

# Life Cycle Risk Reduction Tool Description

In this document we explain how to use the Life Cycle Risk Reduction Tool. New product development (NPD) is inevitably risky as the goal is to develop and market something new. Since that means it has never been done before, risk is inevitable. The key to managing risk is to identify the risks at each stage of the NPD process, and then make decisions as to which risks can and should be avoided, which eliminated, which mitigated, and which you will accept.

The Life Cycle Risk Reduction Tool provides a two-step process to identifying risks and assessing their significance. The first step involves examining the entire life cycle for a product or service under development to identify risks which could affect your ability to complete NPD or to create value for either customers and end-users, or for your company or organization. The second step involves determining the significance of the risks and whether – and how – to avoid, eliminate, mitigate, or accept these risks.

Following Ron Adner's approach in *The Wide Lens*<sup>1</sup>, there are three main types of risks that can be addressed during NPD. Adoption risk refers to whether the intended customer segments will actually buy the product or service and the intended end-users actually deploy it. Execution risk refers to the ability of your organization or company to actually conduct NPD. Co-innovation risk refers to the ability of vendors, suppliers, and partners to provide what you need as part of your NPD and to conduct their own NPD, if necessary, to develop consumables or other essential goods to effectively deploy your product or service. The Life Cycle Risk Reduction Tool can address all three risks, but the emphasis is on execution and co-execution risks. That is because it does not make sense to spend the time and money to conduct a life cycle risk analysis on a product or service until you have determined that product or service which has a good likelihood of succeeding in the market.

## What is the Life Cycle Risk Reduction Tool?

The Life Cycle Risk Reduction Tool is a heuristic tool that helps you examine the risks that might occur during the life cycle of a product or service, from the initial conception of the idea, through new product development, into sales and use, and until its final disposal. Figure 1 illustrates the relationship between the stages in NPD and the product life cycle.

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<sup>1</sup> Adner R., *The Wide Lens: What Successful Innovators See That Others Miss*, Portfolio; Revised edition (June 25, 2013).

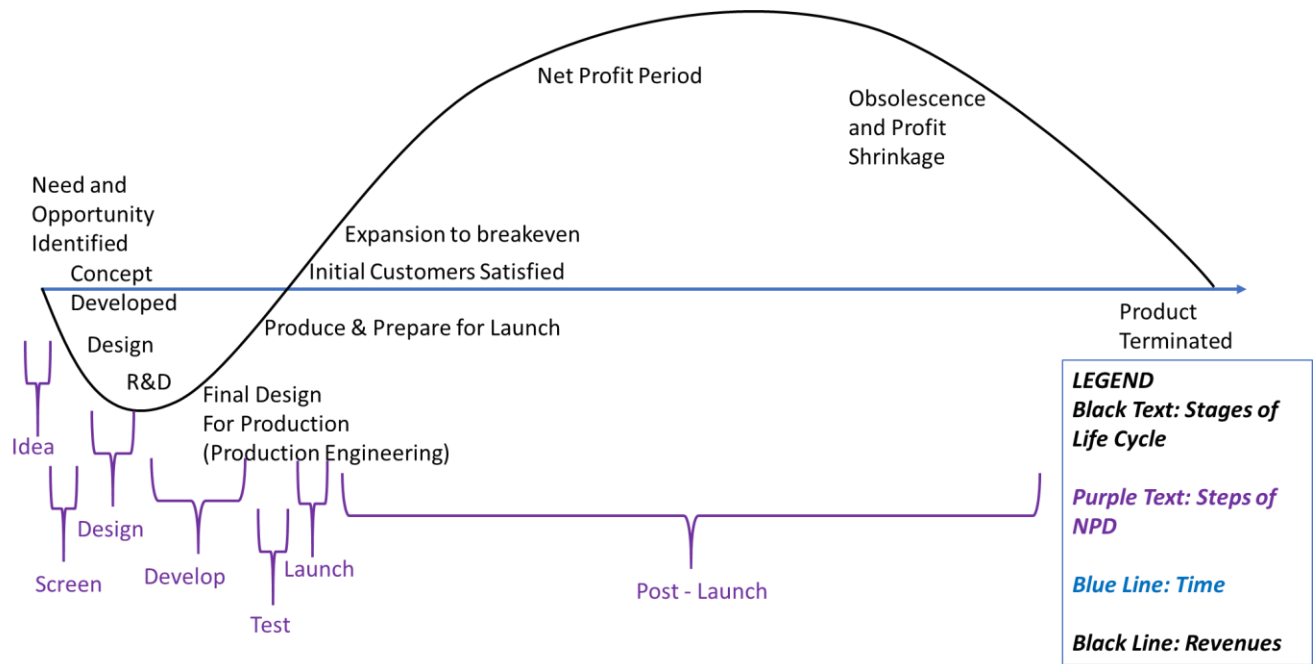


Figure 1: Relationship between NPD, product life cycle, and revenues from product

Risks can occur anywhere in the product life cycle. An objective for NPD is to anticipate and identify downstream life cycle risks as early as possible so they can also be addressed when it is less expensive to do so.

For example, if there is an adoption risk, that means the desired sales may never occur due to a misalignment between the product’s concept and needs and trends in the market likely to exist at the time projected for market entry. This risk can be avoided by reconceptualizing the product during the idea or screening stage. If reconceptualization will not work to eliminate the risk that the product will not sell, it may be prudent to abandon NPD.

As the phrase “Valley of Death” emphasizes, the early stages of NPD are associated with the highest risk because the chance of failure is greatest (see Figure 2). Every potential risk for the entire NPD process and life cycle of the product exists when you first start an initiative. None of these risks have yet to be addressed.

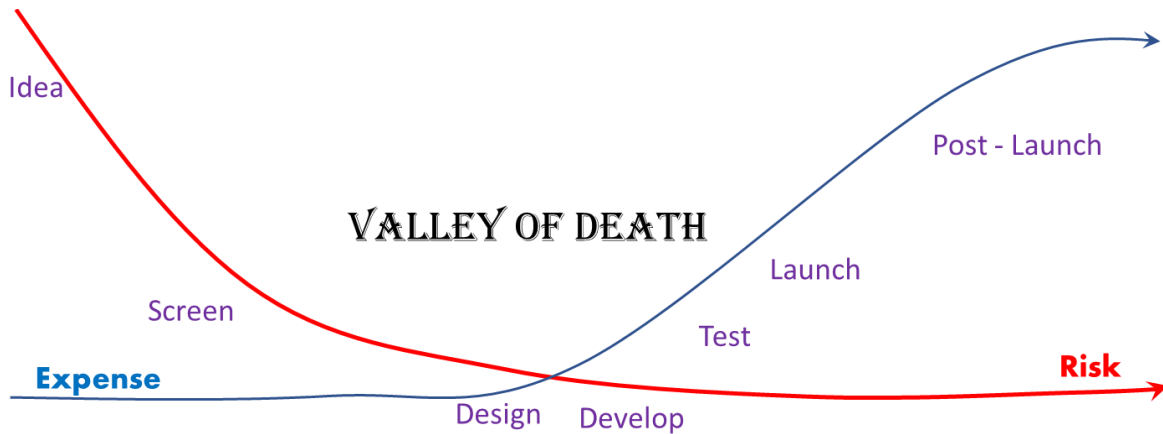


Figure 2: Risks and expenses in NPD. The Design and Development stages are the “Valley of Death”, where risk is still significant and expenses are rising rapidly.

The greater the risk, the lower the likelihood of successfully completing NPD. So the early stages (Idea, Screen) heavily emphasize reducing adoption risk. While adoption risk reduction remains important for design, at this stage execution and co-execution risk reduction are emphasized. The objective is to bring down risk rapidly in the early stages, ideally by avoiding or eliminating it by honing in on a product or service with a strong competitive advantage and then designing that product or service in such a way that it maintains (or improves) the competitive advantage while creating a good that makes it easy and cost-efficient for the primary value chain activities to make, sell, and support the product or service effectively.

The Life Cycle Risk Reduction Tool should be used early in the Design stage and the analysis completed early enough that the findings can inform the preliminary design.

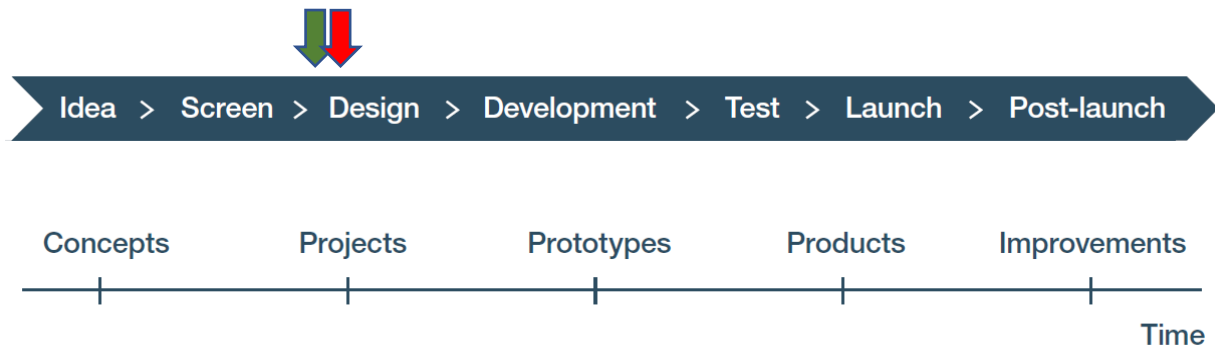


Figure 3: Stages and gates. The green arrow depicts the Life Cycle Risk Reduction Tool being used early in the Design stage but after the Business Model Canvas if it was deferred until this stage. The red arrow indicates that the Tool's workbook and the analysis of results should be completed early enough in the stage to be useful for creating the preliminary design. In larger or multi-product or service companies, the tool may be used even earlier during the Screen stage when screening concepts in order to consider their viability as the basis of a product family. Be aware that risk management is an on-going activity throughout NPD.

Life cycle risk reduction is not discussed directly in the WIPO Publication *Using Inventions in the Public Domain: A Guide for Inventors and Entrepreneurs* (2020). The need to reduce risk, however, is a theme throughout that guide. Technology risk management is the focus of section

9.4 “Design for manufacturing and technology risk management” in Module III “Integrating public domain knowledge into product development process” in the guide.

### How do you enter data in the Life Cycle Risk Reduction Tool?

As with other tools used in the early part of the Design stage, most of the data needed to use the Life Cycle Risk Reduction Tool comes from re-examining data collected during earlier stages of NPD. This time, however, that data is examined from the perspective of what the data suggests about risks that can affect core benefits, tangible features, and augmented features desired by customers and end-users (see Figure 4 below). It is also helpful to review the business plan for the product (the completed Business Model Canvas Tool workbook for example) for potential sources of risk to your own company’s or organization’s objectives associated with the NPD initiative.

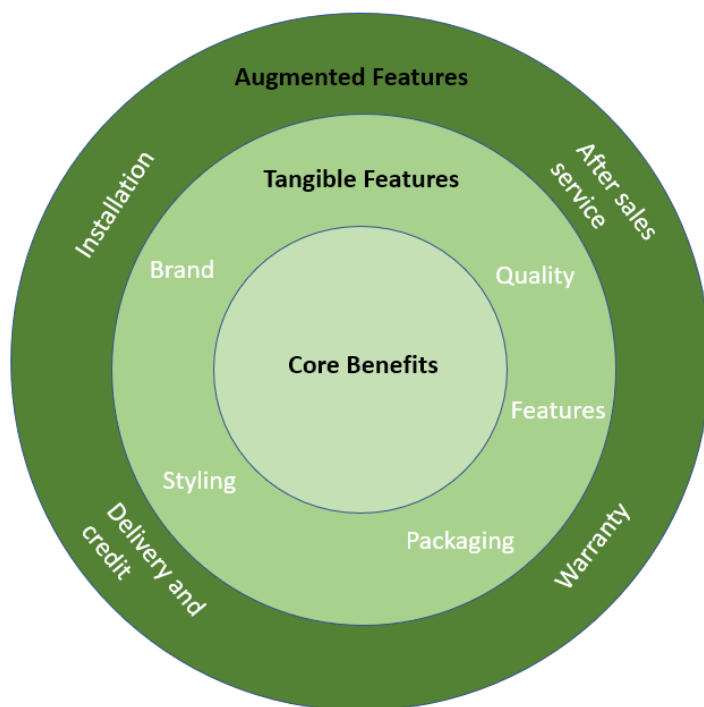


Figure 4: Core benefits or services, with examples of tangible features and augmented features

For example, suppose you are developing a bottled beverage product. Voice of the Customer and Competitive Advantage market research suggests long shelf life – on the order to one year in a sealed container despite exposure to widely fluctuating temperatures from minus 10 to 80 degrees Celsius – would be a critical tangible feature. That suggests a source of potential execution or co-innovation risk. If the ingredients which would be included in the “Inbound logistics” section in the Value Chain Tool cannot handle that temperature range over that time period, then a serious risk to product success has been discovered. This risk could be mitigated by mandating the drink be stored at room temperature to avoid the problem of widely fluctuating temperatures, or it could be avoided altogether by substituting ingredients that can handle that temperature range for over a year without degrading, changing the flavor, or raising health concerns. Each of these risk management strategies would involve tradeoffs because mandating room temperature storage might narrow the potential market, and substituting temperature-tolerant ingredients might affect flavor and other beverage properties.

Note that where a new product or service will rely upon technology in the public domain, regular reassessment of competitive advantage is essential. The reason is that anyone is free to use that public domain technology, so copycat products or services are always a threat.

The amount of data collection and analysis that is done for this analysis depends on the novelty of the product or service being developed, the size of the NPD budget, the importance of successful NPD for the future of the company or organization developing it, and other factors.

Collecting data for the Life Cycle Risk Reduction Tool and then analyzing it requires going back over the results from all the previously deployed tools and looking for potential sources of execution risk, co-innovation risk, or adoption risk which may affect: 1) the customers' and end-users' ability to realize the core benefits and services they are seeking from your product or service and obtain the tangible and augmented features they desire, and 2) your company's or organization's ability to implement your Business Model Canvas.

The Life Cycle Risk Reduction Tool workbook has four main sheets, each on its own tab, and an additional "Notes and references" tab.

The first tab entitled "Risks" (see Figure 5 showing the tab filled out in the Biofuels Example) helps you think about where risks might exist. This tab is for brainstorming. Specific risks are identified by reflecting on the intersections in the matrix and whether a lack of capacity or capabilities indicate a potential problem for NPD or the activities of the value chain with respect to the product or service being developed.

Risks associated with the product or service							
Factors contributing to the risk\Areas where risks are likely to occur	Areas where risks are likely to occur						
	New product development	Purchase	Delivery	Use	Consumables	Maintenance	Disposal or recycling
Communication	On-site biofuels production may not be a high priority, even with government incentives. So it may be hard to identify and reach Beta Testers			Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.			
Labor				Unskilled labor will not understand how to use.	Insertion of new organisms may be difficult if requires new skills	Users may not have high or any literacy.	
Knowhow				1. No existing knowhow in biofuels production, although can leverage familiarity with other equipment. 2. Operating range tolerences are more stringent than the end-users are accustomed to, due to		Probably a significant lack of knowhow in how to handle organisms safely.	
Supplies and materials				May have insufficient biomass to make worthwhile.	Need to send new organisms periodically.		Filters and organism shipping material have to meet all normal waste collection criteria. If the tanks, piping, valves, etc. age out they have to meet the same requirement.
Equipment and facilities				May not have computers, printers, CD readers, WiFi, internet or reliable cell connection.		1. May not have computers, WiFi, internet or reliable cell connection to remotely flush filters, tanks, pipes and valves. 2. How to remotely maintain chippers or anything else requiring lubrication or oil, as well as taking apart to clean	
Technology and IP	License deal for use of organisms and related technology not yet signed.				Organisms cannot cause harm when released into the environment.		
Working capital		Leasing has to have no impact or positive impact on normal costs of operations and normal cash flow.			Cost of organisms cannot cause sticker shock.		
Other factors			1. Delivery services and post may not exist or may require long transit times for remote locations. 2. Roads for delivery by us may be		Delivery services and post may not exist or may require long transit times for remote locations.		

Figure 5: Risks associated with the product or service on tab 1 of the Biofuels Example of the Life Cycle Risk Reduction Tool workbook.

On tab 2 entitled “Significance of risks”, risks entered in tab 1 are automatically copied over into that tab. Next you make an estimate as to the probability of the risk occurring (column D entitled “Probably of occurrence”) and how much impact it could have on product success (column E entitled “Impact on product success”).

A simple scale from low (1) to high (3) is used. Column F entitled “Significance of the risk” gives you a significance estimate created by multiplying the likelihood of occurrence with its likely impact if it does occur. The next three columns (G, H and I) help you think about how to address the risk. The last three columns (J, K and L) are a “reality check” that encourages you to evaluate if your proposed solution is worth the time and money it will involve.

Tab 1: Risks

You develop the data to enter in this tab as follows. First, look at the Business Model Canvas (BMC) developed using the BMC Tool, for example as shown in Figure 6 below for the Biofuels Example.

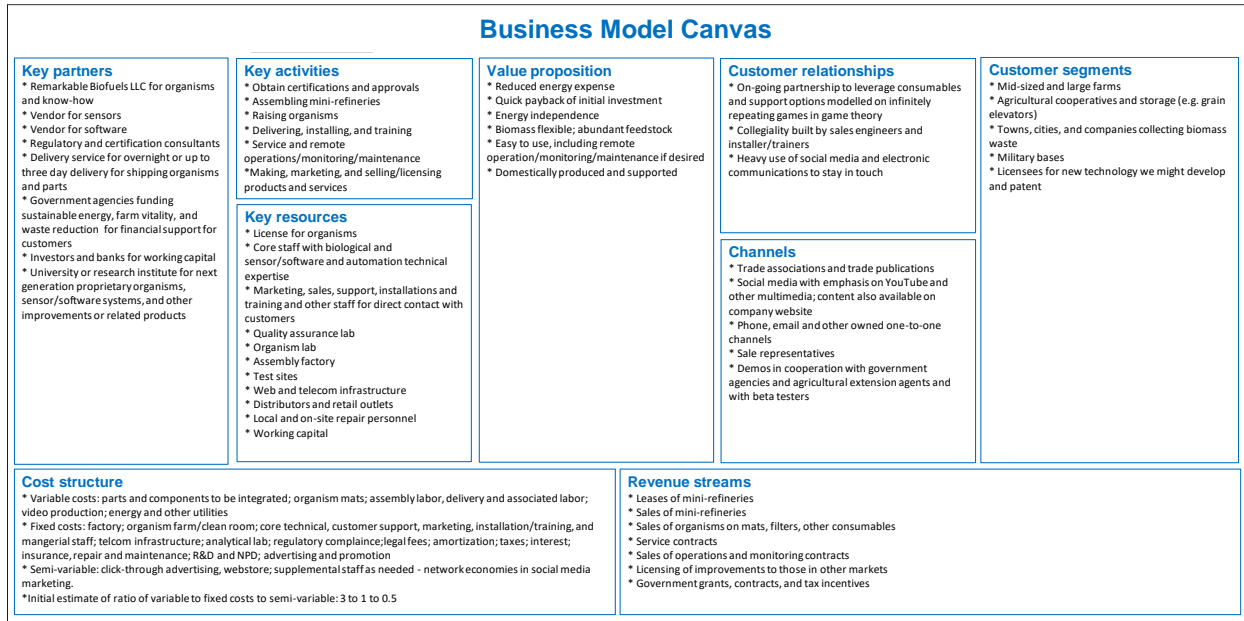


Figure 6: The Business Model Canvas Tool workbook for the Biofuels Example.

Recall that you are always considering three types of risk: execution risk (can you build it); co-innovation risk (can your suppliers, vendors, and partners do what you need them to do); and adoption risk (will your customers buy it and end-users use it). You are also always considering project-specific sources of risk, where different types of risk can emerge from how you conduct your activities during the project life cycle.

To identify other risks, continue your review by looking at your BMC in light of the findings from using the other tools in the NPD Toolkit. Always ask yourself: where can things go wrong?

For example, the BMC for the Biofuels Example calls for a mid-sized and large farm customer segment. It also calls for a customer relationship in which there is heavy use of social media and electronic communications to stay in touch with customers and end-users. What happens if the internet goes down? What if it is not even available in some places? Looking at the “Key resources” component of the BMC highlights the importance of web and telecom infrastructure for this project. The possibility that this is a potential source of risk is strengthened by a statement in one of the expert interviews from the Voice of the Customer Tool workbook (see Figure 7 below) where the expert noted that internet access is a problem for some mid-sized farms and many small ones. Accordingly, it makes sense to do some market research to determine just how widespread and significant this risk might be.

<b>Expert on competitive opening</b>	
<b>Name</b>	ATI
<b>Title</b>	Executive Director
<b>Organization</b>	Crop Farm Bureau
<b>Phone</b>	777-666-555
<b>Email</b>	<a href="mailto:Ati1@farmbureau.country.org">Ati1@farmbureau.country.org</a>
<b>Importance of need(s) being addressed</b>	We are all talking about biofuels in the agriculture sector, but not too much is happening in countries like ours yet. I think we may need stronger government incentives before we see widespread adoption of this kind of technology. The core problem is start-up costs: Who pays for it? Everyone loves the idea of free fuel and being energy independent as well as having another cash product to sell, but right now to a lot of our members it seems like pie in the sky, especially when folks are worrying about drought in one place and too much flooding in another.
<b>Key specifications and features to emphasize for this niche</b>	While the system may work in the lab, it should be demonstrated for field use, where it is harder to be low maintenance and minimal operation because the environmental conditions are different. Sophisticated equipment is limited, especially once you move away from the very large corporate farms. <b>For example, to give you a perspective, some of our mid-sized farm members, and many with small firms, don't even have access to the internet.</b> Also, it should be cost-effective and show efficacy over various types of waste. And it needs to be something a reasonably skilled farm mechanic can operate and repair. I should have started out by saying it has to be affordable in both absolute terms and quick return-on-investment.

Figure 7: Extracted from the tab entitled “Expert interview 2” in the Voice of the Customer Tool workbook for the Biofuels Example, suggesting internet accessibility as a potential risk. The relevant text is highlighted in red for this figure.

Having identified a potential risk or potential source of risk, the risk is listed in a cell on the “Risks” tab. In the Biofuels Example, it shows up as a communication-related risk (fourth row) for the area “Use” (column E). See cell E4 in Figure 8, below.

<b>Risks associated with the product or service</b>							
<b>Factors contributing to the risk Areas where risks are likely to occur</b>	<b>Areas where risks are likely to occur</b>						
	New product development	Purchase	Delivery	Use	Consumables	Maintenance	Disposal or recycling
<b>Communication</b>	On-site biofuels production may not be a high priority, even with government incentives. So it may be hard to identify and reach Beta Testers			Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.			

Figure 8: Risks entered in the Life Cycle Risk Reduction Tool workbook for the Biofuels Example.



In the Biofuels Example, the BMC also includes licensing the organism and related technology that is at the heart of the mini-refinery. If this deal has not yet been signed, then that is clearly a source of risk. This is confirmed by the risks associated with organisms that were identified in the Biofuels Example Value Chain Tool workbook on the “Inbound logistics” tab (see Figure 9 below), as well as on the “Solutions” tab in the discussion of organisms (see Figure 10 below with relevant text written in red).

Inbound logistics												
Requirements	Average of risks	Design requirements/specifications concerns										
		Availability at affordable price	Efficiency/efficacy	Storage of inventory	Payment terms	Environmentally friendly	On-time delivery	Quality				
Parts, components, etc.												
Vats	1	1	1	1	1	1	1	1	1			
Piping and valves	1	1	1	1	1	1	1	1	1			
Sensors	2.1429	3	2	1	2	1	3	3				
<b>Organism</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>				
Mats for organism	2	2	2	2	2	2	2	2				
Conveyers	1	1	1	1	1	1	1	1				
Chippers/mulchers	1	1	1	1	1	1	1	1				
Filters	1	1	1	1	1	1	1	1				
Software for monitoring and maintenance	2	2	2	1	2	1	3	3				
Telecom for data and remote control	1.2857	1	1	1	2	1	2	1				
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<b>Average risk for inbound logistics</b>	<b>1.5918</b>											

Figure 9: Availability of organisms is a risk in the Value Chain Tool workbook for the Biofuels Example as entered here in the “Inbound logistics” tab.

Solutions to risks				
Risk to be addressed	Who is responsible	What will be done	Feasibility (0–100%)	Anticipated effectiveness (0–100%)
Organism selection and their health and replacement over the life of the product, support consumable sales	Technical supported by Logistics for licensing or contract research where these are used	Hire competent consultants or obtain know-how from licensor on how to grow and maintain cultures, ship them, etc.; hire and train up 3 master's level microbiologists to conduct this work in operations and support sales of consumables and addressing customer problems. Ship organism kits directly from us to user. <b>Also develop a backup plan if suitable organism(s) cannot be licensed, so the project does not have to be cancelled.</b>	100%	90%

Figure 10: Possible mitigation measure found on the “Solutions” tab of the Value Chain Tool workbook for the Biofuels Example. The text in red has been highlighted for this Figure.

Going back to the Life Cycle Risk Reduction Tool, the risk should be entered in the matrix on the “Risks” tab where it seems appropriate. This means that, when you see a potential source of risk, you need to describe the nature of the problem and identify the appropriate category or nature of the problem in column A entitled “Factors contributing the risk”, and then decide in which areas and how during the product life cycle this problem could be a source of risk (columns B to H under the heading entitled “Areas where risks are likely to occur”).

Depending on how you analyze and apply your data, you might decide that a problem can be a risk at multiple stages or for multiple activities listed in columns B to H, and you would enter specific comments about the potential risk associated with each stage or activity.

For example, in the Biofuels Example shown in Figure 11 below, the fact that a license for the organism has not yet been obtained was identified as a “Technology and IP” risk factor (row 9), and specific comments were entered in cells in row 9 to show that the licensing issue could be a “New product development” risk (cell B9), as well as a “Consumables” risk (cell F9). Although it is not shown in this example, this licensing issue could also be considered a “Purchase” (licensing) risk (column C) depending on how the issue is perceived. The issue of internet accessibility and telecom infrastructure for users was also identified as a “Communication” risk (row 4) and comments were entered in row 4 to show that this could be a source of risk for both “New product development” (cell B4) and “Use” (cell E4). As long as you place the risk where it seems reasonable, don’t worry about which cell is best. As stated previously, this is a brainstorming tool to identify risks and collect your comments.

Risks associated with the product or service					
Factors contributing to the risk\Areas where risks are likely to occur	Areas where risks are likely to occur				
	New product development	Purchase	Delivery	Use	Consumables
Communication	On-site biofuels production may not be a high priority, even with government incentives. So it may be hard to identify and reach Beta Testers			Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.	
Technology and IP	License deal for use of organisms and related technology not yet signed.				Organisms cannot cause harm when released into the environment.

Figure 11: Potential risks associated with obtaining the organisms classified as a “Technology and IP” risk entered on the Risks tab of the Life Cycle Risk Reduction Tool workbook for the Biofuels Example of as both a “New product development” risk and a “Consumables” risk. Potential risks also associated with the issue of internet accessibility and telecom infrastructure classified as a “Communication” risk in the areas of both “New product development” and “Use”. Some columns and rows have been hidden in this figure to improve readability.

Be aware that not all risks are going to show up through this technique. That is why it is called a brainstorming tool. Use what you know about the market and environment your product or service will be entering, and what you know about your capacities and capabilities to conduct NPD and other activities related to the life cycle of the product.

**Tab 2: Significance of risks**

On the second tab entitled “Significance of risks”, embedded functions automatically copy and categorize the risks identified on tab 1 at the appropriate location on tab 2. Descriptions of risks from tab 1 (Risks) are automatically copied to tab 2 (Significance of risks) in the first column entitled “Risk from user experience table”. Areas where risks are likely to occur from tab 1 (Risks) are automatically copied to tab 2 (Significance of risks) in the second column entitled “User interaction”. Factors contributing to the risk from tab 1 (Risks) are also automatically copied to tab 2 (Significance of risks) in the third column entitled “Nature of the problem”.

The first task on this tab is to think about how probable the risk is and then enter a rank in the fourth column (column D entitled “Probability of occurrence”) and what its impact is likely to be and enter a rank in the fifth column (column E entitled “Impact on product success”). Embedded formulas will calculate the product of these two rankings and display it in column F entitled “Significance of the risk”.

Next on that tab, use the two legends presented below the main table to indicate what phases of the product or service life cycle (using the abbreviations in the legend) is impacted and enter it into column G entitled “Phase of life cycle impacted” and in which stage you believe you can best address this risk during NPD by entering this into column H entitled “Stage of new product development where the risk is addressed”. In the next column (column I) entitled “Preventive or mitigation measure”, identify what you will do to address, and preferably avoid or mitigate, the

risk. You can include concrete suggestions for action as well as mere ideas about possible solutions.

As shown in Figure 12 for the Biofuels Example, one source of risk was that the license for organisms had not been signed yet (cell A9), and the proposed preventative or mitigation measure was listed as: “Accelerate in-licensing and identify next best option and explore licensing that. Approach national universities, research institutes, and companies who may have organisms as well as others in the region first, then seek farther afield.” (cell I9). Another source of risk was associated with whether end-users have reliable access to the internet and other telecoms options (Communications problem – cell A28) and the proposed Preventative or mitigation measure was listed as: “Have CD, videotape, and print options at no additional cost. Also seek to have as much as possible run off a cell phone or satcom if desired. Have a bundle with various telecom equipment as a purchase or lease option” (cell I28). This tab shows how other problems/sources of risk are broken down as separate risks with separate risk analyses and proposed mitigation strategies, for example, the organism-related risk for Consumables is entered in a separate row (row 41) for analysis and proposed mitigation.

Risk from user experience table	User interaction	Nature of problem	Preventive or mitigation measure
License deal for use of organisms and related technology not yet signed.	New product development	Technology and IP	Accelerate in-licensing and identify next best option and explore licensing that. Approach national universities, research institutes, and companies who may have organisms as well as others in the region first, then seek farther afield.
Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.	Use	Communication	Have CD, videotape, and print options at no additional cost. Also seek to have as much as possible run off a cell phone or satcom if desired. Have a bundle with various telecom equipment as a purchase or lease option.
Organisms cannot cause harm when released into the environment.	Consumables	Technology and IP	Either the organisms must be harmless or, however they are removed from the unit has to simultaneously kill them without any special tasking for the user. Prototypes must meet regulatory approval and be certified safe by 3rd party.

Figure 12: The “Significance of risks” tab of the Life Cycle Risk Reduction Tool workbook for the Biofuels Example with some risks entered into the spreadsheet and possible preventive or mitigation measures identified highlighted in yellow. Some columns and rows have been hidden in this figure to improve readability.

Finally, reassess the likelihood of occurrence and impact after the risk management measure is implemented. Enter a value in column J entitled “Probability of occurrence after measure” and a value in column K entitled “Impact after measure”. Embedded formulas in the spreadsheet will then calculate the product of these two new rankings and display it in the last column in the table entitled “Revised significance of the risk”, which indicates how well you think the risk is managed.

If a risk does not seem to be well managed, go back and reassess the risk and your solutions for it. Be aware that you can never completely eliminate a risk identified by this tool and entered in the workbook. That is because you can never have 100% certainty about the future. The only

way you know a risk is totally eliminated is after a time when that source of risk can no longer have a negative impact, and no negative impact was seen prior to that time.

Figure 13 from the Life Cycle Reduction Tool workbook for the Biofuels Example, illustrates what the “Significance of risks” tab should look like after you have done this work.

Risk significance for new product development and life cycle											
Risk from user experience table	User interaction	Nature of problem	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D + column E)	Phase of life cycle impacted	Stage of new product development where the risk is addressed	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J + column K)
On-site biofuels production may not be a high priority, even with government incentives. So it may be hard to identify and reach BSA's Tractor	New product development	Communication	2	2	4	PPL	L	Leverage associations supporting biofuels for help. Also approach military for bases where we can demo as Government policy is to encourage use of biofuels.	2	1	2
0	New product development	Labor			0						0
0	New product development	Knowhow			0						0
0	New product development	Supplies and materials			0						0
0	New product development	Equipment and facilities			0						0
License deal for use of organisms and related technology not yet signed.	New product development	Technology and IP	1	3	3	RPD	R&D	Accelerate in-licensing and identify next best option and explore licensing that. Approach national universities, research institutes, and companies who may have organisms as well as others in the region first, then seek farmer field.	1	1	1
0	New product development	Working capital			0						0
0	New product development	Other factors			0						0
0	Purchase	Communication			0						0
0	Purchase	Labor			0						0
0	Purchase	Knowhow			0						0
0	Purchase	Supplies and materials			0						0
0	Purchase	Equipment and facilities			0						0
0	Purchase	Technology and IP			0						0
Leasing has to have no impact or positive impact on normal costs of operators and normal cash flow.	Purchase	Working capital	2	3	6	ICS	PSD	To extent feasible, everything incorporated should be commercial-off-the-shelf and of moderate cost.	2	2	4
0	Purchase	Other factors			0						0
0	Delivery	Communication			0						0
0	Delivery	Labor			0						0
0	Delivery	Knowhow			0						0
0	Delivery	Supplies and materials			0						0
0	Delivery	Equipment and facilities			0						0
0	Delivery	Technology and IP			0						0
0	Delivery	Working capital			0						0
1. Delivery services and post may not exist or may require long transit times for remote locations. 2. Roads for delivery by us may be very poor.	Delivery	Other factors	3	3	9	ICS	PSD	1. Not really an issue if we plan for it. 2. Has to be able to deliver on small pick-up or trailer in very robust packaging.	3	1	3
Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.	Use	Communication	3	3	9	FPD	PPL	Have CD, videotape, and print options as no additional cost. Also seek to have as much as possible run off a cell phone or satcom if desired. Have a bundle with various satcom equipment as a purchase or lease option.	3	1	3
Unskilled labor will not understand how to use.	Use	Labor	2	3	6	ESB	D	Add smart software and have an intuitive user interface	2	1	2
1. No existing knowhow in biofuels production, although can leverage familiarity with other equipment. 2. Operating range tolerances are more stringent than the end-users are accustomed to, due to the organisms.	Use	Knowhow	3	3	9	ESB	D	Any user interface has to be no more difficult to learn than for the tasks necessary to use and maintain a tractor or truck.	3	1	3
May have insufficient biomass to make worthwhile.	Use	Supplies and materials	3	3	9	RPD	R&D	Allow biomass to be stored until sufficient amount. Also enable to be added once a round is started until there is no further production of fuel and the units shuts off automatically until restarted, or sense sufficient biomass in it.	3	2	6
May not have computers, printers, CD readers, WIFI, internet or reliable cell connection.	Use	Equipment and facilities	3	3	9	PPL	R&D	Remote stuff has to run off a landline, cell or satcom phone, possibly a ham radio if those are in widespread use. Bundle telecom/IT equipment as add-on.	1	1	1
0	Use	Technology and IP			0						0
0	Use	Working capital			0						0
0	Use	Other factors			0						0
0	Consumables	Communication			0						0
Insertion of new organisms may be difficult if requires new skills.	Consumables	Labor	3	3	9	PSD	D	Use a simple, intuitive measuring unit to draw in and deliver the organisms or have them prepackaged in the right volume.	1	1	1
0	Consumables	Knowhow			0						0
Need to send new organisms periodically.	Consumables	Supplies and materials	2	3	6	PSD	D	Design packaging to meet both the units requirements and the available delivery options.	1	1	1
0	Consumables	Equipment and facilities			0						0
Organisms cannot cause harm when released into the environment.	Consumables	Technology and IP	3	3	9	PSD	R&D	Either the organisms must be harmless or, however they are removed from the unit has to simultaneously kill them without any special tasking for the user. Protocycles must meet regulatory approval and be certified safe by 3rd party.	1	1	1
Cost of organisms cannot cause sticker shock.	Consumables	Working capital			0						0
Delivery services and post may not exist or may require long transit times for remote locations.	Consumables	Other factors	3	3	9	ICS	PSD	Once we determine the worst possible delay, head a battery powered thermo unit that is low cost and lasts that long. If need be, the unit can be shipped back and reused to cut costs.	2	1	2
0	Maintenance	Communication			0						0
Users may not have high or any literacy.	Maintenance	Labor	3	2	6	PPL	F	Develop video and pictorial training material.	1	1	1
Probably a significant lack of knowhow in how to handle organisms safely.	Maintenance	Knowhow	3	3	9	PSD	D	Handling should not be more complicated than putting on a set of gloves to protect against heat or chemicals, which we provide at no cost.	1	1	1
0	Maintenance	Supplies and materials			0						0
1. May not have computers, WIFI, internet or reliable cell connection to remotely flush filters, tanks, pipes and valves. 2. How to remotely maintain chippers or anything else requiring lubrication or oil, as well as taking apart to clean.	Maintenance	Equipment and facilities	2	2	4	PSD	D	Some of the tasks will just have to be manual, but these should not require skills beyond those most likely to be already held by users. Also offer bundling of telecom/IT equipment.	1	1	1
0	Maintenance	Technology and IP			0						0
0	Maintenance	Working capital			0						0
0	Maintenance	Other factors			0						0
0	Disposal or recycling	Communication			0						0
0	Disposal or recycling	Labor			0						0
0	Disposal or recycling	Knowhow			0						0
Filters and organism shipping material have to meet all normal waste collection criteria. If the tanks, piping, valves, etc. age out they have to meet the same requirement.	Disposal or recycling	Supplies and materials	3	3	9	ESB	R&D	To the extent feasible everything should biodegrade. If it cannot biodegrade it has to be able to go into the trash or recycling or to a junk dealer. Worst case, we have to pick it up and dispose of it, in which case we need a safe storage unit.	1	1	1
0	Disposal or recycling	Equipment and facilities			0						0
0	Disposal or recycling	Technology and IP			0						0
0	Disposal or recycling	Working capital			0						0
0	Disposal or recycling	Other factors			0						0

Figure 13: The full “Significance of risks” tab of the Life Cycle Risk Reduction Tool workbook for the Biofuels Example.

A closer look at the Biofuels Example in Figure 14 below shows for example that addressing the risk associated with licensing the organism was ranked as a low probability of occurrence (rank 1, cell D9) but high potential impact (rank 3, cell E9) for an overall significance of 3 (cell F9), and after the proposed mitigation measure the potential impact decreased (cell K9) and the overall significance decreased to 1 (cell L9). Likewise, Figure 14 also shows that for the risk associated with the internet/telecoms access problem (cell A28), the probability of occurrence was considered high without the proposed mitigation measure (rank 3, cell D28) for an overall significance of 9 (cell F28) and remained high after the proposed mitigation measure (rank 3, cell J28), but the proposed mitigation decreased the potential impact from 3 (cell E28) to 1 (cell K28), with dramatic decrease in overall significance to 3 (cell L28). Because the likelihood of poor internet accessibility is outside the developers' control, the ranking for the risk of occurrence remains high even after mitigation. However, the ability to reduce the impact through the mitigation measures is very good, reflected in the dramatic decrease in perceived significance from 9 before mitigation (cell F28) to 3 after proposed mitigation (cell L28). This means the developers of the mini-refineries in the Biofuels Example were able to recognize an ongoing source of risk and decide that it is something they would be willing to bear.

Risk significance for new product development and life cycle							
Risk from user experience table	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D * column E)	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J * column K)
License deal for use of organisms and related technology not yet signed.	1	3	3	Accelerate in-licensing and identify next best option and explore licensing that. Approach national universities, research institutes, and companies who may have organisms as well as others in the region first, then seek farther afield.	1	1	1
Poor or no internet may exist limiting access to on-line materials and hinder other communications with customers and end-users.	3	3	9	Have CD, videotape, and print options at no additional cost. Also seek to have as much as possible run off a cell phone or satcom if desired. Have a bundle with various telecom equipment as a purchase or lease option.	3	1	3

Figure 14: The “Significance of risks” tab of the Life Cycle Risk Reduction Tool workbook for the Biofuels Example with risks, their probability of occurrence and impact on product success entered into the spreadsheet, and possible preventive or mitigation measures affecting the final rank and overall significance of the risk. Some columns and rows have been hidden in this figure to improve readability.

### Tab 3: Significance for life cycle and Tab 4: Where risks are addressed

The tables and graphs on the last two main tabs are automatically generated from the data in the “Significance of risks” tab.

On the “Significance for life cycle” tab, a table entitled “Significance of risks by life cycle phase before and after being addressed” and bar graph are automatically generated. On the “Where risks are addressed” tab, a table entitled “Where in new product development risks are addressed” and bar graph are also automatically generated. Figure 15 below shows these two tabs as generated for the Biofuels Example.

These tabs provide summaries and graphs that help you see your progress in addressing risks and help you focus attention on where more work needs to be done. Because future risks can never be completely eliminated with certainty, you can make suggestions about risk management based on results from using the Life Cycle Risk Reduction Tool, but deciding what risk management strategies to implement is ultimately a question for management.

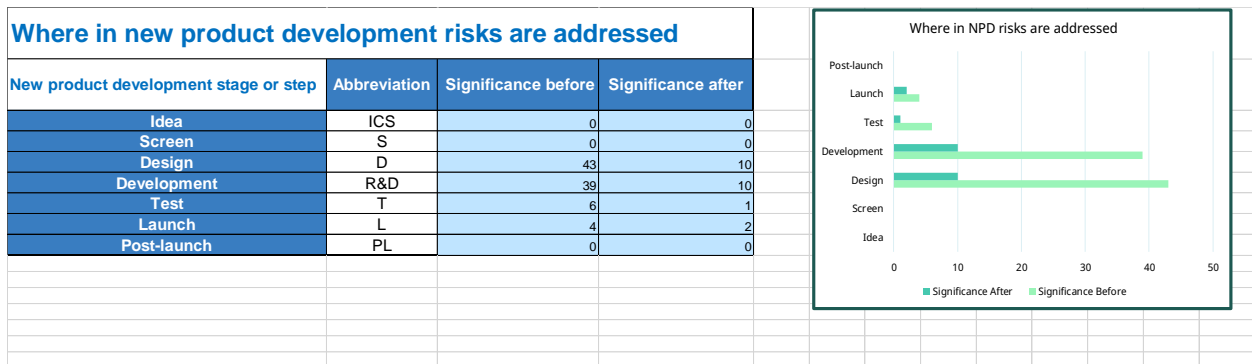
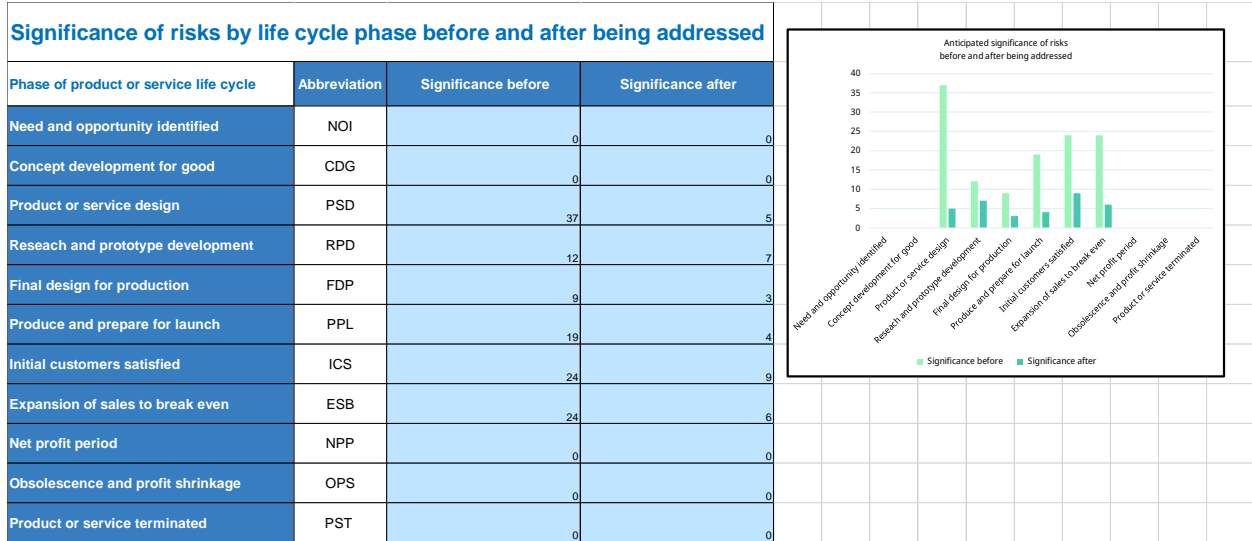


Figure 15: The “Significance for life cycle” and “Where risks are addressed” tabs of the Life Cycle Risk Reduction Tool workbook for the Biofuels Example showing the tables and graphs that are automatically generated from the previous tabs.

## How do you interpret the data from the Life Cycle Risk Reduction Tool and use it in your NPD process?

Once you have entered the Design stage, costs begin to escalate more rapidly and they will escalate even more rapidly during the Development stage. To justify these expenditures, risks must be identified and analyzed, and avoidance, elimination, or mitigation measures must be proposed and evaluated as early as possible during this stage. The Design stage presents opportunities to strategically manage risks because of this ability to incorporate risk avoidance, elimination, and mitigation strategies as guardrails for the design being created.

Putting the solution for these problems and risks in place becomes a task to be added to the Action Plan during the Design or Development stage, if it is not already there. Using the Life Cycle Risk Reduction Tool will trigger a re-examination of the original Action Plan, which usually confirms that you must revise your Action Plan to address the risks and avoidance, elimination or mitigation measures you adopted. When you check where in the Action Plan these measures are implemented, this may reveal other potential sources of risk, such as the lack of any tasking

related to sales and marketing. This indicates the original Action Plan was weaker than previously thought and the newly identified risks associated with product launch that must be addressed before proceeding.

Taking steps to confirm that all risks are being considered and to check when and how risk avoidance, elimination, or mitigation measures are implemented, is essential for navigating the Valley of Death. When you re-examine the Life Cycle Risk Reduction Tool findings concerning what the identifiable risks are, and what compensating measures you have proposed for them, you will gain greater confidence that you are managing risks are at an acceptable level and in line with the level of risk tolerance defined by management. By identifying potential sources of risk and making concrete plans for dealing with those risks, support is increased for a decision to move through the gate at the end of the Design Stage into the more expensive stage of Development.