PrISM by Northwest Green Chemistry

1 Scoping, Problem Formulation & Design Goals

How would you describe the type of product are you planning to make? For example, is the product a substance, a formulated chemical product, a material, or an article? Is it a homogenous or heterogenous material? What is the product?

This product is a re-usable bowl that you use in February. Future iterations will include the March Bowl, April Bowl, and more!

Who are the intended users?

Young children

What is the service provided by the product?

Helps children learn their months and seasons. Holds food - works for wet, greasy, hot, and cold.

What other products are used to provide this service?

Other re-usable and disposable bowls provide the function of holding food while you eat it, and calendars and books can provide the educational service.

What sustainability attributes are you prioritizing to include in the design? Consider the product overall and at each life cycle stage.

Child-safe materials. Support circular economy - made from recycled feedstock and able to be recycled at end of life.

What is the preferred feedstock goal or goals? Please select all that apply

- Waste-based
- Recyclable

Do you have goals to reduce life cycle impacts such as water consumption, waste generation or energy usage in production or manufacturing?

- Reduce/eliminate process chemicals on Restricted Substances Lists (RSLs).
- Reduce/eliminate process carcinogens.

Are you designing the product to contain only ingredients that are recognized as inherently safer such as those on the EPA Safer Chemical Ingredient List (SCIL)? Or are you avoiding chemicals of concern such as those identified on sector-based Restricted Substances Lists (RSLs).

- Use only safer chemicals (e.g. US EPA Safer Chemical Ingredient List (SCIL), TCO approved plasticizers) (specify criteria below)

- Use only certified safer chemicals (e.g. Cradle to Cradle (C2C) certified, CleanGredients)
- Reduce chemicals on RSLs (e.g. ZDHC MRSL) (specify RSLs below)
- Reduce carcinogens
- Reduce other hazardous chemicals (fill in the blank below).

SCIL chemicals, hopefully all from CleanGredients. No developmental toxics or endocrine disruptors.

How long is this product designed to be used for? For example, LEGO blocks are designed for a long use phase, even multi-generational: Blocks made today fit those made more than 50 years ago.

Short use phase (1 day - 2 years)

What attributes are you seeking to meet your longevity goal?

- Other (fill in the blank below)

Are you designing the product for recycling or for biodegradation in wastewater treatment plants or in commercial composting operations?

- Recyclable

Are you planning to meet requirements for an eco-label, standard or environmentally preferable product purchasing specifications?

Yes

Which label?

- Safer Choice

Are you striving for specific life cycle improvements compared to other products that provide the same service?

No

2 Feedstock

What is the base feedstock for the chemical, material or product you are making?

Biobased PLA.

Select the following attributes that describe the base feedstock:

- Biobased

Is the biobased feedstock rapidly renewable?

I don't know

Is the biobased feedstock sustainably harvested?

I don't know

Is it certified sustainably harvested?

I don't know

Is the biobased feedstock waste-based?

I don't know

Does the biobased feedstock compete for land use with social, ecological, or food production value?

I don't know

Can the feedstock be depleted (ie, it is not renewable)?

Don't know

Are there any known social and environmental issues associated with the raw material feedstock you are using?

- Unsure/I don't know

Do you use catalysts?

Yes

Despite the relatively small quantity used, catalysts can have an outsized environmental footprint! Are the catalysts made from:

- I don't know

3 Introduction to Production and Manufacturing

What chemicals and materials are used during production and manufacturing? Consider reagents, catalysts, auxiliaries, and ingredients intentionally added to provide performance properties.

Lactic acid Catalyst Mold release agent

Are the chemicals used during production and manufacturing hazardous?

I don't know

What chemicals and materials are produced during production and manufacturing?

polylactic acid

Are the chemicals produced during production and manufacturing hazardous?

No

Are the chemicals in a form that can be inhaled, ingested or absorbed through the skin?

I don't know

Are the chemicals used or produced in a form that is hazardous to workers?

I don't know

Who is likely to be exposed to production chemicals during production and manufacturing? Workers? Nearby communities?

- Workers

For chemicals used and produced during production and manufacturing, what are the

likely routes of exposure?

- Dermal

Have you conducted a screening chemical hazard assessment on the chemicals used and produced?

Yes - all

Have you conducted a comprehensive chemical hazard assessment, particularly on chemicals for which there is worker and/or community exposure?

No

Have you mapped chemical exposure to chemical hazards using a method such as control banding?

No

Are there potential impacts be to workers and those who live around the production or manufacturing facility who may be exposed to chemicals used in production and manufacturing?

I don't know

What wastes are created during production and manufacturing?

We use injection molding, so bad presses, the leftover bits and pieces outside the press.

Are these wastes hazardous?

No

How are these wastes disposed of?

- Recycling

Do you measure the use of energy, water and materials and the generation of waste in order to benchmark a product against other products to maximize resource efficiency?

No

4 Sustainable Product Design for the Use Phase

How long is this product designed to be used for?

Short use phase (1 day - 2 years)

What chemicals are intentionally included in the product?

PLA

Are the intentionally included chemicals hazardous?

No

What chemical impurities or residuals from production and manufacturing remain in the product?

May be some of the mold release agent

Are the impurities or residuals that remain in the product hazardous?

I don't know

Are the chemicals in a form that can be inhaled, ingested or absorbed through the skin?

I don't know

Does use of the product produce emissions and waste?

No

What are the likely routes of exposure to chemicals in the product as used by customers?

- Dermal

Have you created a conceptual exposure model?

No

How much exposure to the chemicals is likely to occur? Consider amount, frequency and time.

Exposed to food, held in hands, may even be licked clean. Only during meals/snacktime. Main chemical present is PLA and is not bioavailable and is not hazardous.

Have you conducted a screening chemical hazard assessment on the chemicals in the product as used?

No

Are there any chemicals with very high hazards to humans and the environment?

I don't know

Have you conducted a comprehensive chemical hazard assessment on the chemicals in the product as used? Have you focused particularly on those chemicals for which there is likely to be exposure?

No

What are the hazard profiles of the chemicals added to or remaining in the product?

PLA - not hazardous Not sure of residuals from mold release agent

Do the hazards of the chemicals in the product pose a particular concern to vulnerable populations such as children, pregnant women, the elderly, or patients? Are there some population segments who would be placed at greater risk than other populations?

I don't know

How long is the product intended to last?

Short use phase (1 day - 2 years)

Does use of the product generate waste?

No

Does use of the product require the use of energy or water?

No

Are the chemicals in the product stable, or will they result in unwanted or hazardous chemical emissions, especially if subjected to heat or other environmental conditions?

Yes - but only under unintended use conditions

What are the conditions in which unwanted or hazardous chemical emissions occur?

If put in oven, bowl will melt, possibly burn.

How will you ensure customers avoid these conditions?

Labelling on bottom and on packaging.

5 End of Life Considerations

How long is this product designed to be used for?

Short use phase (1 day - 2 years)

Does product durability match the use phase?

No

Does the product have other EOL options that require this mis-match?

Yes

Have you designed your product with a particular waste management strategy or plan in mind? If so, what is it?

Yes

Describe the waste management strategy:

Recycling

End of Life Options

- Landfill
- Waste-to-energy
- Recycling
- Industrial composting
- Non-biodegradable littler

Have you considered strategies for product prolongment (such as repair, remanufacturing, refurbishing, leasing strategies)?

No

Do you have a plan to communicate instructions for proper management of products after use?

Yes

Describe the strategy.

Mark bottom of bowl and on packaging that it is recyclable - PLA #7 - and compostable in

industrial facilities.

This section will help identify the likely end of life pathways that your product will undergo once it is used Consider that waste infrastructure that is available and how it varies by region Does your region have a landfill, a waste to energy incinerator, commercial compost, recycling opportunities, etc?

- Landfill

Landfill:

Regular on-site pick-up

What is the likelihood that your product will end up as litter or that it will otherwise leak into the environment?

5

Once in the environment, how quickly will the product biodegrade?

>= 2 years

Once in the environment, does the product leach hazardous chemicals?

I don't know

Once in the environment, does the product degrade into hazardous byproducts?

No

Landfill:

Yes

Are there chemicals in your material that will impact its ability to undergo certain EOL pathways? For example, if the base polymer is compostable but the additives will not biodegrade, then the product is not fully compostable

I don't know

Will you test your materials for compatibility with available EOL options? For example, is the product certified to be compostable? Have you tested chemicals that will go to wastewater treatment for biodegradability in tests that reflect how they will perform in a wastewater treatment plant? See Standards

I don't know

How is landfill compatibility verified/certified?

- Compatibility will not be certified or verified
- Don't know

Is the product recyclable?

Yes

What kind of recycling does your product undergo?

Can be reprocessed into recycled PLA for new plastic products.

Does recycling it result in a higher, lower or equivalent quality material?

- Lower

Does your product contain toxic ingredients/chemicals/additives that could contaminate the resulting recycled material and reduce its purity and value in its next iteration? For example, many flame retardants used in plastics can contaminate the recycling stream and prevent its use in higher value products.

I don't know

Have you identified opportunities for your product to be converted into a high value product when it becomes no longer needed?

No

Does the waste management infrastructure required by your product impact have life cycle impacts? For example, land use, produce a lot of CO2 or other emissions, require harsh processing chemicals, or have other life cycle impacts?

I don't know

Does your product contain an ingredient/chemical/additive that must be monitored when undergoing certain waste management pathways, such as a metal or halogen that must be tracked by incineration facilities?

I don't know

What chemicals are formed when the product undergoes a certain waste treatment pathway? For example, when halogenated organic materials are incinerated, they can make troublesome inorganic acids like HF or HCl and toxic dioxins and furans (under non-ideal burning conditions).

PLA can form microplastics if littered in the environment. Break down into lactic acid.

Are the chemicals formed hazardous?

No

How could you design the product so that it would have the least possible negative impacts if it were to be mismanaged and leaked into the environment?

Switch from PLA to a material that degrades in the environment.

Can the feedstock be used to make materials that are readily recyclable? Some plastics derived from non-renewable feedstock may support sustainable materials management as long as product design facilitates material recovery, there is readily available recycling and there is ongoing demand for recycled materials. Proof of efficient and broadly accessible recycling infrastructure should be evident before selecting feedstock that is derived from depleting resources.

Yes

Does the product degrade in the marine environment? Has it been tested using standards such as ASTM D7991?

No

Have chemical products or chemical constituents in materials or product been tested for degradation in water, soil and sediment under aerobic and anaerobic conditions?

I don't know

6 Whole Product Assessment

How does this product compare to other products or systems that provide this same service?

It's better than disposable products that provide the same service in holding food, but worse than other re-usables because it doesn't get used for as long a period of time. But it also provides the educational functional

Where are the 'hotspots' or primary impact areas in your products versus other products that provide the same service?

The use phase is too short. Could set it up as a product-as-a-service like GO Box. Parents receive a "new" reusable set every month and return the old set in the same box. OR could set it up like those cups that have an outer transparent sleeve and space to hold pictures. We sell the bowl that is reusable for a longer period then, and also sell the inserts that show the different months/seasons. With either option the product can grow with the child, too. Could offer different kinds of series, like math or science.

Are there any examples in nature that provide the same kind of service as your product?

Exploring asknature.org, I found some interesting packaging/water holding type examples. One idea would be to create a semi-durable bowl using compostable materials that are not water-proof, then coating with something like a lotus leaf nanostructure. But looking at the waste heirarchy, it is preferable to re-use over recycling over composting, so I think the ideas extending the use phase would be more sustainable.

7 Decision Analysis

Does this product meet the sustainable design objectives you set out at the beginning?

No. I need to do some more research on the chemicals used in small amounts - my catalyst and mold release agent - to learn what they are and if they are hazardous and if they stay in the product and if they interfere with recycling. I also need to find a waste-based source for bio-based PLA. And I need to find a way to recycle it. The local facilities in my area don't accept it. And the composters don't, either!

What tradeoffs have become apparent to you?

I could switch to a more permanent product, and either have inserts that provide the different months, or do a service that sends it back and forth. If I do inserts, my product is more complicated - need the clear layer, need more durability. And I need to design the inserts and sell them separately and ensure they are sustainable. If I do the re-usable service option, I have to figure out cleaning and shipping issues. Maybe a better target is to go with the longer longevity but sell to schools and day cares which can re-use them on their own.

Are there data gaps that must be filled in order for you to make more informed decisions for product design?

Yes, I need to do more research on my chemicals and the hazards associated with them. I need to do more research on my feedstock. Can I get waste-based PLA? Ag waste would be great. I need to do some research on how to close the circle when my region doesn't have the infrastructure for recycling or composting. Do a take-back program?

What 'hot spots' or areas of high negative impact, have become apparent to you?

My product would likely either be littered or go to landfill in my area due to lack of infrastructure.

What changes could you make across the life cycle of the product that would improve individual impacts and the overall evaluation of the product?

I think the rethinks from Step 6 are probably the direction to go in. A more durable, longer-lasting product that can be re-used for many years fits the circular economy better.

Describe how your products achieves each of the four PASS principles:

The product will support a circular economy once I have had a more detailed look at feedstock options and end of life options that exist in my region. By using PLA, with safe monomers, it uses life-friendly chemistry, but I need to research some of the chemicals used in small amounts. If I can find a waste-based source, it will restore natural capital instead of using it up. If we use some of our profits to provide these bowls for free to schools and such serving low income families, we will support a just an inclusive society.