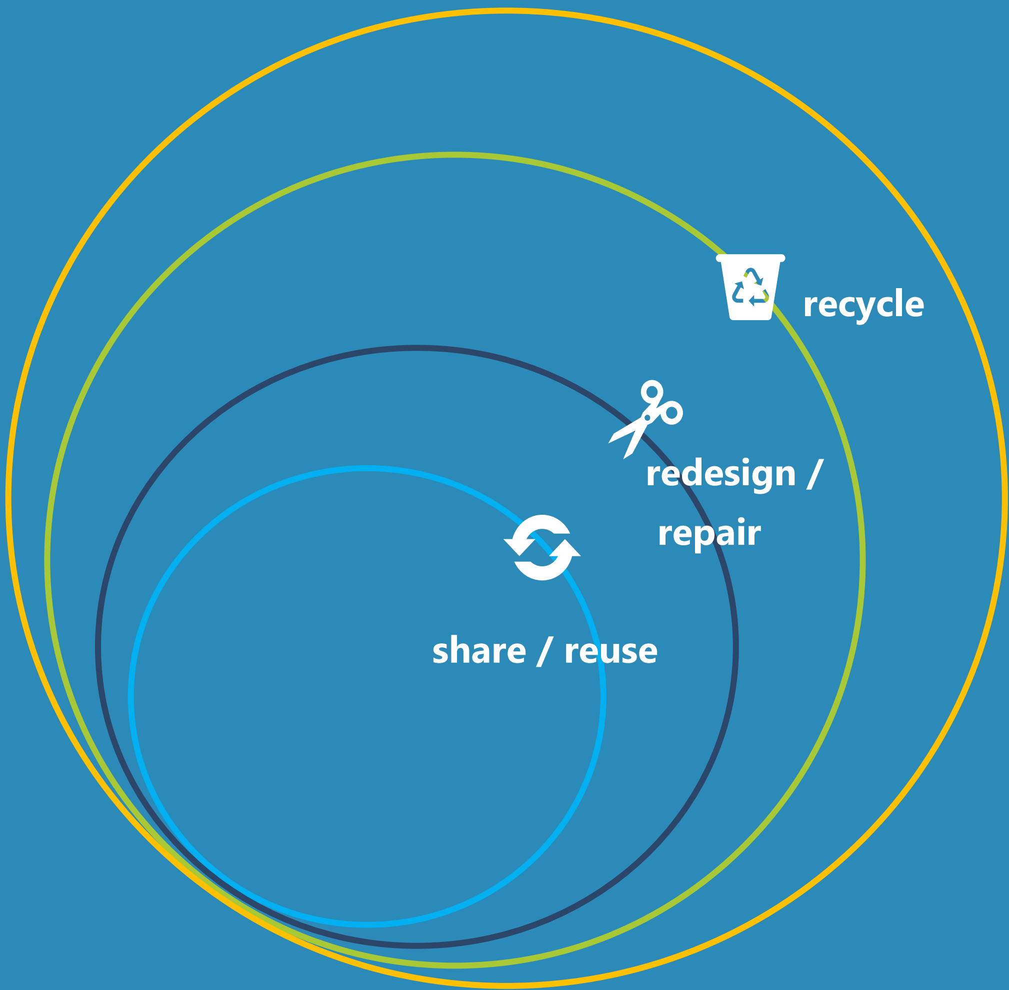
Measuring circular economy impact

Makerspace Adelaide workshop findings



An initiative of SA Makers, Green Industries SA and Rawtec.

makerspace adelaide.org

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Document verification

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Acknowledgments

This workshop was designed and delivered by SA Makers, Green Industries SA and Rawtec.

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We would like to thank all the workshop attendees for the contributions to this initiative.

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Introduction

"A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems

Ellen Macarthur Foundation

1. Introduction

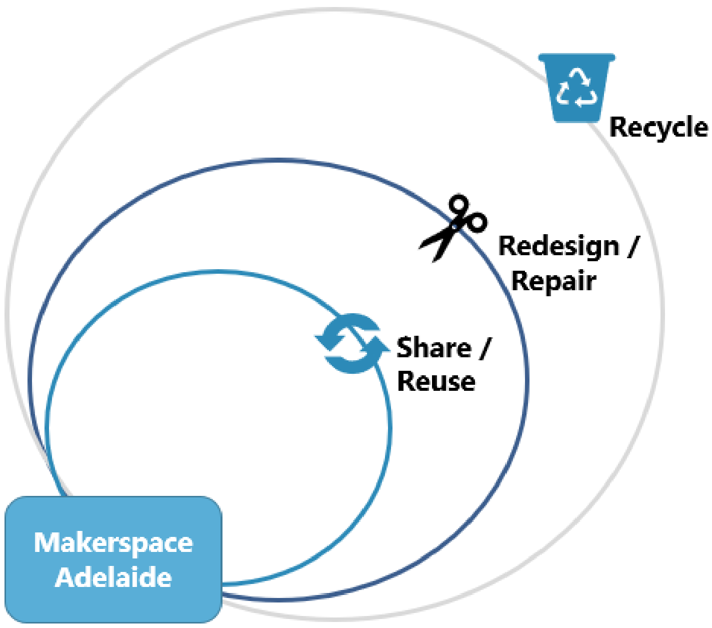
About Makerspace Adelaide

Makerspace Adelaide (the Makerspace) is a community fabrication workshop that provides affordable access to a variety of tools and equipment. Their core values are:

- Make - don't buy
- Repair and reuse – don't throw away
- Share your knowledge and skills with the community

The Makerspace is managed by SA Makers. It is a great example of the circular economy – where products are kept circulating at their highest use, through sharing/reuse, redesign, repair and recycling activities. (Figure 1-1)

Figure 1-1: Circular activities at Makerspace Adelaide



The workshop

Makerspace Adelaide provides its members with access to tools and support to repair and redesign products for circularity. The Makerspace would like to measure its circular economy impact. Measuring diversion of materials from landfill via recycling and/or energy recovery is (relatively) easy. **But how do you measure avoided waste through sharing, redesign, and repair activities?**

A workshop was designed and delivered by SA Makers, GISA and Rawtec to explore circularity measures. We invited people from a range of backgrounds to attend the workshop - including manufacturers, retailers, hackers, recyclers, repairers, waste educators, economists, materials specialists, and academics.

Workshop details

The workshop took place on 22 Sep 2020. It was a hands-on session where participants were tasked with disassembling products that are typically handled at the Makerspace. This included products primarily made of plastics, electronics, timber, and textiles (Table 1-1).

We split workshop participants into groups and assigned them to workstations, where we tasked them with exploring:

- How circular is the product?
- How could it be resigned to improve circularity?
- How can Makerspace measure it contributions to the circular economy, associated with helping its members to repair and redesign products for circularity?

Each workstation had a workshop facilitator and a materials expert to help guide participants through the investigations.

Table 1-1: Product items that were assessed for circularity

plastics	electronics	timber	textiles
plastic toys *baby seat*	*mobile phone* *laptop*	*timber outdoor table* *timber cube (bookshelf)*	*suitcase* *jacket*

This report, prepared by Rawtec, summarises the workshop findings. Appendix 1 provides more detailed findings from workshop product circularity assessments.

Section -

Assessing the circularity of products handled at the Makerspace

The workshop challenged participants to consider how circular products are, and how they might be redesigned to increase circularity.

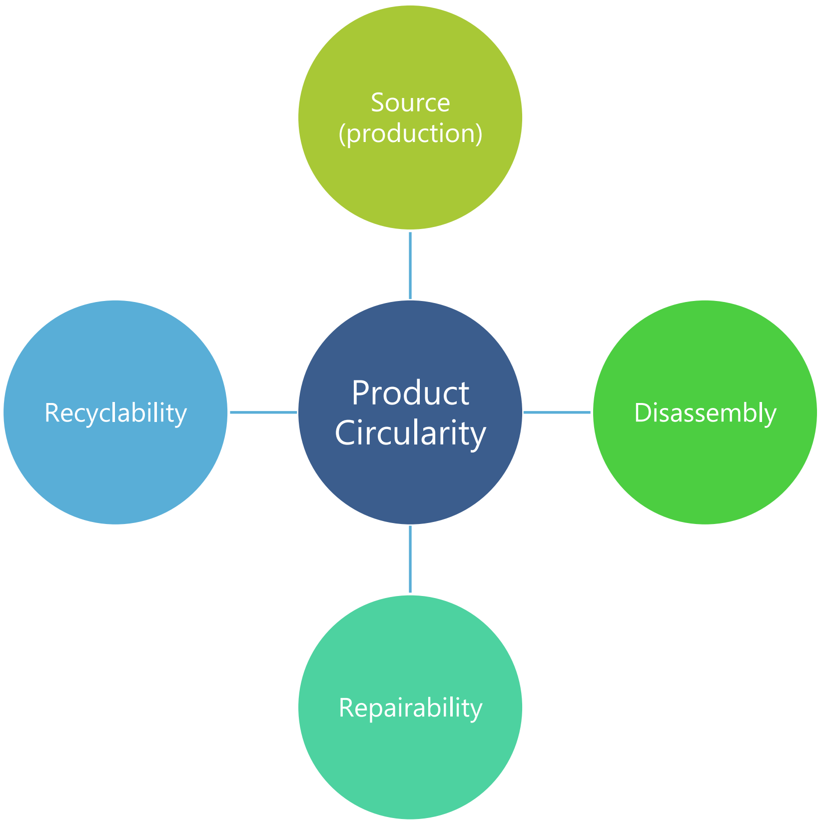
We asked participants to assess the circularity of each of the products across the following areas:

- **Source**: including considering circular materials and production methods
- **Disassembly**: ease of disassembly considering disassembly time, skill level and tools required
- **Repairability**: ease of repairability considering skill level and spare parts required and identifying barriers and potential motivators/enablers
- **Recyclability**: ease of recyclability considering knowledge and services required and identifying barriers and potential motivators/enablers

During these tasks we asked participants how the product could be redesigned to improve circularity.

Workshop findings are summarised in the following sections.

Figure 2-1: Areas to assess product circularity



2. Source (production)

The workshop highlighted the need to introduce product labelling requirements to provide transparency on circular product manufacture

Investigations

- What materials is the product made from?
- Where was it made?
- Under what conditions was it made (i.e. labour/ environmental)?
- Any observations about sustainability of materials for the product – e.g. carbon footprint, use of finite resources, value/cost of material?

Findings

- There was a lack of labelling to help participants determine the circularity of product's production. Most consumers do not know if the products they are buying/using were made using circular materials and production methods.
- The only product that had labelling about the environmental sustainability was the timber table, which had a sign stating the material (wood) is sustainably sourced.
- Participants were able to make educated guesses about the sustainability of the products but found it important to know exactly how the product was made and how sustainable it is.
- None of the products provided information about the labour conditions for production. This means consumers do not know whether the people making the products were provided a safe working environment and paid a fair wage.
- Only half of the products stated the country of manufacturing. Most of the products were made in China and for the products where the origin was unknown, many participants guessed it was manufactured in China.
- Plastic was the most used material. It was found in 7 out of the 8 of the products. The only product that did not contain plastic was the timber outdoor table.
- Some of the products showed signs of being mass produced.
- Introducing requirements for product labelling of environmental footprint (carbon, water, and plastic footprint) and labour standards would provide greater transparency about the circularity of product manufacture.

3. Disassembly

Many products were relatively simple to disassemble using at home tools. However, the average person may lack knowledge and confidence to attempt these activities. This is where makerspaces can help!

Investigations

- How long did it take to dissemble? (minutes)
- What tools are required to disassemble the product?
- What did you notice about how easy (or hard) it was to disassemble?

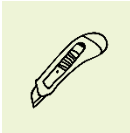
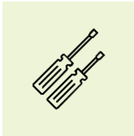
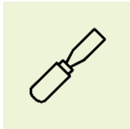
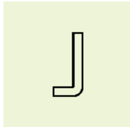
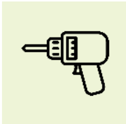
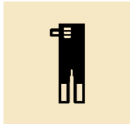
Findings

- Most products were easy to disassemble and could be done in less than 30 minutes (Table 3-1). This surprised some workshop participants – who had not attempted to disassemble the product before.
- Nearly all products (except one) could be disassembled using 'at home' tools, such as a screwdriver, power drill, hammer, scissors, etc. (Table 3-2)
- The most difficult item to disassemble was the suitcase. Disassembling the product while keeping materials intact requires a high skill level and a deriveter (specialist tool).
- Even though most of the products could be easily disassembled, many people would normally not do so due to lack of knowledge and confidence in their abilities to handle/disassemble the item.

Table 3-1: Disassembly time

Less than 10 mins	10 to 30 mins	More than 30 mins
plastic toys	*jacket*	*suitcase*
outdoor timber table	*baby seat*	
timber cube (bookshelf)	*mobile phone*	
	laptop	

Table 3-2: Tools used to disassemble products

					
box cutter	long nose pliers	Phillipshead screwdriver	flathead screwdriver	chisel	Allen key
					
thread picker	fabric scissors	spadger	Electric drill	hammer	deriveter (specialist tool)

4. Repairability

Just over half of the products assessed were repairable. Systemic changes are needed to deal with products that not repairable, and to make repairing products the norm.

Investigations

- Following disassembly, sort, and weigh components/materials into the following categories:

  >The 'average' person can repair at home
  > Requires specialist skills/ tools to repair
  > Cannot repair
  > Unsure

- Can you find spare parts for components that cannot be repaired? If so, where?
- What barriers are in place to prevent you from repairing? (financial, skills, psychological, convenience)
- What are the things that would motivate you to want to repair this product instead of discarding/replacing it?

Findings

- Just over half of the products (5 out of 8) were repairable (Table 4-1)
- It is possible to get spare parts for most of the products, except for the baby seat, plastic toys, and suitcase where it is not possible - or very difficult - to find spare parts.
- Safety standards limit the ability to repair the baby seat
- Many people can repair clothing (e.g. the jacket) at home to a reasonable standard. However, specialist skills are required to restore items to "as new" quality. Changing fashions mean that some fabrics/patterns are no longer stocked by suppliers and so it is not possible to repair the item "as new".
- On larger laptops, many components can be easily repaired/replaced by people at home. This includes the fan, hard drive, RAM, ribbon cable and cover. However, laptops that are more compact have parts soldered on making them more difficult to repair (requiring a soldering iron and specialist skills to repair).

Table 4-1: Repairability of products

Not repairable	Repairable (to a large extent)	Unsure
baby seat *plastic toys*	*outdoor timber table* *timber cube (bookshelf)* *jacket* *mobile phone* *laptop*	*suitcase*

Even though many items can be repaired, there are a range of barriers that prevent people from repairing them (Table 4-2).

Table 4-2: Barriers and motivators/ enablers to repair

Barriers to repair	Motivators/ enablers
warranties becoming void	*introducing "right to repair" legislation*
cost to repair parts more than cost to replace whole item	*product stewardship scheme where producers pay for product repair*
products that are hard to repair at home (i.e. difficult to disassemble, requires specialist skills/tools to repair)	*introducing standards for design of products that are easy to repair at home (i.e. easy to disassemble, find, replace, or fabricate spare parts)*
lack of skills/confidence	*makerspaces/ repair cafes* *school education*
low value products	*products that are sentimental*
lack of spare time/ headspace	*convenient repair locations to drop-off items*

5. Recyclability

Nearly all products assessed were recyclable, but recycling services are not always convenient.

Investigations

- Following disassembly, sort, and weigh components/materials into the following categories:

  >The 'average' person can recycle
  > Requires high effort to recycle (e.g. services not readily available, specialised expertise)
  > Cannot recycle
  > Unsure

- What barriers are in place that prevent you from recycling it? (e.g. availability of recycling services, convenience, financial, knowledge)
- Apart from recyclability and repairability, what other measures may be important for measuring the circularity of the product? E.g. carbon footprint, use of finite resources, value/cost etc?

Findings

- Most of the products were recyclable (Table 5-1).
- Despite the recyclability of products, many of them had obstacles that prevented from them being recycled. The biggest barrier preventing products from being recycled is the lack of convenience, including having to dismantle the product to be able to recycle it, no access to a nearby recycling facility and/or drop off collection points, etc.
- Lacking knowledge about product recyclability or where it can be recycled is another important reason why participants would most likely not recycle the item.
- The products that were not recyclable were made of several different materials that made them difficult and expensive to be separated and properly recycled.
- The time and effort to dismantle the baby seat limited its ability to be recycled.
- Plastic toys were placed in the cannot be recycled category due to lack of knowledge of the type of plastic they are made of.

Table 5-1: Recyclability of products

Not recyclable	Recyclable (to a large extent)
plastic toys *timber cube (bookshelf)*	*outdoor timber table* *timber cube (bookshelf)* *jacket* *mobile phone* *laptop* *baby seat* *plastic toys* *suitcase*

Even though many items can be repaired, there are a range of barriers that prevent people from repairing them (Table 5-2).

Table 5-2: Barriers and motivators/ enablers to recycling

Barriers to recycling	Motivators/ enablers
products that are hard to recycle (e.g. require disassembly or having to drop product off at special location to recycle)	*introducing standards for design of products that are easy to recycle at home*
products that are not recyclable (e.g. due to multi-laminates)	*product stewardship scheme where producers pay if the product is unable to be recycled*
inconvenience	*introduce drop-off collection points in convenient locations*
lack of knowledge/confidence	*makerspaces/ repair cafes* *school education* *government recycling education initiatives*
products that are not recyclable	*product stewardship scheme where producers pay if the product is unable to be recycled*

workshop insight

Other potential measures of product circularity include avoidance of the inbuilt obsolescence, the travel kilometres of products to end users, the age of products, and the product's value in repurposing.

6. Redesign

The workshop identified many redesign opportunities. Makerspaces can educate the next generation of designers to build for circularity.

Investigations

- How would you design this differently to improve outcomes for durability, repair, reuse, and recycling?
- What steps can be taken to reduce offcuts during design/production of this item?
- Are there alternative materials that could be used in the design that better fit within the circular economy ethos?
- What changes in design are likely to reduce embodied energy?
- How do you deal with changing consumer demands that lead to products become obsolescent? (e.g. counteracting fast fashion, getting the latest phone)

Opportunities

- Designing products with an interlock system would eliminate the need for screws and nails and allow them to be dissembled more easily.
- Using a design with the same size/dimensions for as many parts as possible reduces the amount of offcut waste and makes repair simpler.
- A central website providing information about how to repair products and where to get spare parts.
- Using 3D printing to manufacture products and finding value in materials would reduce offcuts during production.
- Using one material to manufacture products would significantly improve the rate at which products get recycled.
- Using products made of materials other than plastic (like timber) to induce a more sentimental appreciation in people.
- Building brand loyalty can improve value retention in products and create a market for resale and collection.
- A producer buy-back or take-back scheme to control refurbishment and redistribution of a reasonably durable product and manage end of life responsibly

There are alternative materials that could be used in the design and/or production that better fit within the circular economy ethos (Table 6-1 overleaf).

Table 6-1:

Status quo vs. alternative ways that fit better within the circular economy ethos

Status quo	***Alternative materials/design that fit better within the circular economy ethos***
buying and owning products such as suitcases, laptops, toys, etc.	*leasing products would lower the scale of production and the limit the time products spent unused*
using materials that are not renewable or using at a scale that does not allow for the resources to regenerate	*using more sustainable materials when manufacturing products, despite the additional cost, such as the timber table, for which materials were sustainably sourced*
mass manufacturing of products	*producing products upon customer's order*
materials are sourced from different parts of the world, products manufactured overseas, which are then flown or shipped to Australia	*manufacturing products locally would reduce transport kilometres*
throwing away items once broken or old and buying new ones	*empowering people with skills to repair products to prolong their lifecycle and lower consumption of new products*
very often producing products with cheap, not durable products (built in obsolescence) that are hard or not cost effective to repair	*using quality materials to ensure longevity of products and keeping repairability in mind when designing products to allow consumers to easily repair products*
people often not knowing whether products are recyclable or where they can be recycled	*including an identifier/scannable code to look up product and material information is a convenient way for people to gain insight on where or if certain materials can be recycled*

Section -

Measuring the contributions of makerspaces to the Circular Economy

7. Possible circularity metrics for the Makerspace

Measuring the value of circular activities of the Makerspace may inspire other makerspaces to be circular by default.

Makerspace Adelaide is an important community asset in helping drive the transition from a linear to a circular economy. Table 7-1 lists circular activities at Makerspace Adelaide, and possible metrics for measuring its contributions to the circular economy. Many of these metrics were identified by workshop participants, and we identified others when reflecting on workshop findings.

Table 7-1:

Circular activities at Makerspace Adelaide and possible circularity metrics

Product circularity	Circular activities at Makerspace Adelaide	Possible circularity metrics
Sustainable production	• *educating members and visitors on circular production, such as choosing sustainable materials* • *helping members to design their products for circularity*	*# products redesigned for circularity at the Makerspace* *# products repaired at the Makerspace* *$ financial savings to members/visitors from repairing products (rather than replacing them)* *# attendees to circular economy workshops/ training sessions at the Makerspace* *# tools that are shared at the Makerspace* *# hours that the tools are used (rather than sitting idle) or % utilisation* *% (by weight) of discarded materials that diverted from landfill* *lifecycle impact of circular activities at makerspace (savings in carbon emissions & water)*
Sharing	• *sharing tools that members may otherwise need to buy* • *reusing spare parts and materials in the makerspace*	
Repairability	• *providing member/visitors with the skills, knowledge, and confidence to repair their broken items*	
Recyclability	• *providing best-practice recycling systems at the Makerspace*	

8. Possible methods for collecting and reporting metrics

Possible methods for measuring and reporting circularity metrics at the Makerspace include:

1. Setting up a data collection sheet for Makerspace members/volunteers to record data every time they repair a product or redesign it for circularity. This could include recording:
    - the number and/or weight of items that are repaired or redesigned
    - financial savings (if any) to members/visitors from repairing an item versus having to replace it
    - the number of hours of Makerspace management/volunteer time
    - tools shared at the Makerspace and the number of hours in use
2. Recording the weight of discarded materials sent for recycling via the services at Makerspace, prior to collection.
3. Entering the above data into a central database. This database could potentially include an in-built calculator for the water, energy and carbon emissions savings associated with the above activities.

Makerspace Adelaide could share their findings with its community by publishing a quarterly 'circularity report card'. This could be visible in the Makerspace foyer (e.g. on chalkboard) and shared via its social media pages.

9. Framework for a circular makerspace

During the workshop, GISA presented a draft framework for a 'circular makerspace'. The objective of this framework is to determine how to quantify and communicate the value of a makerspace to circular economy policy makers and potential funders, and to inspire makerspaces everywhere to be 'circular' by default, enabling them to provide evidence of their circularity through a measurement/reporting framework.

This document is an open source document. We invited participants to contribute to the framework following the day, drawing upon their findings from the workshop and other insights they can bring.

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