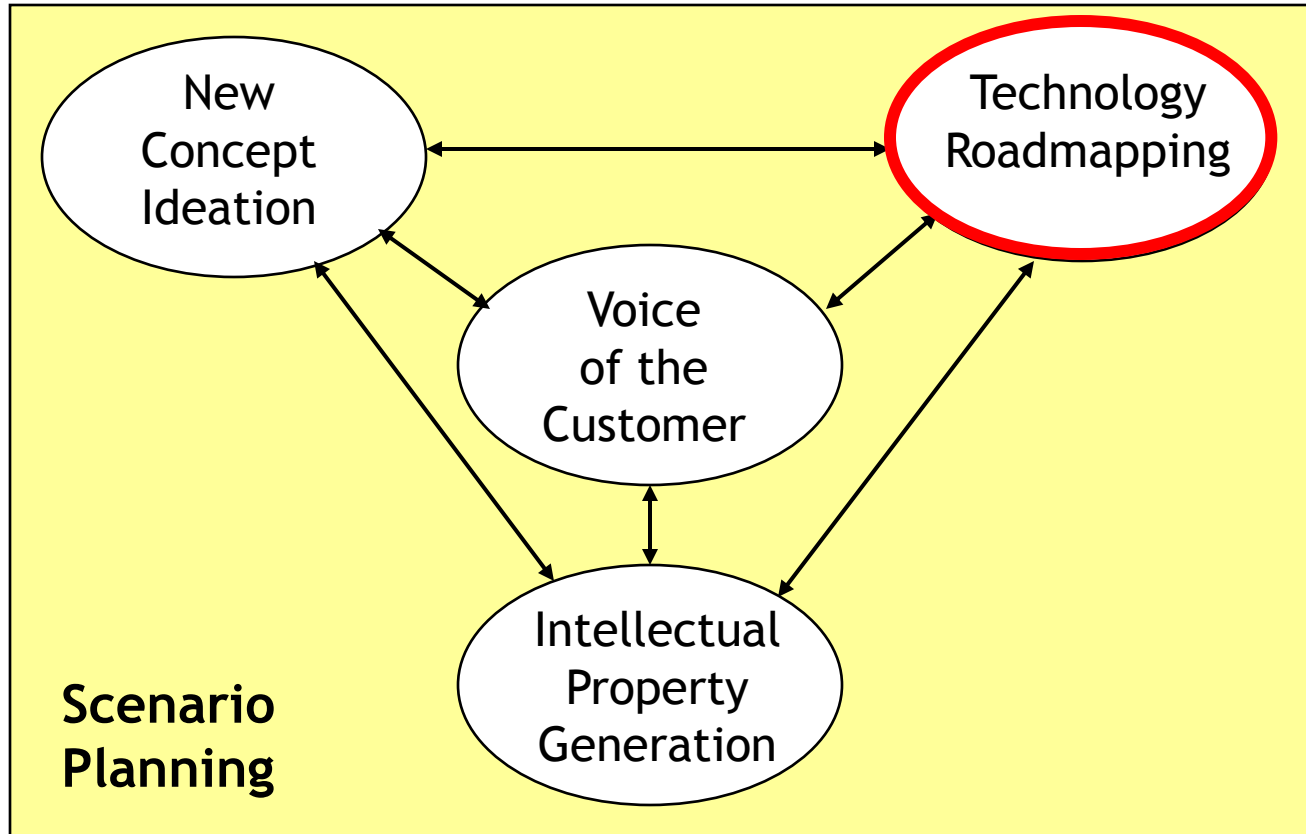


Technology Roadmapping

Two-Step Method

Technology roadmaps are quite useful for tying together all the elements of strategic technology planning...



Here, we illustrate a two-step roadmapping process...

Step 1: Strategic Areas of Focus Roadmap

Step 2: Technology Roadmap

Example: Acme Trap Company Market Segmentation

Acme Trap Company makes two kinds of animal traps
(two **fields of use**):

- Small animal traps (rats, mice),
- Large animal traps (squirrels, foxes).

These traps operate in two general ways (two **applications**):

- Kill traps
- Live traps

Here's Acme's business →

Acme views this as their:

**Strategic
Areas of
Focus**

Acme Trap Co.	Large Animal	Small Animal
Kill Traps	Fur hunters	Households, food industry
Live traps	Zoos, naturalists	<i>No channels to market</i>

Technology Roadmapping Scope

- There are a number of ways to identify strategic areas of focus.
- However you do it, the point is to identify **profitable growth areas**.
- Why? Because technology roadmapping takes plenty of effort and time (and therefore money).
- There's no sense in wasting your money on areas that can't generate significant profits.
- Even more importantly, the ultimate goal of the roadmap is to help answer the question: **Innovate on WHAT?!**
- Here's a great opportunity to keep things focused.

Step 1: Strategic Areas of Focus Roadmap - *Example*

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5							
Kill Probability	2	90%							
Release Force	3	1							
Set Force	4	.8 Nt.				.5 Nt.			
Trap MTBF	5	30 Act.					50 Act.		
Luring radius	6	10 Ft.						20 Ft.	
Small Animal Live Traps Etc...	2								
Large Animal Kill Traps Etc...	3								

Strategic Areas of Focus are primary growth areas - Identified by common application/function

Note: Essential to **explicitly** tie Technology Roadmap to primary **growth** areas. No value in roadmapping dying markets!!

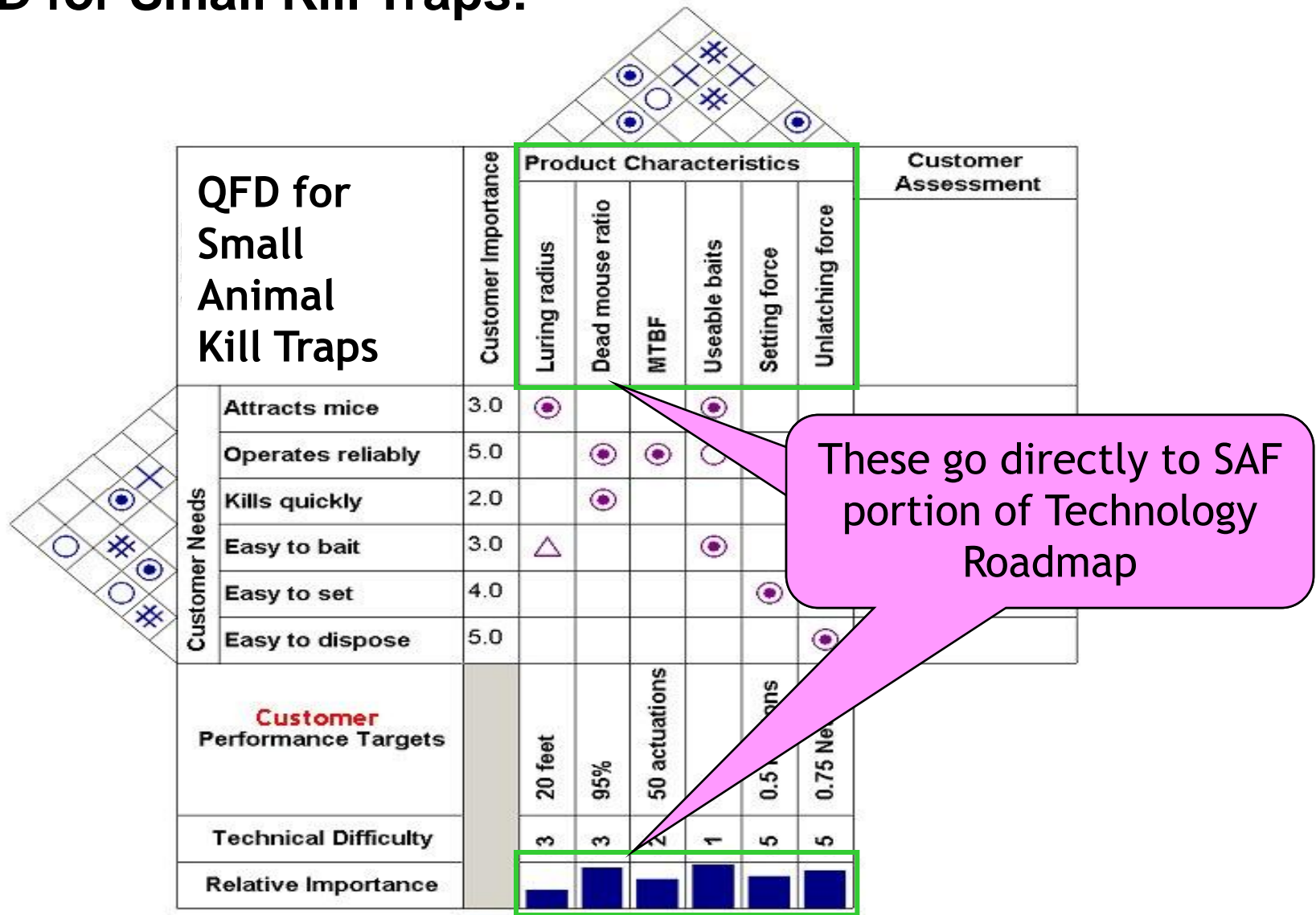
Step 1: Strategic Areas of Focus Roadmap

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%			95%				
Release Force	3	1 Nt.				.75 Nt.			
Set Force	4	.8 Nt.				.5 Nt.			
Trap MTBF	5	30 Act.							
Luring radius	6	70 Ft.							
Small Animal Live Traps	2								
Large Animal Kill Traps									

Note: Essential to **explicitly** tie Technology Roadmap to **customer needs**.

Directly from **HOWs** on **QFD Matrix**

QFD for Small Kill Traps:



Step 1: Strategic Areas of Focus Roadmap

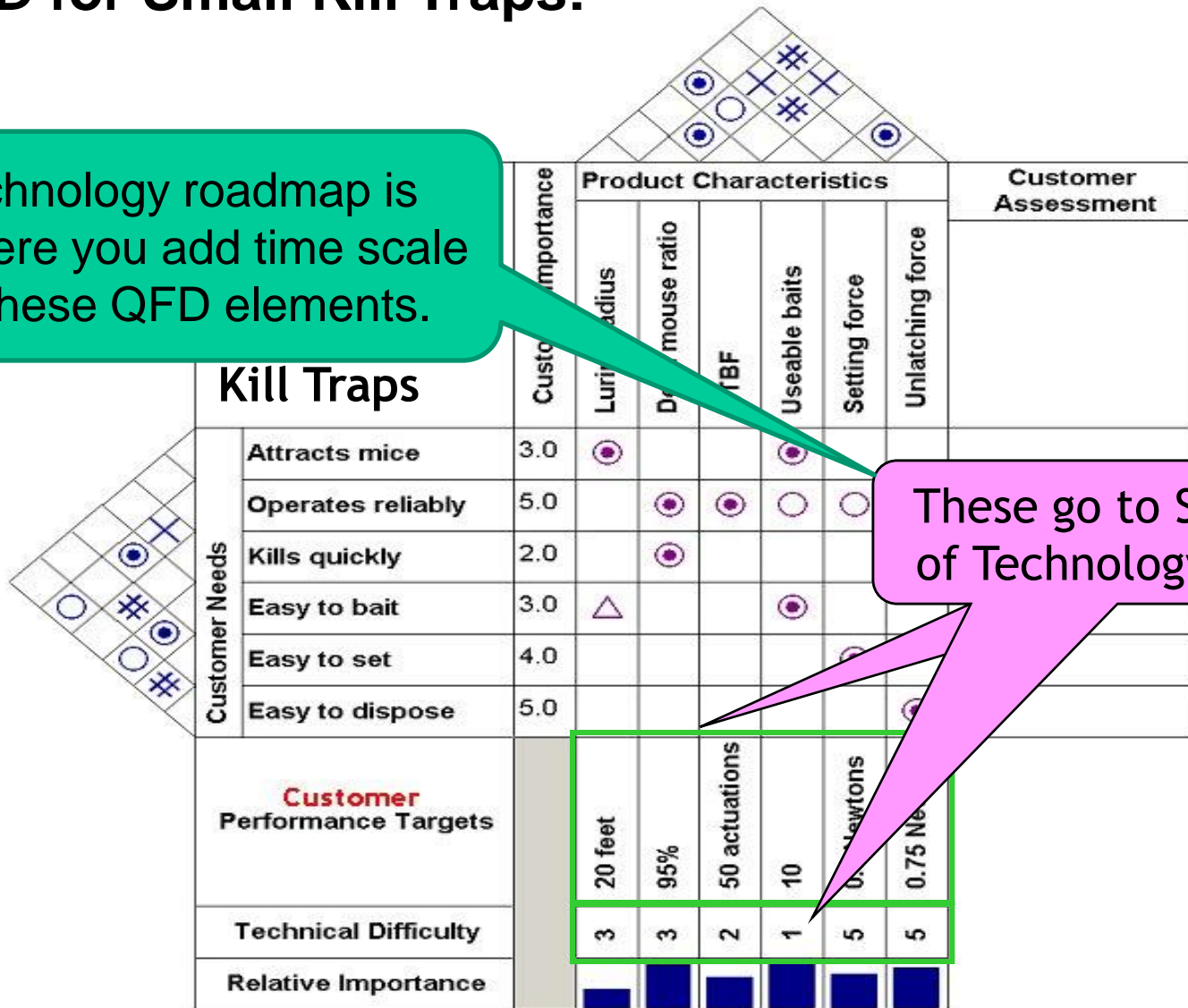
Add **your** targets –
When do you plan to offer these capabilities?

Strategic Area		Q1	Q2	Q3	Q4
Small Animal Kill Traps	1				
Useable Baits	1	5 Baits	10 Baits		
Kill Probability	2	90%		95%	
Release Force	3	1 Nt.			.75 Nt.
Set Force	4	.8 Nt.			.5 Nt.
Trap MTBF	5	30 Act.			50 Act.
Luring radius	6	10 Ft.			20 Ft.
Small Animal Live Traps	2				
Large An					

Duration impacted by QFD Technical Difficulty

QFD for Small Kill Traps:

Technology roadmap is where you add time scale to these QFD elements.



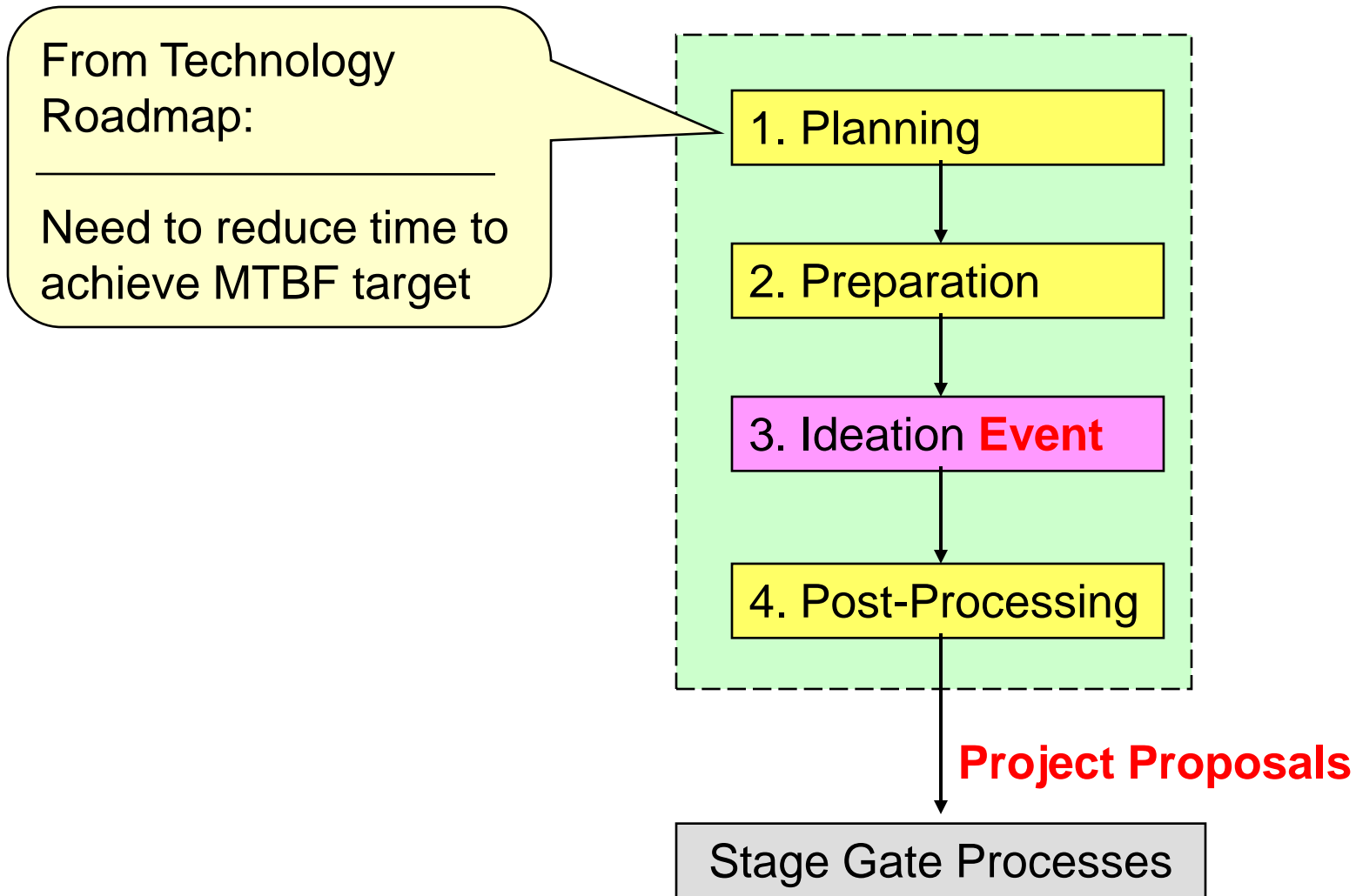
These go to SAF portion of Technology Roadmap

Step 1: Strategic Areas of Focus Roadmap

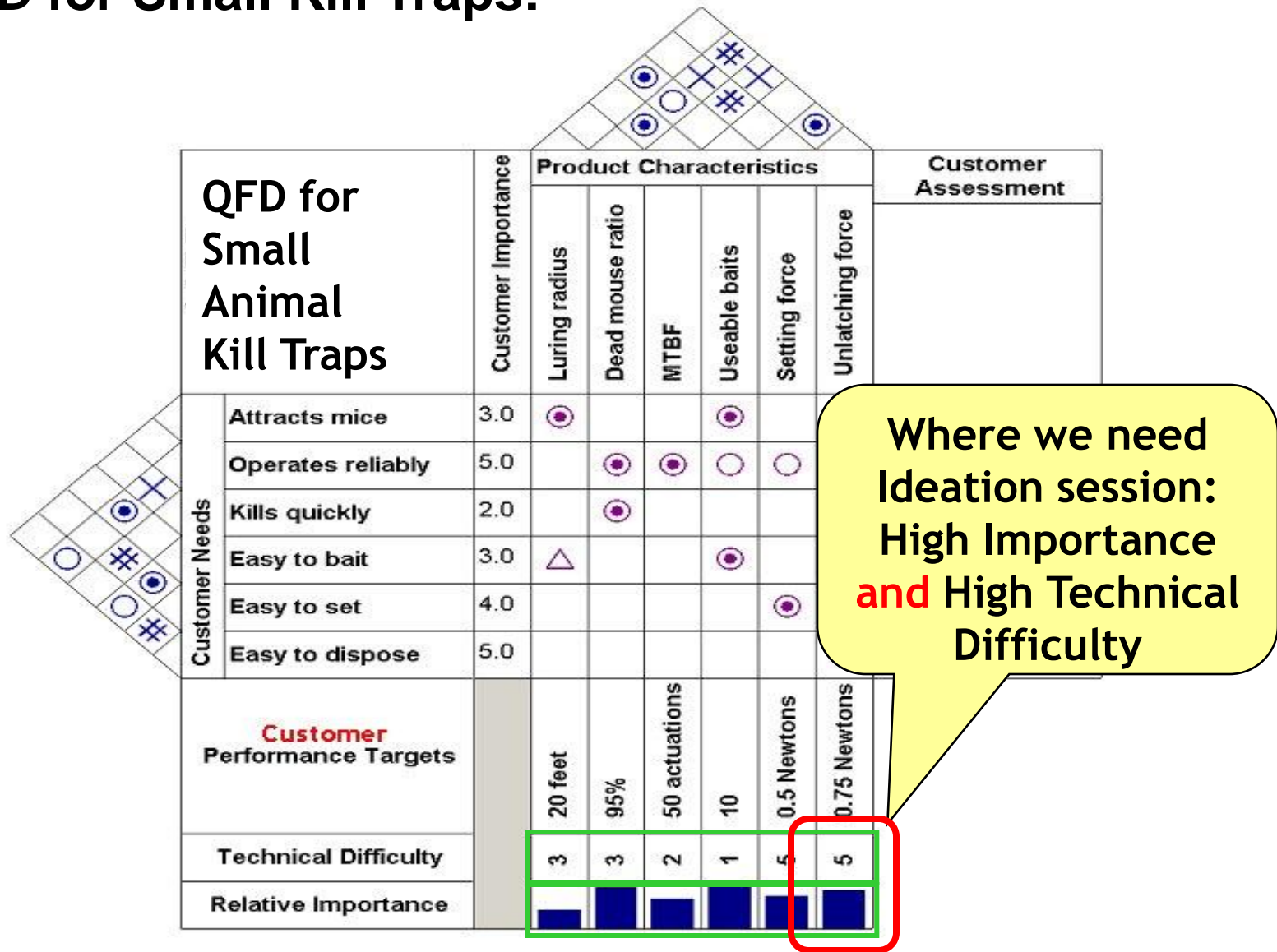
Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%			95%				
Release Force	3	1 Nt.				.75 Nt.			
Set Force	4	.8 Nt.				.5 Nt.			
Trap MTBF	5	30 Act.				50 Act.			
Luring radius	6	10 Ft.						20 Ft.	
Small Animal Live Traps	2								
Large Animal Kill Traps	3								

End dates and target values can be impacted by ideation

High-Level View of Ideation Process



QFD for Small Kill Traps:



Step 1: Strategic Areas of Focus Roadmap

Strategic Areas of Focus	Pri.	2005				2	Q3	Q4
		Q1						
Small Animal Kill Traps	1							
Useable Baits	1	5 Baits	10					
Kill Probability	2	90%			5%			
Release Force	3	1 Nt.			5			
Set Force	4	.8 Nt.						
Trap MTBF	5	30 Act.						
Luring radius	6	10 Ft.						
Small Animal Live Traps	2							
Large Animal Kill Traps	3							

Drives IP generation:
Are we developing IP
in these areas?!

Useable Baits
Kill Probability
Release Force
Set Force
Trap MTBF
Luring radius

Makes the list of patents longer.
What **must** we protect?

Step 1: Strategic Areas

Use priorities to develop overall IP Generation strategy

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%							
Release Force	3	1 Nt.							
Set Force	4	8 Nt.							
Trap MTBF	5	30 Act.							
Luring radius	6	10 Ft.							20 Ft.
Small Animal Live Traps	2								
Large Animal Kill Traps	3								

Makes the list of patents shorter.

What do I need to spend money on for patents?

OK, so lets say...

Areas of Focus R

This is what we **need** to do...

Strategic Areas of Focus	Pri.	2005							
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%							
Release Force	3	1 Nt.							
Set Force	4	.8 Nt.							
Trap MTBF	5	30 Act.					50 Act.		
Luring radius	6	10 Ft.						20 Ft.	
Small Animal Live Traps	2								
Large Animal Kill Traps	3								

But we can **not** do this today...

So how **will** we do this?!

Time to switch to Step 2

Here, we use a two-step process...

Step 1: Strategic Areas of Focus Roadmap

Step 2: Technology Roadmap

Functional Description

To start our technology roadmap, here we start by identifying **functions** common to all of our products/systems.

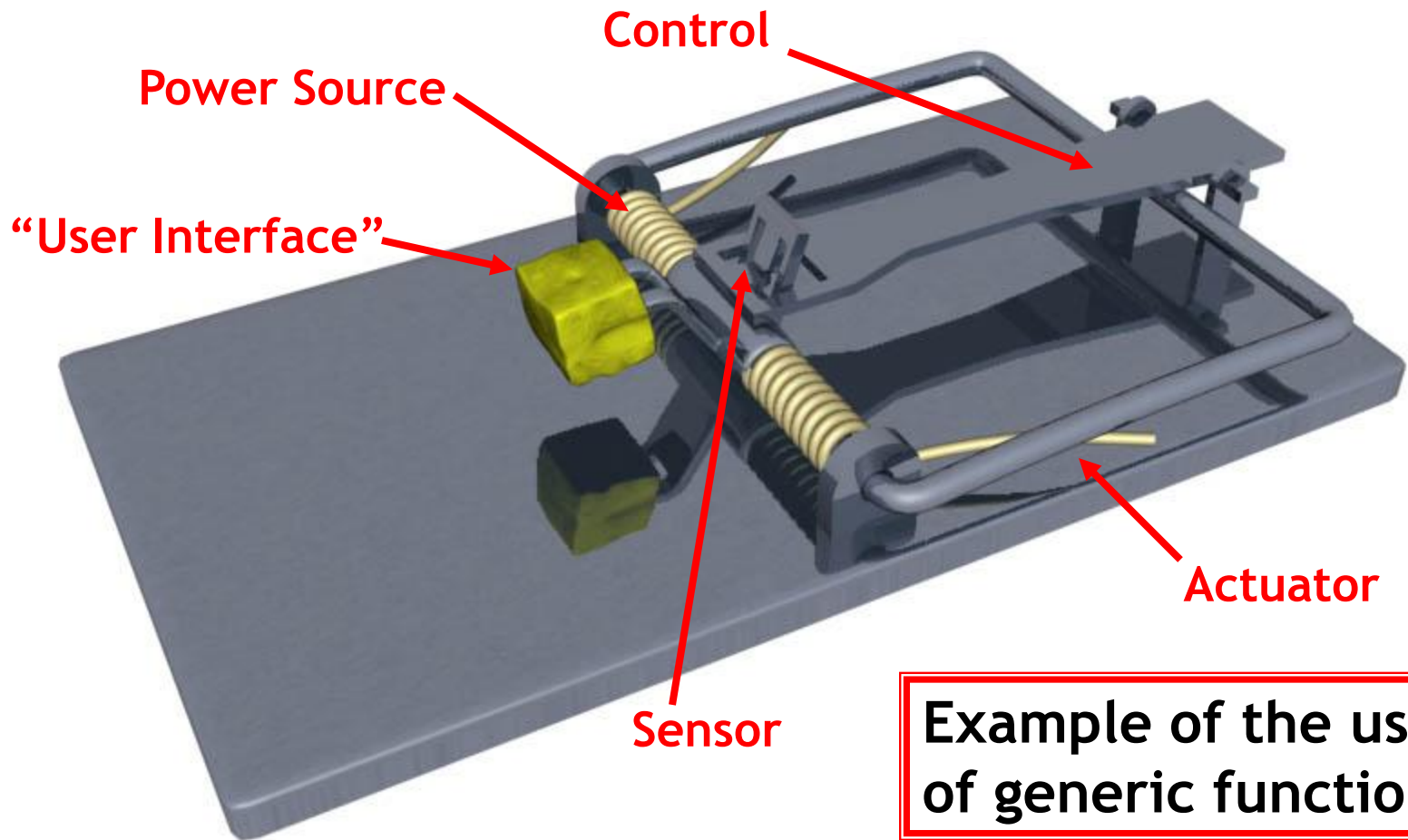
Many systems can be described in terms of these common functions:

- Actuator
- Sensor
- Control
- Power Source
- User Interface

So, how does this apply to Acme traps?

We are going to map technologies by **common functions**.

So for this example, we need to identify functions that are common to **all types of traps** covered in our SAF roadmap.



Step 2: Technology Roadmap - *Example*

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1								
Sensor	2								
Control	3								

Start by group Technology Roadmap subjects by functions (from previous diagram).

Step 2: Technology Roadmap - *Example*

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1								
<div style="border: 2px solid red; border-radius: 15px; padding: 5px; display: inline-block;"> Small animal kill traps </div>	1								
	2								
Large animal live traps	3								
	4								
Sensing	2								
Control	3								

Strategic Areas of Focus
are sub-groups in
Technology Roadmap

Step 2: Technology Roadmap - *Example*

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1								
Small animal kill traps	1	Dynamic modelling of spring structure							
	2	Composite spring							
Large animal live traps	3	Solar-power generation and storage							
	4		Motor-driven actuation						
Sensing Etc...	2								
Control Etc...	2								

Show current or planned **projects** and priorities associated with each function and Strategic Area of Focus

Note: Technology Roadmaps are **not** Product Roadmaps!

Step 2: Technology Roadmap

This approach explicitly links technology development **projects** to strategic **growth** targets.

The object is to show the impact of **NOT** doing a project!

Technology	Pri.	2005							
		Q1							
Power Source	1								
Small animal kill traps	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
Large animal live traps	3	Solar-power generation and storage							
	4		Motor-driven actuation						
Sensing	2								
Control	3								

Step 2: Technology Roadmap - *Example*

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1								
Small animal kill traps	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
Large animal live traps	3	Solar-power generation and storage							
	4		Motor-driven actuation						
Sensing	2								
Control									

Grouping by function also explicitly shows potential synergies among technology development projects.

This creates a “portfolio” of related projects.

Step 2: Technology Roadmap - *Example*

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1								
Small animal kill traps	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
Large animal live traps	3	Solar-power generation and storage							
	4			Motor driven actuation					
Sensing	2								
Attraction	3								

OK, but where do these technology roadmap project priorities and dates come from?

Step 1: Strategic Areas of Focus Roadmap

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Animal Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%			95%				
Release Force	3	1 Nt.				.75 Nt.			
Set Force	4	.8 Nt.				.5 Nt.			
		Act.					50 Act.		
		Ft.						20 Ft.	
Sm									
Large Animal Kill Traps	3								

This drives the TR project date

This drives the Composite Springs TR priority

Note that we are doing the Composite Springs project to increase the Kill Probability of Small Animal Kill Traps. But how did we remember that?

Implementation Hint:

Strategic Areas of Focus	Pri.	2005				2006				
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Small Animal Kill Traps	1									
Useable Baits	1	5 Baits	10 Baits							
Kill Probability	2	90%			95%					
Release Force	3	1 Nt.								
Set Force	4	.8 Nt.			.5 Nt.					
Trap MTBF	5	30 Act.				50 Act.				
Luring radius	6	10 Ft.					20 Ft.			
Small Animal Live Traps	Technology		Pri.				2006			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Source	1									
Small varmint kill traps	1	Dynamic modelling of actuator mechanisms								
	2	Composite spring								
Large varmint live traps	3	Solar-power generation and storage								
	4					Motor-driven actuation				
Sensing	2									
Control	3									

Hyperlink
SAF roadmap line items
with TR line items

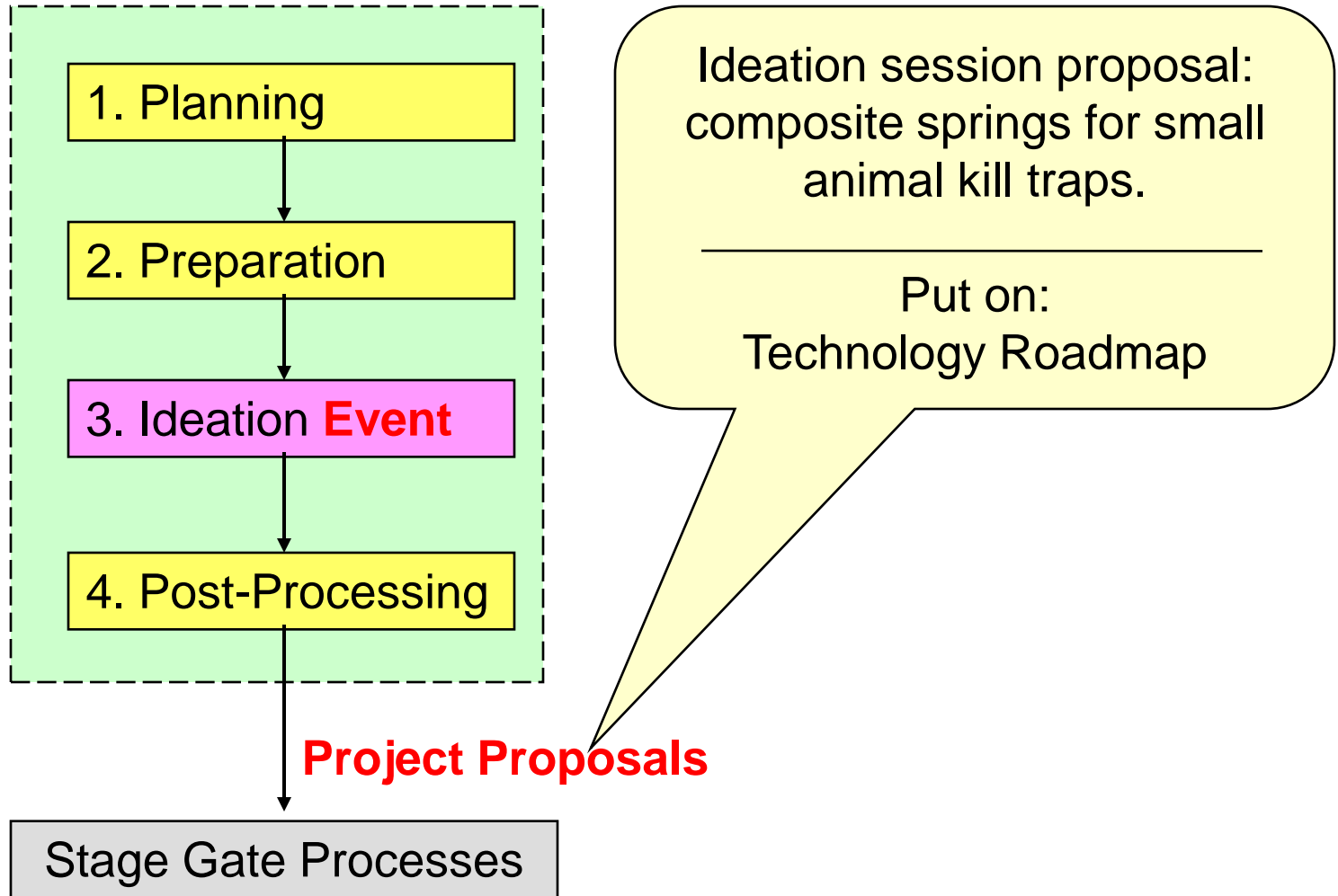
Step 2: Technology Roadmap

Technology	Pri.	2005			
		Q1	Q2	Q3	Q4
Power Source	1				
Small varmint kill traps	1	Dynamic modelling of actuator mechanisms			
	2	Composite spring			
Large varmint live traps	3	Solar-power generation and storage			
	4		Motor-driven actuation		
Sensing	2				
Control	3				

Input to
IP generation:
Where do we
need IP?

New projects can
be output from
ideation session.

High-Level View of Ideation Process



So What?!

What do I actually **use** the Strategic Areas of Focus Roadmap and Technology Roadmap for?

You use them for:

- ***Technology Gap Analysis***
 - Can I get there from here?
- ***Technology Project Portfolio Rationalization***
 - Do I actually need to go there?

Start by laying the roadmaps down side-by-side...

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Varmint Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%			95%				
Release Force	3	1 Nt.				.75 Nt.			
Set Force		.8 Nt.				.5 Nt.			
Trap						50 Act.			
Lu								20 Ft.	
Small Varmint Live Traps	2								

No!!

What we must do.

This is pretty important...

...can we do this?

Technology		Pri.	2005				2006			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Large Varmint Kill Traps	Actuation	1								
	Small varmint kill traps	1	Dynamic modelling of actuator mechanisms							
		2	Composite spring							
	Large varmint live traps	3	Solar-power generation and storage							
		4		Motor-driven actuation						
		2								
		3								

Gap Analysis:

What do I need to work on?

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Varmint Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%			95%				
Release Force	3	1 Nt.				.75 Nt.			
Set Force		.8 Nt.				.5 Nt.			
Trap Actuation						50 Act.			
Lure									
Small Varmint Live Traps	2								

No!!

This is pretty important...

...can we do this?

If there is **no** link to the TR, then we have a **gap** that must be filled.

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Actuation	1								
Small varmint kill traps	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
Large varmint live traps	3	Solar-power generation and storage							
	4		Motor-driven actuation						
	2								
	3								

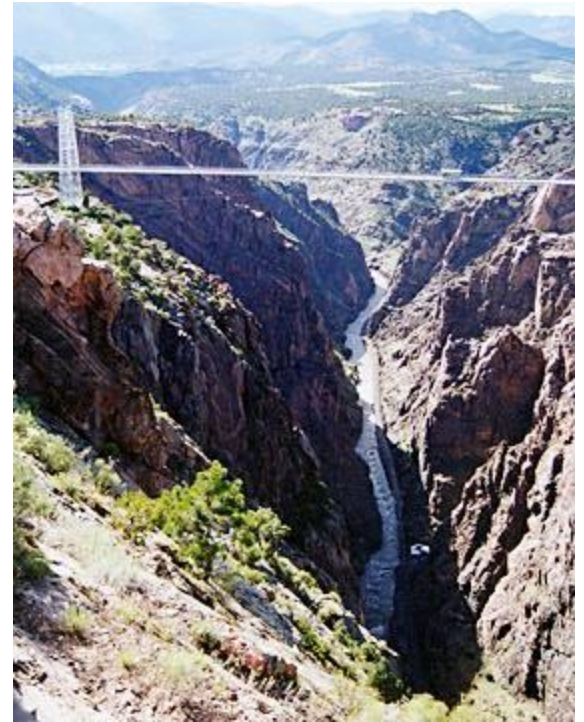
Gap Analysis:

What do I need to work on?

So, looking at the SAF and TR provides a **Technology Gap Analysis** that shows us when we can't get there from here.

What about technology portfolio rationalization?

Well, keep the SAF and TR laid out next to each other when the latest new boss comes snooping around...



Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Actuation	1								
	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
	3	Solar-power generation and storage							
	4		Motor-driven actuation						
Sensing	2								

Strategic Areas of Focus	Pri.	2005				
		Q1	Q2	Q3	Q4	
Small Varmint Kill Traps	1					
Useable Baits	1	5 Baits	10 Baits			
Kill Probability	2	90%			95%	
Release Force	3	1 Nt.			.75 Nt.	
Set Force	4	.8 Nt.			.5 Nt.	
	5	30 Act.			50 Act.	
	6	10 Ft.				20 Ft.
e Traps	2					
Traps	3					

Your Boss: Why are you wasting time and money working on this stupid project?!

Project Portfolio Rationalization:
Why am I working on this?

Technology	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Actuation	1								
	1	Dynamic modelling of actuator mechanisms							
	2	Composite spring							
	3	Solar-power generation and storage							
	4		Motor-driven actuation						
Sensing	2								

Strategic Areas of Focus	Pri.	2005				2006			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Varmint Kill Traps	1								
Useable Baits	1	5 Baits	10 Baits						
Kill Probability	2	90%						95%	
Release Force	3	1						.75 Nt.	
Set Force	4	.8						.5 Nt.	

Project Portfolio Rationalization:
Why am I working on this?

You: Because this is essential to meeting *your* growth targets on schedule (so you get your obscene and undeserved annual bonus and stock options).

Technology Roadmapping - As a **Two-Step** Process:

1. Strategic Areas of Focus:

- Primary **growth** areas,
No value in roadmapping stagnant/declining areas.
- Grouped by **market segments**,
Likely to have common technologies.
- With **performance targets, priority, and time scale**.
What, when, how important.
- Derived from **QFD** matrix.

“Promised”
growth areas

What we need to keep
growth “promises”

2. Technology Roadmap:

- Common technologies **required to achieve growth**,
- Plotted as stage gate technology development **projects**.
- Plotted by **functions**, not products!
- With project start/end dates tied to Strategic Areas of Focus.

Technology Roadmapping Process:

Purpose

- Define and communicate technology directions, associated opportunities, and resource requirements to all stakeholders (what, why, how).
 - This is **project portfolio rationalization**.
- Explicitly highlight technology gaps (can't get there from here).
 - This is the **technology gap analysis**.
- Create a mindset and provide structure for conceptualizing and capturing a technology vision for the future (means as an end).
 - The act of roadmapping is a means to this end.

Technology Roadmapping Process:

Desired Strengths

- Forces clear understanding and articulation of direction (no hand waving).
 - Core technologies, projects, and linkages are all explicitly documented.
- Provides convenient portal/linkages to lower planning levels (projects).
 - Hyperlinks allow navigation through complex relationships.

Technology Roadmapping Process:

Potential Weaknesses

- Easy to roadmap what we know, hard to roadmap *unknown* routes,
 - We need a means of “surveying” unknown territories.
- Can induce tunnel vision - is this where *customers* want to go?
 - We need a means of incorporating the voice-of-the-customer.
- Just a map - no built-in mechanism for driving to the end: New technology transferred into new products.
 - We need a means to follow the map and keep us on course.

Notes:

Strategic Areas of Focus Roadmaps and Technology Roadmaps should also be used at:

- V-O-C discussions to control customer expectations (**SAF only!**).
 - What are we working on?
 - What are we **not** working on?
- IP strategy and patent review meetings to direct disposition on IP.
 - **Why** are we patenting this?
 - Where **is** the patent for this?
- Ideation sessions to frame context for topics.
 - What are we ideating on?
 - Why?
- Stage gate review meetings to justify recommendations.
 - If it's **not** on the roadmap, then why should we do it?
 - If it **is** on the roadmap, can we **kill** it?

Refining Technology Roadmaps: Identifying Core Technologies*

**Based on ["The Core Competence of the Corporation"](#),
by C.K. Prahalad and Gary Hamel.*

Where are we now?

- OK, your technology roadmap clearly identifies what technologies you need to deliver what you are promising in your Strategic Plan.
- But is it **really** a good idea to apply your resources to develop these **specific** technologies?
- What if your company is a world-class Hula Hoop manufacturer, and your Strategic Technology Plan says you need to develop nanotechnology plastics for the new Ultra Hoop product line?
- Would you do it?

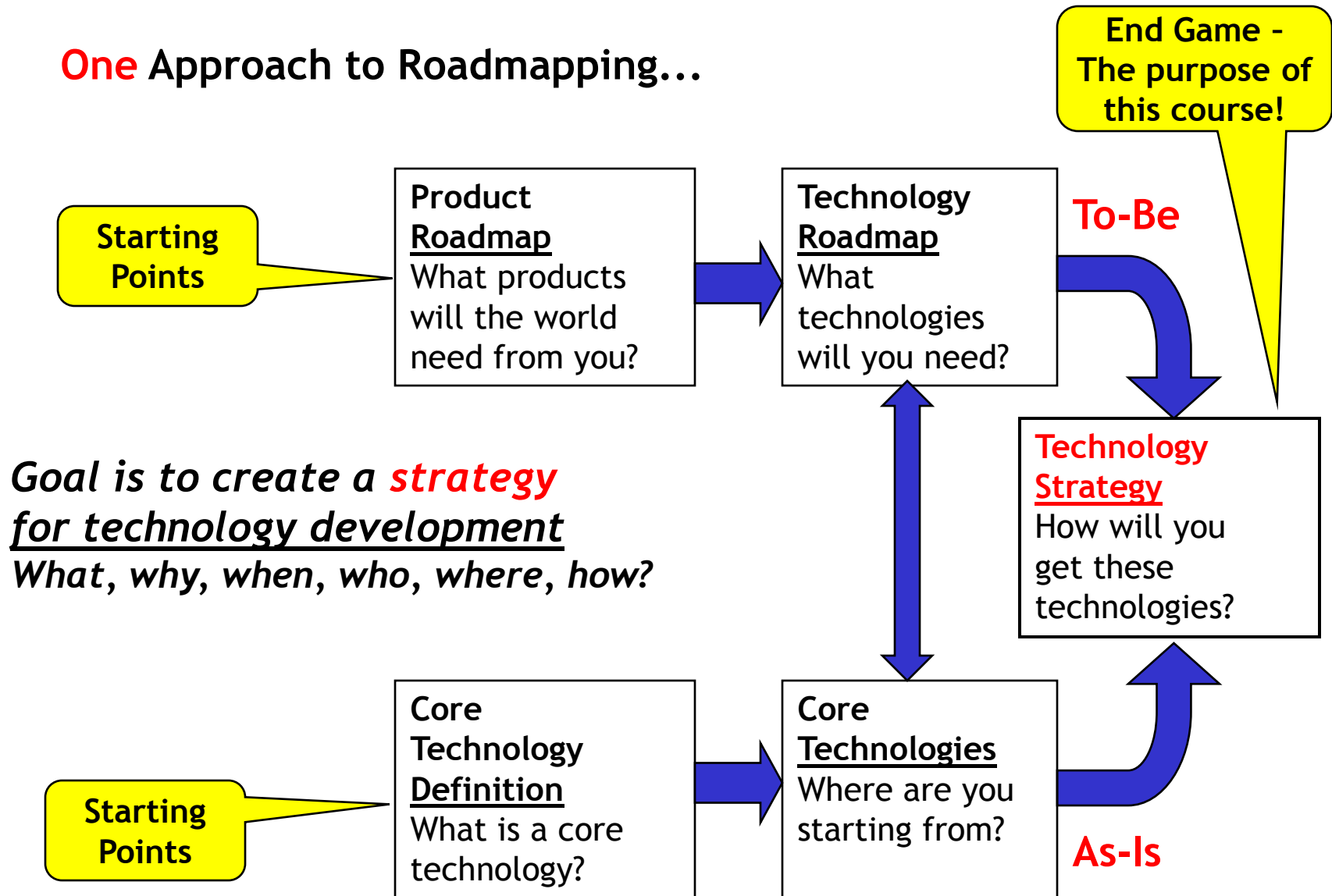
Why “Core Technologies”?

- It’s not enough to just say what technology you need.
- You need to assess your company’s **ability to actually acquire* and transfer a technology**.
- This is where the concept of “**core technology**” comes in.
- In short, if a technology **needed** in your strategic plan is not or could not be a **core** technology for you, then take it off the roadmap!

*This, of course also means that you need to go back and modify your strategic plan and **financial growth estimates!***

* *Acquire* means develop internally or obtain externally.

One Approach to Roadmapping...



Some confusing terms defined...

Capabilities: **Many** things that **everyone** does just to play in the game.

Core Competences: **Few** things that **you** do to **win** -

- Provide you with **sustainable** competitive advantage,
- **Differentiate** you from competitors.

Characteristics of a Core Competency*

- Provides potential access to a **wide** variety of markets.
- Provides perceived **customer** benefit in end product.
- Difficult for **competitors** to imitate.

* Direct from Prahalad and Hamel

Characteristics of a Core Technology

How do you know if something is a core technology?

1. **Opportunity:** Provides significant expansion of existing opportunities,
or a new solution to existing or new problems.
2. **Value Proposition:** Provides significant improvements in cost, reliability, and/or functionality (perceived by **customer**).
3. **Competitive Advantage:** Source of unique, sustainable competitive advantage when incorporated into products.
 - Unique and sustainable relative to competitors - difficult for **competitors** to imitate.
 - Must **combine individual technologies** to create competitive advantage.

Difficult for Competitors to Imitate*

- **Competitors** may easily acquire **some** of the elements that comprise a core competence.
- But it will be difficult to imitate if the competence is a:
 - Complex harmonization of **individual technologies** and production skills,
 - Comprehensive **pattern** of internal co-ordination and learning.

* Direct from Prahalad and Hamel

Example: Company X Core Technologies*

Mechanics

Force/power transmission
(gears/levers/etc.)
Fluid mechanics (air/liquid)
High durability in harsh environment
Low-cost, mass-producible
“Miniaturization” (high power density)
Low noise/vibration

Electronics

High power
Low power
High reliability in harsh environment
Low-cost, mass-producible
Miniaturization (high power/control
density)

Communications

Optimized architecture (interoperability)
Robust/secure
Efficient bandwidth utilization

Algorithms/Software

System
Performance optimization
Diagnostics/prognostics
Embedded
Real time
Minimal hardware
Robust (harsh environment)

Fundamental Sciences

Metals
Polymers
Coatings
Fluids
Electrochemistry
Electromagnetic fields
Arc science

** Each box contains a combination of technologies that can provide products with unique, sustainable competitive advantage.*

Example: Company X Core Technologies*

Mechanics

Force/power transmission
(gears/levers/etc.)
Fluid mechanics (air/liquid)
High durability in harsh environment
Low-cost, mass-producible
“Miniaturization” (high power density)
Low noise/vibration

Electronics

High power
Low power
High reliability in harsh environment
Low-cost, mass-producible
Miniaturization (high power/control density)

Communications

Optimized architecture (interoperability)
Robust/secure
Efficient bandwidth utilization

Algorithms/Software

System
Performance optimization
Diagnostics/prognostics
Embedded
Real time
Minimal hardware
Robust (harsh environment)

Fundamental Sciences

Metals
Polymers
Coatings
Fluids
Electronics
Arc S

Let's examine this core technology at Company X

How does this work in practice?

- Electronics *per se* can be considered a “commodity” (e.g. consumer electronics).
- But for Company X the ability to design and manufacture electronics to **all** of the following requirements constitutes a core technology:
 1. Miniature *and*
 2. High *and* low power *and*
 3. Harsh environment *and*
 4. Low cost, mass producible.
- A competency in miniaturization, for example, does not constitute a core technology for Company X. Only the **combination** of all five capabilities provides a competitive advantage.
- This total set of five competencies provides a source of competitive advantage **if** competitors find this difficult to do or get.

Characteristics of Core Technologies

- Source of unique, sustainable competitive advantage.
 - Unique and sustainable relative to competitors - difficult for competitors to duplicate
 - **Must combine to create unique, sustainable competitive advantage.**
- Provide significant **improvements** in:
 - Functionality (or completely new functions),
 - Cost,
 - Reliability.
- Or, can enable completely **new** products.
- **Sources** of core technologies can be **combinations** of:
 - Division engineering,
 - Corporate R&D,
 - External.

Requirements of a Core Technology

So that's what it is, now how do you know if you “have” this core technology?

1. **Capabilities:** You must have access* to the “**total package**” of capabilities:
 - ~ Theoretical knowledge,
 - ~ Modeling/simulation and/or physical testing capability.
 - ~ Field experience,You must have the ability to use these capabilities to predict behavior and adapt the technology in response to new/unknown applications and conditions.
2. **Intellectual Property:** You must have significant IP and/or the ability to **own and protect** the IP associated with the core technology.
3. **Customers:** **Most importantly**, you must be able to **couple** theoretical knowledge with real-world **customer** needs and applications.

** Source can be internal or external, as long as access is insured.*