Bournemouth University

FACULTY OF SCIENCE AND TECHNOLOGY

BA (Hons) Product Design

June 2019

Tomobeans : Inclusive Social Toy

by

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Date: 03/06/19

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Abstract

Tomobeans are collectible, tradable, low-cost competitive social toys for 6-8 year olds, that are designed to allow even those with the most affecting of fine-motor control abilities to operate them equally efficiently to abled-children (including acquired or congenital limb loss up to, and including, the elbow), allowing a typically underserved demographic to engage in social play with other children using tools that they previously had limited access to.

All of this is achieved without giving the impression that the toy is even designed for this market, preventing the alienation of able-bodied children from participating, and encouraging cross-ability social-interaction.

Tomobeans only requiring a pressing force from above with any part of a limb to play is the defining product feature, and every element of the game and physical product, were informed and evaluated by industry professionals and industry-standard requirements, including conforming to the BSI Kinetic Toy Standard BS71-1.

Acknowledgements

Deepest thanks to:

Bryce Dyer – For giving me the much needed (metaphorical) slap I needed on occasion into the right headspace needed to produce the work I knew I was capable of, his endless support and advice throughout the project, and preventing me from becoming a puddle of verbally inept tears during Viva 2.

Bob Eves – For managing to steer me clear of certain concepts during the crit, even when acted too 'passionately' defensive with my opinion on my aesthetic choices; as always, experience proved the victor, and my total redesign of the aesthetics in response gave me the product I'm proud to have today.

Reach – For just being a wonderful beacon of hope, that allows those who might not feel like a whole kid, feel like so much more than one.

All of the Workshop Staff – For saving my prototype on multiple occasions, AND generally giving the sort of advice that sticks around for a lot longer than one academic course.

Nick Farwell – For saving my prototype on multiple occasions AND reminding me that no matter just how bleak the project outcome might look, it can (and probably will) get worse!

Gary Underwood – For saving my prototype on multiple occasions AND giving some amazing Word of the Day suggestions for the whiteboard AND for undoubtedly having to save my prototype on the multiple occasions after this hand-in.

Mrs Jones – For their phenomenal knowledge surrounding paediatric psychology, and for teaching me lots of fun new specialist words I can butcher trying to pronounce at high-brow parties.

Emyr Peregrine – For being a phenomenal uncle who also happens to be an extremely talented polymer engineer; your advice on plastics has been invaluable in helping find suitable materials on this and many other projects.

Tania and the SciTech Staff: For all of the work behind the scenes that we *don't* see.

Specialist Toy Market Advisor (Anonymous): For helping me discover how varied and wild the Toy Industry can be (and the tickets to next year's Toy Fair in London certainly wasn't unappreciated...)

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1.0 Introduction

1.1 Problem Background

Play is a fundamental aspect to a child's social development. (Quilitch and Risley, 1973).

Reading facial cues, learning social etiquette, encouraging imaginative thinking, and generally developing a social awareness is a critical life-skill, one that has been aided in the modern era by easily accessible, mass-marketed toys designed to encourage social interaction between children and specifically developed for that purpose.

The children's toy market has expanded rapidly into new areas, including more modern, technology-enabled products. The sheer breadth of potential product ideas on the market is one of the widest seen in any industry.

However, despite more variety in possible options of purchasable toys than at any other point in human history, almost every one of these products have one linking factor that shuts a demographic off from this critical instrument for paediatric development:

They require full motor-control of a user's extremities, namely fingers and wrist joints.

Since companies tend to cater from the 5^{th}-95^{th} percentile, children with upper limb deficiencies, fine motor control issues such as mild cerebral-palsy, acquired or congenital limb-loss, or any number of coordination issues that effect less than 5% of the population find themselves without the ability to efficiently interact with mainstream toys, and therefore a vessel of potential social interaction with other children is lost.

This isn't to say mature companies and industries do not exclude disabled demographics entirely, Microsoft releasing a controller for their Xbox console in 2018, solely designed for those with coordination issues, was a rare but noteworthy event (BBC, 2018) These advancements however, are the exception rather than the rule, and can only realistically occur in an environment where a company can afford to invest in a technology that is unlikely to meet expected returns without fear of financial instability.

The problem was chosen with this in mind: to develop a product that could be used expand the potential pool of users, without alienating the mainstream demographic, and in the case of the given market, to provide stronger social connections between all parties.

1.3 The Value of Play | The Toy Market

The toy market is one of the most heavily saturated markets in any sector, with *Figure 1* showing the strongest market to be LEGO owning 7.2% of the market, but with 69.6% of the market owned by companies who themselves own less than 0.3%, the number of competitors is vast (Mintel, 2017). This corresponds to a high level of product variety, with building-blocks, board-games, electronic reading games, and others all taking large portions of market share. This indicates that there is unlikely to be a product that is entirely new to the market, but also that successful new ideas are unlikely to be troubled by monopolistic competitive strategy.

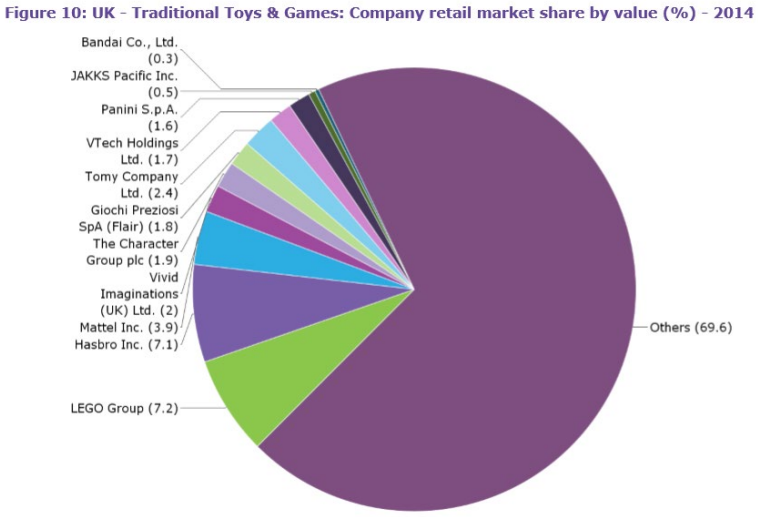


Figure 1 - Traditional Toy Market Share by (%) (Mintel 2017)

The customers, that is, the parents or guardian of the child, are estimated to spend an average of $100 a year on children's toys (Statista 2015), so an estimated figure was set at $50 RRP, a sizeable, but not overwhelming amount of the average budget.

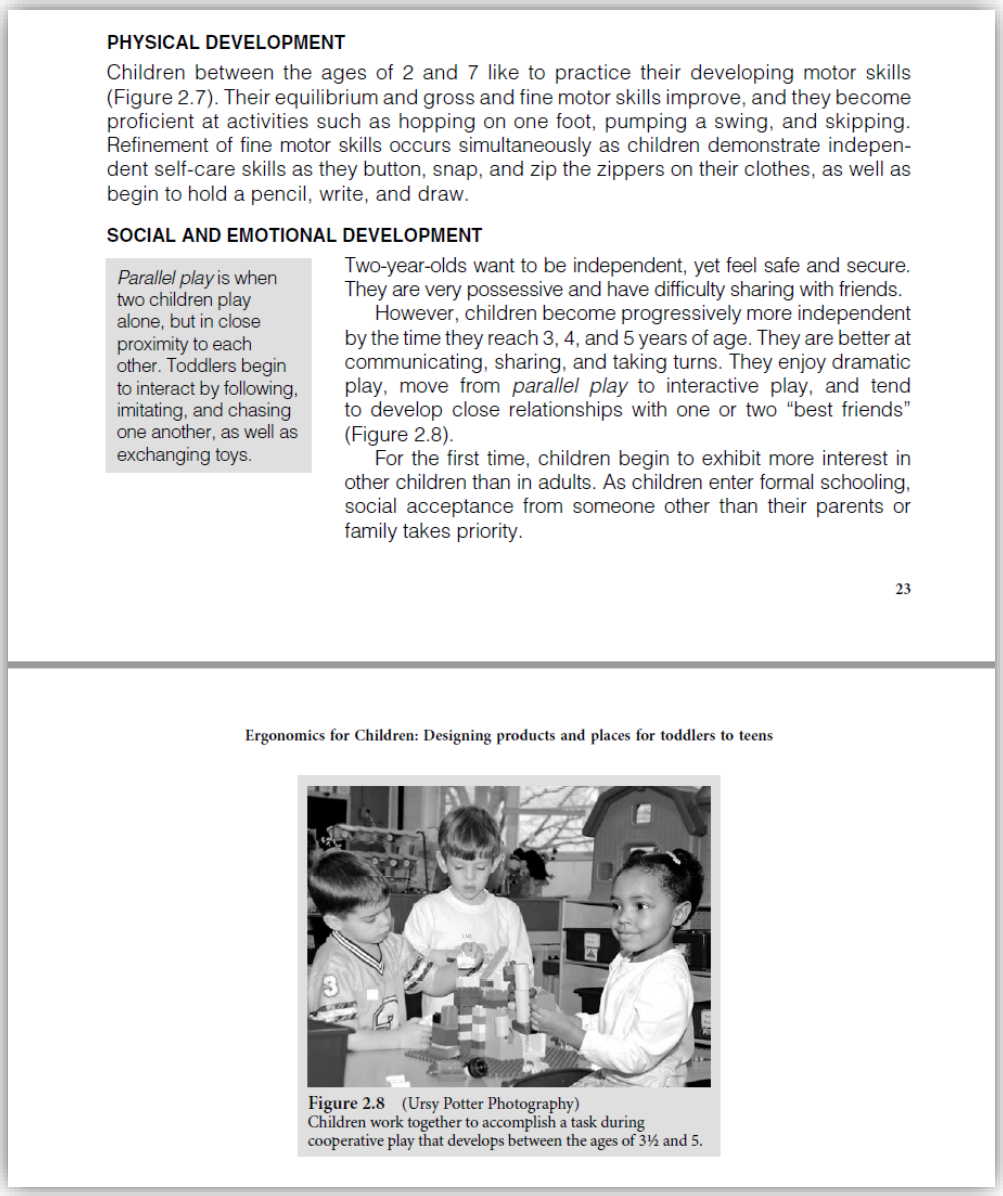
1.4 Impedance on Social Interaction/Psychological Considerations

Having a physical limitation also has significant potential psychological considerations. Fine-motor control is needed for different social conventions, including play, and an inability to interact in a traditional manner has potential to make a child feel "excluded" or "different", especially during the 4-9 age range, where the limb disparity and its social consequences are first starting to be considered by the child (REACH, 2016).

REACH, a charity specifically devoted to children with upper-limb deficiencies (REACH, 2016), mentions and gives advice on how to adapt to these social circumstances, including how to talk and explain the deficiency to other children, how to deal with teasing, and advice regarding prosthesis, such as the importance of allowing the child to have an involvement on the prosthetics styling choices.

1.5 Humanistic Challenges

The psychological considerations tie in heavily to the main humanistic challenges, there's an obvious need to create a toy that manages to be usable by those without the traditional fine-motor control needed in mainstream toys, namely, the two points of grip for posing toy elements.



PHYSICAL DEVELOPMENT

Children between the ages of 2 and 7 like to practice their developing motor skills (Figure 2.7). Their equilibrium and gross and fine motor skills improve, and they become proficient at activities such as hopping on one foot, pumping a swing, and skipping. Refinement of fine motor skills occurs simultaneously as children demonstrate independent self-care skills as they button, snap, and zip the zippers on their clothes, as well as begin to hold a pencil, write, and draw.

SOCIAL AND EMOTIONAL DEVELOPMENT

Parallel play is when two children play alone, but in close proximity to each other. Toddlers begin to interact by following, imitating, and chasing one another, as well as exchanging toys.

Two-year-olds want to be independent, yet feel safe and secure. They are very possessive and have difficulty sharing with friends.

However, children become progressively more independent by the time they reach 3, 4, and 5 years of age. They are better at communicating, sharing, and taking turns. They enjoy dramatic play, move from *parallel play* to interactive play, and tend to develop close relationships with one or two "best friends" (Figure 2.8).

For the first time, children begin to exhibit more interest in other children than in adults. As children enter formal schooling, social acceptance from someone other than their parents or family takes priority.

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Ergonomics for Children: Designing products and places for toddlers to teens

Figure 2.8 (Ursy Potter Photography)
Children work together to accomplish a task during cooperative play that develops between the ages of 3½ and 5.

Figure 2 -Extract from Lueder & Rice's book on child ergonomic and social development (2008), note how the independence of the child is tied to social development.

But along the same vein, the product needs to be equally usable by both disabled and non-disabled alike, such that there is no discernible difference between usage with either demographic. This is a consideration designed to prevent any alienating of those with/without fine-motor control, encouraging a stronger chance of cross-ability play between both parties.

1.6 Technical Challenges

From a technical perspective, toy design is regarded to have some of the strictest requirements with regards to product standards and age-requirements. The BSI (British Standards Institution) holds several volumes entirely devoted to the forces, materials, size requirements, manufacture, and hundreds of other specifications that pertain to child safety when using the toy (BSI, 2017). This is made harder by the inherent nature of a child being unable to understand/likelihood to ignore warnings on a product.

In this sense, the first technical challenge with a product such as this is simply to meet those requirements, but alongside this, the product needs to be able to be manufacturable in quantities exceeding 10,000 units annually, for the $50 RRP estimated price suitable for the customer (typically the parent or guardian). These figures are typical of an average size toy-firm (Mintel, 2017).

2.0 The Design Process

2.1 Design Proposal & Initial Research/Objectives

The design proposal (Appendix A) was used to outline both the design intent, as-well as provide initial contextual research in order to refine the potential avenues of data collection and evaluation; this aimed to assure a focus on the latter, given that the project primary goal is to provide 'cross-ability' play, the project lends itself to a heavier reliance on a wider variety of consumer data, across more demographics than might typically seen in a standard project.

As is often the case with inclusive products, there were some immediate difficulties that were presented with conceiving elements of the proposal that related to this breadth of consumer requirement; for example, the proposal required a price and manufacture quantity for the product, which for typical products of the toy and prosthetic market respectively, differ in price and manufacture quantity by a factor of hundreds, if not thousands.

It was eventually decided that, given that the product is designed to be used by both disabled and able-bodied children alike, and that the former market is historically more expensive to produce for (owing to its specialist nature), that the aim should be to produce a product such that the only defining factor that differentiated it from mainstream toys, was how its ergonomic considerations allowed disabled children to operate the product.

This would be a recurring element throughout development.

(2.1.5)

Contrary to most design process methodology, research objectives were **not** initially broken down into whether the research task required secondary or primary research; rather, *given the scope and variety of research needed*, tasks were categorised into two broad areas, based on whether the task pertained to the areas of the project designed to be universally-usable elements (i.e. the elements that applied to able-bodied children as much as they did for disabled children), or whether they specifically were required to enable disabled children to use the product (such as ergonomics and anthropometrics for disabled demographics, but also more nuanced elements, such as social-stigma, current usability of current toys, and any specific standards that may not be considered in regular products).

Primary research priority was then assigned to the proposal categories that were either critical to the success of the project, or that could not be realistically acquired through conventional secondary research.

This concluded with the selection of two main primary research targets, both related to developing toys for the disabled market, due to the definitive lack of information on inclusive toy development: the first aimed to define the psychological considerations when designing a popular social-toy, that could also that bridge the social divide found within differing coordination abilities, whilst the second regarded the physical considerations themselves with operating children's toys that simple anthropometric and ergonomic data alone does not have the scope to contribute.

2.2 Toy Market Research

The primary psychological research was conducted on two participant interviewees, one a professional academic in paediatric psychology, and the other a professional in the commercial sector; the assumption was made that either interviewees opinions and insight may be influenced by their own agendas and experiences, thus it became important to find multiple, possibly conflicting views.

Figure 3 - The Annual London Toy Fair showcases all of the key manufacture's products for the coming year and is one of the strongest places to conduct market research. (London Toy Fair 2019)

The first of these two participants, a freelance commercial toy-designer with decades of experience in multiple toy-sectors, was reached out to initially: over the course of development, three separate meetings were conducted over the phone, with email visual supplements during this period; the first meeting was setup to ascertain what made for a compelling game, with the other two, shorter meetings serving as follow-ups to check whether the final product followed said advice effectively.

2.3 Child Psychology

The second professional to give insight regarding the psychological aspects of children's toys came through a university academic in paediatric psychology, who had attended the London Toy Fair (LTF, 2018) on multiple occasions and, through a phone conversation, gave insight on the child social development, and the potential issues that might alienate audiences when creating an inclusive advice. Crucially, multiple secondary resources were cited to support the advice, and provide further reading.

2.4 Disability Research

The physical implications of designing an inclusive product was aided by REACH UK, a charity specifically catered for children suffering from upper-limb amputations and disorders. Whilst individual one-to-one contact was not able to be obtained, information regarding the daily issues associated with upper-body coordination issues was acquired through the information guide that was written and recommended by the charity.

Figure 4 - REACH is a charity specialising in multiple limb deficiency in children. (REACH.org)

2.5 Product Design Specification

Combined with secondary research that served to confirm or counter the advice given, along with supplementary data on the market, such as price and spending habits from Mintel's database (Mintel, 2017), a grounded understanding of the critical project elements was attained.

The PDS (Appendix D) was completed shortly after this period, given the breadth of research conducted prior, the document served as much as a collation of research as it did a list of product requirements; development was consistently compared back to the PDS requirements to see whether adjustments were needed, including to the PDS itself if it became apparent that further research was required.

2.6 Concept Development & Selection

Initial concept sketches had begun almost simultaneously, with dozens of designs being drawn up and rejected over the course of several weeks, as new research either supported or conflicted with the idea.

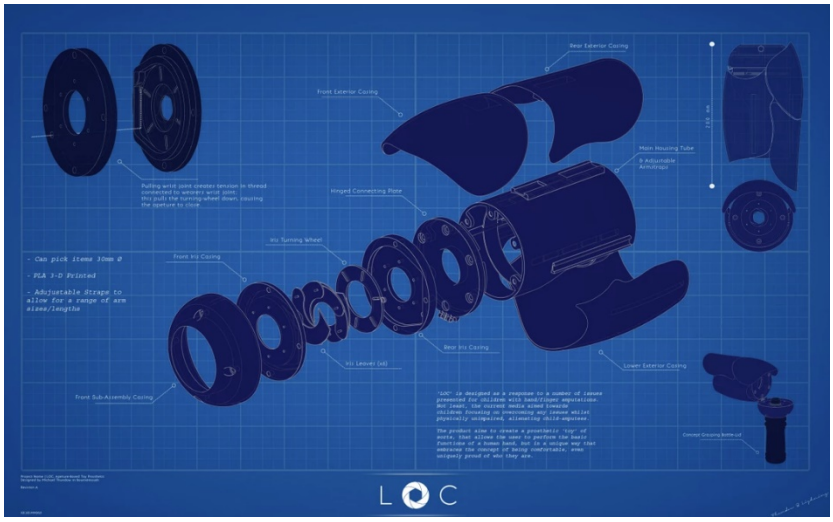

Figure 5 – LOC, the previous design of the author that served as initial inspiration. (Author 2017)

Initially, the concepts looked to be seen as a ‘prosthetic toy’: a device that attached to the arm, but instead of looking to grasp objects, to shoot darts, or launch small plastic planes, or a modular system that could allow for any number of kinetic functions.

In a sense, this was an emulation and expansion of the author’s previous work, which sought to create a prosthetic that had the aesthetic of a fantasy-inspired product.

Ultimately, this collection was abandoned by comparing it to one of the key points of the PDS (Appendix D), which stated that the product should “not appear to be made specifically for those with impairments”.

Instead, the concept generation began to look to emulate current popular kinetic toys, looking to take the elements that lead them to become a social touchstone with children, such as the characterisation of toys, and repurpose it for this new market.

Figure 6 - Collection of models & test rigs.(Author 2019)

Once an eventual ‘toy’ idea and rough functional mechanism was established, through dozens of models to test ease of use with a disabled demographic, an initial concept was chosen to represent in Viva 1.

2.7 Detailed Design & Aesthetic Overhaul

Whist VIVA 1 feedback was shown to have a marked impact on the continuation of development, such as the need to provide more detailed explanation of the product mechanism, it was the unofficial critical feedback session that followed some weeks later that prompted a revisiting of many design elements.

Figure 7 - 'Intial' Final Concept (Author 2018)

It was suggested that whilst functionally, the product was feasible and the ergonomic and anthropometric choices at-least somewhat suited the required markets, the choice of shape and colour choice gave the impression of being a product designed for a male market, where a unisex product had already been a longstanding requirement since the initial proposal (Appendix A)

In light of this, a new selection of research criteria was created, related to the aesthetics of the product, and how a market reacts to gendered-products. Following extensive secondary research into gendered-product psychology, both in regard to the current market ideologies and more academic insights into how children view certain

colours, shapes, and styles, a new product concept was proposed (*Figure 5*); the final solution took forward all of the previous design and game mechanics that were present in the original concept, but changed almost every aesthetic consideration to give more universal appeal: whilst the product was functionally the same, they appeared almost as two different products entirely; these changes and justification are detailed in *Chapter 3.*

Through further design tweaks on paper, and models generated via 3d-printing from CAD models to test ergonomic and anthropometric sizing (Appendix F), a final shape was eventually decided upon.

Figure 8 - 'Final' Final Concept (Author 2019)

The aesthetic overhaul also led to the creation of a new product feature: the stand, or '*Motherpod'* as it's working title, was designed as both a method to hold multiple *'Tomo's'*, but also as an attempt to give a more 'maternal' aesthetic to the product when purchased.

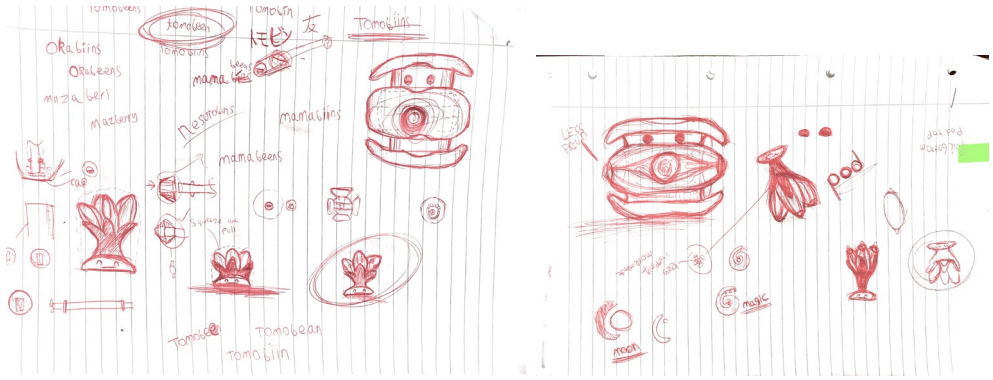

Figure 9 - Early Sketches representing the new concept (Author 2019)

This character was given a more neutral, smiling expression, in contrast to the more energetic faces on the main product, in order to provide a sense of warmth that would entice both user, and customer (parent or guardian).

Figure 10 - Final Products in "Motherpod" (Author 2019)

This, combined with the several dozen printed models (Appendix F) and several test rigs testing and tweaking the mechanism, force calculations, and a thorough analysis

of new anthropometric data (Appendix H), lead to a final concept that could be prototyped.

2.8 Prototyping & Modelling

Given the almost universal use of plastic in the product, and the relatively smaller size of my product, almost all of the product could be manufactured within the workshop, with the exception of the gearing, which owing to its precision-heavy nature, was SLS printed.

The size became its own issue when developing the product, since the product was designed with the intention of near-perfect computer-driven precision being used to create the injection-moulds, creating some elements was near-impossible by eye, where even a .25mm deviance from the drawing could be the equivalent to a quarter of the entire dimension. This became especially important with the sliding parts, where an even tighter tolerance was required to ensure a secure clearance fit.
This, coupled with the fact that the entire product was now created with compound curves that could not be reliably measured for symmetry in any way, and that every

face interacted with every other in order to function, made creating a working prototype the most challenging point of the project.

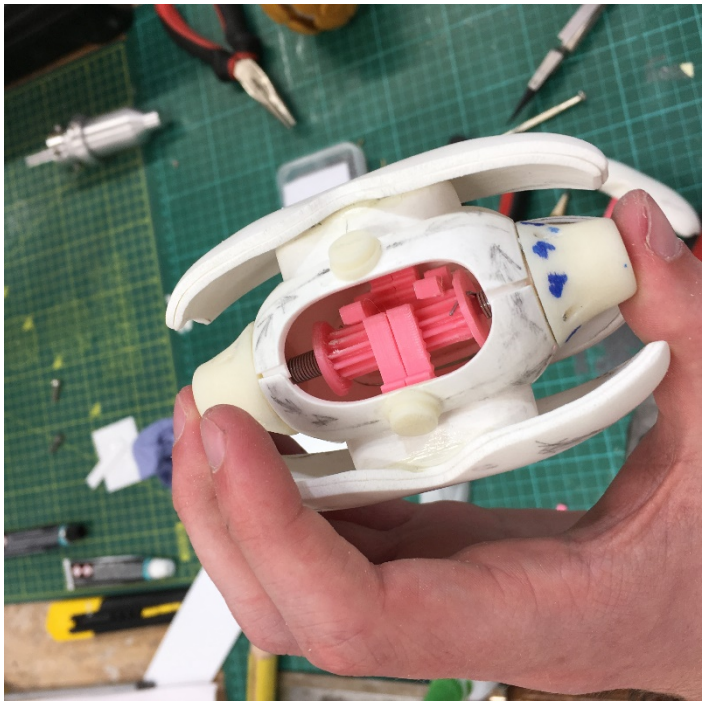

Figure 11 - WIP prototype work (Author 2019)

The main body and faces were created through vacuum formed HIPS, with the curved side pieces were milled from ABS dowel rod. The internal rack-and-pinion system was deemed too complex to create in the workshop, especially given the already mentioned tolerancing, as such these pieces were created to rapid prototyping, and were used as dimensional reference points for the rest of the product.

A prototyping Gantt chart was created shortly after Viva 2 (Appendix P) in order to make sure the prototype was functional with enough time to spare in the inevitably that certain features would be mis-sized.

To further complicate matters, such tight tolerances meant that simply painting the product added enough thickness to the product walls to impede function.

Expectedly, this Gantt chart was re-made multiple times throughout this period, as certain features were completed far earlier than scheduled, such as the central body, and others lasted the entire period, such as sanding the exact curvature of the outer-faces, the latter having to be finished outside of workshop in order to meet the set deadlines.

Figure 12 - Prototype and models side-by-side for the interim viva. (Author 2019)

3.0 Final Design Justification

3.1 Justification Overview

The ultimate goal of the project, defined from the first proposal, is that the product would be a toy designed to promote social interaction between children who have the fine-motor coordination to operate traditional toys, and those who do not. Fundamentally, in order to achieve this aim, the product required two things: usability, and popularity.

Through a broad scope of research into the physical considerations of developing an inclusive product, and the psychological prerequisites of a popular social toy, the final product features resulted from the conclusions of this data.

Tomobeans, are collectible, tradable, dice-based toy creatures that can be battled in teams of three.

3.2 'Game' Justification & Explanation

Using the "inch wide, mile deep" philosophy of game design advised by industry professionals, that is to say that the games mechanics involve a relatively simple set of rules that younger members can learn to understand but open up various levels of mastery that extend beyond what the basic rules suggest.

The game works in a handful of steps, which, for the sake of brevity, is noted in the appendix (Appendix I).

A number of considerations went into the mechanism of the game to create an environment that didn't alienate newcomers, but still rewarded tactical or thoughtful gameplay. These were decided, and evaluated, via input from the aforementioned professional advice.

The dice-based nature of the game incorporates an element of chance into the game, which allows someone who has never played before to assemble a team of 3 *Tomo's* to battle without any prior knowledge of the game and still have a chance of at-least partial victory (statistically speaking, playing randomly has a high-chance of winning at least one round per game). However, the incorporation of 4 weighted number values added a level of 'chance mitigation' (1,1,6,6 or 3,3,3,3 etc. instead of the standard 1,2,3,4,5,6 on a regular dice, with the same average roll for all), and the small chance of landing on a 'special face' to '*unleash'* a special move (with a gameplay-altering special rule) unique to each *Tomo,* adds an element of infrequent spikes in excitement, to keep tensions high throughout the short game-time.

Figure 13 - Rough Game Explaination Board (Author 2019)

When the *advanced rules* are included (notably, the addition of *elements*, explained in Appendix I), the nature of the game is altered even further, to be simultaneously simple enough for younger members to have a chance of reward simple from playing randomly (or by what characters the child likes the look of), but also contains the scope for two advanced players to play against each-other with the sort of tactical scope usually only reserved for teen/adult games, allowing for a far broader range of potential social interaction between more unlikely audiences.

Figure 14 - Example Character : Bubblegum (Author 2019)

3.3 Mechanical/Material Justification & Explanation

From a mechanical perspective, the product uses simple nylon gearing, common in almost any kinetic toy with rotational spring-loaded elements. Push down the product on any face to push the attached rack and turn a central pinion, that in-turn pulls the other three faces in on their own corresponding racks. The pinion turns 90 degrees, loading 2 torsion springs; upon reaching the end of its turn, the curved pinion edges brush up against the edges of the product shell, generating enough friction to hold the

pinion in place momentarily, before releasing the 2 spring's energy and forcing the racks outward at 5N, causing the product to be propelled up to 20mm into the air, and essentially 'self-rolling' itself.

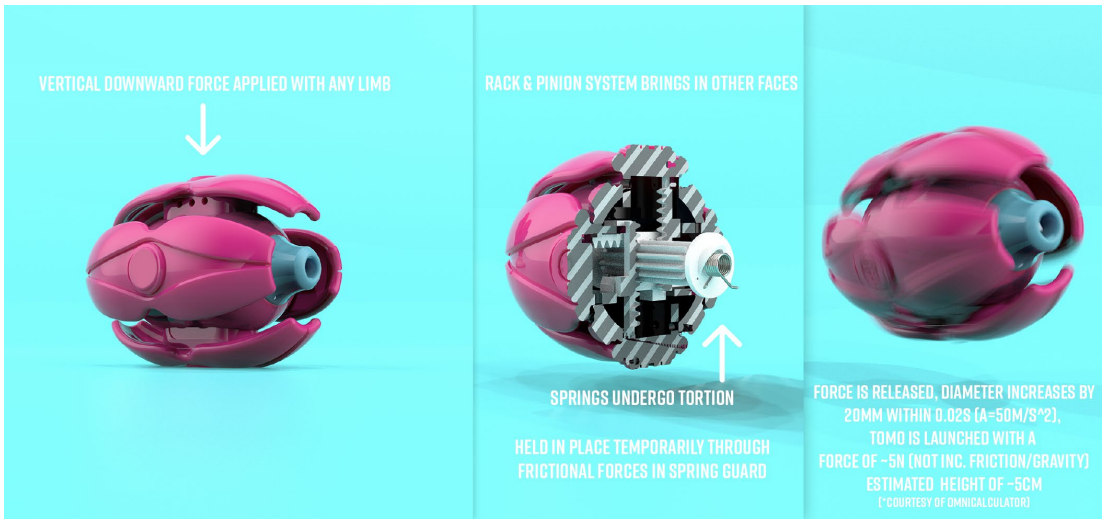

Figure 15 - Abridged Function Board (Author 2019)

The primary materials used, shown in the Costing Sheet (Appendix N), are common plastics commonly used in kinetic toys, with the entirety of the outer shell, faces and side pieces made from *ABS (CHIMEI PA-707),* known for its strength, shock resistance, non-toxic nature, easy moulding, and it's ability for additives to provide a high level of texture and colour variance (Appendix K & M).

The *Motherpod* used to hold the *Tomo's* are comprised of PVC (LG PVC LS-100), which share many of the positive qualities of the former material, but also has the ability to be rotomolded and comes in a frosted clear finish (Appendix M).

The metal components are entirely made from Carbon Steel (ISO 8.8) and Stainless Steel 302 respectively, simply owing to its abundance and suitable mechanical properties; with the exception of the torsion springs, which, as a bought in component, are made of Stainless Steel 302 (Commercial) ASTMA313.

The gearing needed to be made of a very slightly flexible, self-lubricating, strong and hardwearing plastic that could be injection-moulded to a fine tolerance. For these reasons, alongside the fact the material is commonly used as an engineering plastic in toys, Nylon 6 (Nylatron MC 901) was chosen (Appendix M).

3.4 Ergonomic & Humanistic Justification

Aside from game and functional mechanics, the product needed to be able to be used comfortably by those who lack the needed fine-motor skills for operating mainstream toys, namely the dexterity of two grasping points to both hold and pivot an object; the most extreme of these examples being total lower-arm amputation up to and including the elbow.

Almost every dimension on the product had an ergonomic consideration; using Richard Snyder's 1977 (Snyder, 1977) dated, but relevant and extensive anthropometry guide for children, specifically with 'Product Safety Design' as a guide to supplement the advice given through REACH UK.

The number of considerations given to ergonomics and anthropometrics was extensive, but examples included in the literature (Appendix G) are:

- The overall length of the product is slightly larger than is typically expected of typical toys, but is the ideal length for those operating the product with dual-elbow amputations to pick up and manipulate the product with stumps alone, as determined by the width of the elbows when arms are held at 45 degrees perpendicular to held straight out.
- The concave faces curve into a circular 'indent' at the sides of the product that add grip for the stumps, again determined as a proportion of elbow diameter.

- The small ‘indents’ that curve around the *element* symbols are the average size of a child’s fingertips, meaning those who have digits, but perhaps not the required coordination or grip strength, not only have a better location to grip, but this groove channels the finger into the centre of the products mass, the balance created keeping the product stable when held, which is necessary for children who suffer from disabilities that induce shaking, and also reduce the grip needed to holder further.

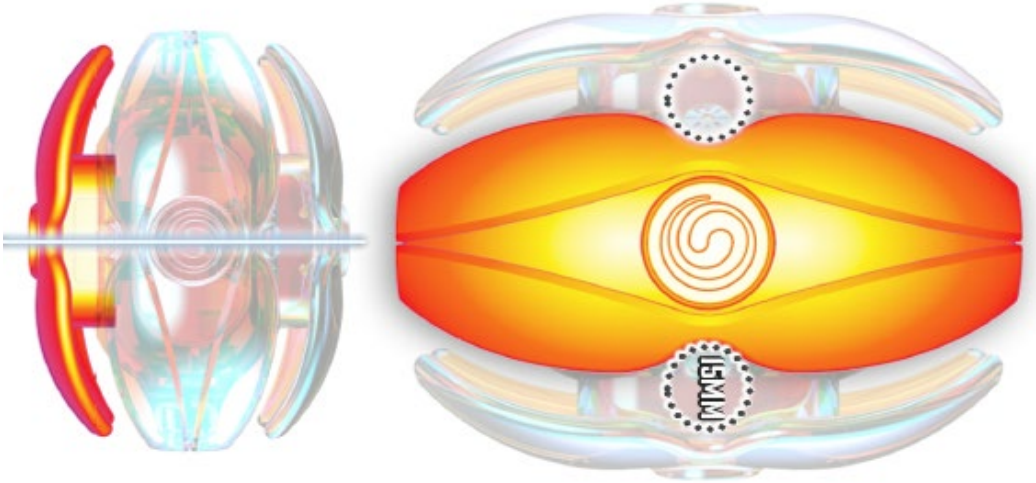

Figure 16 - Anthropometric Finger Considerations (Author 2019)

- The distance between the face ‘indents’ is the ideal gripping distance for a child of that age, as determined by the relaxed distance between thumb and index finger.

3.5 Aesthetic Justification

The ergonomic and anthropometric considerations needed to be married to the aesthetic themes, as it is the aesthetic elements that would mask the hidden intention this product aimed to accomplish.

Whilst the curved and organic ergonomics naturally leant themselves to the intended aesthetic theme, as an inclusive toy, the product was brought into conflict with a long-standing prejudice within the toy industry: gender-discriminatory toys.

Visually, the new product concept was designed with an acceptance that the toy industry is itself heavily engendered, and that academic studies have shown that this acceptance is so engrained that it extends into a child's early psychology, where the abundance of gendered toys cements an immediate negative reaction if a child recognises the toy as designed for the opposite sex. This reaction is strong enough to occur even if the child initially believes the toy to be designed for them, and then informed during play that this isn't the case (Brown, C. 2014).

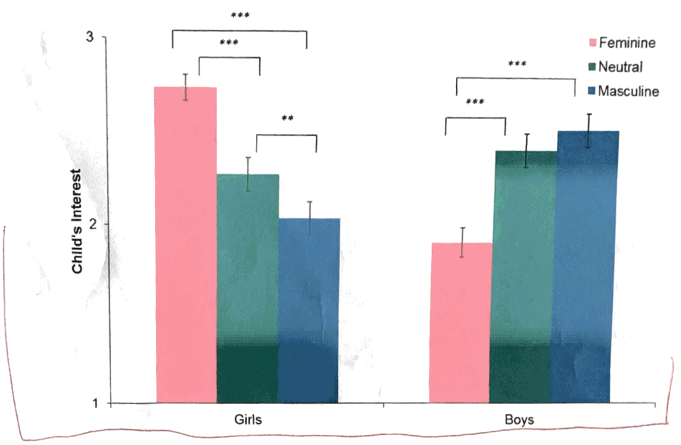

Figure 4. Children's interest in future play with other construction/STEM toys, by toy marketing (feminine, neutral, masculine). Ratings were made using a 3-point Likert scale from 1 (*not at all*) to 3 (*a lot*). **$p < .01$. ***$p < .001$.

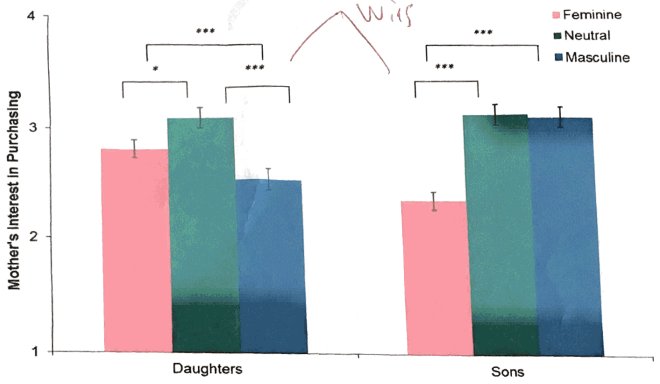

Figure 5. Mother's interest in purchasing construction/STEM toys, by child gender and toy marketing (feminine, neutral, masculine). Ratings were made using a 4-point Likert scale from 1 (*not at all interested*) to 4 (*very interested*). *$p < .05$. ***$p < .001$.

Figure 17 - Graph showing the difference between parent/guardian interest vs child interest (Coyle and Liben 2017)

This gender-discrimination is often domestically-based: toys for males tended to have a strong emphasis on role-models outside of the domestic environment, such as explorers, astronauts, heroes and the like; whereas, to quote Coyle & Liben (2018), girls toys tended to focus on a "domestic-fantasy".

The market revaluation (Appendix J) showed that successful unisex products tended to avoid any real-life examples of gender-stereotyping, or even relations to *people* in its entirety, instead choosing more nature-based aesthetic themes such as plant-life,

or fantasy-based characters that were far removed from the typical biases seen in human characters/human-built characters.

With that in mind, this led to new concepts with a greater focus on curved lines and more natural proportions to the aesthetic of the body of the new product. This in turn meant that not only did the products have a more unisex appeal, but the body redesign lead to a more comfortable product to hold; to the extent that even the small depressions on each face became closer to the ideal finger size of a 6-8-year-old.

Making a product that didn't give an impression that it was designed for any sex wasn't a goal that was intended to hold as much priority as making a product that didn't give an impression that it was designed for any disability or lack thereof; but it was a goal that proved to require a far more nuanced solution.

3.6 Market, Price & Manufacture Justification

As a product, the solution was not designed to challenge any of the established practices with regards to the industry-related elements, namely the manufacture or pricing of the product. This was to keep customers/market from feeling that the product wasn't aimed at their broader market, and therefore reducing the potential social impact the toy has.

Figure 18 - The product in situ.

The product was developed with this in mind, using other products on the market as a guideline on how to manufacture the toy; hence why the product is exclusively built from either injection-moulded or bought-in parts. The final manufacture cost (Appendix N), and thereby the RRP, is within the estimated $50 retail price described in the PDS.

**In order to prevent costs of producing dozens of different sets of tooling for the initial run of products, given that at-least for the initial range of products, the only differentiating factor between products that required different tooling was the individual face symbols/values, cost and time was saved by using the same mould, with ‘inserts’ that could be swapped out depending on the symbol/value on each face.

4.0 Professional Issues

4.1 Design Registration/Rights

Protection of the product's aesthetics, shape and colours/materials used are made through examination and registration of the design by the World Intellectual Property Office (WIPO). Typically, this is used to gain an advantage against competition if being first to market is not enough to penetrate said market. Prerequisites for registering a design include that the design must be novel and unique, and that the registered aspects of the design do not determine function. These registrations last 25 years and cost £50, on top of four renewals at £70, £90, £110 and finally £140. This only covers the UK however. Unregistered design rights are automatically applied in the UK and Europe, but offer less protection, and only last 10-15 years.

The legal firm representing the project (Appendix R) have suggested that whilst even in a crowded market such as the toy industry, there may be unique aesthetic elements. Unfortunately, the representatives also advised that they believe that, since the aesthetic elements tie into the product function, that the design may not be suitable for registration; although there was some debate between representatives regarding whether the functional impact of the aesthetics was that explicit.

All things considered, given the relatively small registration costs, it was decided that it would be worth at-least attempting regardless.

4.2 Patents

Patents pertain to the functional elements of a product. The patent will grant the owner the exclusive temporary right to exclude others from using said invention. Much like design registration, there are strict prerequisites to a successful

application, namely that they must involve an obvious inventive step, and they are feasible to produce.

An important aspect of patents is that they can be used as assets, either through selling the rights, or by licensing them for a fee, in market as large as the toy-industry, this can prove especially lucrative. Renewing the patent over its 20-year period will cost £4950 The legal representatives suggested that whilst the technical elements (the gears) were not themselves patentable, the assembly and function of the product had potential to be; other patents that had some similarities have been filed, but these were filed in 1969 and 1973 (Appendix R). Given the cost of filing for patents in the UK is £310 for a basic UK patent, this was also an option that was deemed worth pursuing.

4.3 Trademarks

Trademarks refer to the name, designs, shapes or elements that distinguish a business and its goods or services from its competition, and provides exclusivity to those elements in order to reduce confusion between businesses. The fee in the UK is £200 and an extra £50 for every extra classification applied to it. They last indefinitely if renewed every 10 years.

Trademarks must be unique and capable of graphic representation.
The legal representatives advised that *'Tomobeans'* as a name (and such, the text logo) is unused and trademarkable, and falls under the trademark classifications 28, 37, 41, and 42 (Appendix R).

Given the relatively low fees involved, trademarking was seen as an appropriate step.

4.3 Copyright

Copyright is an automatic right in the UK that applies to all creative works, including all art, music, literature, dramatic works, photographs, recordings, software, cinema, radio, television or any other fixed form of expression.

Copyright is unique in that not only is there no fee or registration, but the rights themselves are flexible, allowing a creator to authorise the use of their work under certain circumstances, such as distributing copies, or adapting the work, or even license it's use for a specified period. The maximum duration for this copyright is the life of the creator, plus 70 years.

Unfortunately, this only protects the drawings and blueprints of a product; which whilst in an ideal world would stop other companies from being able to produce the required drawings, doesn't protect the actual design, and would be near-impossible to enforce.

4.4 Trade Secrets

The legal representatives recommended trade-secrets as the most effective form of protection: that is to say, simply preventing anybody from knowing the important details of the product.

Unfortunately, whilst the advice would apply strongly to devices with elements that are difficult to reverse-engineer, such as circuitry or software, *Tomobeans* only requires a single disassembly to immediately reveal the mechanics of the product in its entirety.

4.5 Standards and Liability

Whilst the product is likely to be manufactured and assembled in China, the product is to be sold internationally, which identifies a key issue with the legal-representation advice given, in that the suggestions were heavily focused on UK sales-only: when it comes to meeting manufacturing and design standards, the specific criteria will likely be dependent with location.

However, the standards described by British Standards Institution are usually heavily linked with international standards, often exceeding them. In this regard, designing a product to BSI standards will likely prove sufficient worldwide in most cases.

The BSI standard dedicate multiple volumes to the design of children's toys, most notably *BS71-1* (BSI, 2017), which relates to the mechanical and physical aspects of the toy, including methods in which to test said criteria.

These were listed in the product specification (Appendix D), with the critical applicable requirements being either tested, such as a drop-test (Appendix E), through force calculations, or through secondary research such as the kind used in material selection, that confirmed that the chosen materials would meet the given criteria (Appendix Q).

CE Marking is another required certification in order to sell to EU-member countries, and another that has specific criteria for toys. The 2009/48/EC Directive (EC, 2009) outlines the perquisites of placing the CE marking on the child's product of this nature. Conforming to these directives is critical to success in the European market.

4.5 Economic Scope & Sustainability

'Tomobeans' is designed as a collectible toy, and as such has a far better innate ability to expand and adapt to its market through new additions, ranges, and expansions far better than traditional products.

This could include expanding the age-range to better fit both older and younger markets or adapting to an aging current market, further improvements to the products ergonomics, or simply relaunching ranges to better reflect a changing market taste, especially with the parent or guardian, who as the customer is ultimately responsible for the purchasing of the product.

This lends itself to a better chance of economic sustainability in the long term, where even older ranges can find themselves passed down to younger siblings/family members, or traded with peers, which keeps exposure of the product in constant circulation.

5.0 Conclusion and Recommendations

5.1 Technical Challenge

As discussed, the main elements of the technical challenge centred around the solution abiding by product standards for British-sold toys, since therein lied most of the technical requirements for the product itself. The most critical of these were both the forces generated by a kinetic product, and the size of the product parts, such that they could not become a choking hazard.

All critical parts of these standards were tested using available equipment, and those that could not were evaluated by merit in relation to the details of the standard requirements.

5.2 Humanistic Challenge

The humanistic challenge can be described in three requirements:

The product's primary function was to simply be a fun, deep, and most critically, socially encouraging game. Every other requirement becomes irrelevant without satisfying this requirement first.

From an ergonomic perspective, the product needed to suit the widest possible array of potential 6-8 users, who may suffer any or no upper-limb coordination issue, most notably total amputation in both limbs, up to and including the elbow joint.

And finally; it couldn't give the impression it was built with that intention.

This was accomplished through developing the product as if it were a normal toy first and foremost, and then adapting the product from the drawing board up, through further extensive research and data-collection.

5.3 Practicality & Feasibility

From a manufacturing/practical perspective, the product needed to suit a large-batch production at <10,000 units, such that many different ranges could be produced, discontinued, and changed without affecting production rate; and through designing the product as if it was a standard toy, rather than a specialist item, this goal was achieved.

All parts were either injection moulded in materials typical and suitable for the toy-industry and it's users, or bought-in components. The products size is similar to most other handheld toys on the market, and as such can easily fit on a toy-store shelf, or be easily packed for online delivery. Logistically this is standard of what is an efficient and mature industry, and the inclusive nature of the product is not mutually exclusive from following these established patterns.

5.4 Design Improvements

The second VIVA brought useful critical feedback, the most obvious of these was a matter of explanation, rather than concept itself. Explaining the rules of the game was met with a "Catch 22" situation: if the rules were explained in their most basic form, it seemed boring or lacking depth. If all of the nuances were explained in the opening pitch, they immediately confused. A more visual approach that was integral to the game itself was deemed an appropriate improvement, that will be used at the design show at a later date.

Other critiques included cleaning of the product; small moving pieces and multiple crevices meant the product developed ingress relatively quickly, and since the product couldn't be taken apart to be cleaned, the dirt could quickly clog the gears

and prevent the product's function. A method of protecting the gears was deemed a suitable development consideration.

5.5 Product Scope & Context within wider Market Shifts.

One of the critical points that the research into the market found, was that *Tomobeans* exists within a market undergoing transition, from a consumer standpoint, a supplier standpoint, and a customer perspective: the parent/guardians purchasing the toy in-store.

That is if the product is displayed in a store, at-all, however. Whilst we know that currently the market still shows a bias to physical, in-store purchases over online stores such as Amazon, with Argos still holding the largest percentage of sales annually (Mintel, 2017). But this a margin that is becoming smaller over the last few years and holds a trend that is likely to see online purchases overtake physical sales in the near-future.

Combined with mobile and screen-based games becoming more popular amongst younger children (Mintel, 2018), the future of the product, and its game-mechanics, may be forced to be adapted into an app, or at-least create some form of mobile integration, in order to remain popular. A screen is inherently less usable to those with fine-motor coordination issues, but investment into adapting screen/mobile use for this demographic is far higher, and solutions more abundant than the niche nature of the toy market.

6.0 Personal Summary

If this had been any other open-brief conditions, I'd have avoided a project of this nature. I'm absolutely certain that if I'd decided on a brief I'm more familiar with, I'd have garnered a better academic result.

The point of this project, from a personal perspective, was to work on something so out of my comfort-zone that I'd be forced to adopt new methods and avoid assumptions that normally I could get away with: I can't assume that the ergonomics would suit the older market I typically build for, because not only are these handheld products meant for someone with far larger hands than my new market, I can't even assume that my market even *has* hands.

But as a result, I can confidently say that, as a designer, the project has marked itself as a watershed moment in the way I design and taught me more than even my best-executed work ever could.

Unfamiliar territory inherently demands exploration, and for myself this meant an almost exclusively data-driven approach to the brief; very little of the project ended up being a result of my subjective input and assumptions; and when it was, I'd often find feedback to reflect this, forcing me to *revaluate* my designs, conduct further research, and redo the design, often from scratch, over and over until every curve, face, and vertex of the design could have its origin traced back to an interview, handbook or datasheet.

Perhaps this is simply the design process as intended, but for me personally, it was an exercise in workflow restructuring, and in the humility that results from realising I can't just rely on the design instincts I've relied on so heavily so far.

I've tried to keep a mantra as a designer that the most important skill in a designer's toolset is observation: anything a designer makes can only be a result of the experiences they've had; a collation of memories condensed into a physical object. No design is truly 'original', or to summarise aptly;

> "We know that a text [or any creative work] does not consist of a line of words [or one creation], releasing a single "theological" meaning, but is a space of many dimensions, in which are wedded and contested various kinds of writing [creation], no one of which is original: the text [creation] is a tissue of citations, resulting from the thousand sources of culture." – Roland Barthes (1967)

Tomobeans was my attempt to add another colour to my palette, another "citation" to draw from.

> And perhaps, beyond all odds,
> add some colour to make my portfolio look a little less dull.

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Appendix Table of Contents

Appendix A - Project Proposal

t Design 4 (AY2018/19)

Student Name: Michael Thundow

Final Choice:	**BA**		~~BSc~~		

Proposed Project Title: Bridging the social barrier for young children with limited fine-motor control & congenital/acquired limb deficiency/loss, through **play**.

The problem - what is the problem?

Toys, more specifically, children's toys designed to promote social interaction, are a critical part of a child's development and for teaching social behaviours.
One study concluded that when provided with social toys, that intersocial play between children was 78%, over 3x higher than without.
(https://onlinelibrary.wiley.com/doi/abs/10.1901/jaba.1973.6-573)

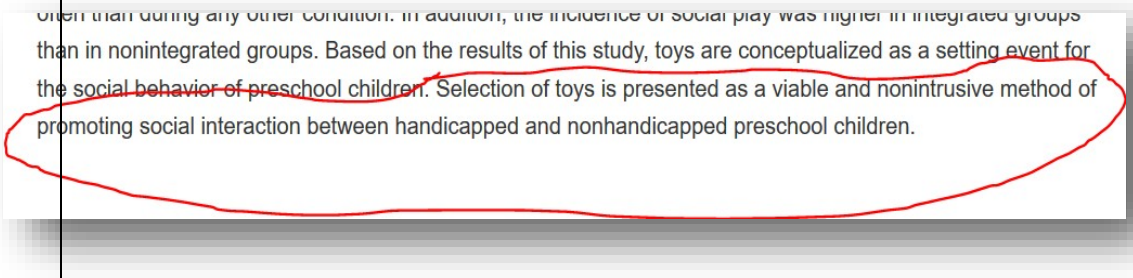
Which is why children living with limb deficiencies, *or generally who have poor fine-motor skills*, not being able to interact with toys in an effective way is a fundamental disconnect between them, the children around them, and thus their ability to be included within a wider group.

It would be impossible to think of a current children's toy on the market that does not require at least partial use of a child's digits, or at-least one that could be used with the limited dexterity that most modern coordination aids or prosthetics currently provide: action figures, Lego, dolls, etc., all of them cannot be used to their fullest *without* a finer lever of motor control.

This is critically important when you consider that it was found that toys were a "viable and nonintrusive" method of creating social connections between handicapped and non-handicapped children. Toys appear to be a useful tool in bridging gaps in physical and mental health at a young age.

(http://journals.sagepub.com/doi/abs/10.1177/105381519101500204#articlePermissionsContainer)

I want to see if there is a new way for children to interact, to create a toy(s)/tool that specifically focuses on making it easy for children without fine motor control to play with non-disabled children on the same level of interaction, and deliberately facilitate an environment that promotes social interaction between all children.


often than during any other condition. In addition, the incidence of social play was higher in integrated groups than in nonintegrated groups. Based on the results of this study, toys are conceptualized as a setting event for the social behavior of preschool children. Selection of toys is presented as a viable and nonintrusive method of promoting social interaction between handicapped and nonhandicapped preschool children.

The important feature(s) of the potential product solution - To function equally well for the user regardless of limb control abilities, so that even non-disabled children can participate just as well. - Functionally, likely to focus on those with limb *loss* (lack of posable digits) since that would be the most extreme usage scenario. - To promote social interaction between able and disabled children in some way. - To promote the normalisation of disabilities to educate better on the subject. - To fit/suit a wide variety of potential children users and perhaps provide the opportunity for self-expression in some form, whilst keeping the social aspect a primary focus.
Sustainable design issues Whilst recyclable/sustainable material usage in the solution is very important and should be used wherever possible, the product would hopefully be used for a long enough period (2-4 years) that any non-recyclable materials could be justified, and that reparation would be preferable to disposability.
Market/customers – the user(s), the buyer(s)? - Pre-school children – younger schoolchildren ages 4-7 - **The product is *specialised* for those with very limited fine-motor control, but the *aim* is to specifically have non-disabled children interact in the same way, thus promoting social play, so the product is not *marketed* for just that demographic of children.** - The *buyers* would be the parents or guardians, which is going to be an important factor to take into account when designing.
Existing products – competition In terms of toys focused on those without fine motor control, they're almost non-existent. Outside of specialised medical products/aids, the closest things you can find to items like this are not even market-items, they tend to be DIY projects. It's not to say that a child is totally cut-off from the toy market, it's more that any given product *within* that market is not designed for them to use fully and as such can be harder to use within the context of a social setting. For those with limb defects specifically, there are also simply 'themed' prosthetics, which in some way try to create a social keystone by turning the prosthetic into something more exciting, like a Marvel: Iron Man gauntlet and remove the stigma of it being an 'aid item'. Unfortunately, my product is looking to tackle more than just congenital/acquired limb conditions and doesn't provide any social interaction opportunities between groups of children.

Manufacturing Cost £10 Based on a mark-up from the retail price, this would be an upper limit estimate but owing to the more complex nature of the product, this figure might not be too surprising.			Retail Price £39.99 Based off of a number of factors, including how long a user might own the product, the average price that might be spent on a large/upper-range toy. http://business.time.com/2012/09/20/ouch-majority-of-hot-holiday-toys-cost-50-or-more/ Whilst it would be great to have the price a lot lower, in order to be able to suit a wide potential range of disabilities in children, the manufacture cost is likely to be substantially higher than a normal toy.
Product Quantity: based off of a fairly conservative estimate of sales that would likely begin in highstreets stores with a gradually increasing presence online.	Year 1: 10,000 – 15,000	Year 2 >30,000	Year 3 >100,000

Technical Challenge - *[please identify, even though you may choose to read for BA]*

- The nature of the mechanisms involved with the solution have to be well-considered, the product is likely to incorporate whole new mechanical elements designed with a lack of motor control in mind.
- Material Usage is an important aspect, especially given the likelihood of some of the younger users putting the product in their mouths.

Humanistic Challenge - *[please identify, even though you may choose to read for BSc]*

- The solution requires an in-depth understanding of ergonomics, anthropometrics and a detailed knowledge of the nature of motor-skills development in children
- The solution needs to be sensitive to a child's self-esteem, and not damage the child psychologically.
- The solution needs to have a foundational understanding of the psychology of inter-social interactions in groups of children, how to bridge this gap in a non-intrusive way.

Student signature:	Michael Thundow 09	Date:	27 / / 2018

Appendix B - Research Ethics Checklist

Bournemouth University

Research Ethics Checklist

About Your Checklist	
Reference Id	22996
Date Created	26/10/2018 14:02:49
Status	Approved
Date Approved	29/10/2018 11:52:34
Date Submitted	26/10/2018 21:52:18

Researcher Details	
Name	Michael Thundow
Faculty	Faculty of Science & Technology
Status	Undergraduate (BA, BSc)
Course	BA/BSc/MDes (Hons) Product Design
Have you received external funding to support this research project?	No

Project Details	
Title	Inclusive Social Toy for Children
Start Date of Project	02/10/2018
End Date of Project	22/06/2019
Proposed Start Date of Data Collection	29/10/2018
Supervisor	Bryce Dyer
Approver	Bryce Dyer

Summary - no more than 500 words (including detail on background methodology, sample, outcomes, etc.)

I will be designing a children's toy designed to be promote social interaction and play across both able-children, and children lacking fine-motor control in their fingers, such as children with congenital or acquired limb-defects; aged between 5-7.

I will be conducting primary research into the psychological considerations that need to be taken into account when creating a universal and social product for children, gaining insight into how social connections can best be made; I will also be looking to conduct research into how a disability effects the nature of play in young children, and the effects this can have on social development. This will all be conducted through phone, email, or face-to-face interviews with professionals in the field, including child-psychologists and charities who specialize in upper-body limb-loss.

Human Participants

Participants	
Describe the number of participants and specify any inclusion/exclusion criteria to used	
As there will only be individual professionals interviewed, the number of participants is not expected to exceed 5-6. In terms of criteria, the individual must be a professional related either to paediatric psychology, and/or paediatric limb-defects.	
Are your participants considered vulnerable?	No
Is a Disclosure and Barring Service (DBS) check Required?	No

Recruitment	
Please describe how participants will be identified, approached and recruited. Include details of any relationship between researcher(s) and participant(s), e.g. teacher-student	
The charities and research facilities associated with the participant criteria will be contacted via official email channels, and any participants willing to participate in an interview will be able to volunteer to recieve more information. Then, providing once they are comfortable with the interview criteria, research can go ahead.	
Do you need a Gatekeeper to access your participants?	No

Data Collection Activity	
Will the research involve the completion of a questionnaire/survey? If yes, don't forget to attach a copy of the questionnaire/survey or sample of questions.	No
Will the research involve interviews and/or focus groups? If yes, don't forget to attach a copy of the interview/focus group questions or sample of questions.	Yes
Will the research involve the collection of audio materials?	Yes
Will the audio recordings be used solely for the purposes of producing an anonymised transcript/summary and then deleted and will not be used in any outputs or made publicly available?	Yes
Will your research involve the collection of photographic materials which will identify a participant?	No
Will your research involve the collection of video materials?	No
Will the study involve discussions of sensitive topics (e.g. sexual activity, drug use, criminal activity)?	No
Will any drugs, placebos or other substances (e.g. food substances, vitamins) be administered to the participants?	No
Will the study involve invasive, intrusive or potential harmful procedures of any kind?	No
Could your research induce psychological stress or anxiety, cause harm or have negative consequences for the participants or researchers (beyond the risks encountered in normal life)?	No
Will your research involve prolonged or repetitive testing?	No

Consent	
Describe the process that you will be using to obtain valid consent. If consent is not to be obtained explain why	
Participants, alongside a brief explanation of the intended method of research, will also be provided with a Participation Form to sign that provides written consent, and an Information Sheet detailing important aspects of research practice.	
If participants are minors or for other reasons are not competent to consent, describe the proposed alternative source of	

consent	
N/A	
Will it be necessary for participants to take part in your study without their knowledge and consent?	No

Participant Withdrawal	
Describe how the participants will be informed of their right to withdraw from the study	Participants will be informed of their withdrawal rights through the Participant Information Sheet.
Explain what will be done with the participants' data if they withdraw	Participants are informed that any data collected will be withdrawn from the dataset if they choose to withdraw themselves from the research, although if this occurs substantially after the point that research was taken that anonymised data may not be able to be removed.

Participant Compensation	
Will participants receive Financial compensation (or course credits) for their participation?	No
Will financial or other inducements (other than reasonable expenses) be offered to participants?	No

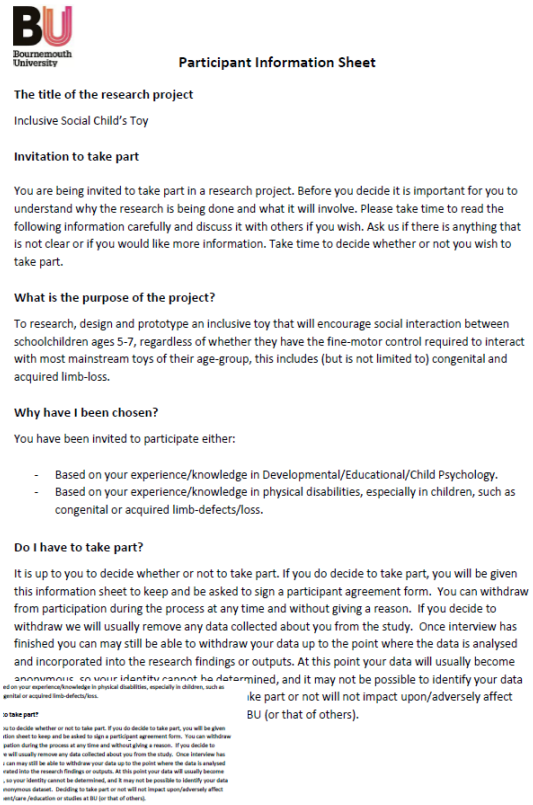
Personal Data	
Will identifiable personal information be collected, i.e. data which identifies or could enable identification of the research participant?	No

Storage, Access and Disposal of Personal Data	
Will any data be stored on the BU's Data Repository "BORDaR"?	No

Risk Assessment	
Have you undertaken an appropriate Risk Assessment?	Yes

Attached documents
Participant Agreement Form MT2018.pdf - attached on 26/10/2018 21:51:46
Participant Information Sheet MT2018.pdf - attached on 26/10/2018 21:51:51

Appendix C - Participant Information Sheet



Bournemouth University

Participant Information Sheet

The title of the research project

Inclusive Social Child's Toy

Invitation to take part

You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?

To research, design and prototype an inclusive toy that will encourage social interaction between schoolchildren ages 5-7, regardless of whether they have the fine-motor control required to interact with most mainstream toys of their age-group, this includes (but is not limited to) congenital and acquired limb-loss.

Why have I been chosen?

You have been invited to participate either:

- Based on your experience/knowledge in Developmental/Educational/Child Psychology.
- Based on your experience/knowledge in physical disabilities, especially in children, such as congenital or acquired limb-defects/loss.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a participant agreement form. You can withdraw from participation during the process at any time and without giving a reason. If you decide to withdraw we will usually remove any data collected about you from the study. Once interview has finished you can may still be able to withdraw your data up to the point where the data is analysed and incorporated into the research findings or outputs. At this point your data will usually become anonymous, so your identity cannot be determined, and it may not be possible to identify your data ike part or not will not impact upon/adversely affect BU (or that of others).

What would taking part involve?

Participants will be asked to participate in an interview either over the phone, or in-person if appropriate, the questions will be related to how children (around 5- 7 years of age) acquire social bonds/develop social skills, specifically through play; OR related to the physical and psychological effects that the lack of fine-motor control has on day-to-day life, specifically in regards to play and social integration.

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work, and your contributions to it, that will allow for a design solution that would be better informed and well-researched for the children using it.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

The only form of information needed will be verbal expertise, opinions, and advice in response to said questions, any further sources related to the topic would be greatly appreciated but not required.

Will I be recorded, and how will the recorded media be used?

The audio recordings of your activities made during this research will be used only for analysis and the transcription of the recording(s) for illustration in conference presentations and lectures. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

How will my information be kept?

All the information we collect about you during the course of the research will be kept strictly in accordance with current data protection legislation. Research is a task that we perform in the public interest, as part of our core function as a university. Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after your information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your information.

Appendix D - Product Design Specification

Design Projects & Prototypes
Final Project 2018 | Inclusive Social Toy for Children

4808993 | Michael Thundow

Issue	Modification	Date
0.1	Initial Draft	08/10/18
0.5	Final First Draft, added standards and noted what needs to be considered next.	18/10/18
0.9	Added more information on standards and combined into Environment Category.	20/10/18
1	Final Initial Submission, formatted but still containing notes on what to develop.	26/10/18

1 Scope

The product's primary function is to facilitate and encourage social play between children ages 5-7, regardless of whether they have the necessary motor-skills in their digits to interact with mainstream toys/products.

2 Background

Play is a fundamental aspect to a child's social development.

Reading facial cues, learning social etiquette, encouraging imaginative thinking, and generally developing a social awareness is a critical life-skill, one that has been aided in the modern era by easily accessible, mass-marketed toys designed to encourage social interaction between children and specifically developed for that purpose. The children's toy market has expanded rapidly into new areas, including more modern, technology-enabled products. The sheer breadth of potential product ideas on the market is one of the widest seen in *any* industry.

However, despite more variety in possible options of purchasable toys than at any other point in human history, almost every single one of these products have one linking factor that shuts a demographic off from this critical instrument for paediatric development:

> They require full motor-control of a user's extremities, namely fingers and wrist joints.

Be it motor-control issues, congenital or acquired limb-loss and deficiencies, or any other form of impairment affecting fine-motor control, there's an extreme lack of toys

that can be used by children who lack a typical level of dexterity. The issue is so prevalent in-fact, that REACH UK, one of the leading charities that give advice on paediatric limb deficiencies, have suggested that a child "should be encouraged to use their feet" (ReachUK, 2016) in order to use those same toys that abled children use without issue.

There are a number of potential reasons for this; firstly, there are many potential disabilities that can affect a child, leading to a wide of demographics that can be difficult to cater for, so for a large company, it is sensible to market towards the 95% of the market that *can* easily use their products without needing to invest into developing specialist toys that may not sell as well.

This can be no better evidenced by looking forward into a more mature age-market, to how the media covered Microsoft's new Xbox controller; specifically designed to broaden the gaming market to include those without the necessary motor-control to use traditional solutions, ***exactly*** what I am attempting to do with the children's toy market: a market of "30 million" (Mark C. Barlet, 2013), but "few major gaming companies had even considered developing consoles for players with restricted movement" (Parker, 2018) let alone implemented it, which made Microsoft's product so unique and widely-published.

Aiming to emulate this philosophy, my objective is to produce a commercially-viable, socially-educational toy that bridges the gap between these markets, in a way that does not explicitly draw attention to the disability as an *issue*, but rather empowers disabled children to take part in social interaction in the same way any child would.

3 Performance

3.1 To allow early primary school children, who may or may not have the motor-skills in their *fingers* to interact with typical toys for their age-group: types of disabilities that are included as part of this project are but not limited to:

- Congenital or Acquired Limb Defects
- Total limb loss, up to and including the elbow joint.
- *Early* stage Duchenne muscular dystrophy, (effecting hands/fingers, designing for beyond this stage is beyond the scope of the project.)
- Mild Developmental Coordination Disorder (Dyspraxia)
- Mild Spastic, Dyskinetic, Ataxic or Mixed upper-limb cerebral palsy effecting fine-motor control (Acute conditions would be aspirational an aim to provide a solution to but may require too specialist a solution.)

Again, to reiterate, these are issues focused around ***fine***-motor control issues, whilst these conditions can affect different parts of the body to more extreme degrees, these would be beyond the scope of the project.

The aim should be to focus on the ***extreme*** end of this spectrum; those who lack those digits entirely, on *both* sides. It may even be the case that the user lacks a wrist joint to interact with a suitable mechanism, so this needs to be considered.

3.2 Fundamentally, to facilitate *play* of some respect when using the product, even if the user has a typical level of motor-control; the product should be as exciting to use as a regular toy would be.

3.3 To require some form of social interaction between all users when using the product to be used most effectively, whether this is *cooperative* or *competitive* is yet to be decided.

3.4 Following on from the previous point, this should not be so heavily enforced that the product actively alienates those who don't have enough peers to play with at that given moment, individual play must still be possible.

3.5 The product must be strong enough-to withstand typical forces that can be exerted by young children in most predictable settings; being thrown, hit against objects in social situations etc. *(also see Environment)*

4 Product Details

4.1 Environment and Normal Usage Considerations

4.1.1 Normal use: The device will be used in potentially any household/social/outdoor environment. The product will need to be suited for all scenarios as such: sunlight damage, hard-surfaces etc. (*see Materials)*

4.1.2 Temperature: The unit must not be affected by thermal expansion in a way that compromises the product quality or possesses the ability to harm the user, especially true in a likely scenario where the product is in contact with skin, where the skin temperature might cause small levels of expansion, in reference to this, the product's accessible parts likely to be touched by a human hand must not increase by more than 35K. (BSI, 2017)

4.1.3 Neither must the product be damaged in temperature -20°C to 70°C.

4.1.4 The product should be corrosion resistant to the sorts of chemicals used in households etc.

4.1.5 The toy "shall be visually clean and free from infestation" (BSI, 2017), and as such, easy to clean.

4.1.6 The toy shall not include any sharp edges in any part of the product that is accessible to the user. This includes any burring on the finished product that may cause wounds or abrasion. (BSI, 2017), this also includes any protruding parts capable of puncture injuries.

4.1.7 Mechanical Considerations (BSI, 2017):

4.1.7.1 If it's decided that a driver mechanism is required as part of a kinetic toy, the mechanism should not be exposed to the user.

4.1.7.2 If the part is connected via a hinge element *and* has a mass of more than 250g, must have the gap between hinge and body either <5mm or >12mm to avoid finger injuries.

4.1.7.3 If a spring is required, the gap between spiral elements must be <3mm, or be made inaccessible. This includes compression/extension springs under 40N of force.

4.1.7.4 Must withstand significant shock load without cracking or breaking; to demonstrate as example, a metal weight of mass 1Kg over area with diameter 80mm being dropped onto the product from 100mm.

4.1.7.5 The product must withstand being dropped from a height of at-least 850mm multiple times onto a flat steel sheet multiple times without breaking or cracking.

4.1.7.6 If a projectile is used, it should not have any sharp edges, nor gain any after impacts.

4.1.7.7 Further to this, the leading face of any projectile should not be greater than 4mm, or as specified in BS EN 71 -1 | 8.43 : Assessment of leading Parts on Projectiles.

4.1.7.8 If projectile discharges with kinetic energy greater than 0,08J, the projectile must not have a kinetic energy per unit area < 2500J/^2 else may cause damage to the user.

4.2 Life in Service

The product should maintain an optimum usage life of at least 2 years under regular use, the average amount of time the child is likely to use the product as they grow.

4.3 Maintenance & Sustainability

4.3.1 The product is should be simple enough to manufacture that it is inherently cheap enough to replace, DIY repairs may compromise on safety, and doesn't tend to be a factor in current consumer products.

4.3.2 The product's material should lend it to be easily recyclable or be comprised of mostly recyclable materials. *(see Materials)*

4.4 Size & Mass

Whilst the size of the product could vary considerably, a few guidelines need to be followed in order for the product to easily be transported to retail stores/delivered to homes, as-well as be easily on display at retail locations, **since despite Amazon being a strong method of purchasing toys, the largest go-to for retail toys is actually Argos; and when combined the physical retail sector still outweighs online sales when it comes to toys.** (Mintel, 2017)

4.4.1 When laid down flat the product:

4.4.2 Length should not exceed 400mm.

4.4.3 Height should exceed 400mm.

4.4.4 Depth should exceed 400mm.

4.4.5 Must have all individual parts fail to fit into a diameter of 100mm or smaller in order to not be a choking hazard. (See BS EN 71 Series)

4.4.6 The mass of the product is handheld, so based off of other similar products should not exceed 800g.

4.5 Materials

4.5.1 The use of existing materials for manufacture is preferable. We do not have the capabilities to develop a new material.

4.5.2 The materials used will have to be widely available and cheap to produce relative to similar categories of material (see target price)

4.5.3 Furthermore, the product should be created through a moulded plastic, or at-least be primarily composed of this material.

4.5.4 The materials must be able to withstand its environmental conditions (see Environment)

4.5.5 The materials must be lightweight or be deliberately weighted for ergonomic ideals. (see *Ergonomics & Anthropometrics)*

4.5.6 The material must not react to human skin in any way, chemically or abrasively.

4.5.7 Non-Toxic. The material cannot be dangerous if licked/bitten/somehow ingested in some way. This isn't directed at the market specifically, but is likely to be used in an environment where younger children will be present. In this case, following standard **PD CEN/TR 16918:2015 : Safety of toys. Children's mouthing behaviour in contact with toys** (BSI, 2015) would be a suitable set of parameters to develop to.

4.6 Ergonomics & Anthropometrics.

4.6.1 The anthropometric data used will be from the BS EN standards **BS EN 7231-2: Body Dimensions of Boys & Girls from Birth up to 16.9 Years** (BSI, 1990), the specific measurements that are used will be determined as required by concept, but should ***not*** compromise/fall outside the ideal measurements by >5% of the ***averaged*** dimensions of boy/girl without due justification, such as wild variations between sexes, or the factor of missing limbs taking precedence over a specific dimension (e.g. a certain part needs to be larger in diameter, in order to take into account those without fingers being able to reach it.)

4.6.2 One of the most important factors, should be built to the extreme scenario user that has had congenital/acquired limb defect/removals at around ***elbow-length***, including joint loss at that location. Full arm loss may prove too complex a user for the scope of this project.

4.6.3 Use should be obvious by form.

4.6.4 Should **not** alienate those without those issues, the aim is to attract the whole market in

4.7 Aesthetics

4.7.1 The product ideally should be aesthetically pleasing and suitable for children of that age-range; very likely creating some form of brand around the product in order to appeal to a collective market.

4.7.2 The product must not appear to be made specifically for those with impairments; this is a universal toy that *may* include prosthetic-like elements, and may include branding to support those markets, but it is ***not*** a medical prosthetic aiming to restore motor-control.

4.7.3 Must also be presented in an appropriate manner that appeals to the *parent or guardian*, as they are the customers for the product, not the children *(see Brand).*

4.8 Product Standards and Certifications

4.8.1 **BS 71-1**, **Toys: Mechanical and Physical Properties** (BSI, 2017), is likely to be the most crucial standard to follow when designing this product. The product is almost certainly going to be a form of kinetic toy, and this standard gives full-parameters for stored-energy products, as well as any projectile standards. This is a key standard to hold any solutions to. (see *Environment and Testing)*

5 Secondary Details

5.1 Time-scale

The development should ideally take around 6 weeks to research and develop a suitable concept, with more detailed development another 6 weeks, finally prototyped, tested and evaluated within a final 6 weeks.

5.2 Packing

Whilst package materials haven't been decided, some guidelines must be followed in the event that packaging would be designed:

5.2.1 Size must be kept to a minimum (or at-least within size guidelines (*see size guidelines*).

5.2.2 Cost must be kept to a minimum so as not to increase the products price point excessively (see target price).
5.2.3 Weight must be kept to minimum.
5.2.4 The package must be presented in a way that is appealing to the *customer & user:* it is the ***parents*** who will be purchasing the product, so both demographics need to be accounted for.
5.2.5 Must prevent the product from being damaged through shock load.
5.2.6 Must be easily be opened by the consumer.
5.2.7 Must not be opened in any way where the product poses a risk to the user.
5.2.8 Recyclability would be a bonus, if not an essential requirement.

5.3 Manufacturing Facility & Manufacture Cost

5.3.1 Anonymous company means facilities are unknown. Assumption is made that the resources are similar to that of a typical large toy brand such as *Hasbro*.
5.3.2 Further to this, the product should be suited to large-scale batch, or low level mass-production runs of >10,000, as this is a consumer product designed to be standardised and shipped commercially on an international scale.
5.3.2 Manufacture costs per unit should not exceed £10, to make a rough minimum of 300-350% mark-up. This is manageable if economies of scale are considered for the intended production run.

5.4 Testing

5.4.1 Ethically, testing this product first-hand may prove impossible, so a specialist will be needed to confirm that the product is suitable and solves the issue from a humanistic perspective:

5.4.2 In terms of mechanical testing, all mechanical parameters (see *Environment)* in reference to ***BS EN 71 -1*** will be tested as instructed in the standard specification, or to as thorough standard as can reasonably be expected using testing equipment available.

5.5 Product Life-Cycle

The cradle-to-grave cycle for this product is designed to be flexible and branching: this product needs to have scope to both be developed into new ranges as the market grows older/newer markets arrive with new tastes, but also retain obvious characteristics that keep the brand identity strong to *parents and guardians; the customers.*

6 Market

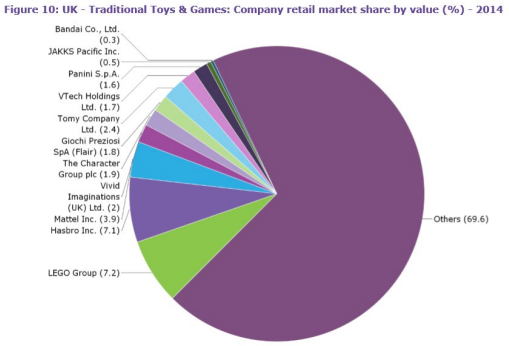
6.1 Target Price

As a likely complex/branded toy, the product would be expected to range from £40.00 & £50.00. This falls in line with most interactive, non-electronic analogue children's toys, and falls within the likely $500 annual spend on children by parents. (Statista, 2015)

6.2 Competition

The toy-market as a whole is incredibly saturated: and this is a potential issue given the product isn't designed to fill a niche in the 'disabled-toy' market; it is designed to

go toe-to-toe with the traditional toy market, only improve upon this market and *expand* it to suit all users of a given age-range. So, the product needs to not-only stand-out in this sense, but also have a niche that challenges the market as a whole.



A sign of how saturated the market is, where the largest single company only owns 7.2% of the market, where the vast majority (69.6%) is owned by smaller businesses.

6.3 Paediatric Social-Psychology Considerations

6.4 Brand

Whilst not particularly related to the practical design of the product itself, this category is very specific to my age demographic; since a product of this nature is strongly reliant on the nature of the brand that the customers (the parents) see. If this is truly going to be a consumer product, these factors need to be considered.

6.4.1 The product needs to be unisex, in the sense that it doesn't deliberately try to emulate an older trend of using gender stereotypes to market towards a given group, rather attempt to galvanise a new generation using strong universally appealing imagery.

6.4.2 The product needs to suit the age-range I've chosen upon (5-7 years), and not contain any typically unsuitable imagery/language.

6.4.3 Evidence suggests that anchoring the product's image in a "strong role-model" is likely to fair better with consumers. Ideally this role-model should be a "teacher, scientist, inventor, athlete or similar aspirational career path." (Mintel, 2018), this could also be an opportunity to create a disabled-heroic role-model, in order to further improve a disabled child's self-image, as well as educate their peers.

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Appendix E - Force Calculation & Tests

FORCE ANALYSIS

[& BSI 7I-I DROP TEST ANALYSIS]

a = 2 * (Δd - Vi * Δt) / Δt

Acceleration = 50m/s^2

hmax = V * sin(α) / (2 * g)

Maximum Height = 51mm

f=ma (m = 0.1kg)

Force at ejection = ~ 5N

Force to press down = ~15N (*experimental*)

F = μ * N (μ = ~ 0.7, N = 0 to 7N)

Frictional holding forces = ~ 0 - 4.9N

(dependent on how far gear has turned)

(*slowing down acceleration to allow hand clearance)

Spring Torque @ Δ 1 = 0.375lbs

= 0.5nm *2 = 1nm

SLO-MO FOOTAGE

INITIAL VELOCITY = 0 M/S

DISTANCE = 10MM

FILMING FPS = 240

FRAMES TAKEN TO TRAVEL = 5 FRAMES

TIME (S) = 5/240 = 0.02 S

** THE TRUE IMPACT FORCE CANNOT BE DETERMINED THROUGH EXPERIMENTATION; AS IN THE FINAL PRODUCT, THE SPRING-LOADED RACK AND PINION WOULD ACT AS A SELF-DAMPENING DEVICE, CAUSING THE IMPACT FORCE TO BE A FRACTION OF THIS TEST. **

SURVIVED MULTIPLE TESTS

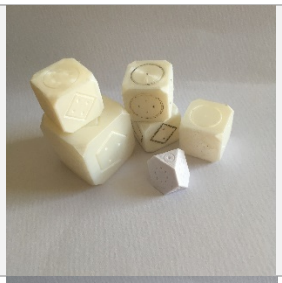
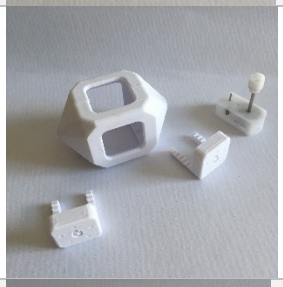
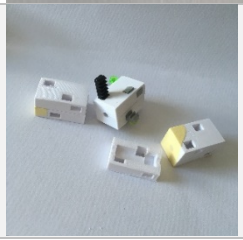
BSI 7I- I DROP HEIGHT = 800MM

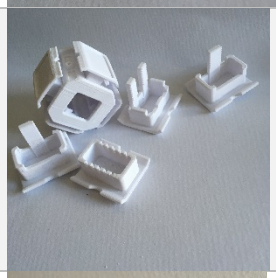
IMPACT VELOCITY = 4 M/S

(PASSED TESTS DESPITE BEING IN 20% INFILL PLA, SO IN ABS PA 707 WILL FAIR EVEN BETTER)

Appendix F - Test Rigs & Model Evaluation

Test Rigs & Model Evaluation Sheet

ModelSetNo.	Photo Evidence	Description	Comments
1		First Dice print. Testing initial game functionality before deciding upon method of rolling 'dynamically'.	Game makes functional sense but needs that dynamism to keep interest.
2		Initial Test after initial concept phase to check centre-of-gravity.	Impossible to manufacture, requires a full redesign. Proportions too small for functional elements.
3		First attempt with full sliding faces and offset racks.	Need to remove 'suspect' imagery.
4		First Model to test size of concept and aesthetics/weight.	Good initial model, arms are FAR too heavy for functional use, and far too large. Faces work but suspect imagery still present.
5		Initial Test Rig to test rack & pinion setup using Lego Technics	Good lack of friction, and strong sturdy tolerances. Could do with spring test.

6		Resizing to better fit the internal elements. Halved casing for easier assembly/manufacture.	Still far too small.
7		Resize #2, added gears to the faces in order to prepare for testing.	Starting to look more like a finished article. The 'battlements' that mesh into each face is overengineered.
9		Gear Test Rig #2 : Incorporating and testing various springs	Spring chosen, now need to finish up on ergonomic principles.
10		Cycled through various arm sizes in order to find point at which centre of gravity falls to centre. Also added gear mechanism into mix.	Finally pleased with size, and certainly light enough. Rather angular at not particularly appealing.
11		First partially-done model after aesthetic redesign, central piece is solid so needs to be broken into two halves to make moulding easier.	Liking the new aesthetic, manufacturability is questionable.
12		Initial method of assembly involving plastic rivets to hold two homogenous components together.	Rivets are unexpectedly strong, but draft angles make it an absolute nightmare to tolerance.
13		Split the component along its length instead and added a lip and groove. Using arms to hold product together.	Getting closer, still a struggle to get the faces attached.
14		Broke the part into 4 separate pieces, each with a lip & groove	This may be the one.

Appendix G - Anthropometric Justification Board

Anthropometric/Ergonomic Justification

OBJECTIVES:

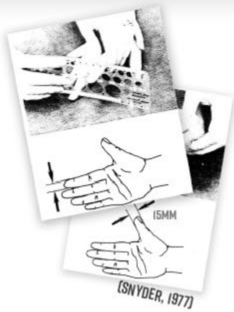
1) Create a product that can be used equally by all 6-8 year olds, regardless of fine-motor skills.

2) Not make it *look* like I designed it that way.

CONSIDERATIONS FOR:
Early stage Duchenne muscular dystrophy, (effecting hands/fingers).
Mild Developmental Coordination Disorder (Dyspraxia).
Mild Spastic, Dyskinetic, Ataxic or Mixed
upper-limb cerebral palsy effecting fine-motor control.

CURVED-GRADIENT BASED OFF MEAN FINGER/THUMB DIAMETERS.

GIVES TACTILE FEEDBACK ON FINGER PLACEMENT, AS WELL AS MAKING OPTIMAL GRASPING SPOT OBVIOUS VISUALLY



FINGERS PUSHED TO CENTRE NATURALLY, CURVE CATERS FOR VARIETY OF SIZES-AGES.

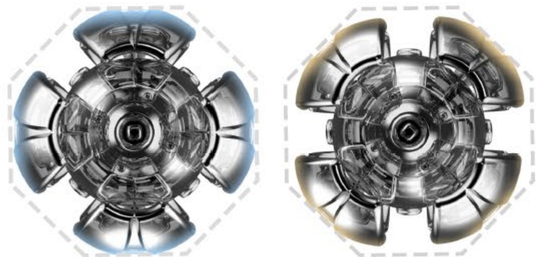
HELPS WITH GRIP, COORDINATION AND SHAKING HANDS.

GRIP KEPT TO MASS CENTRELINE (GREATLY HELPS WITH GRIP)
((NO FINGERTRAPS AS FACES SPRING *OUTWARD*, NOT *INWARD*))

CONSIDERATIONS FOR:
Congenital or Acquired Limb Defects.
TOTAL limb loss, up to and including the elbow joint.

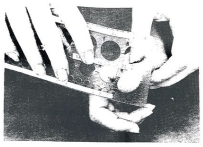
EXTREME USE CASE

LARGER THAN USUAL HANDHELD PRODUCTS (NOT BEYOND BSI 71-1 LIMITS)
TO MAKE FOR EASY GRASPING WITH UPPER FOREARMS



RADIUSED REGULAR OCTAGON
CREATES EASY MANIPULATION INTO PUSHABLE STATE.

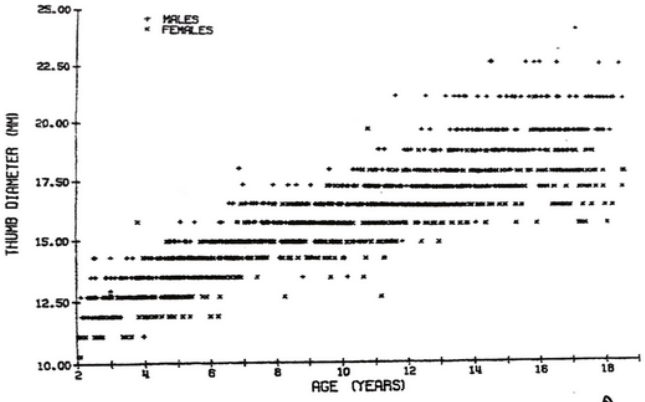
Appendix H - Anthropometric Data (Snyder 1977 Excerpts)



280.

Thumb Diameter

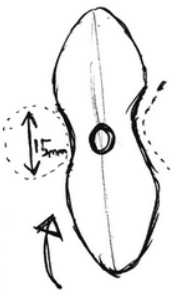
(52)



Avg 15mm Ø

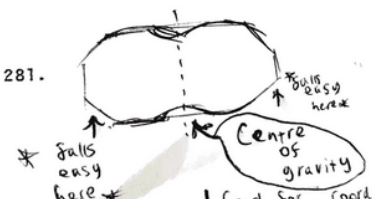
THUMB DIAMETER (mm)
(Males and Females)

Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	77	12.4	0.9	10.3	10.5	11.9	13.5	14.3
3.5-4.5	70	13.1	0.9	11.1	11.1	12.6	14.1	15.8
4.5-5.5	93	13.6	0.9	11.9	11.9	13.2	14.7	15.8
5.5-6.5	62	14.1	0.8	11.9	12.2	13.7	15.0	15.8
6.5-7.5	62	15.0	1.0	13.5	13.5	14.6	16.5	18.1
7.5-8.5	59	15.4	0.9	12.7	13.0	14.9	16.5	17.4
8.5-9.5	79	15.7	0.8	13.5	13.8	15.3	16.5	17.4
9.5-10.5	90	15.9	1.0	13.5	13.9	15.5	17.3	18.1
10.5-11.5	99	16.5	1.2	12.7	14.3	16.2	17.9	19.9
11.5-12.5	91	17.0	1.1	15.0	15.0	16.5	18.4	21.4
12.5-13.5	106	17.5	1.1	15.0	15.4	17.0	19.0	21.4
13.5-14.5	98	18.1	1.5	15.8	15.8	17.4	20.3	21.4
14.5-15.5	95	18.7	1.5	15.8	16.1	18.1	20.9	23.0
15.5-16.5	55	19.4	1.7	15.8	16.5	19.0	21.5	23.0
16.5-17.5	80	18.9	1.8	15.8	15.8	18.5	21.2	24.6
17.5-19.0	46	19.5	1.8	15.8	16.1	19.2	21.4	23.0

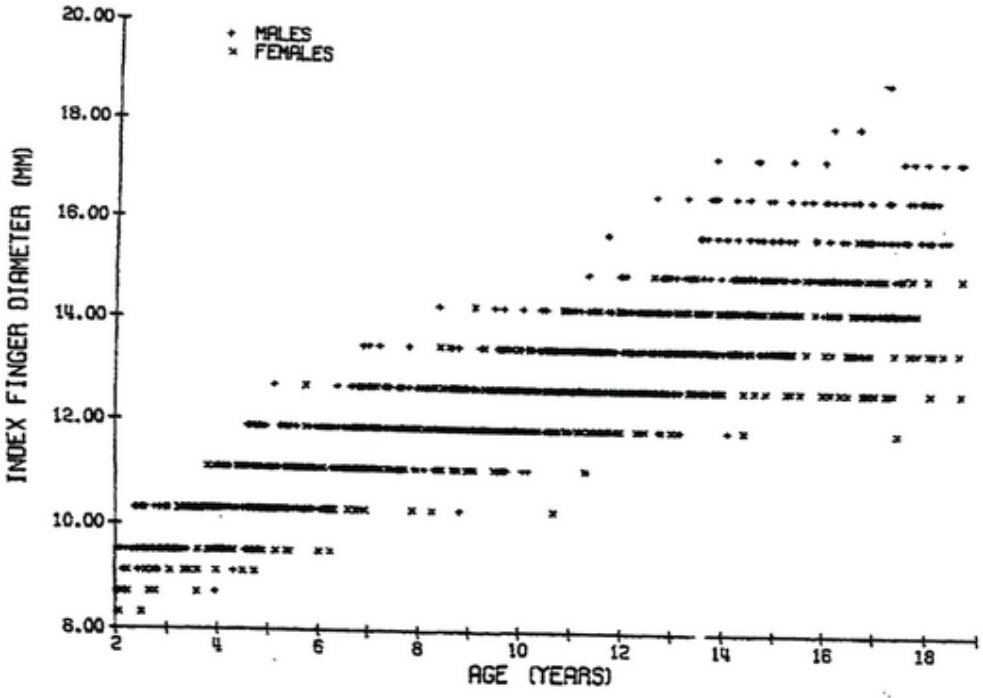


Groove for stability

281.



Good for coordination issues!



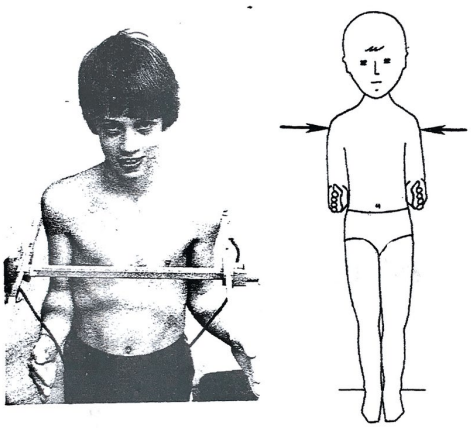
INDEX FINGER DIAMETER (mm)
(Males and Females)

11.5-12mm Ø

Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	76	9.6	0.6	8.3	8.4	9.3	10.2	10.3
3.5-4.5	70	10.1	0.6	8.7	8.9	9.7	10.9	11.1
4.5-5.5	93	10.6	0.8	9.1	9.2	10.1	11.7	12.7
5.5-6.5	61	11.0	0.7	9.5	9.5	10.6	11.8	12.7
6.5-7.5	62	11.7	0.8	10.3	10.3	11.3	12.7	13.5
7.5-8.5	60	11.9	0.8	10.3	10.3	11.5	12.7	14.3
8.5-9.5	79	12.2	0.7	10.3	10.6	11.8	13.1	14.3
9.5-10.5	92	12.6	0.8	11.1	11.1	12.2	13.5	14.3
10.5-11.5	99	13.0	0.8	10.3	11.2	12.6	14.0	15.0
11.5-12.5	94	13.2	0.9	11.9	11.9	12.8	14.3	15.8
12.5-13.5	106	13.8	0.9	11.9	11.9	13.3	14.8	16.6
13.5-14.5	98	14.1	1.1	11.9	12.1	13.7	15.8	17.4
14.5-15.5	94	14.6	1.1	12.7	12.7	14.2	16.3	17.4
15.5-16.5	56	15.0	1.2	12.7	12.7	14.6	16.7	18.1
16.5-17.5	80	14.8	1.4	11.9	12.1	14.5	16.5	19.0
17.5-19.0	46	15.4	1.4	12.7	12.7	15.2	17.1	17.4

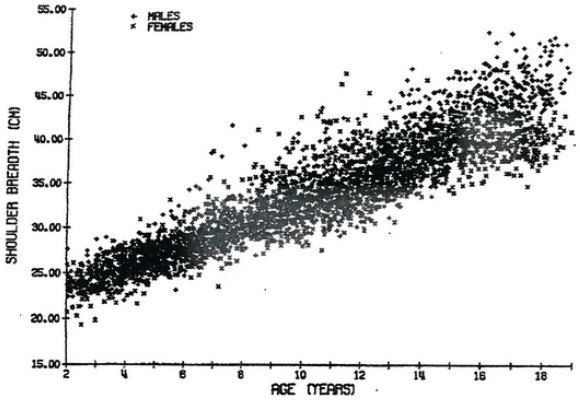
289.

Subject stands erect, upper arms at sides, and elbows flexed 90°
With the paddle blades of an automated anthropometer, measure th
horizontal breadth across the shoulders at a fixed pressure valu



Shoulder Breadth

(35)



SHOULDER BREADTH (cm)
(Males and Females)

30 cm

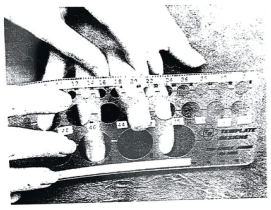
Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	211	24.4	1.5	19.3	22.0	24.3	26.9	28.9
3.5-4.5	228	25.7	1.6	21.6	23.0	25.6	28.2	30.9
4.5-5.5	262	26.8	1.4	22.7	24.7	26.8	29.1	31.4
5.5-6.5	216	28.1	1.8	23.1	25.4	27.8	31.3	34.6
6.5-7.5	225	29.3	2.2	23.5	26.5	29.1	33.1	38.5
7.5-8.5	192	30.7	2.2	26.0	27.7	30.4	34.1	41.4
8.5-9.5	251	32.1	2.2	27.1	28.7	31.9	35.7	40.4
9.5-10.5	253	33.1	2.6	27.9	29.0	32.9	37.9	42.4
10.5-11.5	282	34.4	3.0	27.4	30.5	33.9	39.9	47.2
11.5-12.5	267	35.3	2.6	29.6	31.2	35.1	39.9	45.0
12.5-13.5	312	36.9	2.5	30.5	33.1	36.6	41.2	46.4
13.5-14.5	270	38.6	2.8	33.3	34.4	38.3	43.3	47.7
14.5-15.5	262	39.9	2.7	33.7	35.7	39.7	44.8	47.4
15.5-16.5	198	41.4	3.3	34.7	36.4	41.0	47.3	51.8
16.5-17.5	221	42.0	3.4	34.3	37.3	41.8	48.0	51.7
17.5-19.0	154	43.2	3.7	36.1	37.5	43.4	49.5	51.2

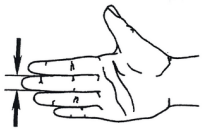
Required
Prod-ver length
for double-arm
amputees.

213.

MIDDLE FINGER DIAMETER

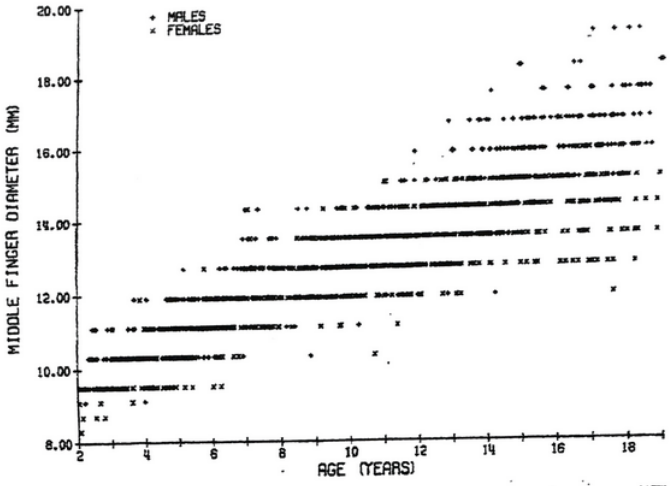
Subject extends middle finger of right hand. With a finger measurement board, record the greatest diameter through which the first joint of the middle finger cannot pass. The measurement is typed into the computer.





Middle Finger Diameter.

(56)

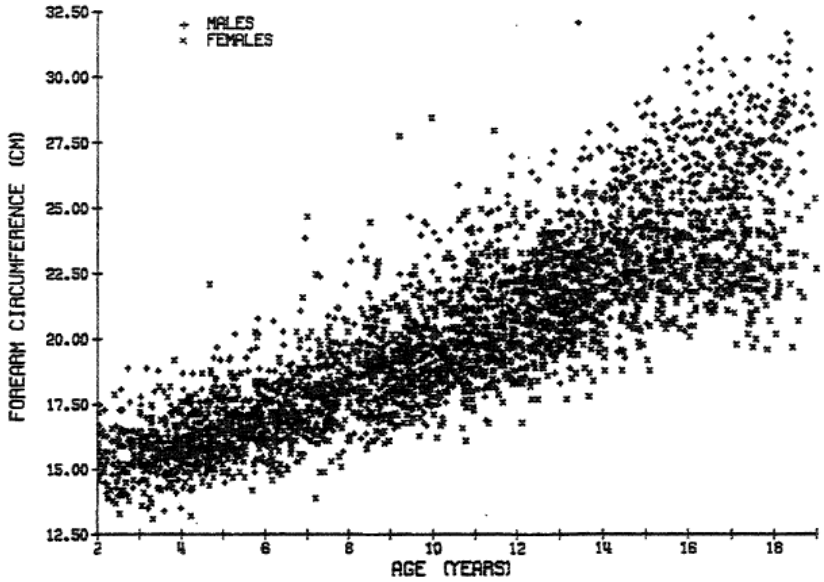


12mm Ø

MIDDLE FINGER DIAMETER (mm)
(Males and Females)

Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	77	9.9	0.6	8.3	8.7	9.4	10.8	11.1
3.5-4.5	71	10.4	0.7	9.1	9.1	10.0	11.2	11.9
4.5-5.5	93	10.8	0.8	9.5	9.5	10.4	11.7	12.7
5.5-6.5	62	11.3	0.7	9.5	9.6	10.9	12.1	12.7
6.5-7.5	63	12.0	0.9	10.3	10.3	11.5	13.5	14.3
7.5-8.5	60	12.2	0.7	11.1	11.1	11.8	13.2	14.3
8.5-9.5	79	12.6	0.7	10.3	11.2	12.2	13.4	14.3
9.5-10.5	92	12.9	0.8	11.1	11.2	12.4	14.0	14.3
10.5-11.5	99	13.2	0.9	10.3	11.4	12.9	14.3	15.0
11.5-12.5	94	13.5	0.8	11.9	11.9	13.1	14.4	15.8
12.5-13.5	106	14.0	0.9	11.9	12.0	13.5	15.1	16.6
13.5-14.5	98	14.4	1.1	11.9	12.3	13.9	16.1	17.4
14.5-15.5	95	15.0	1.1	12.7	12.7	14.5	16.5	18.1
15.5-16.5	56	15.3	1.3	12.7	12.7	14.8	17.2	18.1
16.5-17.5	80	15.1	1.4	11.9	12.2	14.7	17.0	19.0
17.5-19.0	46	15.8	1.5	12.7	12.9	15.4	18.0	19.0

Soften curve to suit multiple diameters



FOREARM CIRCUMFERENCE (cm)
(Males and Females)

Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	212	15.7	1.0	13.1	13.9	15.7	17.4	18.9
3.5-4.5	227	16.0	1.0	13.2	14.3	15.8	17.7	19.2
4.5-5.5	263	16.6	1.1	14.4	15.0	16.4	18.5	22.1
5.5-6.5	219	17.0	1.2	14.2	15.1	16.9	19.1	20.8
6.5-7.5	225	17.7	1.4	13.9	15.8	17.6	20.0	24.7
7.5-8.5	189	18.5	1.5	15.1	16.1	18.2	21.0	24.5
8.5-9.5	250	19.1	1.6	16.0	16.7	19.0	21.5	27.8
9.5-10.5	253	19.6	1.7	16.2	17.4	19.4	22.7	28.5
10.5-11.5	281	20.5	1.9	16.1	17.9	20.0	24.1	28.0
11.5-12.5	286	21.0	1.8	16.8	18.4	20.8	24.4	27.0
12.5-13.5	313	21.9	1.8	17.7	19.3	21.7	24.8	32.1
13.5-14.5	271	22.9	2.0	17.8	19.6	22.8	26.4	28.2
14.5-15.5	264	23.7	2.1	18.8	20.5	23.4	27.5	30.3
15.5-16.5	198	24.6	2.5	20.1	20.9	24.1	28.7	31.6
16.5-17.5	220	24.8	2.5	19.7	21.0	24.6	28.8	32.3
17.5-19.0	155	25.7	2.9	19.6	21.2	26.2	29.8	31.7

Appendix I - Tomobean Game Explanation

tomobeans : ruleset explaination

Disclaimer: This is not designed to be a 'child-friendly' explaination, more to explain WHY those decisions were made.

Two players choose three Tomo's from their collection to battle; like a 4 sided-dice, every Tomo has four faces containing a number of dots (colloquially called 'pips').
For the first round, both opponents choose and announce which Tomo they want to battle with simultaneously, and, after rolling, the highest number (highest POWER) is victorious.

For all of the following rounds, the winner of the previous round must choose and announce their next Tomo **before** their opponent, allowing the to loser of the last round to pick more their Tomo more tactically.

A **victorious** Tomo cannot be used again for the battle, but any Tomo that loses a round can still be played again, leading to a scenario where the player who is losing the battle overall will have a greater choice of Tomo than the winning player, creating a more level playing field.

The first player to three victories (a win with each one of the player's Tomo's), is crowned champion of the battle.

The only other rule is unique to every Tomo: alongside the standard four-faces, each character's geometry is such that it has a very small chance to onto one of four **'SPECIAL'** faces, represented by a large spiral. If this is the case, the round is decided by that character's **'SPECIAL'** rule; for one Tomo, this may be that if the roll is indeed higher than the opponent that they steal a victory from their opponent, but rules vary with each character.

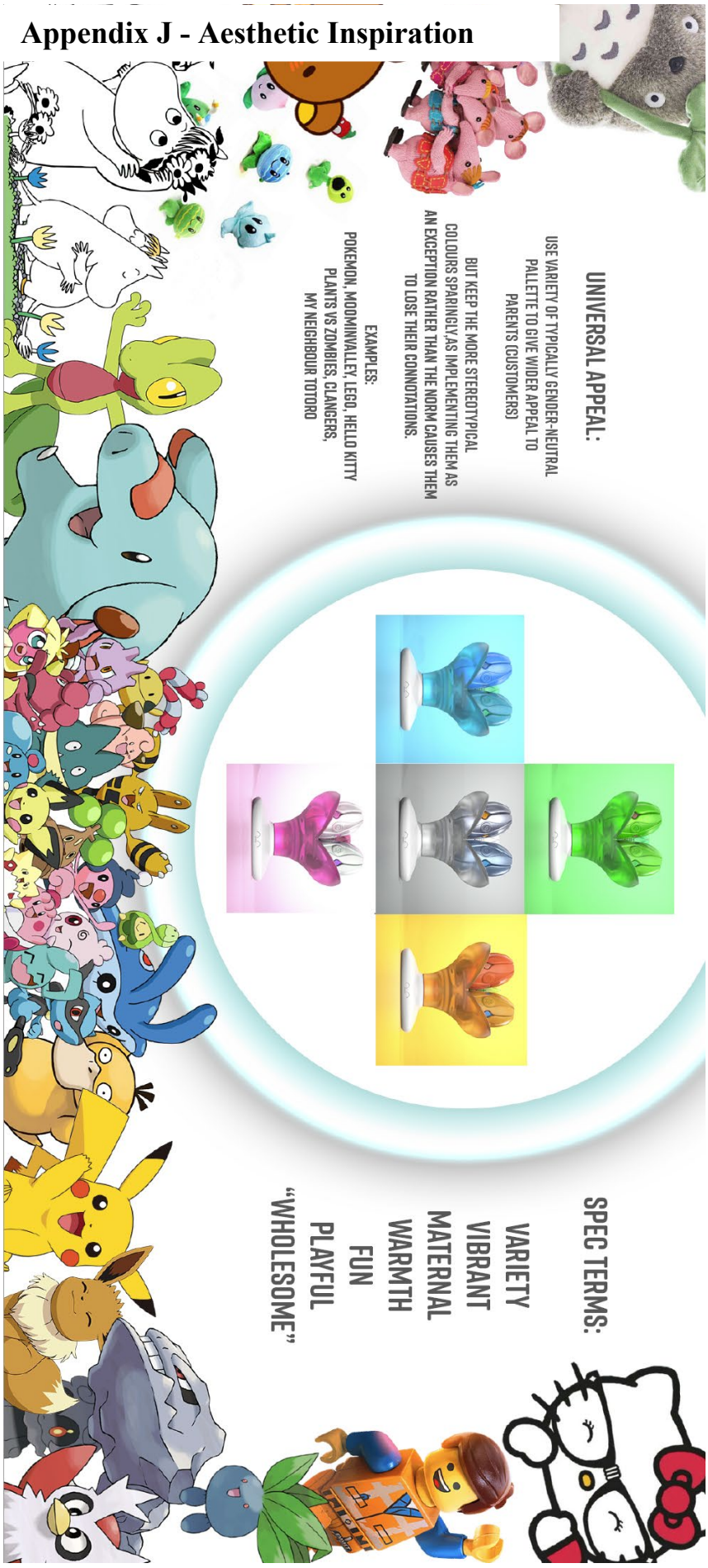
These are exceedingly rare, but are incredibly powerful and can completely swing the fate of the battle.

Accompanying **Victory Tokens** and Tomobean playing cards can be used to represent the victorious Tomo's of a round, and the Tomo's roll stats/special move respectively, and may be a useful visual aid for newcomers to learn the game faster but is not necessary.

In the advanced rules, this is also amplified by **'elements' system: 1 of 3 potential symbols that can be found each face alongside the number (**'Stars < Planets < Moons**, [the rules for this being written on the back on every card and thus always in view]), that in a rock-paper-scissors style of gameplay mechanic, will **double** the score of the Tomo that rolls an element that's effective against the opponents.

Now with the option to beat an opponent with nearly twice as high a roll as yourself, and with each Tomo having a bias towards one element or another (one may favour all 'Star' elements, another a balance of two 'Moon' two 'Planet' elements), this drastically alters what selection of Tomo's should be used against one-another. culminating in a new ruleset that requires a far greater level of skill to be regularly victorious.

Appendix J - Aesthetic Inspiration



Appendix K - Colour Research & Choice

pantone colour swatch

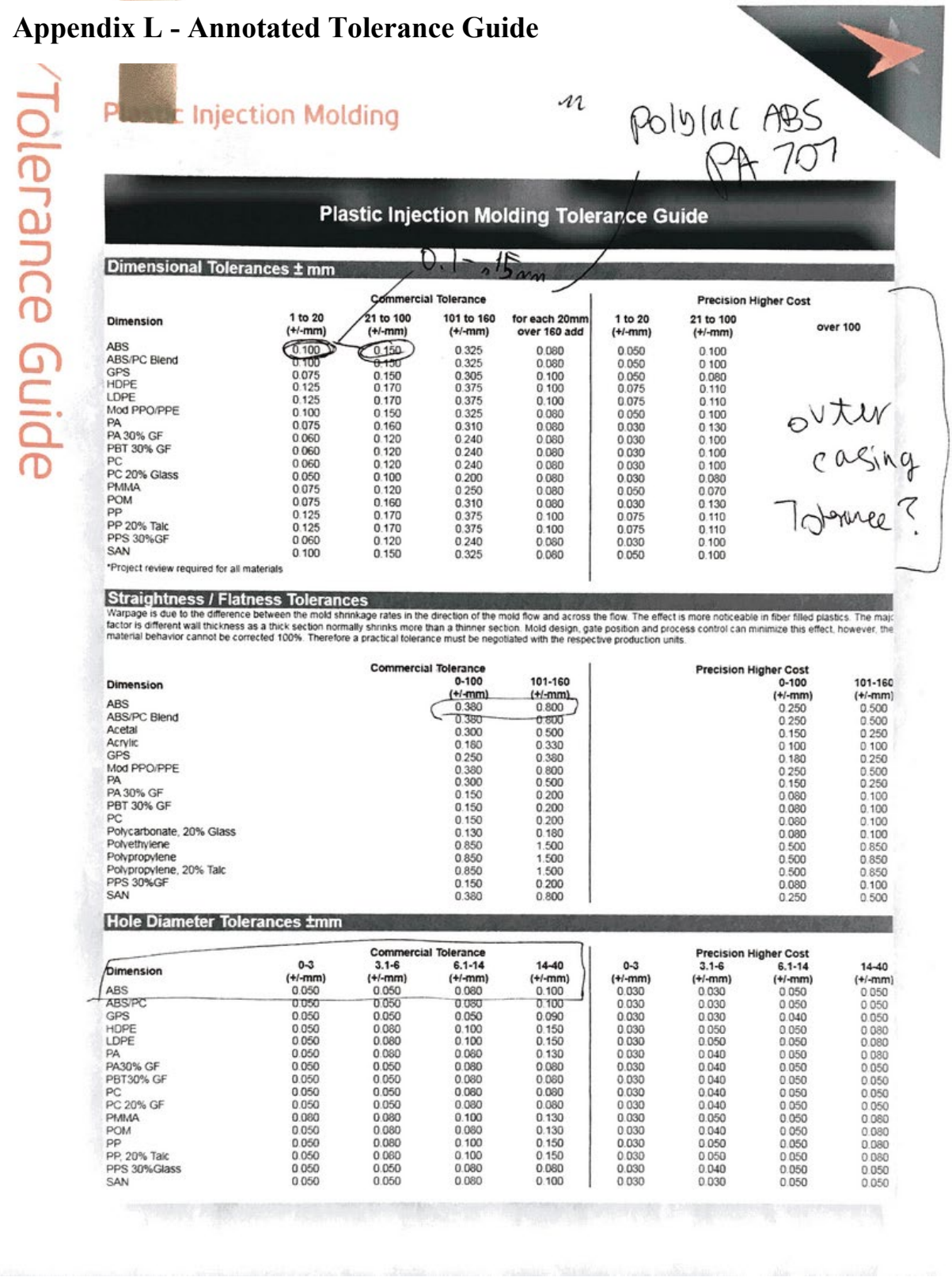
(initial range colour scheme)

STRAWBERRY RED PANTONE 199	KETCHUP RED PANTONE 186		
PEONY PINK PANTONE 7424	CUPCAKE PINK PANTONE 204		
MONSTER PURPLE PANTONE 254	ONION PURPLE PANTONE 2405		
TURQUOISE BLUE PANTONE 312	PEACOCK BLUE PANTONE 3005		

CATERPILLAR GREEN PANTONE 376	PARROT GREEN PANTONE 354		
DANDELION YELLOW PANTONE 109	GIRAFFE YELLOW PANTONE 7549		
CARROT ORANGE PANTONE 172	SALAMANDER ORANGE PANTONE 179		
CHARCOAL GRAY PANTONE 425	DOLPHIN GRAY PANTONE 7543		

*based off PANTONE children's colour guide

Appendix L - Annotated Tolerance Guide



Tolerance Guide

Plastic Injection Molding

Polylac ABS PA 707

Plastic Injection Molding Tolerance Guide

Dimensional Tolerances ± mm

0.1 - 15mm

Dimension	Commercial Tolerance 1 to 20 (+/-mm)	21 to 100 (+/-mm)	101 to 160 (+/-mm)	for each 20mm over 160 add	Precision Higher Cost 1 to 20 (+/-mm)	21 to 100 (+/-mm)	over 100
ABS	0.100	0.150	0.325	0.080	0.050	0.100	
ABS/PC Blend	0.100	0.150	0.325	0.080	0.050	0.100	
GPS	0.075	0.150	0.305	0.100	0.050	0.080	
HDPE	0.125	0.170	0.375	0.100	0.075	0.110	
LDPE	0.125	0.170	0.375	0.100	0.075	0.110	
Mod PPO/PPE	0.100	0.150	0.325	0.080	0.050	0.100	
PA	0.075	0.160	0.310	0.080	0.030	0.130	
PA 30% GF	0.060	0.120	0.240	0.080	0.030	0.100	
PBT 30% GF	0.060	0.120	0.240	0.080	0.030	0.100	
PC	0.060	0.120	0.240	0.080	0.030	0.100	
PC 20% Glass	0.050	0.100	0.200	0.080	0.030	0.080	
PMMA	0.075	0.120	0.250	0.080	0.050	0.070	
POM	0.075	0.160	0.310	0.080	0.030	0.130	
PP	0.125	0.170	0.375	0.100	0.075	0.110	
PP 20% Talc	0.125	0.170	0.375	0.100	0.075	0.110	
PPS 30%GF	0.060	0.120	0.240	0.080	0.030	0.100	
SAN	0.100	0.150	0.325	0.080	0.050	0.100	

*Project review required for all materials

outer casing Tolerance?

Straightness / Flatness Tolerances

Warpage is due to the difference between the mold shrinkage rates in the direction of the mold flow and across the flow. The effect is more noticeable in fiber filled plastics. The majo factor is different wall thickness as a thick section normally shrinks more than a thinner section. Mold design, gate position and process control can minimize this effect, however, the material behavior cannot be corrected 100%. Therefore a practical tolerance must be negotiated with the respective production units.

Dimension	Commercial Tolerance 0-100 (+/-mm)	101-160 (+/-mm)	Precision Higher Cost 0-100 (+/-mm)	101-160 (+/-mm)
ABS	0.380	0.800	0.250	0.500
ABS/PC Blend	0.380	0.800	0.250	0.500
Acetal	0.300	0.500	0.150	0.250
Acrylic	0.180	0.330	0.100	0.100
GPS	0.250	0.380	0.180	0.250
Mod PPO/PPE	0.380	0.800	0.250	0.500
PA	0.300	0.500	0.150	0.250
PA 30% GF	0.150	0.200	0.080	0.100
PBT 30% GF	0.150	0.200	0.080	0.100
PC	0.150	0.200	0.080	0.100
Polycarbonate, 20% Glass	0.130	0.180	0.080	0.100
Polyethylene	0.850	1.500	0.500	0.850
Polypropylene	0.850	1.500	0.500	0.850
Polypropylene, 20% Talc	0.850	1.500	0.500	0.850
PPS 30%GF	0.150	0.200	0.080	0.100
SAN	0.380	0.800	0.250	0.500

Hole Diameter Tolerances ±mm

Dimension	Commercial Tolerance 0-3 (+/-mm)	3.1-6 (+/-mm)	6.1-14 (+/-mm)	14-40 (+/-mm)	Precision Higher Cost 0-3 (+/-mm)	3.1-6 (+/-mm)	6.1-14 (+/-mm)	14-40 (+/-mm)
ABS	0.050	0.050	0.080	0.100	0.030	0.030	0.050	0.050
ABS/PC	0.050	0.050	0.080	0.100	0.030	0.030	0.050	0.050
GPS	0.050	0.050	0.050	0.090	0.030	0.030	0.040	0.050
HDPE	0.050	0.080	0.100	0.150	0.030	0.050	0.050	0.080
LDPE	0.050	0.080	0.100	0.150	0.030	0.050	0.050	0.080
PA	0.050	0.080	0.080	0.130	0.030	0.040	0.050	0.080
PA30% GF	0.050	0.050	0.080	0.080	0.030	0.040	0.050	0.050
PBT30% GF	0.050	0.050	0.080	0.080	0.030	0.040	0.050	0.050
PC	0.050	0.050	0.080	0.080	0.030	0.040	0.050	0.050
PC 20% GF	0.050	0.050	0.080	0.080	0.030	0.040	0.050	0.050
PMMA	0.080	0.080	0.100	0.130	0.030	0.050	0.050	0.080
POM	0.050	0.080	0.080	0.130	0.030	0.040	0.050	0.080
PP	0.050	0.080	0.100	0.150	0.030	0.050	0.050	0.080
PP, 20% Talc	0.050	0.080	0.100	0.150	0.030	0.050	0.050	0.080
PPS 30%Glass	0.050	0.050	0.080	0.080	0.030	0.040	0.050	0.050
SAN	0.050	0.050	0.080	0.100	0.030	0.030	0.050	0.050

tomobeans

Bournemouth University

Appendix M - Annotated Material Datasheet

www.chemwide.com

Updated : Mar. 2013

	TEST METHOD			
熔融指數 Melt Flow Index	D1238	200 ℃, 5 Kg 220 ℃, 10 Kg	g/10 min	1.7 -
比重 Mass Density	D792	23 ℃	-	1.06
硬度 Hardness	D785	-	R Scale	116
拉伸強度 (屈服) Tensile Strength (Yield)	D638	6 mm/min	Kg/cm² lb/in²	490 6950
延伸率 Tensile Elongation	D638	6 mm/min	%	20
彎曲強度 Flexural Strength	D790	2.8 mm/min	Kg/cm² lb/in²	860 12200
彎曲彈性模數 Flexural Modulus	D790	2.8 mm/min	10^3 Kg/cm² 10^5 lb/in²	2.9 4.1
IZOD 衝擊強度 Izod Impact Strength	D256 (Notched)	6.4 mm, 23℃	Kg-cm/cm ft-lb/in	15 2.7
		3.2 mm, 23℃	Kg-cm/cm ft-lb/in	16 2.9
維氏軟化溫度 Vicat Softening Temp.	D1525	1 Kg,50 ℃/hr	℃ ℉	105 221
熱變形溫度 Heat Distortion Temp.	D648	1.8 MPa Annealed	℃ ℉	95 203
		1.8 MPa Unannealed	℃ ℉	85 186
UL 燃燒等級 UL Flammability	UL 94	-	-	1.5 mm HB

May 2, 2013

Notes : These are typical properties only and are not to be construed as specifications. Users should confirm results by their own tests.

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General Description

LS100 is a general-purpose product used for soft and hard products and is most widely used in PVC grade.

Main Applications

Pipe, power cable jacket, leather, sheets, hoses, soft/hard sheets, wrapping film and innoxious film.

Resin Properties

Parameter	Test Method	Unit	Test Condition	Typical Value
K-Value	DIN 53726	-	-	66
Degree of Polymerization	ASTM D1243	-	30 ℃	1,000 ± 50
Particle Size	ASTM D1921	%	45 Mesh pass	99.8
Apparent Bulk Density	ASTM D1895	g/cm³	-	0.56 ± 0.04
Specific Gravity	ASTM D792	-	23 ℃	1.4
Volatiles	ASTM D3030	%	110℃, 1hr	Max. 0.3

Packaging

Paper bag(25kg), Jumbo bag

Certificate Numbers

ISO 9001:2000 00048-1997-AQ-SEO-RvA (rev.1)
ISO 14001:2004 0008-1996-AE-SEO-RvA
OHSAS 18001:1999 0015-2000-HSO-SEO-DNV (rev.1)

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Keep the directions and advices contained in MSDS (Material Safety Data Sheet) made and distributed by LG Chem when handling the product and work out proper safety countermeasures. The substance described in MSDS is intended for general condition and such user must work out additional safety countermeasures when mixing with other products or using in special condition.

LG Chem

LG Chem, Ltd. LG Twin Towers, 20, Yeouido-dong, Youngdeungpo-gu, Seoul 150-721, KOREA Tel : +82-2-3773-7785 Fax : +82-2-3773-7754 (Overseas Sales Team)

Density		ISO 1183-1	g/cm³	1.15
Water absorption:				
- after 24/96 h immersion in water of 23 °C (1)		ISO 62	mg	49 / 93
		ISO 62	%	0.72 / 1.37
- at saturation in air of 23 °C / 50 % RH		-	%	2.3
- at saturation in water of 23 °C		-	%	6.6
Thermal Properties (2)				
Melting temperature (DSC, 10 °C/min)		ISO 11357-1/-3	°C	215
Glass transition temperature (DSC, 20 °C/min) (3)		ISO 11357-1/-2	°C	80
Thermal conductivity at 23 °C		-	W/(K·m)	0.29
Coefficient of linear thermal expansion:				
- average value between 23 and 60 °C		-	m/(m·K)	80×10^{-6}
- average value between 23 and 100 °C		-	m/(m·K)	90×10^{-6}
Temperature of deflection under load:				
- method A, 1.8 MPa		ISO 75-1/-2	°C	80
Max. allowable service temperature in air:				
- for short periods (4)		-	°C	170
- continuously: for 5,000 / 20,000 h (5)		-	°C	105 / 90
Min. service temperature (6)		-	°C	-30
Flammability (7):				
- "Oxygen Index"		ISO 4589-1/-2	%	25
- according to UL 94 (1.6 mm thickness)		-		HB / HB
Mechanical Properties at 23 °C (8)				
Tension test (9):				
- tensile stress at yield / tensile stress at break (10)	+	ISO 527-1/-2	MPa	82 / -
	++	ISO 527-1/-2	MPa	50 / -
- tensile strength (10)	+	ISO 527-1/-2	MPa	84
- tensile strain at yield (10)	+	ISO 527-1/-2	%	5
- tensile strain at break (10)	++	ISO 527-1/-2	%	35
	+	ISO 527-1/-2	%	> 50
- tensile modulus of elasticity (11)	+	ISO 527-1/-2	MPa	3300
	++	ISO 527-1/-2	MPa	1600
Compression test (12):	+	ISO 604	MPa	32 / 61 / 90
- compressive stress at 1 / 2 / 5 % nominal strain (13)				
Charpy impact strength - Unnotched (13)	+	ISO 179-1/1eU	kJ/m²	no break
Charpy impact strength - Notched	+	ISO 179-1/1eA	kJ/m²	3
Ball indentation hardness (14)	+	ISO 2039-1	N/mm²	160
Rockwell hardness (14)	+	ISO 2039-2	-	M 85
Electrical Properties at 23 °C				
Electric strength (15)	+	IEC 60243-1	kV/mm	25
	++	IEC 60243-1	kV/mm	17
Volume resistivity	++	IEC 60093	Ohm cm	> 10^{14}
	+	IEC 60093	Ohm cm	> 10^{12}
Surface resistivity	+	IEC 60093	Ohm	> 10^{13}
	++	IEC 60093	Ohm	> 10^{12}
Relative permittivity ε_r - at 100 Hz	+	IEC 60250	-	3.6
	++	IEC 60250	-	6.6
- at 1 MHz	++	IEC 60250	-	3.2
	+	IEC 60250	-	3.7
Dielectric dissipation factor tan δ - at 100 Hz	+	IEC 60250	-	0.012
	++	IEC 60250	-	0.14
- at 1 MHz	+	IEC 60250	-	0.016
	++	IEC 60250	-	0.05
Comparative tracking index (CTI)	+	IEC 60112	-	600
	++	IEC 60112	-	600

Note: 1 g/cm³ = 1,000 kg/m³, 1 MPa = 1 N/mm², 1 kV/mm = 1 MV/m.

+ : values referring to material in equilibrium with the stand
++ : values referring to material in equilibrium with the stand
atmosphere 23 °C / 50 % RH (mostly derived from literature)

(1) According to method 1 of ISO 62 and done on discs ∅ 50 mm
mm.

(2) The figures given for these properties are for the most part deriv
from raw material supplier data and other publications.
Values for this property are only given here for amorphc
materials and not for semi-crystalline ones.

(3) Only for short time exposure (a few hours) in applications where
or only a very low load is applied to the material.

(4) Temperature resistance over a period of 5,000/20,000 hours. At
these periods of time, there is a decrease in tensile strength
measured at 23 °C – of about 50 % as compared with the origir
value. The temperature values given here are thus based on t
thermal-oxidative degradation which takes place and causes
reduction in properties. Note, however, that the maximum allowat
service temperature depends in many cases essentially on t

(5) duration and the magnitude of the mechanical stresses to which t
material is subjected.

(6) Impact strength decreasing with decreasing temperature. T
minimum allowable service temperature is practically main
determined by the extent to which the material is subjected
impact. The value given here is based on unfavourable impa
conditions and may consequently not be considered as being th
absolute practical limit.

(7) These estimated ratings, derived from raw material supplier dat
and other publications, are not intended to reflect hazard
presented by the material under actual fire conditions. There is n

(8) UL File Number available for Nylatron MC 901 stock shapes.
The figures given for the properties of dry material (+) are for th
most part average values of tests run on test specimens machine
cut of rods ∅ 50 mm. Except for the hardness tests, the tes
specimens were then taken from an area mid between centre an
outside diameter, with their length in longitudinal direction of th
rod.

(9) Test specimens: Type 1B

(10) Test speed: 50 mm/min (chosen acc. to ISO 10350-1 as a functio
of the ductile behaviour of the material (tough or brittle))

(11) Test speed: 1 mm/min

(12) Test specimens: cylinders ∅ 8 mm x 16 mm

(13) Pendulum used: 4 J

(14) Medium used: 10 mm thick test specimens (discs), mid between
diameter and outside diameter

(15) Electrode configuration: ∅ 25 / ∅ 75 mm coaxial cylinders ; ir
transformer oil according to IEC 60296 ; 1 mm thick tes
specimens.

This table, mainly to be used for comparison purposes, is a
valuable help in the choice of a material. The data listed here fall
within the normal range of product properties. However, they are
not guaranteed and they should not be used to establish
material specification limits nor used alone as the basis of
design.

AVAILABILITY: see "Delivery Programme"

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Any illustration of the possible fields of application of the Products shall merely demonstrate the potential of these Products, but any such description does not constitute any kind of coveru whatsoever. Irrespective of any tests that Quadrant may have carried out with respect to any Product, Quadrant does not possess expertise in evaluating the suitability of its materials Products for use in specific applications or products manufactured or offered by the customer respectively. The choice of the most suitable plastics material depends on available chemi resistance data and practical experience, but often preliminary testing of the finished plastics part under actual service conditions (right chemical, concentration, temperature and contact time, well as other conditions) is required to assess its final suitability for the given application.

t thus remains the customer's sole responsibility to test and assess the suitability and compatibility of Quadrant's Products for its intended applications, processes and uses, and to choose thc products which according to its assessment meet the requirements applicable to the specific use of the finished product. The customer undertakes all liability in respect of the applicati processing or use of the aforementioned information or product, or any consequence thereof, and shall verify its quality and other properties.

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Appendix N - Costing & Material Sheet | BOM

Part Number	Part Name	Mass (kg) (per part)	Manafacture Method	Material	Finish	Part Quanitity (per unit)	Part Price ($) per part	*(10,000 unit order)* ($) per unit	($) Tooling	($) per Unit inc. Tooling	($) Gross per unit (inc. shipping)	Chinese Manafacture Price ($) ($) Gross per unit (inc. shipping)
1	central_housing	0.0046	Injection Moulding	ABS (CHIMEI PA-707)	SPI- A1	4	0.250	1.000	3989.000	1.399	1.429	1.021
2	outer_faces	0.0158	Injection Moulding	ABS (CHIMEI PA-707)	SPI - A1	4	0.380	1.520	5356.000	2.056	2.096	1.497
3	side_arms	0.0043	Injection Moulding	ABS (CHIMEI PA-707)	SPI - A1	2	0.270	0.540	3228.000	0.863	0.913	0.652
4	racks_MOD_0.8	0.0005	Injection Moulding	Nylon 6 (Nylatron MC 901)	-	6	0.200	1.200	2215.000	1.422	1.452	1.037
5	M1x4mm_selftap_screws	0.0001	Imported Component	Carbon Steel (ISO 8.8)	Black	8	0.004	0.032	-	0.032	0.032	0.032
6	M1x3mm_selftap_screws	0.0001	Imported Component	Carbon Steel (ISO 8.8)	Black	6	0.004	0.024	-	0.024	0.024	0.024
7	0.8MOD_12T_piniongear	0.0006	Injection Moulding	Nylon 6 (Nylatron MC 901)	-	1	0.300	0.300	2904.000	0.590	0.680	0.486
8	central_axis_rod_2mm	0.0004	Imported Component	Stainless Steel 302	-	1	0.001	0.001	-	0.001	0.001	0.001
9	tortion_springL	0.0001	Imported Component	Stainless Steel 302 (Commercial) ASTMA313	-	1	0.030	0.030	-	0.030	0.030	0.030
10	tortion_springR	0.0001	Imported Component	Stainless Steel 302 (Commercial) ASTMA313	-	1	0.030	0.030	-	0.030	0.030	0.030
11	rod_endcaps	0.0001	Injection Moulding	ABS (CHIMEI PA-707)	SPI - A2	2	0.150	0.300	2201.000	0.520	0.570	1.021
12	mother_pod_top	0.2169	Roto Moulding	PVC (LG PVC LS-100) (Frosted Clear)	SPI- A1	1	0.900	0.900	2310.000	1.131	1.831	1.308
13	mother_pod_bottom	0.1469	Roto Moulding	PVC (LG PVC LS-100)	SPI- A2	1	0.560	0.560	1853.000	0.745	0.875	0.625
14	m4x5mm_seltap_screw	0.001	Imported Component	Carbon Steel (ISO 8.8)	-	1	0.004	0.004	-	0.004	0.004	0.003
16	sticker_face	-	Imported Component	-	-	1	0.005	0.005	-	0.005	0.005	0.005
~	*Assembly/Post/Labour*	-	-	-	-	-	-	0.200	-	0.200	0.200	0.143
TOTAL						110		16.73		23.05	24.91	19.87
TOTAL (individual pod)						36		5.21		7.16	7.53	5.98
TOTAL (£)										£17.51	£18.93	£15.10
TOTAL (£) (individual pod)										£5.44	£5.72	£4.54
RRP (£)												£49.99
RRP (£) (individual pod)												£12.99
Markup (%)												~ 250-270%

Exchange Rates	$	£
	1	0.76

Chinese Production Modifier
1.4

Appendix O - PDS Evaluation

4808993 | Michael Thundow

3 Performance

3.1 To allow early primary school children, who may or may not have the motor-skills in their *fingers* to interact with typical toys for their age-group: types of disabilities that are included as part of this project are but not limited to:

- Congenital or Acquired Limb Defects
- Total limb loss, up to and including the elbow joint.
- *Early* stage Duchenne muscular dystrophy, (effecting hands/fingers, designing for beyond this stage is beyond the scope of the project.)
- Mild Developmental Coordination Disorder (Dyspraxia)
- Mild Spastic, Dyskinetic, Ataxic or Mixed upper-limb cerebral palsy effecting fine-motor control (Acute conditions would be aspirational an aim to provide a solution to but may require too specialist a solution.)

Again, to reiterate, these are issues focused around ***fine***-motor control issues, whilst these conditions can affect different parts of the body to more extreme degrees, these would be beyond the scope of the project.

The aim should be to focus on the ***extreme*** end of this spectrum; those who lack those digits entirely, on *both* sides. It may even be the case that the user lacks a wrist joint to interact with a suitable mechanism, so this needs to be considered.

3 Performance

3.1 The final solution performed the main criteria for this specification to a satisfactory degree.

Every dimension of the product has been designed with ergonomics in mind. Every curve is designed to support a whole host of ergonomic issues faced by a whole host of potential fine-motor control issues.

All of this was achieved without ever giving the impression that the product set out to do this.

The product performs to standard even in the most extreme-case scenario, that is multi-amputation on both hands up to the elbow.

Again, without giving the impression that it was specifically designed for that demographic.

3.2 Fundamentally, to facilitate *play* of some respect when using the product, even if the user has a typical level of motor-control; the product should be as exciting to use as a regular toy would be.

3.3 To require some form of social interaction between all users when using the product to be used most effectively, whether this is *cooperative* or *competitive* is yet to be decided.

3.4 Following on from the previous point, this should not be so heavily enforced that the product actively alienates those who don't have enough peers to play with at that given moment, individual play must still be possible.

3.5 The product must be strong enough to withstand typical forces that can be exerted by young children in most predictable settings; being thrown, hit against objects in social situations etc. *(also see Environment)*

4 Product Details

4.1 Environment and Normal Usage Considerations

4.1.1 Normal use: The device will be used in potentially any household/social/outdoor environment. The product will need to be suited for all scenarios as such: sunlight damage, hard-surfaces etc. (*see Materials)*

4.1.2 Temperature: The unit must not be affected by thermal expansion in a way that compromises the product quality or possesses the ability to harm the user, especially true in a likely scenario where the product is in contact with skin, where the skin temperature might cause small levels of expansion, in reference to this, the product's accessible parts likely to be touched by a human hand must not increase by more than 35K. (BSI, 2017)

4.1.3 Neither must the product be damaged in temperature -20°C to 70°C.

4.1.4 The product should be corrosion resistant to the sorts of chemicals used in households etc.

4.1.5 The toy "shall be visually clean and free from infestation" (BSI, 2017), and as such, easy to clean.

3.2 The game manages to barely give the impression that it was designed with the disabled in mind, and is thus a success.

3.3 The competitive element makes the solution inherently social-focused.

3.4 The product doesn't have a lot of potential for play outside of the social game, although still has a strong kinetic focus that may provide solo-enjoyment.

3.5 *See BSI impact tests*

4.1.1 The product is UV resistant and the grade of ABS materials are extremely hard-wearing.

4.1.2 The chosen material has extremely tough temperature resistance and has strong insular properties

4.1.3 The product will not be damaged in these conditions

4.1.4 The materials are relatively inert and do not pose a risk

4.1.5 The product is visually free from infestation, though some small crevices may be harder to clean

4.1.6	The toy shall not include any sharp edges in any part of the product that is accessible to the user. This includes any burring on the finished product that may cause wounds or abrasion. (BSI, 2017), this also includes any protruding parts capable of puncture injuries.	4.1.6 The product does not include sharp edges of any kind.
4.1.7	Mechanical Considerations (BSI, 2017):	4.1.7
4.1.7.1	If it's decided that a driver mechanism is required as part of a kinetic toy, the mechanism should not be exposed to the user.	4.1.7.1 Any driver mechanism is not exposed to the user.
4.1.7.2	If the part is connected via a hinge element *and* has a mass of more than 250g, must have the gap between hinge and body either <5mm or >12mm to avoid finger injuries.	4.1.7.2 The product is 100g
4.1.7.3	If a spring is required, the gap between spiral elements must be <3mm, or be made inaccessible. This includes compression/extension springs under 40N of force.	4.1.7.3 The spring is inaccessible under all conditions.
4.1.7.4	Must withstand significant shock load without cracking or breaking; to demonstrate as example, a metal weight of mass 1Kg over area with diameter 80mm being dropped onto the product from 100mm.	4.1.7.4 The product passed the test in a weaker material, so should easily pass in ABS
4.1.7.5	The product must withstand being dropped from a height of at-least 850mm multiple times onto a flat steel sheet multiple times without breaking or cracking.	4.1.7.5 The product passed the test in a weaker material, so should easily pass in ABS
4.1.7.6	If a projectile is used, it should not have any sharp edges, nor gain any after impacts.	4.1.7.6 n/a
4.1.7.7	Further to this, the leading face of any projectile should not be greater than 4mm, or as specified in BS EN 71 -1 | 8.43 : Assessment of leading Parts on Projectiles.	4.1.7.7 n/a
4.1.7.8	If projectile discharges with kinetic energy greater than 0,08J, the projectile must not have a kinetic energy per unit area < 2500J/^2 else may cause damage to the user.	4.1.7.8 n/a

4.2 Life in Service

The product should maintain an optimum usage life of at least 2 years under regular use, the average amount of time the child is likely to use the product as they grow.

4.2 The product's material and form is designed to last at least five years of regular use and beyond.

4.3 Maintenance & Sustainability

4.3.1 The product is should be simple enough to manufacture that it is inherently cheap enough to replace, DIY repairs may compromise on safety, and doesn't tend to be a factor in current consumer products.

4.3.1 The product is easy to replace, as it is a collectible product

4.3.2 The product's material should lend it to be easily recyclable or be comprised of mostly recyclable materials. *(see Materials)*

4.3.2 The product would not be easily recycled.

4.4 Size & Mass

Whilst the size of the product could vary considerably, a few guidelines need to be followed in order for the product to easily be transported to retail stores/delivered to homes, as-well as be easily on display at retail locations, **since despite Amazon being a strong method of purchasing toys, the largest go-to for retail toys is actually Argos; and when combined the physical retail sector still outweighs online sales when it comes to toys.** (Mintel, 2017)

4.4.1 When laid down flat the product:

4.4.2 Length should not exceed 400mm.

4.4.3 Height should exceed 400mm.

4.4.4 Depth should exceed 400mm.

4.4.1 The product does not exceed any of these parameters.

4.4.5 Must have all individual parts fail to fit into a diameter of 100mm or smaller in order to not be a choking hazard. (See BS EN 71 Series)

4.4.5 The product does not contain any inherently detached parts that are smaller than 100mm

4.4.6 The mass of the product is handheld, so based off of other similar products should not exceed 800g.

4.4.6 The product is around 100g, and such doesn't exceed the 800g limit.

4.5 Materials

4.5.1 The use of existing materials for manufacture is preferable. We do not have the capabilities to develop a new material.

4.5.1 The product is made from widely used grade of ABS.

4.5.2 The materials used will have to be widely available and cheap to produce relative to similar categories of material (see target price)

4.5.2 The popularity of this grade makes it relatively cheap to purchase

4.5.3 Furthermore, the product should be created through a moulded plastic, or at-least be primarily composed of this material.

4.5.3 The product is created through injection or roto moulding.

4.5.4 The materials must be able to withstand its environmental conditions (see Environment)

4.5.5 The materials must be lightweight or be deliberately weighted for ergonomic ideals. (see *Ergonomics & Anthropometrics)*

4.5.6 The material must not react to human skin in any way, chemically or abrasively.

4.5.7 Non-Toxic. The material cannot be dangerous if licked/bitten/somehow ingested in some way. This isn't directed at the market specifically, but is likely to be used in an environment where younger children will be present. In this case, following standard **PD CEN/TR 16918:2015 : Safety of toys. Children's mouthing behaviour in contact with toys** (BSI, 2015) would be a suitable set of parameters to develop to.

4.5.4 There is nothing to suggest that the materials used would fail any of these tests

4.5.5 The materials are lightweight

4.5.6-7 The product is FDA approved and does not react to skin in any fashion, and has an AP1 mirror finish, so isn't abrasive.

4.6 Ergonomics & Anthropometrics.

4.6.1 The anthropometric data used will be from the BS EN standards **BS EN 7231-2: Body Dimensions of Boys & Girls from Birth up to 16.9 Years** (BSI, 1990), the specific measurements that are used will be determined as required by concept, but should ***not*** compromise/fall outside the ideal measurements by >5% of the ***averaged*** dimensions of boy/girl without due justification, such as wild variations between sexes, or the factor of missing limbs taking precedence over a specific dimension **(e.g. a certain part needs to be larger in diameter, in order to take into account those without fingers being able to reach it.)**

4.6.1 The ergonomics were a compromise between handheld use, and use without limbs, the product is a little larger than expected, but only to accommodate those using stumps to handle and transport the product.

4.6.2 One of the most important factors, should be built to the extreme scenario user that has had congenital/acquired limb defect/removals at around ***elbow-length***, including joint loss at that location. Full arm loss may prove too complex a user for the scope of this project.

4.6.3 Use should be obvious by form.

4.6.4 Should **not** alienate those without those issues, the aim is to attract the whole market in

4.6.2 The larger size & diameter allows for easy movement even with total limb loss on both arms

4.6.3 The product only has one method of use, so is easy to use

4.6.4 The product doesn't have any features that explicitly show it as a universal product

4.7 Aesthetics

4.7.1 The product ideally should be aesthetically pleasing and suitable for children of that age-range; very likely creating some form of brand around the product in order to appeal to a collective market.

4.7.2 The product must not appear to be made specifically for those with impairments; this is a universal toy that *may* include prosthetic-like elements, and may include branding to support those markets, but it is ***not*** a medical prosthetic aiming to restore motor-control.

4.7.3 Must also be presented in an appropriate manner that appeals to the *parent or guardian*, as they are the customers for the product, not the children *(see Brand).*

4.7.1 The aesthetics are based around research into aesthetic ideals within the market.

4.7.2 The product doesn't have any features that explicitly show it as a universal product

4.7.3 The product is created as gender-neutral, the most appealing to parents & guardians

4.9 Product Standards and Certifications

4.8.1 **BS 71-1**, **Toys: Mechanical and Physical Properties** (BSI, 2017), is likely to be the most crucial standard to follow when designing this product. The product is almost certainly going to be a form of kinetic toy, and this standard gives full-parameters for stored-energy products, as well as any projectile standards. This is a key standard to hold any solutions to. (see *Environment and Testing)*

4.8.1 The product has been tested to the most relevant BS71-1 standard tests.

5 Secondary Details

5.1 Time-scale

The development should ideally take around 6 weeks to research and develop a suitable concept, with more detailed development another 6 weeks, finally prototyped, tested and evaluated within a final 6 weeks.

5.2 Packing

Whilst package materials haven't been decided, some guidelines must be followed in the event that packaging would be designed:

5.2.1 Size must be kept to a minimum (or at-least within size guidelines (*see size guidelines*).

5.2.2 Cost must be kept to a minimum so as not to increase the products price point excessively (see target price).

5.2.3 Weight must be kept to minimum.

5.1 The product is on schedule

5.2 The product has not had a packaging designed for it as of writing, though this is not a core specification detail.

5.2.4 The package must be presented in a way that is appealing to the *customer & user:* it is the ***parents*** who will be purchasing the product, so both demographics need to be accounted for.
5.2.5 Must prevent the product from being damaged through shock load.
5.2.6 Must be easily be opened by the consumer.
5.2.7 Must not be opened in any way where the product poses a risk to the user.
5.2.8 Recyclability would be a bonus, if not an essential requirement.

5.3 Manufacturing Facility & Manufacture Cost

5.3.1 Anonymous company means facilities are unknown. Assumption is made that the resources are similar to that of a typical large toy brand such as *Hasbro*.

5.3.2 Further to this, the product should be suited to large-scale batch, or low level mass-production runs of >10,000, as this is a consumer product designed to be standardised and shipped commercially on an international scale.

5.3.2 Manufacture costs per unit should not exceed £10, to make a rough minimum of 300-350% mark-up. This is manageable if economies of scale are considered for the intended production run.

5.4 Testing

5.4.1 Ethically, testing this product first-hand may prove impossible, so a specialist will be needed to confirm that the product is suitable and solves the issue from a humanistic perspective:

5.4.2 In terms of mechanical testing, all mechanical parameters (see *Environment)* in reference to ***BS EN 71 -1*** will be tested as instructed in the standard specification, or to as thorough standard as can reasonably be expected using testing equipment available.

5.5 Product Life-Cycle

5.3.1 n/a

5.3.2 The product uses injection moulding, which suits 10,000+ production runs shipped internationally with ease.

5.3.2 The products manufacture costs differ dependent on what product is being purchased, the estimated mark-up is 250% - 270%, which isn't ideal.

5.4.1 As a suitable specialist couldn't be found, the product was evaluated to the anthropometric standard instead.

5.4.2 The solution passed all BS71-1 Mechanical test relevant to it.

5.5 The product is specifically designed to suit new ranges and products being added.

The cradle-to-grave cycle for this product is designed to be flexible and branching: this product needs to have scope to both be developed into new ranges as the market grows older/newer markets arrive with new tastes, but also retain obvious characteristics that keep the brand identity strong to *parents and guardians; the customers.*

6 Market

6.1 Target Price

As a likely complex/branded toy, the product would be expected to range from £40.00 & £50.00. This falls in line with most interactive, non-electronic analogue children's toys, and falls within the likely $500 annual spend on children by parents. (Statista, 2015)

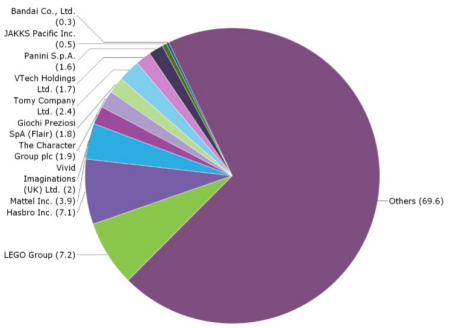
6.1 The product is priced at £49.99 for a 'starter pack' and £12.99 per individual unit, leaving it comfortably suited alongside competition prices.

6.2 Competition

The toy-market as a whole is incredibly saturated: and this is a potential issue given the product isn't designed to fill a niche in the 'disabled-toy' market; it is designed to go toe-to-toe with the traditional toy market, only improve upon this market and *expand* it to suit all users of a given age-range. So, the product needs to not-only stand-out in this sense, but also have a niche that challenges the market as a whole.

6.2 The product creates its own niche in the market, without alienating consumers within said marketplace.

Figure 10: UK - Traditional Toys & Games: Company retail market share by value (%) - 2014



A sign of how saturated the market is, where the largest single company only owns 7.2% of the market, where the vast majority (69.6%) is owned by smaller businesses.

6.3 Paediatric Social-Psychology Considerations

6.4 Brand

Whilst not particularly related to the practical design of the product itself, this category is very specific to my age demographic; since a product of this nature is strongly reliant on the nature of the brand that the customers (the parents) see. If this is truly going to be a consumer product, these factors need to be considered.

6.4.1 The product needs to be unisex, in the sense that it doesn't deliberately try to emulate an older trend of using gender stereotypes to market towards a given group, rather attempt to galvanise a new generation using strong universally appealing imagery.

6.4.2 The product needs to suit the age-range I've chosen upon (5-7 years), and not contain any typically unsuitable imagery/language.

6.4.3 Evidence suggests that anchoring the product's image in a "strong role-model" is likely to fair better with consumers. Ideally this role-model should be a "teacher, scientist, inventor, athlete or similar aspirational career path." (Mintel, 2018), this could also be an opportunity to create a disabled-heroic role-model, in order to further improve a disabled child's self-image, as well as educate their peers.

6.4 The product evokes a strong sense of brand and character, even if said brand is rather abstract.

6.4.1 A lot of research was made sure the product evokes a more gender-neutral theme, resulting in a product that tends to be considered as male or female dependant on who you ask.

6.4.2 It doesn't

6.4.3 As the product features a more abstract theme, it aimed to remove itself from more domestic role-models in favour of fantasty.

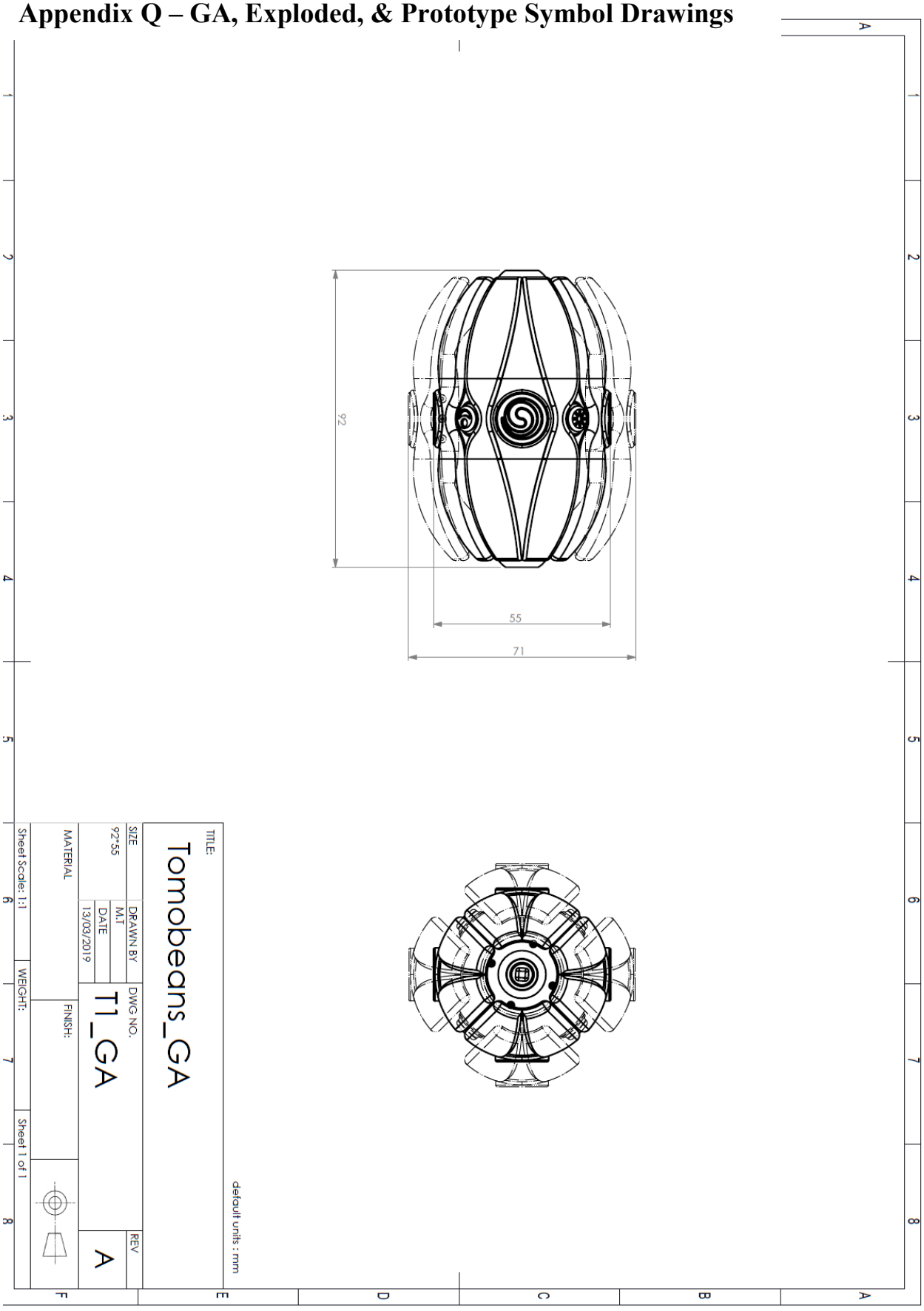
Appendix P – Prototype Gantt Chart

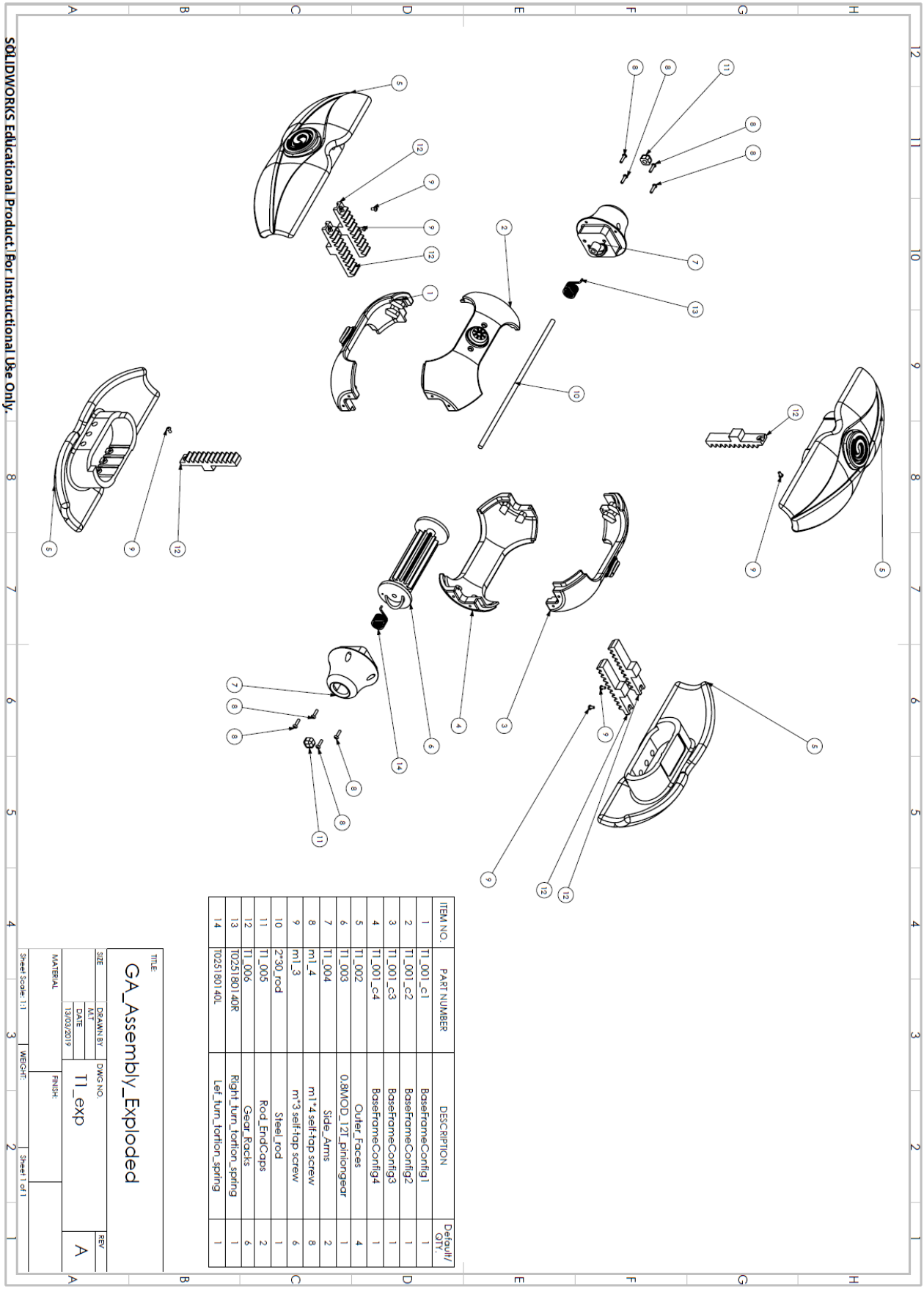
Tomobeans Workshop Gantt Chart

Today's Date	03 Jun 2019, Monday
Designer	Michael Thundow
Week Starts from	Monday
Start Date	01/04/2019

Part	Tasks Name	Material	Method	Date	Duration	Projected End
	MainBaseFrame			01/04/2019	3	03/04/2019
1	MainFrameSkins	HIPS	VacForm	01/04/2019	2	02/04/2019
2	Symbols/Embelishments Fab.	Acryllic	LaserCut	01/04/2019	2	02/04/2019
3	MainFrameJig&Cut to Size	MDF	MDF Fab	03/04/2019	1	03/04/2019
4	Assembly	-	Adhesive	03/04/2019	1	03/04/2019
	Outer_Face			01/05/2019	6	06/05/2019
1	Outer_Face Top Skins	HIPS	VacForm	01/05/2019	2	02/05/2019
2	SpiralDisk & Other Features Fab.	Acryllic	LaserCut	01/05/2019	2	02/05/2019
3	OuterFaceAssemble	-	Adhesive	01/05/2019	1	01/05/2019
4	SlidingFaceSkins	HIPS	VacForm	02/05/2019	2	03/05/2019
5	Assemble	-	Adhesive	03/05/2019	4	06/05/2019
	SideArms			04/04/2019	30	03/05/2019
1	MasterCreation	ABS	ABSLathe	04/04/2019	25	28/04/2019
2	MoldMaking	Resin	MoldMake	29/04/2019	2	30/04/2019
3	Casting	TPU	Casting	01/05/2019	3	03/05/2019
	OtherParts			07/05/2019	3	09/05/2019
1	RodEndCaps Fabrication	HIPS	HIPSFab	07/05/2019	1	07/05/2019
2	GearRacks Fabrication	Acryllic	Laser&Fab	07/05/2019	1	07/05/2019
3	GearPinion Fabrication	Acryllic	LC&Fab	08/05/2019	2	09/05/2019
4	Stickers	Adhesive Paper	Decaler	10/05/2019	1	10/05/2019
5	MotherPodBase	HIPS	VacForm	13/05/2019	10	22/05/2019
6	MotherPodTop	PLA/PETG	Print	06/04/2019	14	19/04/2019
	Assembly & Test			**13/05/2019**	**22**	**03/06/2019**
1	QA Test & Check	-	Eye	13/05/2019	1	13/05/2019
1.1	Assemble Test	-	Screws etc.	14/05/2019	1	14/05/2019
2	**Duplicate Parts for Show / Buffer**	-	-	**14/05/2019**	**21**	**03/06/2019**
3	Painting & Finishing	Painting/Sandpaper	Paint	20/05/2019	23	11/06/2019

Appendix Q – GA, Exploded, & Prototype Symbol Drawings





ITEM NO.	PART NUMBER	DESCRIPTION	Default/ QTY.
1	T1_001_c1	BaseFrameConfig1	1
2	T1_001_c2	BaseFrameConfig2	1
3	T1_001_c3	BaseFrameConfig3	1
4	T1_001_c4	BaseFrameConfig4	1
5	T1_002	Outer_Faces	4
6	T1_003	0.8MOD_12T_piniongear	1
7	T1_004	Side_Arms	2
8	m1_4	m1*4 self-tap screw	8
9	m1_3	m*3 self-tap screw	6
10	2*30_rod	Steel_rod	1
11	T1_005	Rod_EndCaps	2
12	T1_006	Gear_Racks	6
13	T025180140R	Right_turn_torfion_spring	1
14	T025180140L	Lef_turn_torfion_spring	1

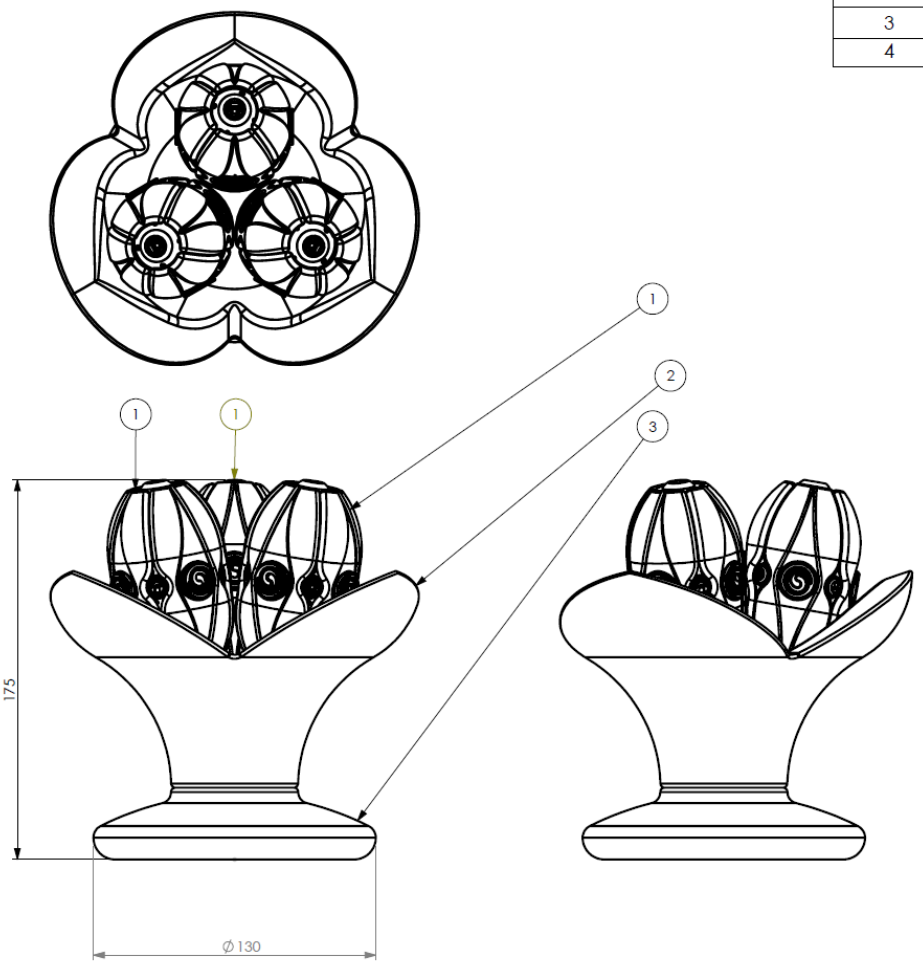
TITLE: GA_Assembly_Exploded

SIZE	DRAWN BY	DWG NO.	REV
	M.T	T1_exp	A
	DATE 13/03/2019		

MATERIAL: FINISH:

Sheet Scale: 1:1 WEIGHT: Sheet 1 of 1

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	T1_001	TomoBean	3
2	MP_001	Mother_Pod_Top	1
3	MP_002	Mother_Pod_Bottom	1
4	BS EN M4 x 5 - ST	m4*5_Self_Tap_Screw	1



default units : mm

TITLE:

Tomobean_&_Stand_GA

SIZE	DRAWN BY	DWG NO.	REV
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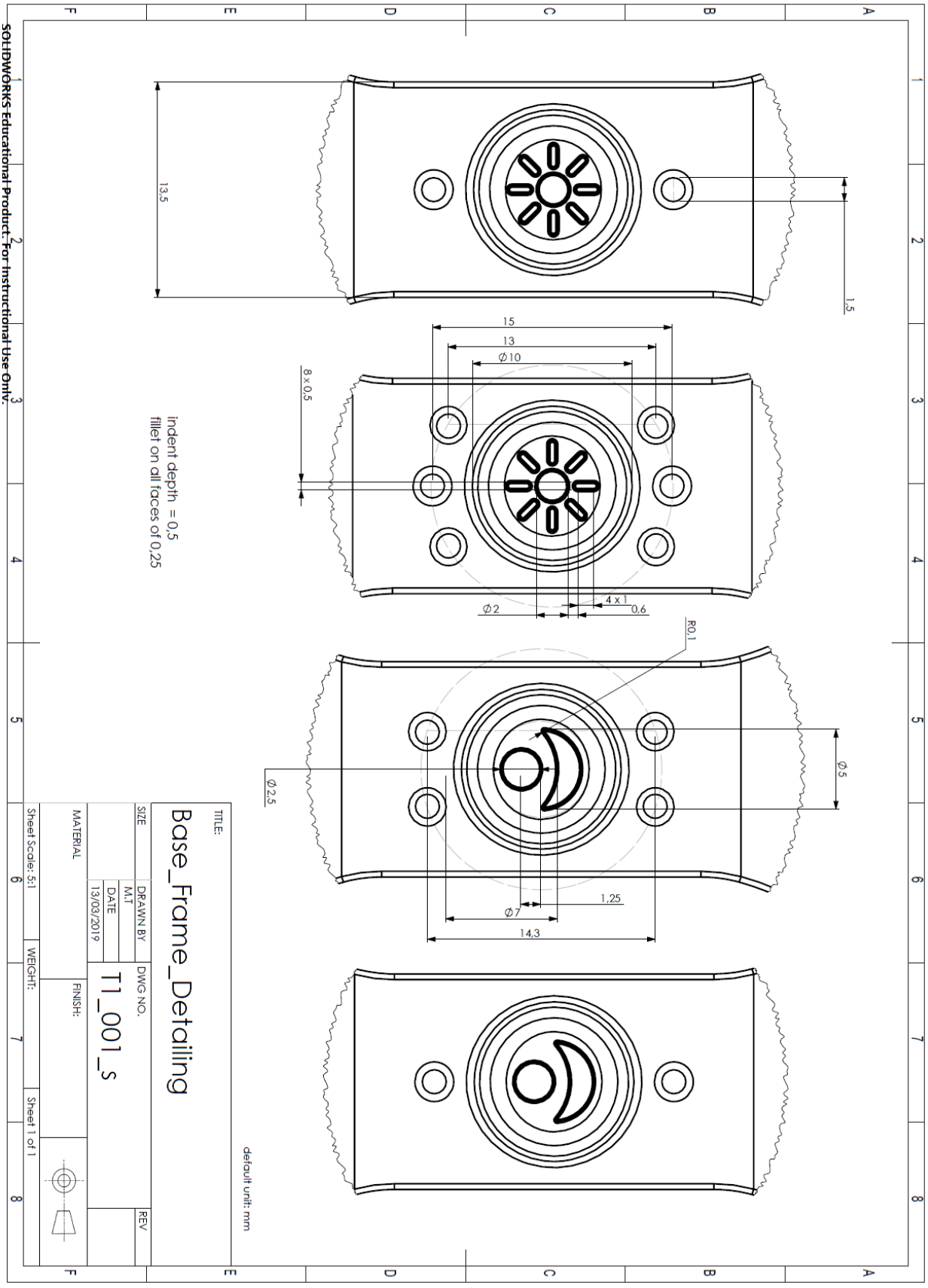
	DATE 13/03/2019		

MATERIAL | FINISH:

Sheet Scale: 1:2 | WEIGHT: | Sheet 1 of 1


SOLIDWORKS Educational Product. For Instructional Use Only.
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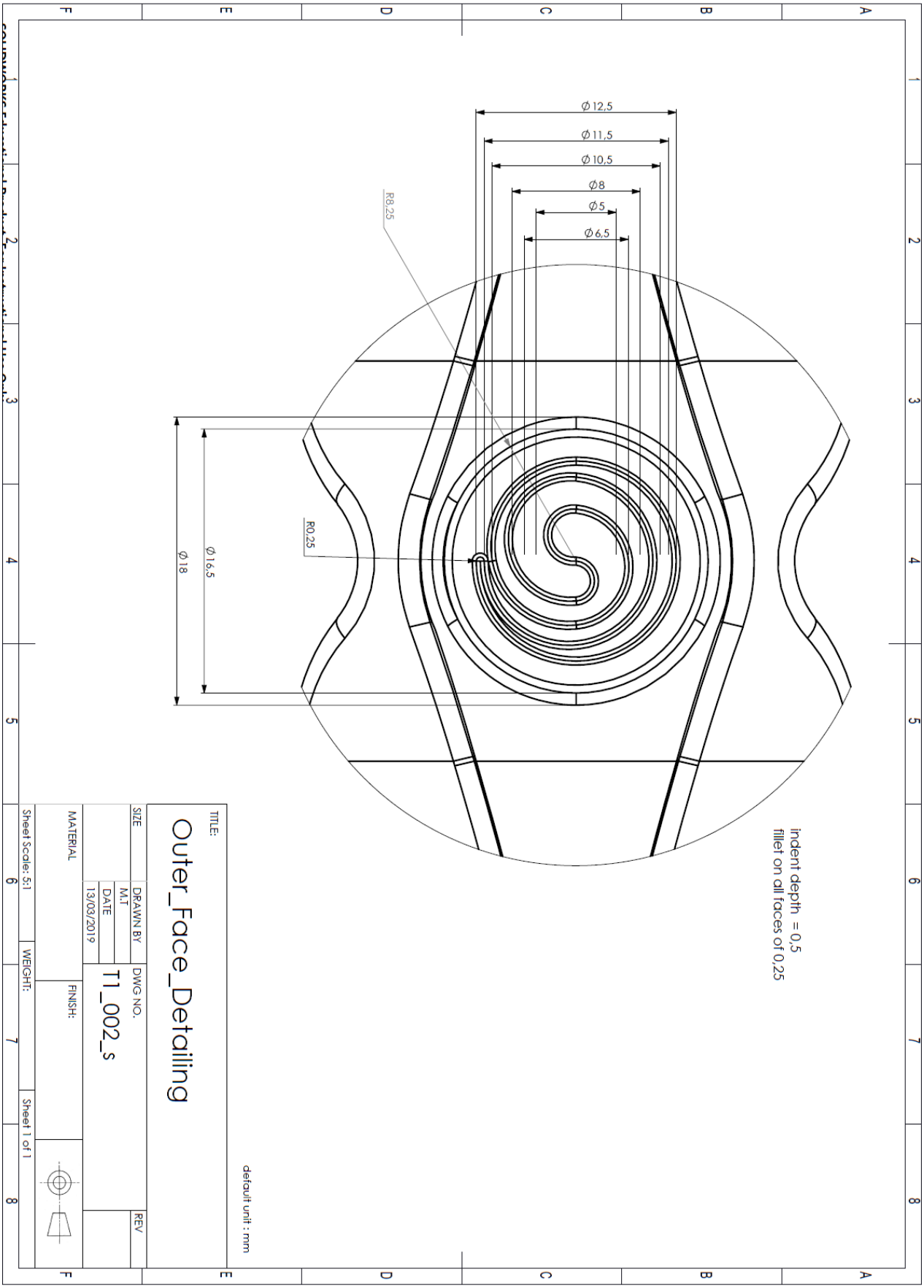
1,5
15
13
Ø10
8 x 0,5
indent depth = 0,5
fillet on all faces of 0,25
Ø2
4 x 1
0,6
R0,1
Ø5
Ø2,5
1,25
Ø7
14,3
default unit: mm
TITLE:
Base_Frame_Detailing
SIZE
DRAWN BY
M.T
DATE
13/03/2019
DWG NO.
T1_001_s
REV
MATERIAL
FINISH:
WEIGHT:
Sheet Scale: 5:1
Sheet 1 of 1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Ø11,5
Ø10,5
Ø8
Ø5
Ø6,5
R8,25
R0,25
Ø16,5
Ø18
indent depth = 0,5
fillet on all faces of 0,25
default unit : mm
TITLE:
Outer_Face_Detailing
SIZE
DRAWN BY
M.T
DATE
13/03/2019
DWG NO.
T1_002_s
REV
MATERIAL
FINISH:
Sheet Scale: 5:1
WEIGHT:
Sheet 1 of 1

13 Bedford Row
London
WC1R4BU

Morris & Phillipson LLP
Intellectual Property Experts

03/05/2019

Dear Mr Thurlow, Ms Smith and Ms Taylor

RE: Intellectual Property Law Protection for Designs

I hope this letter finds you all well.

Further to our previous correspondence regarding the intellectual property protection for your designs, I am providing you with an overview of the intellectual property rights and protections your designs may be eligible to.

Trade Mark

A trade mark distinguishes a business and its goods or services from competitors[1] and minimises risk of confusion.[2] A successful registration will confer exclusive rights upon its owner.[3] Words, designs, names and shapes are capable of registration.[4] Shapes are registrable if they differ significantly from other products in the market.[5] Your trademarks should be clear and precise.[6] For a successful application it must be capable of graphic representation,[7] which means that it is possible to determine what is being protected. [8]

It is possible to protect an unregistered trade mark through passing off in the UK, however, registration offers greater certainty.[9] By registering a trade mark, you can prevent others from exploiting your brand identity. Trade marks can be licensed, franchised or sold as an asset. They encourage creativity and innovation by rewarding the creator. Trade marks are beneficial as they indicate quality[10] and establish designs in the market.[11]

The fee for a trade mark is £200 for one class and £50 for each extra classification. Trade marks can last indefinitely as long as they are renewed every 10 years.[1213] You can apply online, which provides for a £30 discount.[14]

There are different classifications for trademarks which are important to know before applying. The relevant classifications for each client are; Tomobeans' classes are 28, 37, 41 and 42. Backbuddie's classes are 10, 16, 18 and 20. Belinda's classes are 20, 21 and 39.[15]

For Tomobeans and Backbuddie you could trade mark the name. I have searched the Trade Mark Register and the names are not currently trademarked.[16] The oil container does not have a name and therefore you could create an interesting name to trade mark in the future.

For Backbuddie the logo is markable. For Tomobeans and the oil container, you could create a logo which could aid in establishing your brands in the market.[17] For all of the designs the shape will not be registrable. They do not significantly differ from goods and services currently in the market and/or their shape is necessary for their technical function.[181920]

Copyright

Copyright gives the right to exclusively control and exploit creative works. It protects literature, art, music, dramatic works, sound recordings, photographs, software, databases, films and radio and television broadcasts.[21] The work must be a fixed expression (written down) and original to obtain copyright. [22]

The benefits of copyright are that it grants copyright owner exclusive rights to authorise or prohibit certain uses of their works. This includes; copying the work, distributing copies to the public, adapting the work, communicating the work to the public[23] and renting/lending copies to the public.[24] You can license its use which allows someone to use the work in a specified way for a period of time.[25]

In the UK copyright is an automatic right which exists as soon as a qualifying work is created. There is no formal registration and no fees to pay. The duration of copyright is for the life of the creator, plus 70 years from the end of the calendar year in which they died.[26]

Technical drawings and blueprints can be copyrighted.[27] All of your drawings for your designs, as long as they are original, will be automatically copyrighted.[2829] However, this does not protect the design itself and the production of your designs.[30]

Design

Design refers to the appearance of products. A registered design is where your designs are examined and registered by the Intellectual Property Office.[31] The design must be new and have individual character.[32] The design must have a special shape, configuration, pattern or ornamentation to be registered.[33] The shape cannot determine its function. The designs must be different from existing products.[3435] This is the equivalent to the European Community Registered Design.[36]

Automatic design rights exist in the UK (UK Unregistered Design Right) and in Europe (Unregistered Community Designs). They offer limited protection and can be difficult to enforce. They have a shorter duration 10-15 years compared to 25 years for a registered design. Relying solely on unregistered design right may not be as effective as a registered design. [37]

Registering your design allows you to gain a marketing edge by preventing others from using it. This includes the making, offering, putting on the market, importing, exporting or using of a product in which the design is incorporated, or stocking such a product for those purposes[38]. A design can last for 25 years as long as you renew it every 5 years. The fees for renewal are; first renewal £70, second renewal £90, third renewal £110 and fourth renewal £140.[39]

For Tomobeans, I believe the shape dictates the function and therefore it cannot be registrable. You must be aware of how large the toy market is, and there are similar

shapes and designs on the market, which means that Tomobeans may lack individual character.

Backbuddie may not be registrable because the shape and ornamentation of the design is common. The removable lumbar support itself will not be able to be protected under this right. A consumer is likely see this product as an ordinary child's backpack.[40]

For the oil container the shape may not be registrable as it dictates the technical function of the product. If the design dictates the technical function of the product, then it cannot be protected by design rights.[41]

Patents

Patents are granted for new technological developments, or in other words inventions.[42] A patent grants its owner a temporary right to exclude others from using the invention.[43] In order for successful patent application, the invention must be new, involve an inventive step and can be made or used.[44] Patents are beneficial as they can be sold as an asset. You could license your patent and use it as a revenue. Global value in IP licenses is worth over £600bn per year.[45]

Obtaining a patent in the UK requires registration. The registration process in the UK and in the European Patent Office entails a full examination of the patent which can be costly and time-consuming, but improves the quality of the patent.[46] Patent protection is granted only if there is complete disclosure.[47] This means a patent will not be granted if the applicant holds back information.[48] The invention must be clear and complete.[49] The patent will not be granted where the invention is in the public domain, for example if information regarding your invention can be accessed by the public.[5051] Therefore, it is important that your designs are confidential and precautions are taken such as using non-disclosure agreements.[525354]

There are three stages to the patent application; Filing the patent, a worldwide search to check your invention is new and patent examination.[55] This process can take 5 years.[56] Patents can last up to 20 years.[57] It costs £310 for a basic UK patent application online and £400 by post. If you were to renew your patent through the 20year period it would cost £4950[58].

It is useful to search the published patents for similar patents. Once this is done, your designs have to satisfy the criteria I have mentioned.[59]
Tomobeans could satisfy the criteria and through the inventive use of the rack-and-pinion system of motion which itself is not unique, but unlikely to have been used in this way before.[60] However, it is important to consider the large market as there may be similar inventions.[61] Having searched the patent organisation there are toys which use this system in a similar way, however, they were filed in 1969 and 1973.[62] This will not prevent you from applying for a patent as it is subject to examination.

Backbuddie does not satisfy the inventive step criteria.[63] There are similar products on the market which I found through a search for current patents.[64] It must be clear that your design is unique in comparison, which it does not appear to be. [65]

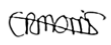
For the oil container, the design does not satisfy the criteria through lack of inventive step. Having searched the patent organisation, there are similar inventions patented.[66] Therefore, a successful patent application is unlikely.

Trade Secrets

Trade secrets are a secret which has commercial value, and reasonable steps must be taken to keep it secret.[67] Trade secrets are one of the greatest forms of defence of intellectual creation and innovative know-how.[68]
Trade secrets can be applied to all of your designs. For Backbuddie and the oil container it is a good alternative to patents.[69] Your designs will be protected if you do not disclose any information to the public and keep strict confidentiality.[70]

I hope this information can be of some help to you. If you have any queries please do not hesitate to contact me.

Kind regards.
Your sincerely



Word Count: 1500

[1] Trade Mark Act 1994 S1(1) and Trade Mark Directive 2008/95/EC Art 2
[2] Trade Mark Act 1994 S1(1) and Trade Mark Directive 2008/95/EC Art 2
[3] Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016)
[4] Trade Mark Act 1994 S1 (1)
[5] C-136/02 Mag Instrument v OHIM [2005] ETME 46 (ECJ)
[6] (C-273/00) *Ralf Sieckmann v Deutsches Patent und Markenamt* Sieckmann [2002] ICLR 424-, self-contained, easily accessible, intelligible, durable and objective
[7] Trade Mark Act 1994, S1 (1)
[8] C-49/02 Heidelberger Bauchemie GmbH [2004] All ER 268
[9]Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016)
[10] Trade Mark Act S3 (c)
[11] Robert G. Bone· Trademark Functionality Reexamined, (2015) JLA 7
[12] Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016) -Example of Bass Plc, they first registered the red triangle on 1st January 1876 and it still a valid registered trademark.
[13]Trade Marks Act 1994 S42(1)-(2)
[14] Government, 'Apply to Register a Trademark', (2019) <https://www.gov.uk/how-to-register-a-trade-mark/apply> accessed 26 April 2019
[15] Government, Search for a trade mark (Trade Mark Register) <https://www.gov.uk/search-for-trademark> accessed 25 April 2019
[16] Trade Mark Act 1994 S10(2)
[17] Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016)
[18] C-48/09 *Lego Juris A/s v OHIM* [2010] ALL ER 223
[19] Trade Mark Act 1994 S3(2)
[20] C-215/15 *Societe des Produits Nestle SA v Cadbury UK* [2015] All ER 85
[21] Copyright Designs and Patents Act 1988, S1(a)-(c)
[22] Copyright Designs and Patents Act 1988 S16 (a)-(e)
[23] Copyright Designs and Patents Act 1988 Sections 16-21
[24] Copyright Designs and Patents Act 1988 Sections 16-21
[25] Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016)
[26] Copyright Designs and Patents Act 1988 Sections 12-15
[27] *British Northrop Ltd v Texteam Blackburn Ltd* [1974] RPC 57 (CH)- drawings as original artistic works for copyright purposes
[28] *Interlego v Tyco Industries* [1988] 3 All ER 949 (PC)
[29] Justine Pila, An Intentional View of the Copyright Work, 71(4) MLR 535–558 (2008)
[30] Copyright Designs and Patents Act 1988, S51 (1)
[31] Charlotte Waelde, Abbe Brown, Smita Kheria, Jane Cornwell, Contemporary Intellectual Property, (4th Edn, Oxford University Press, 2016)
[32] Registered Designs Act 1949, S1B(1)