Sara Pitto

SUSTAINABLE SELF-PUBLISHING

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Abstract

The objective of this study was to determine the most sustainable solution to self-publishing a children's book, focusing on the main aspects of printing a book: paper, inks, and finishes. Although equally important, the publishing and distribution processes were not analyzed in this study.

A literature review was used to understand the paper-making and printing processes, and to highlight the most sustainable solutions and practices on an ideal level. Upon contacting printing and self-publishing companies, the most realistic options available were underlined.

After the necessary information was gathered, the "Harris profile" provided a better understanding of paper sources, enabling the author to compare the most promising ones, and revealing the real difficulty of the situation, that as there is no one single best solution; this method stressed the necessity for the ideal implementation of multiple sources to achieve a truly sustainable result. The "People Planet Profit" method analyzed three realistic solutions, highlighting digital printing with the Ashely House Printing Company as the most realistic and sustainable one.

The study led to an unsuccessful outcome, as the book was not printed. The selected company did not reply to the final enquiry, possibly because of the current lockdown situation slowing supply chains and closing many businesses. The situation affected the results, as well as the high standards that the author had, which were hard to meet.

Keywords

self-publishing, sustainability, ecological, book, resources, paper, inks, printing

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1 INTRODUCTION

The idea of publishing a children's book has been developing in my head for some time. Once I had an idea for the story and themes, I started worrying about the consequences and impacts that my book would have. How do I go on with my project and not feel guilty about creating more waste? Is it even worth it? I decided I would explore whether a self-published book could be sustainable, and complete my project.

Nowadays, sustainability and global warming are the main topic of discussion: they are discussed daily, but very often they are misrepresented in the media, which leads to confusion and anxiety on one side and denial to accept the reality of facts on the other (Clayton & Doherty 2011, 269). No real solutions have been found and there seems to be a lack of dedication in resolving the issues from political leaders, who only use global warming as a tool to get elected.

As a designer, it is my responsibility to analyse the life cycle of my projects before the design process. Information is the sole means not only to overcome denial and anxiety, but also to introduce or make way for lasting change; this motivates me to learn and study the topic thoroughly.

Therefore, this project will start with a research phase: the elements that constitute a book need to be understood together with the processes to create the aforementioned elements. Through a literature review, I will explore paper, inks, bindings and finishes, and finally the printing process. Then, I will look at the main options available for printing and self-publishing, contacting companies and gathering information about them. E-books will also be analysed, in particular their impacts on the environment and whether or not they could be a sustainable alternative to print.

After the research, the best solutions will be determined in an idealistic way; then the solutions will become realistic options, which will be tested through two main methods: the Harris profile (Digital Society School, Harris profile), which analyses all options and, though a simple calculation, selects the best one; and the People Planet Profit (Digital Society School, People Planet Profit), which calculates the projects through the three criteria listed in the name: How much does the project

benefit people? How much does it impact the environment? What are the real economic impacts?

2 OBJECTIVES

The final objective of this project is to self-publish a children's book in the most sustainable way possible. The issues relating to printing a book are various (Figure 1); first of all, the paper: what material sources are consumed? How is it obtained? Is it ethical?

The inks are another important part at play; research is needed to explore what substances are contained in inks and what types of ink exist. Bindings and coatings also pose a problem; are the standards sustainable enough? Are there better alternatives?

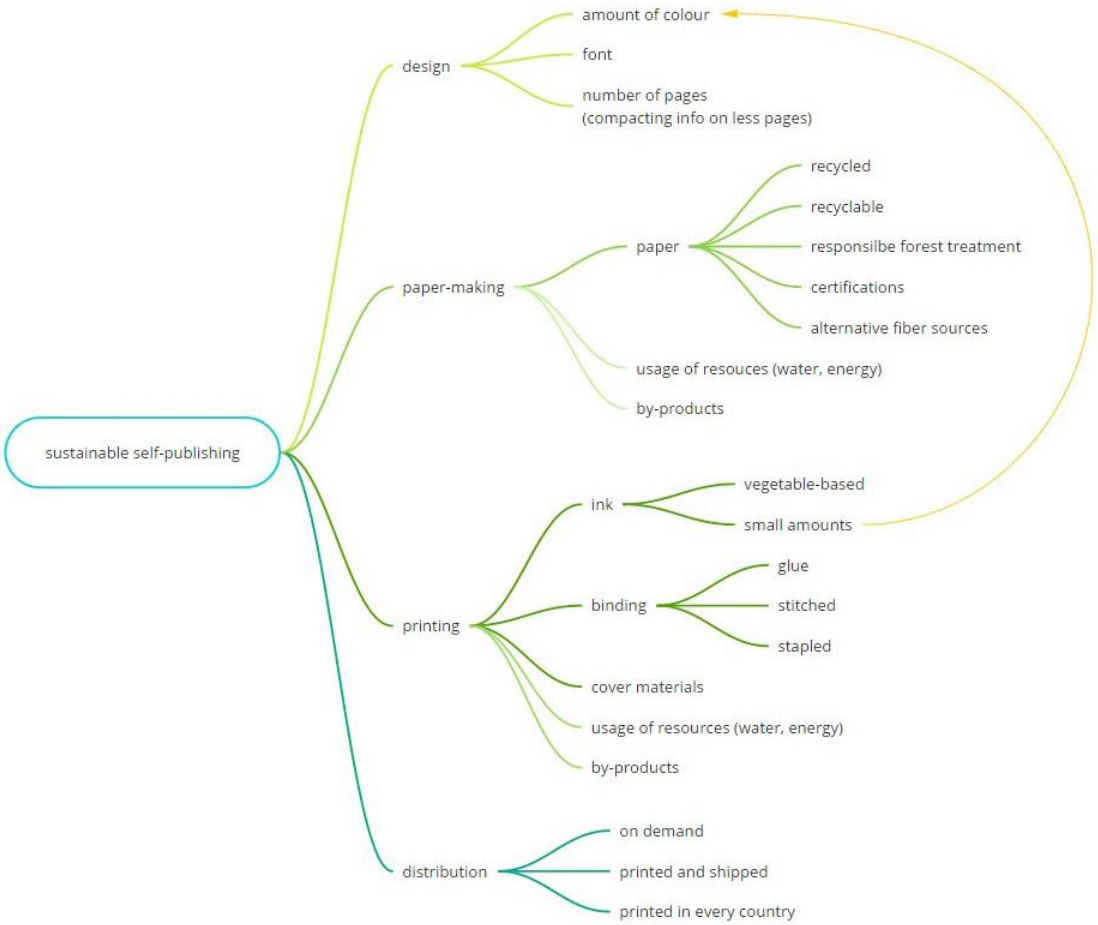

Figure 1. Mind-map of the aspects of sustainable self-publishing.

Some solutions might lay within the design process, for instance, reducing the amount of pages and ink used.
Other aspects to consider are the paper-making and the recycling processes, and their impact on the environment; such as water and energy usage, water pollution, and CO_2 emissions.
The distribution of the book is equally important, as transportation also generates issues, although these will not be examined within the scope of this paper.

3 PAPERMAKING, PRINTING & RECYCLING

Before delving into the environmental impacts of books, let's talk about publishing.
Publishing is the process of distributing works (printed or digital) to make them available to the public. Traditionally, this is done by publishing houses, like HarperCollins, Einaudi, Penguin Random House to name a few. However, self-publishing has become a second very viable option: anyone can publish their work, as self-publishing services eliminate the need for an author to be signed to a publisher, removing the selection process.
Traditional publishing ensures validation to an author's name and work, and it requires no further effort on the author's part. However, publishing houses can limit one's creative control and it is hard to meet the requirements be selected in the first place.
When one self-publishes there is less pressure to fail. However, it requires more work, as the author is alone in their effort. (Penn.)

To begin to understand the printing and publishing of books, we need to consider the physical elements that together form a book: paper, ink and finishes.
The processes of paper-making and printing are resource intensive: large amounts of energy and water are consumed, and fibres are mainly sourced from either forests (which suffer the consequences of mismanagement) or recycled pulp (which always needs new fibres). Moreover, these processes use various chemicals, some of which are toxic. Since World War II, copious amounts of new chemicals have been developed, many of which spread and bioaccumulated in the environment. Animal and human cells cannot handle these chemicals, only

later found to cause cancer, hormone disruption and other problems. (Jedlička 2010.)
This chapter examines the paper-making process, inks and recycling in order to have a view of how books impact the environment; the chapter is based on information from Jedlička (2010).

3.1 Paper

The first element to explore is the essence of the book: paper. Paper's current largest source is wood, which comes from tree plantations and forests. When forests are not well managed, the harvesting causes damage not only to the forest itself, but also to the animals and plants that inhabit it, as well as the indigenous people. Even when forests are managed, the result is still not positive: wood as a fibre is not ideal, as trees take long periods of time to grow, leaving a gap between how much is harvested and how much can grow. Moreover, tree plantations are treated with toxic herbicides and pesticides. Tree plantations are monocrops: one species is cultivated, with the risk that these genetically engineered invasive trees could threaten the existence of other native species. Not to mention the difference between such plantations and proper forests: rich habitats and ecosystems are lost through the introduction of these monocultures.

Trees need to be transported from their growth site to the processing site; this releases pollution, more than with other lighter alternative fibres. Wood requires an intensive process to extract the fibres necessary for making paper: trees are debarked, chopped, transformed into pulp, and then treated with chemicals to whiten the pulp and remove lignin. Lignin is a substance present in wood that, if not removed, causes deterioration and yellowing in the paper. These processes require copious amounts of energy and water to complete, resulting in a discharge of toxic waste. These bi-products need to be handled with care to avoid contamination of the environment.

Interestingly, wood is a recent source of fibre; it was introduced in the 1850s in response to an increasingly large demand in the publishing sector that could not be met with cotton and linen anymore. In this period various experimentations

took place in the search for a new source of fibre; wood became the favoured choice because it was seen as abundant and renewable (and required less processes at the time). Because of shortages of cotton and rags, during the two world wars wastepaper began to be considered as a fibre source, and people started testing de-inking processes. After World War II, virgin pulp took precedence, as no shortages or economic pressures were pushing the search for alternatives.

Alternative fibres exist, some of which, among other benefits, require little or no bleaching, which is impressive, as it is normally an unavoidable process in order to remove lignin. The main alternative fibres are discussed below.
Bamboo (Figure 2) is a great alternative: it grows fast (a normal pine tree takes 15-20 years to grow, while bamboo takes around 4 years) which makes it a viable source; once cut, bamboo re-grows from the root, and does not need to be re-planted (Romano 2014, 39). Problems arise when it is not sourced responsibly, endangering native ecosystems and populations that might depend on bamboo as a resource; also, the need to transport bamboo from plantation (usually in Asia) to production facilities requires large amounts of fuel. Being similar to trees, bamboo shares their paper-making process, with all its attendant downsides.

Figure 2. Bamboo plant (Pinterest).

Cotton (Figure 3) is another alternative. Its use for paper-making is not new: cotton had been used until wood was introduced in the 1850s. It produces high quality papers, creating a more resistant product; moreover, the cotton used for paper is a by-product of the cotton production for textiles (which would otherwise go to landfills). The production of paper from this source does not produce additional impacts; cotton does not contain lignin, meaning that it requires little or no bleaching. However, cotton crops have negative impacts on the environment due to the large quantity of pesticides employed in their growth; this could be perhaps avoided by growing organic cotton or species that are more resistant to insects. Another drawback of cotton is that it requires copious amounts of water to cultivate.

Figure 3. Cotton plant (Dudina).

Hemp (Figure 4) is a plant with many qualities that make it a good candidate. It grows fast and has a larger fibre yield than pine; unlike cotton, it is a resistant plant, eliminating the need for pesticides; and there is little to no bleaching required. The downside of hemp is that its cultivation is illegal in many countries, leading to the need for importing hemp pulp (therefore transportation is a big contributor to global warming).

Figure 4. Hemp plant (Reusable Art).

Kenaf (Figure 5) is a plant member of the mallow family (Malvaceae) like cotton. (LeMathieu at al.) Like hemp, it does not require pesticides, because it is grown for nothing but fibre. It has the most potential to replace wood as a fibre: it grows quickly, and yields three to five times more than pine; it can rotate with other crops, has low production costs and uses less energy and chemicals to be turned into pulp, and little to no bleaching is required. The by-products derived from it during processing can generate bio-energy. Kenaf is not popular yet, which means that few mills are economically capable of turning it into pulp.

Figure 5. Kenaf plant (Perlowin).

Agri-pulp is another promising alternative. This pulp is derived from agricultural residue, which would otherwise become waste (such as sugarcane bagasse, wheat straw, banana fibre and rice straw). However, significant infrastructure to support this type of pulp is lacking. (Romano 2014, 40.)

With all fibre crops, the issue of monoculture arises, in addition to land mismanagement, which means employing large quantities of chemicals, lack of crop alternation, endangering local populations and ecosystems, using large quantity of water; also, many believe that such plantations would replace the ones destined for food.

3.2 Inks

Inks are made out of four components: a solvent, a vehicle or binder, a colorant and additives. The solvent is the largest part of the ink; its function is to dilute the ink and adjust its viscosity. The vehicle or binder has multiple functions: it helps the ink bind to the printing material, and it is the element that gives the ink its characteristics (such as gloss or matte effect, water resistance, drying speed, etc.). (Höfer et al. 2019.)
Colorants can be dyes (liquid) or pigments (solid). Pigmented inks are particles suspended in resins or binding agents; these type of inks adhere to the surface of the paper and are more resistant to fading. Dye-based inks are absorbed into the paper; the final product is a poor quality print, although the colour is more saturated. Additives are substances that improve certain properties of the ink, like making it waterproof, wear-resistant, glossy, or improving its printability, and so on.
Each printing process requires a specific type of ink; in other words, not all inks are suitable for the same printing process.

Inks can contain several metals. Throughout the last 30 years, efforts have been made to reduce and eliminate the presence of heavy metals in inks (such as cadmium, chromium and lead). Although inks containing these metals were considered safe when on paper, the issues could arise when disposing of them

(recycling, landfilling, incinerating), as these toxic substances would be released and would contaminate the environment. Another problem arises at the end of the product's life: any metal contained in inks is irretrievable; this waste cannot be overlooked, as metals require huge amounts of resources to be extracted, with equally large amounts of by-products.

Most inks are petroleum-based; these release VOCs (volatile organic compounds), highly toxic substances that pollute the air and cause health problems in animals and humans (Wondemu 2011).
Vegetable-based inks offer a great alternative to petroleum-based inks: not only do they emit considerably smaller amounts of VOCs, they are also easier to remove from paper in the recycling process. There is no significant difference in performance when printing between petroleum inks and vegetable inks. It is important to note that the amount of vegetable oil contained varies: some inks that are labelled as soy inks can still contain petroleum oil.
Vegetable oils come from crops (such as flax, soy, etc.). If plantations are treated with chemicals and pesticides, the consequences for the environment undermine the benefits of using vegetable-based inks.

3.3 Printing and binding

There are several types of printing processes. The most common ones are listed here.
Lithographic printing (Figure 6) uses oil-based inks, which react with a fountain solution that contains water, that repels the oil from the areas that are not going to be printed on. Chemicals are used to treat the plate during the pre-press and printing processes, so that the ink will adhere only to the image areas, as a water solution will repel it in the other areas. If the inks are nonheatset web, they dry through a process of oxidation and penetration; these inks release few VOCs. Heatset inks dry through the use of hot air dryers that cause the evaporation of the oil; this releases the largest amounts of VOCs emissions in lithography. Ultraviolet inks react to UV light, and usually release very little if any amounts of VOCs.

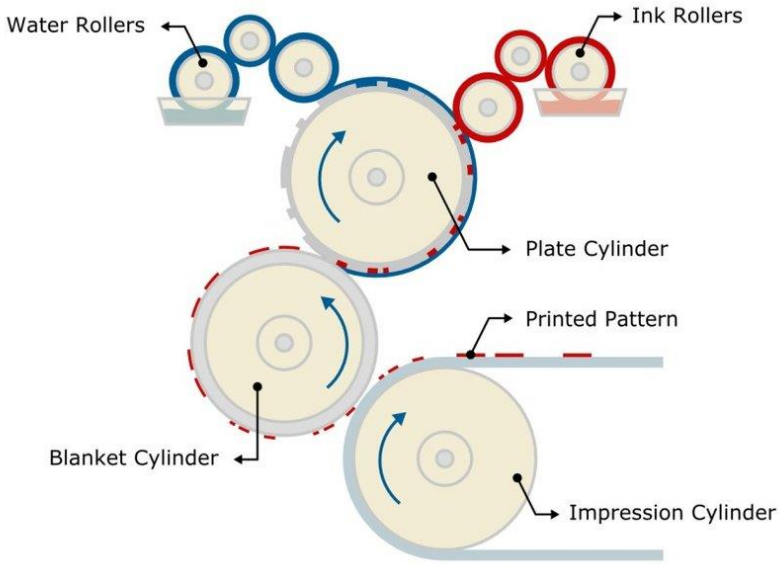

Figure 6. Lithographic printing diagram (Rosa).

Waterless printing, a variation of traditional lithographic printing, is a good option for saving water; however, this system requires specific temperatures for the inks, which requires a large use of energy. This option would be viable if the energy sources were renewable.
The cleaning up of the printing machines requires large amounts of toxic solvents (Romano 2014).

Digital printing does not need a plate or cylinder, as the ink is directly transferred to paper (Höfer et al. 2019). Air emissions take place throughout this printing process; usually systems are in place to contain the emissions and control air quality. This type of printing is the most recommended for small projects (1-1000 impressions). However, it does not support all types of papers, as it demands a specific surface as to allow the ink to set. (Romano 2014.)

The printing process is followed by various finishing steps, most commonly folding, cutting and binding, plus additional special finishing such as die cutting, embossing and foiling. When needed, the first step after printing is usually coating; coatings can be applied to protect the paper product or to add visual interest. They can be water-based, varnishes, UV coatings, laminates.

Water-based or aqueous coatings dry through the evaporations of water and ammonia. They are composed of polymeric resin, wax or silicone, surfactants and additives. These coatings release little VOCs, making them preferable to other types of coatings, such as varnishes. Varnishes, usually petroleum-based, are harder to remove during the de-inking and recycling processes, and add contaminants to the resulting waste.

UV coatings release little or no substances when dried, as the curing process uses light instead of heat. However, as with varnishes, the resulting products are more difficult to recycle.
Laminates are plastic films or liquids adhered to the paper. New laminates derived from bioplastics are in development: they provide the same level of protection as petroleum-based ones, however, they are easy to remove during the recycling process.
These coatings are not needed in all projects, but only in the ones where the products are handled a lot and need protection (for example, packaging). (Jedlička 2010; Romano 2014.)

Bindings can be mechanical or chemical in nature. Mechanical bindings include stitching, spiral binding, stapling. These types of binding are easy to separate from the paper, and can be made out of recycled materials. Chemical bindings use chemical substances like adhesives. Most adhesives come from petroleum-based substances. Glue needs to dry; some types work at room temperature, like polyvinyl acetate (PVA), which is non-toxic and does not emit any VOCs, while others, like polyurethane (PUR) are hot glue melts, which is more durable but emits VOCs. Although some types of adhesives can be separated during the recycling process, some still can cause problems. (Romano 2014.) However, some biodegradable options are available (for example, gum-arabic).
Binding, together with other finishing processes (such as cutting and die cutting), can produce paper dust, which needs to be contained in the facilities through air pumps.

3.4 Paper-making and recycling impacts

As Wondemu (2011) states: “The paper production industry takes the 4th place of all the manufacturing industries in energy consumption globally. It is also one of the dirtiest to generate air and water pollutions besides solid wastes”.
As previously discussed, when the paper-making industry sources its fibres from virgin wood (forests), it has great impact on the environment: both managed and mismanaged forests have consequences, from the endangerment of indigenous people and animals, to the use of pesticides and lack of biodiversity in tree plantations.

During the paper-making process, various substances are released; during bleaching (necessary to remove lignin and whiten the pulp), toxic substances such as dioxins and furans are released, in addition to greenhouse gases that come from the fossil fuels used to run facilities. These compounds are dangerous to humans and marine life; dioxins in particular have been found to cause cancer and hormonal disruption, along with damage to the reproductive and immune systems. These substances are released during chlorine bleaching; elemental chlorine has been replaced by chlorine dioxide, which releases less toxic substances; however, chlorine in any form is still harmful. Alternatives are in use, such as hydrogen peroxide, ozone, or oxygen. Information is scarce on why the alternatives have not been used more. Bleaching is necessary with wood fibre for the removal of lignin; however other types of fibres do not need as much bleaching, if any. It would be interesting to consider the need for white papers: do we really need white paper all the time or could we adjust our needs to more of a natural colour?
Jedlička (2010) states that “the paper industry is the fourth largest greenhouse gas contributor among manufacturers”. Not only because by harvesting trees it subtracts precious storage of CO_2, but also because it is among the largest consumers of energy. However, many mills are working towards using more renewable sources of energy.

When paper products reach the end of usefulness, they can be composted, incinerated, recycled or disposed of by shipping to landfills.

Because of all the chemical substances they contain, very few papers are safe or suitable for composting; an interesting example of one that does work is Plant-it®, a company that sells papers that contain seeds, so your paper products can bloom into flowers when they are not needed anymore. When organic materials are composted, the carbon they contain returns to the soil, avoiding its release into the atmosphere.
Incineration emits greenhouse gases. Systems are in place to retrieve the energy released during combustion that allow incineration to self-support. The residual waste can be used, for example, by being incorporated into bricks and cement. (Bajpai 2014.)

The anaerobic condition of landfills causes paper to decompose. Methane is released as a bi-product, a gas with twenty-five times more power to trap heat than CO_2. It is to be noted that methane is released by all organic matter in landfills, not only paper. Some landfills use this gas as a source of energy. Currently about half of paper waste is recycled, yet paper waste still accounts for a large part (40%) of landfill contents globally. (Kaplan 2019.)
When paper is recycled, trees are conserved; recycling saves water, has lower energy usage and reduces the amounts of chemicals used in comparison to paper from virgin sources. (Table 1).

Table 1. Recycling benefits. Based on Jedlička 2010.

Recycling 1 ton of paper saves:
17 trees (35-foot tall or 10.7-metres tall)
7000 gallons (32000 litres) of water
2 barrels of oil (enough fuel to run the average car for 1260 miles or from Dallas to Los Angeles)
4100 kilowatts of energy (enough power for the average home for 6 months)
3.2 cubic yards (2.5 cubic metres) of landfill space (one family-size pickup truck)
60 pounds of air pollution
4.2 megawatts of energy (enough energy to power a computer for almost a year)

Recycling costs less than waste collection, incineration and landfilling.
The first step of recycling is collection, which is the most expensive part. This includes collecting, sorting the papers and transportation to a re-pulping facility. Here the paper is soaked in water and chemicals so that once the ink has separated from the fibres of the waste it will not stick again. The ink is then

removed through the de-inking process through the use a cocktail of chemicals (Table 2). After soaking the pulp goes to the flotation process, where a chemical mixture induces any remaining ink to float to the surface.

Table 2. Function of the common de-inking chemicals (Bajpai 2014, 123).

Sodium hydroxide	Fibre swelling, breaks down ink vehicle by saponification or hydrolysis, ink dispersion
Sodium silicates	Source of alkalinity and pH buffering agent, wetting, ink dispersion, peroxide stabilization
Surfactants	Wetting, ink removal, ink dispersion, emulsification
Hydrogen peroxide	Bleaching, ink degradation, anti-yellowing
Collector soap	Ink collector (renders the ink hydrophobic and facilitates its attachment to the air bubble)
Calcium salts	Reacts with the collector soap to form small insoluble calcium soap particles that adhere to the ink particle; calcium helps agglomerate the ink particles into large hydrophobic clusters
Chelating agents	The role of the chelant is to form soluble complexes with heavy metal ions. The complexates prevent these ions from decomposing the hydrogen peroxide

After de-inking, the pulp is ready to become paper through the same process that takes place to make paper from virgin wood pulp. (Bajpai 2014.)

Paper can only be recycled a finite number of times (between five and seven). Fibres become shorter every time they are recycled, decreasing the strength of the resulting paper, therefore, new fibres need to be introduced during every cycle.

Although the recycling process saves water when compared to paper made from virgin fibre, it still consumes large amounts meaning there is still the need to treat the wastewater so it does not contaminate the environment. However, closed-loop systems are available that decrease the amount of fresh water needed. (Sb.)

Additional treatments of paper cause problems in the recycling process; the substances used are called “stickies” and they include:

- Adhesives
- Styrene-butadiene rubber
- Vinyl acrylates
- Polyisoprene

- Polybutadiene
- Hot melts

The range of melting points is broad, rendering their separation from paper difficult. Both mechanical and chemical methods are used to treat stickies. Table 3 shows the chemicals used to remove them. (Sb.)

Table 3. Chemical additives used for stickies control (Bajpai 2014, 232).

Talc
Bentonite
Diatomite
Dispersants mixed with solvents
Zirconium compounds
Alum-sequestering agents
Cationic polymers
Surfactants

Not every type of paper is suitable for recycling. For example, milk cartons are not accepted in many recycling facilities, as the equipment required is not commonly found. Also, papers that have been printed with dyes are more difficult to de-ink, as dyes soak into the paper, while inks adhere to the surface.

3.5 Certifications

Many companies are guilty of the act of greenwashing. Greenwashing is a process of creating a sustainable image without actually being sustainable. This is achieved by using earthy colours and green, claiming that the product sold is “eco-friendly” and “green”, and sometimes placing logos that look like certifications but that are in fact invented.

It it may be difficult to distinguish the companies who are genuinely responsible and sustainable. Fortunately, official labels and certifications have been established to help understand better the impact of what we buy.

The primary constituent of a book is paper, which is generally wood fibre. When wood fibre comes from forests, several certifications oversee the process of retrieving these fibres, and companies need to meet a set of requirements in order to become certified. Figure 7 shows some certifications’ logos.

Figure 7. Forest management certifications.

The most respected third-party certification is the Forest Stewardship Council (FSC). The FSC requires printing companies to have a chain-of-custody (CoC) certification. This shows that the wood products come from FSC-certified forests and manufacturers, and it can be traced back. The FSC certification has high standards, and assures the buyer that the product comes from environmentally and socially responsible sources. (Jedlička 2010.)
The FSC certification has three different labels, which refer to the contents of the product (Figure 8).

Figure 8. FSC labels. (World Centric 2018)

They display whether the paper is made from 100% virgin fibre, whether it is 100% recycled fibre, or if it is a mixture of the first two options. In all cases, responsible sources are ensured.

The Ancient Forest Friendly™ certification requires papers to contain a high percentage of recycled fibres or agricultural residue, while any virgin fibre contained needs to be FSC certified.
The Programme for the Endorsement of Forest Certification Schemes (PEFC) is a global umbrella organization; this means that standards vary in each country. (Sb.)

The ISO 14000 (International Organization for Standardization) needs mentioning as well. It is a group of standards that provide companies with help managing their environmental impact; “ISO 14001:2015 sets out the criteria for an environmental management system and can be certified to. It maps out a framework that a company or organization can follow to set up an effective environmental management system”. (ISO 14000 family: Environmental Management.)

Using ISO 14001:2015 can provide assurance to company management and employees as well as external stakeholders that environmental impact is being measured and improved.

Paper is composed of fibres and other substances such as coatings and fillers. When it comes to recycled content, it needs to be noted that it indicates the fibre content and not the weight. This means that if the fibre comes from 100% recycled waste, the origin of those other substances goes overlooked. Some certifications go beyond forest management, for instance EcoLogo (Figure 9), which considers the whole life cycle (including factors like energy consumption and water toxicity).

Figure 9. EcoLogo label. (University of British Columbia 2016)

As seen previously, the paper-making process uses many substances. Chlorine is one of the most toxic, as it disrupts reproductive and immune systems. The following are certifications that state the chlorine content of papers:

- Totally Chlorine-Free (TCF): no chlorine is used in the manufacturing of papers that show this certification; to obtain it, a chain-of-custody for the fibres is required as well.
- Processed Chlorine-Free (PCF): this ensures that the bleaching uses no chlorine compounds, and it requires products to contain at least 30 percent recycled content and that mills use “post-consumer content sources”.
- Elemental Chlorine-Free (EFC): elemental chlorine needs to be substituted with chlorine dioxide, which reduces the release of VOCs. However, chlorine is still used.
- Enhanced EFC with extended or oxygen delignification: more lignin is removed before bleaching, lowering the amounts of chemicals and energy used during the bleaching process.
- Enhanced EFC with ozone or hydrogen peroxide delignification: in addition to the label above, chlorine is substituted in the first part of bleaching.

The preferable option between the above is PCF, followed by TCF (which is used exclusively for 100% virgin paper).

Paper-making is a major consumer of energy. The Green-e certification promotes the use of renewable energy sources, while the Biogas logo attests that the energy comes from the decomposition of waste in landfills.
As for the inks, there is a lack of certifications and programs to support sustainable inks. The most common certification is the SoySeal, which requires a minimum of 7-40% soybean content. (Jedlička 2010.)

Some certifications may not be trustworthy, because members of their governing boards belong to the forestry industry, or they are funded by logging companies, which suggests a conflict of interests; certifications work but can only be trusted when they are independent and non-biased.

3.6 Completely sustainable: a utopia (for now)

So what is the most sustainable solution? The answer is not a clear sole option; ideally, the paper-making process could obtain its fibres from several different sources, like kenaf, agri-pulp, hemp, bamboo. This would take pressure off forests and prevent any other fibre source becoming overburdened. If the

pressure is equally divided between sources, then it would eliminate risks such as aggressive management of plantations or the risk of food crops being replaced by fibre crops. Implementing different sources could be successful in addition to responsible transportation and farming practices (both environmentally and socially).

As for bleaching, not all fibres need it (such as kenaf and hemp). Perhaps a social change is needed, where we get used to greyish- or cream-coloured papers, especially in everyday life where pure white is not really a necessity. There is a need for more research in the inks sector; the best solution for now is to use vegetable-based inks with the highest percentage possible of soy. Embossing and die cuts can be used in place of ink in some applications: embossing can create raised or recessed text; through die cutting, the text is sliced and a text-shaped hole left in its place, which is a great effect when the paper behind is of a different colour.

The paper-making and printing industries have developed significantly due to legislation to reduce their impacts. However, more research is needed to achieve the most sustainable solutions. Today it is easy to get frustrated with the strict processes employed that do not seem to allow for change; but I believe that as more people become aware of the existing issues, the demand for sustainability in products will rise. Awareness and information are the key to avoid senseless greenwashing and to promote real change.

4 SELF-PUBLISHING & PRINTING SERVICES

There are many printing services available including print-on-demand options that are widespread among them. Print-on-demand is a more sustainable option, as it reduces shipping impacts and eliminates storing needs. It also prevents waste, as there is no risk of unsold books.
I have focused on five companies: Lulu, Book Printing UK, IngramSpark, Doxzoo and Ashley House Printing Company.

Lulu offers printing on demand and the possibility of publishing through them and other platforms (as most companies that offer print-on-demand services do). There is no information on their website regarding certifications or environmental policies. Upon contacting them through customer care, they informed me that Lulu uses “FSC certified, lead-free, acid-free, buffered paper made from wood-based pulp” (Isabel 2020); however, they do not provide the FSC labels, authors need to contact FSC directly. I was not given any proof of this certification. Moreover, certified printers should provide the labels directly.

Book Printing UK offers printing on demand services as well. I looked through their website and could not find any information on certifications. However, they claim to use FSC-certified paper, as well as using LED energy in their facilities, but provided no proof. (Gray 2020.)

IngramSpark displays its certifications. It is ISO 14001 certified (IngramSpark), however that is not sufficient, as the ISO certifications are so common that they can be viewed as a minimum requirement. More can be done to be sustainable, and although IngramSpark is the only one so far that displays and proves its certifications, they are not enough for me.

Doxzoo is a printing company and while it offers print-on-demand, it does not offer a publishing service. However, they display the following certifications: ISO 14001, FSC and PEFC for most papers. It does not provide proof of these, but it is stated clearly on their website. They also informed me that they use recycled packing paper inside boxes instead of plastic (although they use bubble wrap for large foam boards). They do not use vegetable-based inks. (Lucy 2020.)

The Ashley House Printing Company offers a printing service and print-on-demand, but no publishing services. According to their website, they are FSC, ISO 14001 and 100% Green Energy certified. They also support the Woodland Trust Carbon Capture Scheme and Forest Carbon. They claim to use 100% renewable energy and to reduce carbon delivery by planning their deliveries thoroughly. Moreover, they are attempting to become completely plastic-free,

substituting biodegradable options in their packaging, and have a “Zero Landfill Policy”, aiming at recycling and reusing rather than wasting. (Ashley House Printing Company.)
Their lithographic printing service offers vegan-friendly vegetable based inks, while the digital printing makes print-on-demand possible.
Although they have not replied to my enquiries, they display information clearly on their website, which makes them more believable.

None of these companies provided me with their products’ Material Safety Data Sheet, a document that details the compositions of products, warning about any hazardous ingredients, their effects on health and how to use, store and dispose of said product (Jedlička 2010). Manufacturers should make this document available upon request.
Moreover, most websites seem to hide any environmental information, as it is hard to find, if present at all. When such information is provided, is very vague and not proven, which can be considered a greenwashing attempt.

5 E-BOOKS

The alternative to a printed book is an e-book. However, this option is not as sustainable as it seems: the production of e-readers and their disposal are quite problematic.
Tablets are made with tin, tantalum, tungsten and gold (the 3TGs); these minerals are mined in countries like the Democratic Republic of Congo, where armed conflicts benefit from said mining. About half of mines are controlled by armed groups; companies have the responsibility of making sure they do not contribute to armed conflicts. Cobalt as well is deemed a “conflict mineral”, as it is linked to child labour. (Denyer 2018.)

Another unsustainable consequence of tablets and e-readers, is their disposal; most of our e-waste results in piles that more often than not end up in developing countries, all these items are searched for sellable parts. This means that very often electronics are burnt to separate the various elements (for example copper wires covered in PVC). These fires emit highly toxic and dangerous substances.

(Sb.) Jedlička (2010) says: “Up to 80 percent of e-waste is illegally shipped to Asia […] Laborers, including child workers who have developed lead poisoning as a result, dismantle the e-waste by hand”.

Moreover, the manufacturing process has consequences as well: workers are exposed to toxic chemicals that cause several types of cancers and negatively impact the reproductive system. (Denyer 2018.)
So is an e-reader or tablet a better choice than paper? The answer varies: each person has different needs that can be met in different ways.
Kozlowski (2017) says: “There is roughly 168 kg of CO2 produced throughout the Kindle’s lifecycle and 1,074 kg of CO2 if you purchase three books a month for four years; and up to 26,098 kg of CO2 when used to the fullest capacity of the Kindle DX. Less-frequent readers attracted by decreasing prices still can break even at 22.5 books over the life of the device”. This means that to reduce one’s environmental impact using an e-reader, one should read more than 22.5 e-books.

6 DESIGN

When publishing a book, one can try to be environmentally responsible in the design process as well.

It’s important to attempt to reduce ink usage, no matter what type of ink; so the illustration process for this project has kept this aspect under consideration: the illustrations rely on the smallest amount of colour possible, making use of white backgrounds and line art extensively. Large empty areas of white space are also an element present in the design of expensive books, which can be an advantage since ecological printing is usually more expensive. (Appendix 2.)
The number of pages is also taken into consideration: the book items such as end papers are not included and all publishing data is included on the inside front cover.

Although not compatible with this project, the software Ecofont is worth of mention: this program helps save ink by creating holes in the copy, too small to

be perceived by the human eye but big enough to save 46,5% of ink. (Ecofont; Wondemu 2011.) The fonts supported by this software are the most common typefaces (Arial, Calibri, Tahoma, Times New Roman, Verdana), which were not suitable for this project, so the font utilizes a more child friendly and aesthetically appropriate typeface.

The aspects that did not involve any direct sustainability issues were designed following the theme of the book. The story revolves around a child who is trying to comfort their stuffed penguin, who is sad about having to move so much to be with each parent. The child reminds the penguin of all the fun things they do at each parent's house. The story takes place in a dozen pages where scenes alternate between what happens at mom's house and what happens at dad's. To keep the illustrations as simple as possible, and to aid this type of narrative, the design employs three colours: one for the main character, and the other two for the two environments they inhabit. These two colours would change based on whether the child is at mom's or at dad's house (Figure 10), a visual contrast that reflects the contrast present in the child's life. Because it is not relevant to the story, the character's gender is not defined: the drawing of the child is purposefully ambiguous.

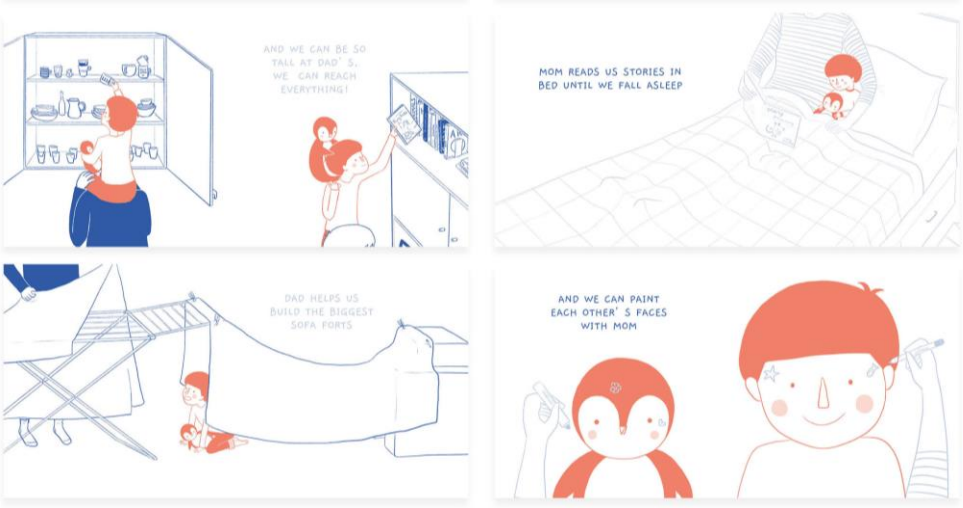

Figure 10. Spreads illustrating the use of three colours and white space (Pitto 2020).

The story is narrated by the child, who is talking to a toy stuffed penguin, the font needed to reflect the child's voice. It was decided the text should look handwritten, possibly imperfect, to visually suggest a child's narration viewpoint.

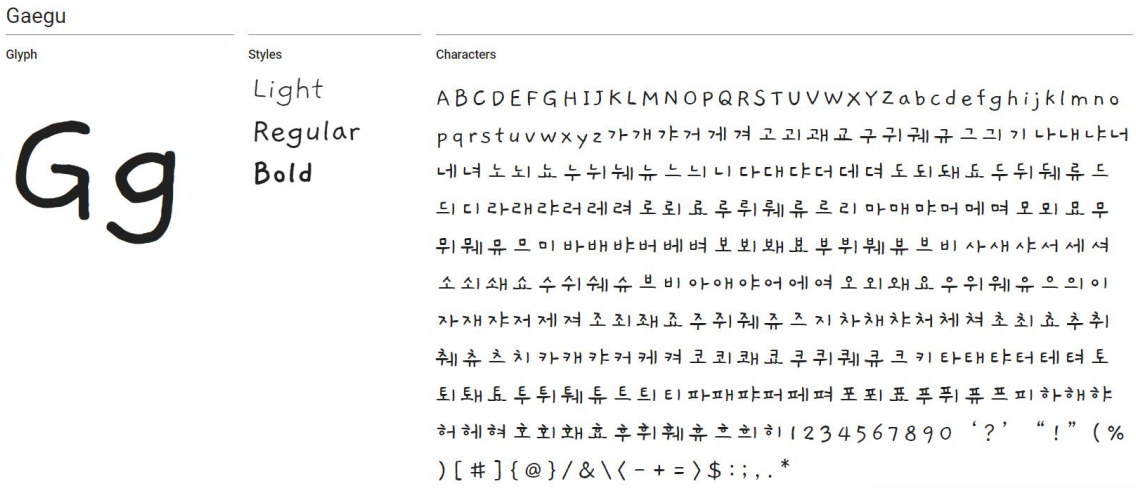

Figure 11. Gaegu font from Google Fonts (Google).

The Gaegu font (Figure 11) was selected as it simulates handwriting, with imperfect lines, but at the same time it is legible enough for children who want to try and read the book themselves.

The format of the book is square. Square books are quite common in children's publishing. The chosen size of 8 inches (approximately 20 cm) allows children to hold the book by themselves, as it is not too big and by reducing thickness of the book, by limiting the number of pages and considering the weight of paper stock, the design is further made child friendly.

7 SOLUTIONS

The gathered information shows a few possibilities when it comes to sustainable self-publishing. Below is a conclusive analysis of each element seen so far.

For paper, there are a few very promising options in terms of sustainability: hemp or kenaf fibres, bamboo fibres, and recycled paper. Agri-pulp is also very promising but there is no structure in place to make it a viable option. The Harris Profile (Digital Society School, Harris profile) helped in the analysis of the three above mentioned fibres; this method evaluates concepts based on how well they meet the established requirements, giving each a score between -2 and +2. The final result shows which concept (in this case, which fibre) is the best one. When analyzing these fibre sources, the requirements were few but very important:

- Availability of the source
- Little or no pesticides

- Little or no bleaching
- Availability of equipment to treat
- Economically viable
- No need for added fibres

The results (Appendix 3) show the difficulty of the situation, with results being +6 for kenaf and hemp, +5 for bamboo, and +4 for recycled paper. There is no clear solution, for all sources have pros and cons. If kenaf and hemp became more popular, they could become a stronger sustainable candidate; however, the best solution is an implementation of many different sources, in order to avoid monoculture and relieving pressure from one single source of fibre.

As for the printing process, the Harris profile is not necessary, given the small amount of variables: the options are restricted to lithographic printing and digital printing. Lithographic printing allows for the use of vegetable-based inks, although it requires the use of other materials to create the printing plates; this also means that the amount of printed items need to be high and excludes the possibility of print-on-demand. Digital printing is excellent for printing on demand, however it does not offer the possibility of using vegetable inks. This is because digital printing uses laser or inkjets to transfer colour to paper and vegetable inks' viscosity is not suitable.

As for the cover, an ideal solution would be the use of thread instead of glue. This would not require a thick cardboard cover, but a simple thicker paper, which is simpler to make and recycle. However, the book is destined for children, and even though parents might be the ones reading it to them, it still will be put to test and suffer damage. This would require a thick cardboard cover, which could be combined with a special binding with thread, However, this is quite uncommon, which would make the cost of creating this book raise too much. As for glues, gum-arabic seems the most natural option, although not very common.

As printing and publishing services do not offer any option for bindings and glues, the following analysis will concentrate on what is available: printing methods, paper, inks.

The study has pointed to three main possible solutions:

- Digital printing with the Ashley House
- Lithographic printing with Ashley House
- E-book

These options are not the most sustainable ones, however, they are the most realistic possibilities available at the moment.

These three options can be compared with the use of the “People Planet Profit” method (Digital Society School, People Planet Profit) that allows one to assess whether a project is beneficial from three points of view: Does it benefit people? Is environmentally sustainable? Is it economically sustainable?

The results (Appendix 4) indicate digital printing with Ashley House as the most viable and sustainable option at the moment. Digital printing allows for print-on-demand: this means lower financial risk and a lower price for the customer (compared to other types of printing). This type of service lowers the risk of unsold copies and the consequent risk of these copies becoming waste. Ashley House is FSC certified, and claims that their HP Indigo Digital Press “has Nordic Swan Accreditation and is the most sustainable digital press on the market” (Ashely House Printing Company).

Digital printing does not offer vegetable inks, an option available with lithographic printing. The latter method does however pose a risk of unsold copies, as it requires higher numbers of items to be printed.

The last option analyzed with the People Planet Profit method is that of e-publishing the book. This option seems sustainable on the surface, as it requires no printing or paper, however, as discussed above in chapter 5 “E-books”, tablets and e-readers are not sustainable. The requirement “People” highlights another issue, which will not be discussed here, but is important nonetheless: that is, the relationship between children and tablets. Without discussing the subject in depth (as it would need a whole other study of its own), small children should be able to explore different materials, and a tablet limits all the sensory data compared to what books offer. This is another reason why e-publishing will not be taken into consideration right now, although it might become a second possibility in the future to go alongside traditional printing version for those who would like a digital version instead.

8 CONCLUSION

In recent years, sustainability has become a more discussed subject; this has encouraged many businesses to make new improvements and apply new solutions to their services so as to meet today's need for eco-friendly options. It is important to acknowledge that progress has been made in the recent years, just for the fact that more people are aware of sustainability and its impact on global warming.

However, this is no excuse to forget our duty to always strive for a better, more sustainable option, even if it is not available yet. Designers, architects, engineers, all have the responsibility to plan their projects paying strong attention to their life cycle, ensuring its efficiency and sustainability.

From the results of this study, it is clear that the paper-making and printing industries have made progress, with certifications such as FSC used extensively; however, there is the need for improvement in many areas, from the fibre source, to inks, to water and energy usage.

The outcome has pointed to digital printing with the Ashley House as a realistic solution for the printing of my children's book. The company has been contacted but has not replied yet, which halts the process. This outcome results in it being impossible to print the book currently; and as e-publishing was not kept under consideration, this means that the project has failed.
However, the project can be considered as not concluded: if Ashley House ever replies, the outcome of this project would change, as the chance of printing might become a reality.

The reasons for failure are simple: the high requirements of the author were hard to meet and would require the paper-making and printing industries to be revolutionized. The paper-making industry would need to rely on an implementation of multiple different sources of fibres (kenaf, hemp, bamboo, agri-pulp, recycled fibres), thus relieving pressure on a singular source. Vegetable inks would need to be developed to be more compatible to digital systems so that

they could become more commonly used. It would be necessary that all facilities employ sustainable and responsible energy sources and improved the way waste and wastewater from these facilities were dealt with.
There is a huge gap between the high standards I demanded and reality. Most available services are limited to print-on-demand and FSC certified papers, which are both good options, but not enough to consider the result truly sustainable. Many solutions exist on a theoretical or niche level, such as alternative fibre sources or vegetable inks. In addition, not many facilities employ renewable energy sources.

However, if the requirements employed lower standards, making the printing of the book possible, the project would have to be considered a failure nonetheless, as it would miss the sustainability mark.

Another reason for the project to have failed is its timing, as the current lockdown due to Covid-19 has closed or set back many businesses. This could be the reason why the Ashley House printing company to have not replied to my enquiry.

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LIST OF FIGURES

LIST OF TABLES

OTHER ALTERNATIVE FIBRE SOURCES

The information included in this appendix comes from Jedlička (2010).

Recycled textiles

These are used to produce high quality papers. This option is highly environmentally friendly, because it involves recovering materials that would otherwise end up in landfills. Some companies separate fabrics by colour, eliminating the need for bleaching and colorants.

Stone and minerals

Made out of calcium carbonate plus a plastic polymer binder, these papers are marketed as tree free. Calcium carbonate is not a new material to paper-making, as it is used as a whitener and additive for coated paper. The environmental impact of such a material is not small: to retrieve stone and minerals, mining is required, which is one of the most dangerous jobs. However, most companies claim to get this material for paper-making from recycling construction scraps. These materials are combined with a binder (polyethylene, PE); this process requires little to no water and little energy, and the pulp requires no bleaching. The result is a water resistant and tear resistant paper, usually destined for specific applications where “regular” paper can be easily damaged.
Proper recycling facilities for such papers are not available. Also, the binder may come from petroleum-based plastic.
In addition, not all printer types are compatible with this type of paper.

Synthetic fibres

Synthetic fibres make for durable and water resistant papers, although they are heavier than other types of paper, increasing costs and emissions for transport. The advantage of this fibre is the possibility of a closed loop system, where the papers could be endlessly recycled, without losing quality. However, at the moment not many recycling facilities accept these papers.
It is important to highlight the fact that many of these synthetic fibres come from a non-renewable source.
Specific inks and printing methods are required (any heat based process would fuse the paper). Like with stone fibres, the derived papers weigh more than normal.

Animal processed fibres

These come from animals that don’t digest fibres, like elephants. The product is cleaned and processed, often mixed with recycled materials to give strength. This resourceful use of this pulp, is more adapt for fundraising options to raise

awareness of problems (for example, some pandas in Thailand provide the material, which is then turned into paper for the gift shop of the zoo they live in).

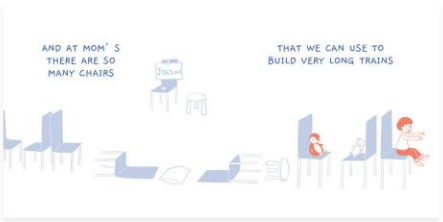
BOOK


TITLE
AUTHOR


TITLE
WHAT' S WRONG, PENGUIN?


I KNOW YOU' RE TIRED OF MOVING AROUND
BUT THINK OF ALL THE THINGS WE GET TO DO!


WHEN WE' RE AT DAD' S WE MAKE CRAFTS
AND USE OUR HANDS TO PAINT
FOR DADDY

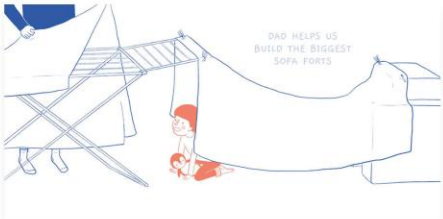

AND AT MOM' S THERE ARE SO MANY CHAIRS
THAT WE CAN USE TO BUILD VERY LONG TRAINS


WE COOK WITH DAD AND MAKE PANCAKES FOR BREAKFAST


MOM LETS US EAT ON THE COUCH ON THE WEEKENDS


AND WE CAN BE SO TALL AT DAD' S, WE CAN REACH EVERYTHING!


MOM READS US STORIES IN BED UNTIL WE FALL ASLEEP


DAD HELPS US BUILD THE BIGGEST SOFA FORTS


AND WE CAN PAINT EACH OTHER' S FACES WITH MOM


SO WHAT DO YOU THINK, PENGUIN?
"READY TO GO?"


YES, WE' RE READY!
THE END

HARRIS PROFILE

mediaLABamsterdam

HARRIS PROFILE ‡ + – =
TEMPLATE

	REQUIREMENTS	-2	-1	+1	+2	-2	-1	+1	+2	-2	-1	+1	+2
1.	Availability of the source			X				X					X
2.	Little or no pesticides				X		X						X
3.	Little or no bleaching				X			X		X			
4.	Availability of equipment to treat	X						X					X
5.	Economically viable			X				X					X
6.	No need for added fibers				X				X	X			
7.													

NOTES/ADJUSTEMENTS

The results reflect the realism of the situation: there is no clear solution, decisions need to be made independently for each singular situation.

CONCEPT 1
Kenaf paper/hemp paper

Total: +6

CONCEPT 2
Bamboo paper

Total: +5

CONCEPT 3
Recycled paper

Total: +4

PEOPLE PLANET PROFIT

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PEOPLE PLANET PROFIT TEMPLATE

DESCRIBE YOUR IDEA: Digital printing with Ashley House on recycled paper

RATE CONCEPT
Give two pluses if it fits the criteria very well, one if it just fits it, a minus if it doesn't fit it, and two minuses if it really doesn't fit the criteria.

PEOPLE

Describe how your concept aims for interdependent well being of all the different stakeholders

With the possibility of print-on-demand, the costs will be reasonable: the customer would benefit from a reasonable price.

PEOPLE	++	+	-	--
Beneficial	X			
Fair	X			
Correct business	X			
~~Good for community~~				
~~Good for the region~~				

PLANET

Describe how your concept aims to benefit the natural order or at least minimize as much as possible any negative impact on the environment

Possibility of print-on-demand means no need of space to stock unsold copies and eliminates the risk of unsold copies becoming waste.
According to their website, Ashley House's printer HP Indigo Digital Press "has Nordic Swan Accreditation and is the most sustainable digital press on the market" (Ashely House Printing Company).
Ashley House claims to use recycled papers and is FSC certified.

PLANET	++	+	-	--
Sustainable	X			
Non polluting		X		
Eco friendly		X		
Low CO2 footprint		X		
Craddle to Grave		X		

PROFIT

Describe how your concept takes into account the real economic impact it will have on its economic environment

The print-on-demand service does not require any sort of big investment in order to print copies, and is comparatively inexpensive.

PROFIT	++	+	-	--
~~Social benefit~~				
Generates revenue	X			
Economically sustainable	X			
Economically viable	X			
Profitable	X			

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PEOPLE PLANET PROFIT TEMPLATE

DESCRIBE YOUR IDEA: Lithographic printing with Ashley House on recycled paper and with vegetable inks

RATE CONCEPT
Give two pluses if it fits the criteria very well, one if it just fits it, a minus if it doesn't fit it, and two minuses if it really doesn't fit the criteria.

PEOPLE

Describe how your concept aims for interdependent well being of all the different stakeholders

This type of printing may involve more people in the process (risk: higher costs, higher price).

Vegetable based inks are the safest, which makes them ideal for a children's book (parents and children would benefit).

PEOPLE	++	+	-	--
Beneficial		X		
Fair	X			
Correct business	X			
~~Good for community~~				
~~Good for the region~~				

PLANET

Describe how your concept aims to benefit the natural order or at least minimize as much as possible any negative impact on the environment

Vegan frindly vegetable inks
Ashley House claims to use recycled papers and is FSC certified.

PLANET	++	+	-	--
Sustainable	X			
Non polluting		X		
Eco friendly		X		
Low CO2 footprint		X		
Craddle to Grave		X		

PROFIT

Describe how your concept takes into account the real economic impact it will have on its economic environment

Risk: no print-on-demand possible, which means a bigger amount of prints are necessary.

PROFIT	++	+	-	--
~~Social benefit~~				
Generates revenue		X		
Economically sustainable		X		
Economically viable		X		
Profitable		X		

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PEOPLE PLANET PROFIT TEMPLATE

DESCRIBE YOUR IDEA **Ebook**

RATE CONCEPT
Give two pluses if it fits the criteria very well, one if it just fits it, a minus if it doesn't fit it, and two minuses if it really doesn't fit the criteria.

PEOPLE

Describe how your concept aims for interdependent well being of all the different stakeholders

This sparks a whole other discussion about tablets and children. To keep it short, small children should be able to explore different materials, and a tablet limits all the sensory data that books offer. Moreover, this book could be a bedtime story, which means that a tablet is not the ideal choice (whereas an e-reader could work).

PEOPLE

	++	+	-	--
Beneficial		X		
Fair		X		
Correct business		X		
~~Good for community~~				
~~Good for the region~~				

PLANET

Describe how your concept aims to benefit the natural order or at least minimize as much as possible any negative impact on the environment

No need for printing.

However, tablets and e-readers are not sustainable (see chapter 5 Ebooks).

PLANET

	++	+	-	--
Sustainable		X		
Non polluting		X		
Eco friendly		X		
Low CO2 footprint		X		
Craddle to Grave		X		

PROFIT

Describe how your concept takes into account the real economic impact it will have on its economic environment

Without the need to print, costs lower significantly, making the profits raise (although an e-book does not sell at the same price as a printed one). However, different services have different costs to e-publish your book, often taking part of your royalties.

PROFIT

	++	+	-	--
~~Social benefit~~				
Generates revenue	X			
Economically sustainable	X			
Economically viable	X			
Profitable	X			