -Selling to ROS community R&D projects -good on ROS, weak on electronics

Cost Structure	Revenue Stream
Design MFR unit – 50% unit sales Support Customer aqqn+retention CE £240 per unit 1 off, £70 per unit, 200off	1 off sale @ £300/u => £130 gp Addon units @ £120/u => £60go Volume sales @ £ 230/u => £100gp, 100off Licence @ £50/u => £50/u, 10000off Training, oem retainer, nice cases

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Where do the resources come from to keep innovating?

(three more Geoffrey Moore slides,
This time from “Dealing with Darwin”)

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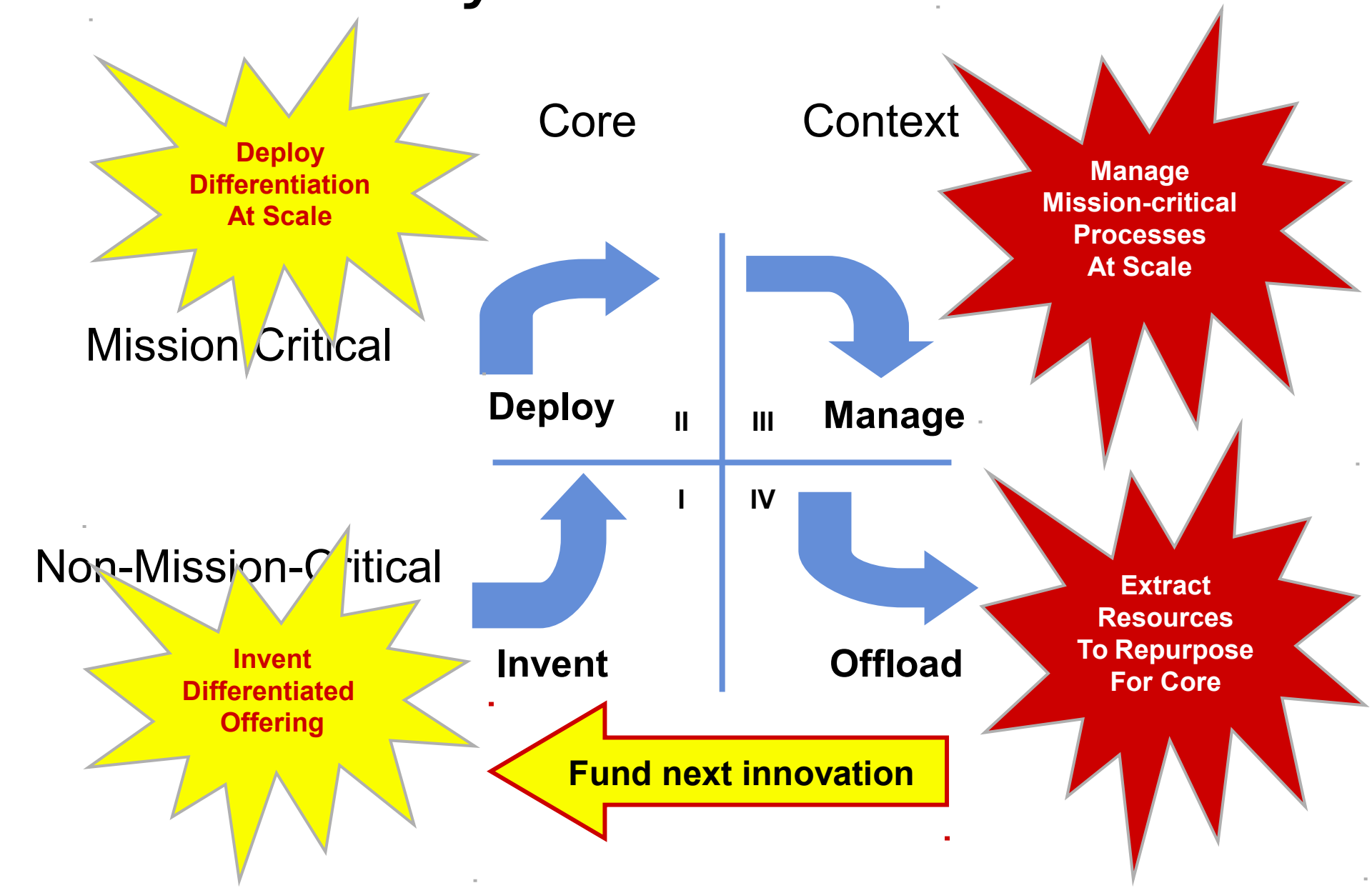
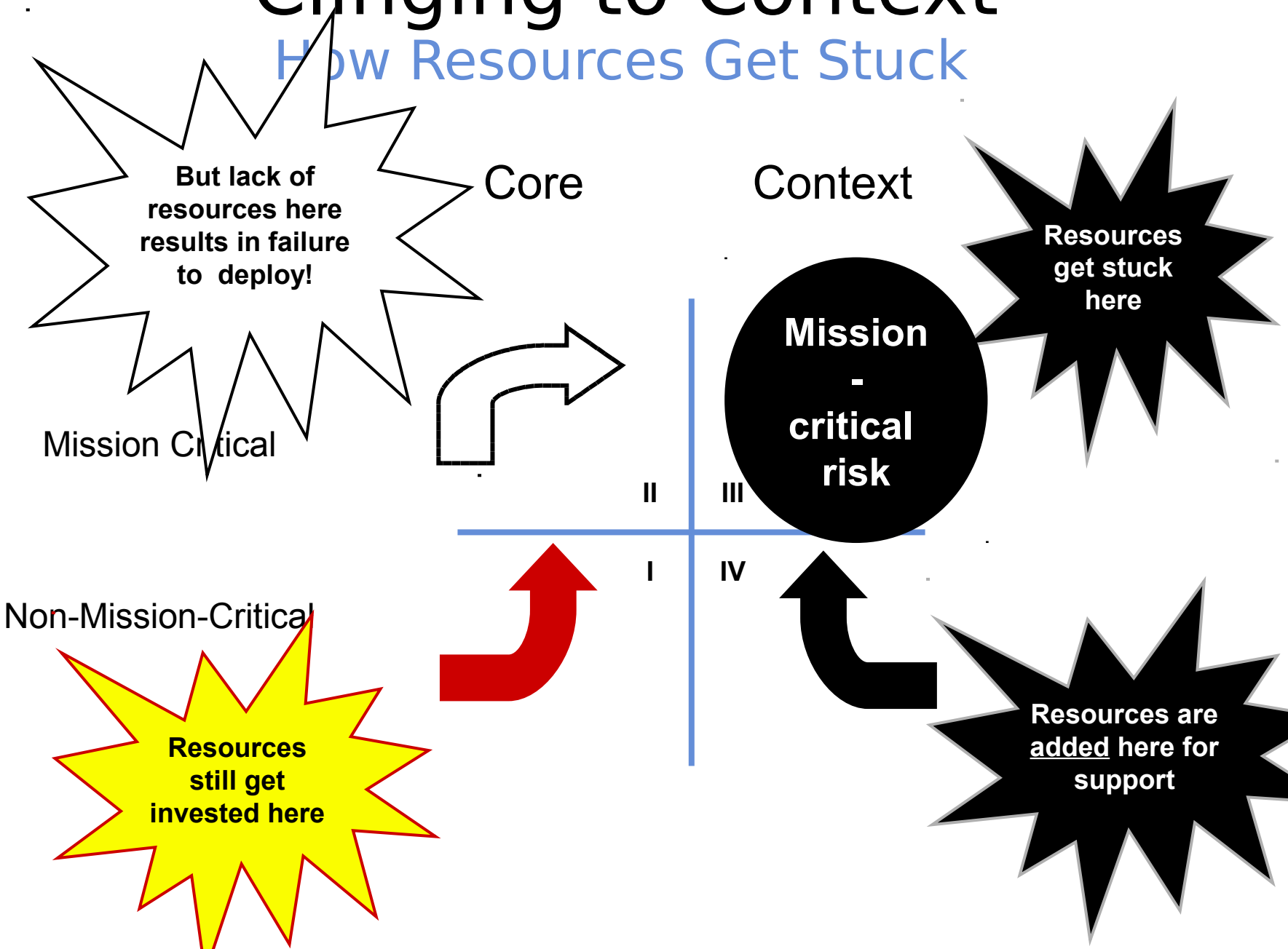
The Cycle of Innovation

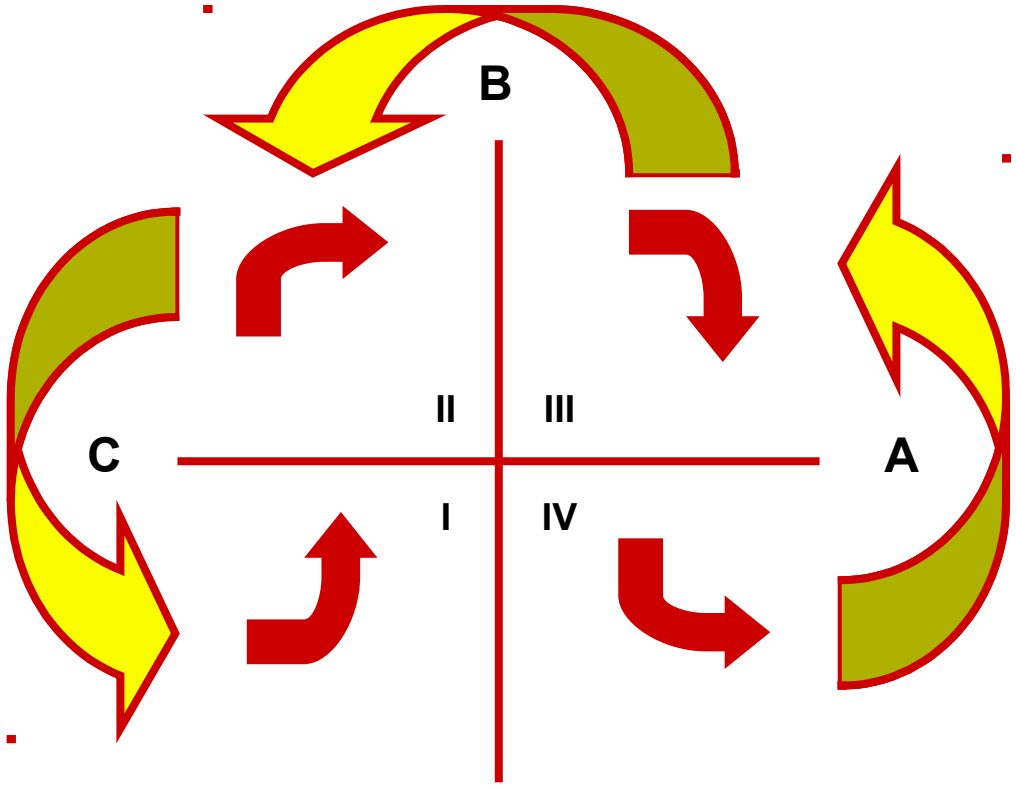


Clinging to Context

How Resources Get Stuck



Resource Recycling

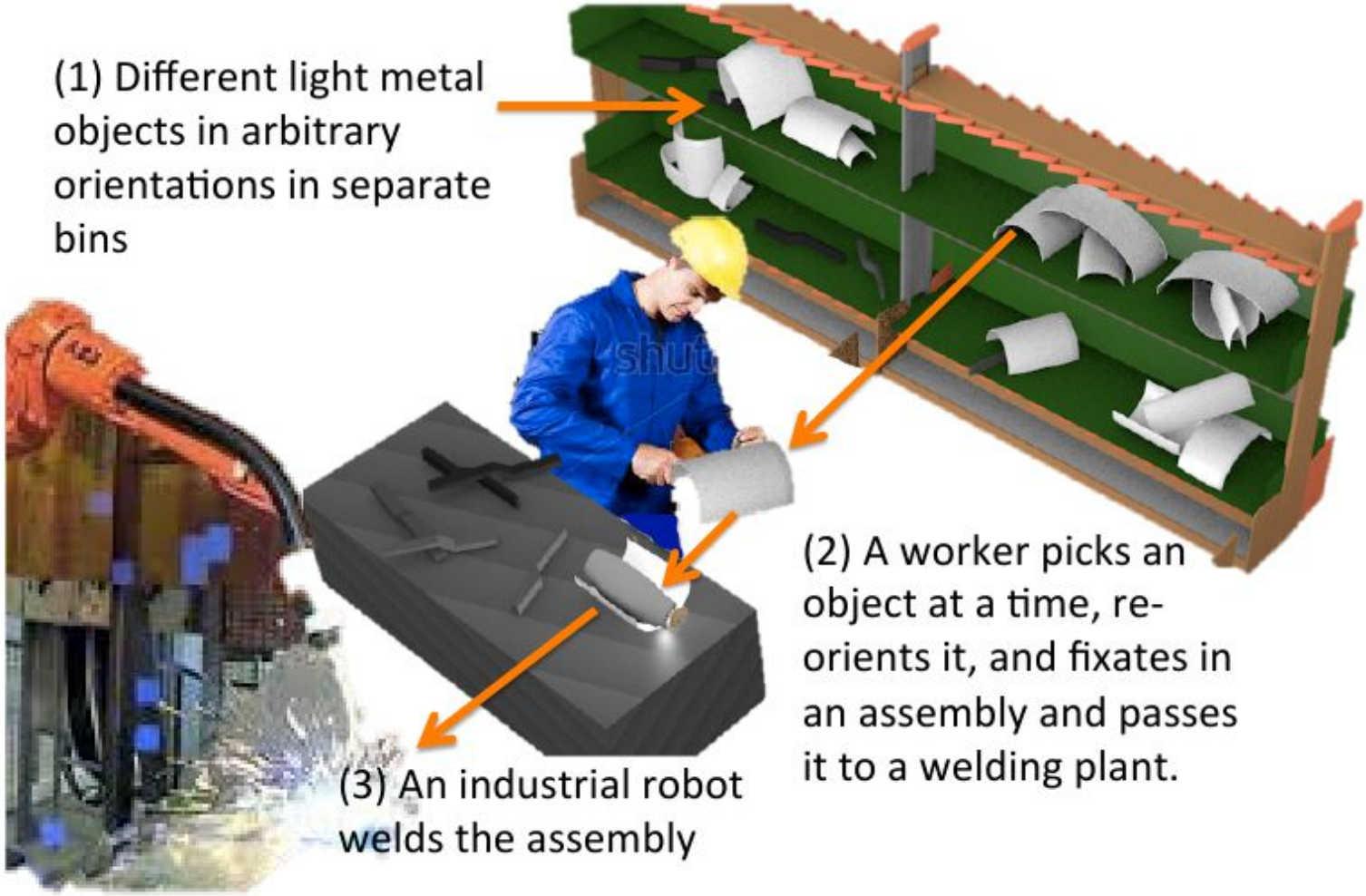


Work circulates clockwise

People recycle counter-clockwise

What next?

Exciting places for cognitive robots



Exciting places for cognitive robots

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Thank-you!

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