THE UNIVERSITY OF WARWICK

The Imagineerium

Pilot Project 1 - with schools

- Report for Imagineer Productions

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EXECUTIVE SUMMARY

Between March and August 2014, 75 9-10 year olds from Coventry schools sited in some of the most deprived areas of the city worked with professional designers, engineers and artists to imagine and create kinetic structures and perform them as part of the Festival of Engineers on 9th August 2014. The project sought to stimulate interest in a new kind of creative engineering, developed through quality aesthetic experience.

Three kinetic structures and performance events, generated through children's ideas and interests featured as a central part of the Festival of Imagineers on 9th August 2014, attracting the interest of the public, the council, engineering companies and businesses. The models, structures and film of the process will also feature as a 'Godiva Cavalcade for the 21st century', alongside Jaguar LandRover and other regional engineering companies at the Festival of Motoring, Stoneleigh Park on 23rd and 24th August 2014.

Positive Outcomes

- The imaginative and aesthetic frame for the project inspired the children. Costumed Imagineers arriving at school, on a cycle powered travel machine with an urgent task of invention for which children's imaginations are needed, coupled the story of a resilient hummingbird encouraging children to never give up, set high expectations and gave a real impetus to the project. A number of children spoke of this metaphor as encouraging self-belief.

- A physical and practical approach to learning scientific concepts was highly successful, with 80% or more of children rating the interest and effectiveness of all such approaches. They learnt about how forces and gravity operate and how mechanisms such as levers, cams and pulleys work, through physical arts-based movement. As they designed and made their imaginative structures they learnt how materials can work.

- The experience of the professional working space of the Imagineerium (a vast industrial warehouse space in Coventry city centre, kitted for construction and rehearsal across arts and technologies) was highly significant. 94% of children considered there was high value in seeing products (like the 6mtr tall Godiva puppet) made through engineering and arts processes, and working with professionals in the Imagineerium.

- The professional expertise of the Imagineers (artists and engineers working together in creative roles) was recognised and highly rated with over 80% of children reporting the importance of these skills. The fact that the project was a real-life commission was considered equally important.

- The experience of working on a real commission, mirroring the working practice of a professional design team, whose members support and learn from each other, was exceptionally successful. 90% of children rated this aspect of the project highly.

- Children reported a high sense of ownership of learning. They attributed this to the invitation to use their own ideas and record ideas in their own journal, the responsibility they took within for their team and also to the freedom of the various professionally resourced Imagineerium workshop spaces.

- Before the project 38% of children did not know what an engineer was. The most common definition was a ‘fixer’ or a mechanic, mending broken cars, electronic or mechanical objects. After the project 93% of children could explain what an engineer was. Explanations centred upon making, with the idea of inventing also being present. The same expansion of insight happened in relation to artists, with a significant shift from painting and drawing into designing, making, inventing. There was a new understanding of the interrelationship between the skill sets of engineers and artists.

- The project stimulated interest in engineering and ‘Imagineering’ (combining arts and engineering skills) with 60% of children stating interest in a career in engineering, arts or imagineering a week after the project. Over 80% of children also stated that they were now more curious about engineering and the arts as a result of the project. In interview some children explained this as ‘having more questions now’.

What we learnt

As a pilot project of new partnerships and practice, the experience generated a wealth of learning:

- To develop depth in a complex interdisciplinary project like this, we need greater strategic development with partners in engineering, STEM education, arts and social change. This will help us to identify shared aims and develop a better focus for each project.

- So that all partners can suggest what approaches, resources and connections they can bring to a project we need earlier clarification of aims, core content and personnel roles.

- We need greater opportunity for partners to witness and exchange practice-based insights into each sectors’ processes, to plan collaboratively and develop the embodied approach more integrally before the work with children starts.

- Partners need further training in facilitating and questioning and in the signature pedagogies which foster artistic and engineering habits of mind in order to work more effectively with children in the project and improve the quality of creative and

engineering thinking and talking in children. STEM education experts may be helpful here.

- Engagement of other STEM education partners to deepen the interest in and experience of engineering habits of mind. This might include imagineering clubs, engineering students and STEMNET ambassadors leading complementary strands or parts of the project.

- Greater use of the Imagineerium as experience of a professional resource and working space. There is potential for digital developments to complement access to the professional resource.

- Greater use of group roles for children to give responsibilities which challenge children to work from their interests and also to deliver systematically.

- Review and strengthening of the imaginative frame and the professional arts context for the project as motivation, inspiration and social practice is needed.

- Development of the huge and specific expertise from participatory arts for social change to develop more in depth public engagement in the Imagineerium initiative.

RECOMMENDATIONS

- The impact of embodied, arts-based learning on children's STEM learning is demonstrated here and can be taken further
- The impact of this embodied, arts-based learning on raising children's understanding of engineering and arts, and their aspirations, especially for girls, is also demonstrated and can be taken further
- This was an effective partnership which developed new skills in teachers, engineers and artists which can be taken further through recognising that attention to the partnership itself is a key part of project success
- There is a need for further joint work for partnerships of teachers, artists and engineers to together develop their understanding of each others' professional practices and languages so that new collaborative methodologies can be implemented in future projects
- Training for teachers, artists and engineers, in facilitating and questioning in the signature pedagogies which foster artistic and engineering habits of mind will be key to the success of future projects
- Embedded evaluation was shown to produce deeper and richer conversations about practice and impact and can be taken further

1. The Imagineerium

1.1. The Imagineerium Initiative

The Imagineerium Initiative is concerned with developing a new kind of creative engineering with economic, artistic and social value for post-industrial centres such as Coventry. It is focused on *coaching the habit of invention* and feeding the appetite for and valuing of applied and innovative craft which require engineering know-how and social connection. The Imagineerium will be a physical, virtual and symbolic space in which to imagine, engineer and invent.

The initiative has grown from Imagineer's experience of connecting community, engineers and artists, which suggested that there is potential to generate extraordinary engineering, cultural products and events. These are shaped by, and appeal to, a wider set of capacities and purposes than each industry might draw on separately. In the Imagineerium, artists and engineers will have access to young people's thinking and young people will have access to the vision, expertise and knowledge of artists and engineers. Together, working on live projects, they will learn and invent.

The scope and potential appeal of Imagineerium projects is across generations, across interest groups, across the past and into the future of the city. While Coventry is a post industrial centre with engineering skills and passions located predominantly in one strand of engineering (mechanical engineering and cars) this project explores show how, through creativity and partnerships with the arts, these skills might be adapted, new ones learnt and further innovation possible.

1.2. Why does the Imagineerium approach matter?

In a situation of intense international competition to produce desirable products, the shortage of engineers in the UK presents a significant challenge. The paucity of women in engineering is part of this problem. The Imagineerium pilot project sought to test the appeal of the arts to engage girls and boys of primary school age in thinking imaginatively and like engineers. It chimes with the recommendations of the recently published report 'Thinking like an engineer' which recognises a 'signature' pedagogy for engineering and advances the growth of dualistic habits of mind which span creativity and logic (Royal Academy of Engineering / Centre for Real World Learning, May 2014).

The notion of 'Imagineering' in this context draws from Walt Disney, who used the term to describe 'its blending of imagination and engineering'. It reflects the partnership between Imagineer Productions and Imagineer Technologies to imagine, design and invent for social, aesthetic and economic purposes.

The pilot project at the heart of this project engaged young people as apprentice Imagineers, here commissioned to build amazing kinetic structures for Coventry's Festival of Imagineers in August 2014. It followed a tested professional Imagineer process of imagining, alone and collaboratively, designing, creating a model, building a prototype and testing it. The whole commission was set through an imagined frame of time-travelling Imagineers who appear costumed and on a cycle-powered structure one morning in the children's playground seeking to commission imaginative children. This framework, supported by the professional resource of the Imagineerium and expertise of the Imagineers generated a powerful arts context combining the imagined and the real, the playful and the serious, creativity and logicality.

Additionally the project drew on previously tested embodied cognitive practices developed by Highly Sprung Physical Theatre Company to teach scientific concepts as part of a very practical learning process.

2. Pilot project aims and outline

2.1. Aims

To initiate the Imagineerium vision a research and development plan has been scoped, with its first step being a pilot project in Coventry primary schools. Through this pilot we began to create and test the kinds of frameworks, processes, opportunities, spaces and resources needed for such practice. Our question was, how effective might an 'Imagineerium', real world project be, in terms of helping young people to

- be inspired by imagining, designing and making within a professional arts and engineering context
- learn experientially about the arts and science (and their connectedness), through imaginative, arts-based, embodied and practical learning approaches
- develop their creative capacities
- apply their analytical abilities
- develop an idea from the imagination through to realisation

We are especially interested in the extent to which these innovative processes help all young people, but particularly girls and disadvantaged young people become motivated and curious to find out more, study STEAM subjects (science, technology, engineering, arts and maths), and pursue careers in engineering, the arts or imagineering. Above all, the project feeds into and informs young people's raised aspirations.

The Imagineerium initiative also seeks to provide opportunities and routes to support artists and engineers to collaborate and create in new ways. Whilst this was

not the lead priority of this pilot, the establishment of a partnership between education, engineering and the arts was an element of the evaluation. Imagineer were interested in how possible it might be for professional artists and engineers to

- become excited about creating from young people's ideas
- collaborate with and learn from professionals across the arts and science fields
- innovate in their own practice.

2.2. Outcomes

Young people from three Coventry city schools created 13 design ideas and models collaboratively with artists and engineers, using professional processes and environments they had not previously known. Through school based voting, three ideas were selected (one from each school) and built to full scale for the Festival of Engineers 2014. Following this brief, young people have imagined, sketched, designed, constructed and dressed a model for an extraordinary moving vehicle and also developed performance and costume ideas for performers to accompany it. They have seen the build in process, tested mechanisms at structural stage, dressed it at soft structural stage and then, children have engaged in additional workshops to develop the performance which accompanies their kinetic structure.

This August the Godiva event in Coventry City centre will explore how the concept of imagineering can be articulated and celebrate a past and future of imaginative, exciting and extraordinary engineering and invention. These three mini-cyclopaedia with their unique designs will form a key part of this public event, alongside local and national partners in engineering, cycling sports and culture, The designs potentially mark the beginning of a new kind of pageant for the 21st century: in which children's imaginative and scientific capacities and their potential as Leonardo da Vinci-like artist inventors are celebrated. Their work will also be celebrated at the Royal Show, Stoneleigh on 23rd and 24th August alongside internationally renowned engineering companies.

2.3. Participants

Imagineer Productions developed the Imagineerium pilot project during Autumn 2013. The potential impact of developing new ways of working through partnerships with young people, artists and engineers emerged following their highly successful Godiva Awakes project for the UK 2012 Cultural Olympics. The Imagineerium Pilot builds on the relationships developed then with local businesses interested in the regeneration of Coventry's engineering sector.

A number of engineers were involved at different levels. Key was Roger Medwell ex CEO of NP AeroSpace and now of Imagineer Technologies. Nick Martin, also from Imagineer Technologies, an electronic as well as mechanical engineer, designer and filmmaker was also involved in early planning of the project. Two retired mechanical engineers from the Imagineering Foundation were also consultants and advisers. In the latter stage of planning Phil Eddols a theatre designer and engineer joined the team, as Nick's commitments clashed with project dates. Nick intends to be part of the next project.

Three Coventry based artists were involved in the project: Kathi Leahy as project lead for Imagineer and Sarah and Mark Worth of Highly Sprung Physical Theatre Company.

All three Coventry schools were sited in high deprivation areas, according to government indices of multiple deprivation (IMD), and were chosen as schools known to be pro-active in seeking exciting opportunities to feed learning and for having developed engaging, skills-based curricula. This was recognised as an important test for this project, which was designed to excite learners.

The project began in March 2014 with 75 children aged 9-10 (Year 5). All of the children live in areas classed as having multiple deprivations. 60% of children live in the '10% most deprived' lower super output areas (LSOA) in England, 30% living in the '20% most deprived' and just 10% in either 30% or 40% most deprived'.

At least 15 different ethnicities are represented across the schools. Pakistani is the dominant ethnicity in school two which is almost totally South Asian. It is a significant ethnicity in School One but there is a wider variety of ethnicities here. School Three has more variety between ethnicities.

Across the 75 children involved, 58 are learning daily in a language which is not their home tongue. Twenty different languages are spoken at home. 26% of children speak Urdu at home, 22% speak English, almost 10% speak Panjabi, but almost half of these children are speaking a language no-one, or ocassionally one other person, in their class speaks. All children and adults spoke in English throughout the project.

Fewer than half of children (42%) began schooling from nursery (age 3) and even by the legal age of rising five, only 54% of this cohort were admitted into their current school. We have no data to reveal whether they were in an English speaking school elsewhere. Certainly within the timescale of the project (4 months), 7 children left or arrived in their class, 5 locally, 2 unknown. Schools report a relatively transient population in this area. Admissions after reception occur at a rate of between 5 and 9 per year, with approximately 10% of children having only been in the current school since Autumn 2013 or more recently. In School Two, seven children who are regularly supported with literacy have a range of admission dates

from 2007 to 2013 suggesting that a greater complexity of factors beyond years schooling and stated language spoken at home affect language acquisition.

This pilot project sought to increase the opportunity for families living in areas of multiple deprivation to access new opportunities and test possible learning and career aspirations.

2.4. Activity

The main project activity involved each school over a five-week period. Once a week, for four weeks Imagineer led a three-hour long session in each of the three schools and in the fifth week schools came for a full day to the Imagineerium, (Imagineer's central Coventry workshop). Additionally schools did some additional writing about the project and ran a school event where groups of children presented their design idea for other children throughout the school to vote on.

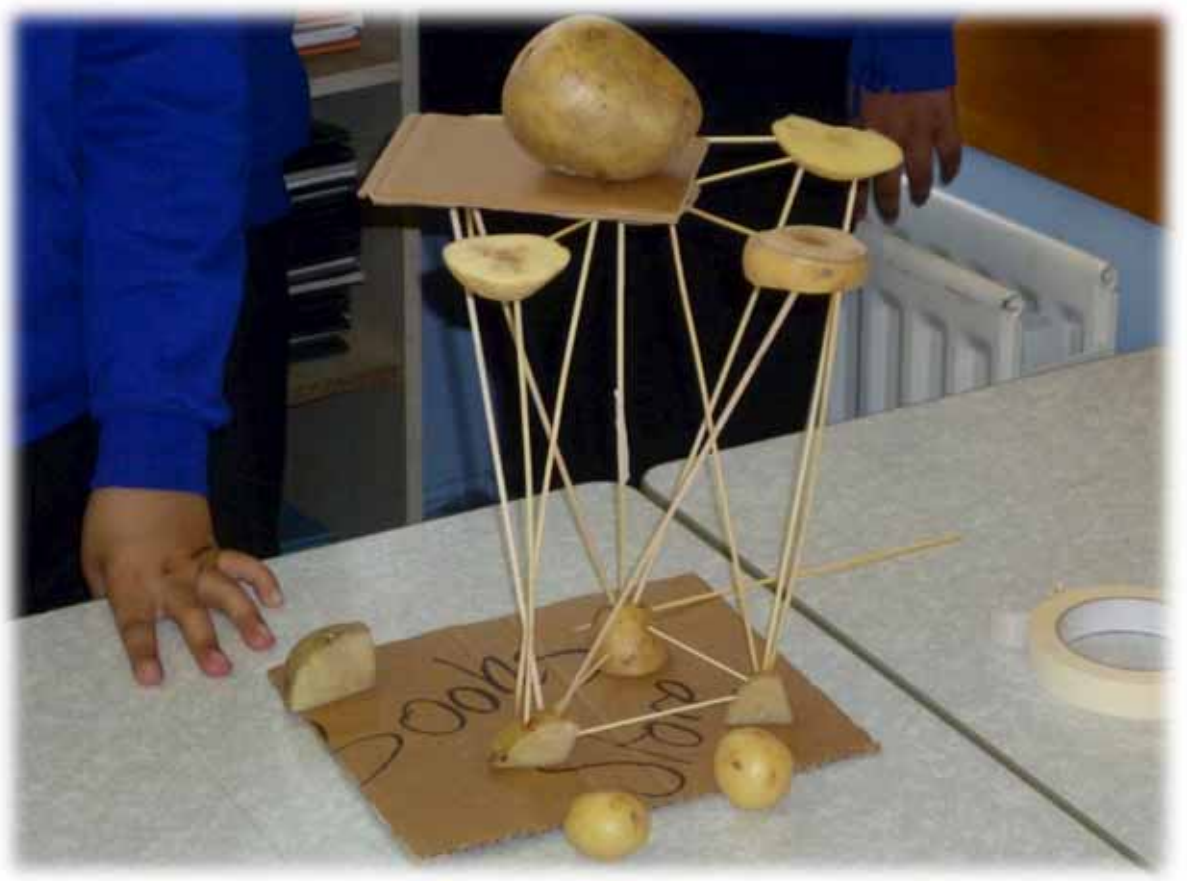
Two engineers, three performance artists and an Imagineer project manager led the sessions, with Imagineer's CEO joining the work in the Imagineerium.

The project began with the arrival of a 'mini-cyclopaedia' (a platform powered by three tricycles), dressed as a time travelling machine, powered by and bringing five 'imagineers': adults costumed as 1930s aviators, with long flowing coats, waistcoats, flying helmets and goggles. They told the children that they had been travelling time and space to locate a particular class of Year 5 pupils who were full

of imagination - the Imagineer's had exhausted their ideas – and who could help them with a challenge set by a Coventry City Councillor. The group arrived before school and were in the playground talking to children and adults about their mission and their journey. Teachers and assistants had a kind of 'navigator badge' – like a homing device - and had primed the children to expect something new. Children were typically curious and then excited about the prospect of the challenge. Once chests and suitcases were transported to the classroom, clues were discovered about the task: a commission on a scroll to 'imagine, design and create a unique, moving performance vehicle powered by cycles', which would engage audiences and show how inventive children can be as part of Coventry's Festival of Imagineers on August 9th 2014. Investigating a box of clues about Godiva's Coventry and then a drama activity allowed children to learn Godiva's story and her significance to the city. Through enacting and discussing a story about a resilient hummingbird story, children were invited to agree to work like hummingbirds: trying their best and persisting even when results are not yet apparent. The idea of invention and the development of ideas using science and the imagination was introduced through drawings from one of Imagineer's designers and from some historic inventors.

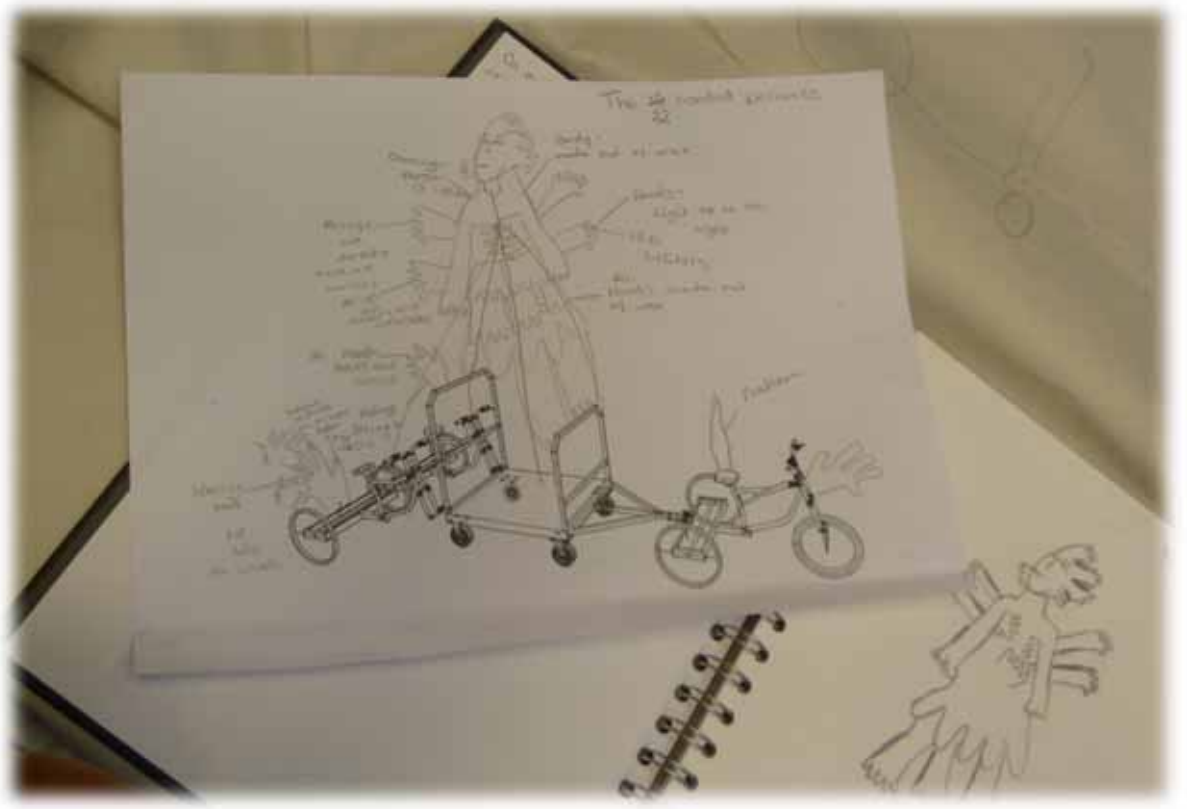
All sessions used embodied, practical hands-on and active learning approaches. In sessions two and three, the human body, animated by artists trained in physical theatre provided an arresting, visual and experiential introduction to scientific concepts key to engineering. Through their own bodies, children learnt how forces operate, how braces make structures strong to maximise and counteract natural

forces and how certain mechanisms such as levers, pulleys and cams create a mechanical advantage of natural forces to lift and move things. Engineers employed large-scale drawings and a range of large-scale models plus various everyday examples of levers, pulleys and cams for children to explore and test. Children were then set challenges with simple materials like card, sticks and potatoes to build and test model size structures, which might take a weight (a heavy potato) and thus simulate the problem of effectively supporting a weighty structure above the height of people. The engineers gently shook them to test how well they might cope with the mild forces of nature (the jolt of the road and the wind and rain of Coventry weather in August). Scientific and mathematical principles applied here were explained during the activities.



Alongside this, there was practice in how ideas can be developed collaboratively through talk and drawing. In each session children were drawing: sketching their own ideas in journals, sharing and developing and idea and then deciding on either one chosen idea or an amalgamation of ideas together as the group idea. They proposed a structure for their idea and worked on large paper, transferring the idea it to a scaled template of the mini-cyclopaedia platforms to begin the process of creating a 3D model.

A presentation was given of Imagineer's 6 metre tall Godiva Puppet, from initial idea to drawing, through to model and build of her and her transport mechanisms. Aspects of the worldwide history of carnival performance were demonstrated and children experienced through performance how devils led the procession, sweeping away the evil of the last year in a playful but menacing way.



The final day offered a different environment at the Imagineerium. Here the arts and engineering environments were experienced. Children were greeted by the animated 6 metre high Godiva and got to walk around her, try out the remote control eyes and head and look closely at her mechanisms. A designer / visual artist Imagineer presented an example display of a model and sample materials. She talked through how this might be developed to be animated, enlisting engineer help. She modelled how to pitch an idea for an animated model of a structure. Children's 3d models were significantly enhanced by the range of materials on offer and by access to the tools makers employ – with expert adult aid. Alongside model making, children created props, tried out and created some costume and headwear ideas. Outdoors, children developed a bespoke performance for their own design idea and performed together and in groups as if alongside their cyclopaedia in a procession, with an example structure at the height their own models will be when built. The project design phase concluded by groups creating an installation / display of their design idea using their model, fabric, journal sketches, other materials, props and costumes created. This was focal in each of their presentations where they pitched

their ideas to the Imagineers and their peers explaining persuasively the rationale behind their choice of concept, materials and design.

The following week each class rehearsed and again presented the pitches to either years 5 and 6 or the whole school, and children voted for the idea they thought was best.

Technical drawings of the selected model were drawn up and an Imagineer visited the school to show this to the children (now as if clients) and consult for clarification about structure, mechanisms and overall effect. In smaller groups of between 8 and 15, children visited the Imagineerium to see, advise on and help the build process.

At the first visit the structure for their model was in development and, using the support of a STEM education partner, children explained how the structure might be fit for purpose, how mechanisms worked or might work and what potential challenges we needed to consider. Some children bent metal for welding on to their structure but in this pilot there was limited actual build. At the second visit when the structure was complete and basically dressed, children worked in the workshop making things to decorate: a hand shaped necklace for a Princess, idea leaves for the Tree of Ideas and golden jewels for the tremendous Tree of Gold.

Children were invited to be part of the August event, which required parental support to bring them to a rehearsal and to the event in the city centre. These children attended an after-school workshop to develop the performance vignette which will perform repeatedly alongside the animated kinetic structure at the Festival of Engineers.

2.5. Funding

Project funding was provided by Arts Connect West Midlands, Coventry, Solihull and Warwickshire Partnerships (CSWP) and Coventry City Council. In kind support was provided by Imagineer Technologies, Shaw Sheet Metal, MIRA and the University of Warwick.

Schools contributed match funding for teacher cover for planning and evaluation, some resources and the cost of travel for children to the Imagineerium.

Additionally the project benefited from advice and interest of Imagineer's patrons: the Institution of Engineering and Technology (IET), The Imagineering Foundation and The Premier Group.

3. Evaluation methodology

3.1. Approach

A series of evaluation approaches were employed, to create a multi-perspective insight into the project before, during and after the events.

Early meetings between evaluation consultant Sue Challis and researcher Jo Trowsdale with engineers / artists / teachers separately were part of a new approach (developed by Sue Challis) being tested by Arts Connect, West Midlands. This approach positions evaluation as core to planning and asks adult partners to focus upon enabling the conditions to foster the kinds of creativity and learning key to the project. Using the collectively defined aims of the project as a reference point, each practitioner was invited to define the aspect they would like the project to address and how they might know if such change happened.

Additionally children's views were engaged directly through observations, surveys, discussion and interviews.

The following tools were used:

Before the project

- Children were asked 'to write on bespoke project postcard in response to two questions: 'What do artists do?' and ' What do engineers do?'
- Children completed a questionnaire asking them what were their interests, subjects enjoyed and kinds of learning activities they enjoyed. This was conducted by the researcher, who was able to talk through the questions, clarify and discuss any issues.
- 18 children, half of whom were considered by their class teacher to access learning easily and half who found learning challenging were interviewed in groups to deepen insight into their interest and attitudes to learning begun through the questionnaire.
- Parents were asked to rate: their child's interest in learning; their likely encouragement if their child were interested in a career in engineering or a career in the arts.
- Schools provided contextual data on children's postcode, ethnicity, language spoken at home and admission to school, current numeracy and literacy scores

- Imagineers and teachers identified an aspect they wanted to see change and proposed how they would record this change. Two schools planned to engage teaching assistants to conduct observations. Most artists planned to use journals; one suggested trialling an electronic / social media based journal
- Imagineers completed a pre-project online questionnaire about their ideas on arts and engineering, partnership working, their expectations and aims for the project, and their own professional development
- Funding partners were also invited to complete a shorter online questionnaire
- A wider public pool of artists and engineers were invited to complete an online questionnaire.

During the project

- Children were invited to take on additional roles as 'Scientist (noting in a book what has been discovered), Investigator (noting down evidence), Artist (sketching what is happening), Paparazzi (taking photos of learning), Interviewer (recording asking other children what they are finding out)
- Teachers took photographs of activity in response to their identified priorities of developing curiosity, persistence and collaboration.
- In two of the schools, teaching assistants noted examples of children demonstrating curiosity and persistence, using prompts suggested by the researcher in light of their school skills development approach.
- Imagineers reflected individually using different formats, often in written journals
- The researcher observed, photographed and filmed the process with a focus upon the 18 children interviewed.

After the project

- Children completed a questionnaire asking them to rate what had interested them and inspired them, what they had most enjoyed and had learnt from through the project. A rating for activities was conducted, especially to ascertain the appeal and effectiveness of embodied and practical approaches. Career ambitions were tested.
- The same 18 children interviewed before the project, were interviewed individually to deepen insight into their interest and attitudes to learning.
- After the build was complete, children completed a further questionnaire to test findings from the interviews against the whole group. Career ambitions were also re-tested at this point.
- After the build was complete, parents were asked to rate: their child's interest in the project; their own encouragement if their child were interested in a career in engineering or a career in the arts.

- After the build was complete, children were asked to write again on a bespoke project postcard in response to two questions: ‘What do artists do?’ and ‘ What do engineers do?’
- Schools provided re-tested numeracy and literacy scores

- A collective evaluation session was conducted with all partners. Initial findings from interviews and 80+ quotations form children and Imagineers were shared for wider review. Ideas were gathered in response to key aspects emerging from the project and revisions for a further project.

3.2. Arts Connect Pilot

The core concept of this evaluation process has real potential to develop valued reflective practice as an approach which

- *focuses upon the conditions* necessary to enable certain kinds of change,
- *invites practitioners to position themselves as the significant actors* in enabling and thinking about evaluation
- uses the very *medium of a practitioners’ practice* – in which they are expert - to evidence changes.

The format of the process in tabular form did not appeal to artists and did not feed into existing ways of recording for teachers or artists. Whilst orally Sue represented these ideas clearly, the underpinning principles (see above) were differently understood, despite pre-meetings. Whilst each aspect was covered and ideas discussed, the form was completed after the evaluation meeting – collating a range of possibilities following conversations – but without real opportunity to refine and individually commit to what actions would happen as part of the whole.

For us one possibility might have been to have a brief collective introduction to the principles as part of an early collective planning meeting where purpose is being agreed between partners with a task set to each partner to

- think about one change (which matters to the person, but fits under the umbrella of the project) and the conditions such a change might require.
- Begin to think about one means of evidencing change (tested or new; arts-based / active / practice based if desired).
- Email the key change to the evaluation coordinator before the next meeting

At the evaluation focus meeting

- All desired change / aims could be shared amongst partners.
- The evaluation coordinator might share examples of how evidencing might happen and how these examples reflect a focus upon conditions and actions. Partners can suggest ideas and offer peer support / affirmation to encourage

active evaluation, making use of media natural to the partners (if they are artists – this might be an art-form; if they are teachers this might be games / activity based) and appealing to those involved (in our case young people). Agreed actions could be recorded and heard within meeting,

- Buddies could be agreed to peer support in evidencing and encourage completion
- Agreed actions are emailed to each partner before and a reminder sent mid-way by the evaluation coordinator
- At a collective review meeting, each partner shares evidence and their own analysis of their evidence.

The Imagineerium pilot project, involved new partners who had not worked together before in this way and thus at outset had varied and limited insight into the others' field of expertise (be it education, design, performance or engineering). The project is a first step as part of an original concept and vision to begin to develop artistically minded engineers and engineering minded artists. As such all partners knew this would be a big stretch and this demand and the intensity of delivery (three days a week over five days in three different schools) may have been a factor in the heightened attention to reflection. Conversely it could be argued that attention was given to the design of sessions which might engage learners across the arts and sciences and ensure a professional process completed to time and may have

limited the time for reflection upon changes in participants. It is likely that both factors (and others) are true.
It is impossible to know how important this context was, however *it appeared that the effect of inviting practitioners to consider their own interest and how they might gather evidence of change was significant in provoking individual and collective thought* – almost as a licence or permission to contribute their own ideas and interact in relation to each others or collective aims. The quality of talk, especially in the latter weeks of the project and at the collective evaluation was good, allowing honest recognition of areas in need of development, of elements which were in tension and a positive desire to move things forward. Our experience suggested that this combination of factors heightened practitioners' sense of their role in affecting, recognising and evidencing change

In the intensity of planning it was challenging to give attention to all approaches and partners found themselves over committed to deliver everything. Consequently not all planned methods were fully realised, or sustained.

- The roles of paparazzi, scientist, artists, interviewer and investigator proposed to engage children in owned evaluation were embraced by the children but required further focusing to be purposeful and important to the project. Some later trialling took place of children working as 'secret investigators' - noting observations on paper or in relation to seeing peers doing things opportunistically within sessions. They were asked to record speech or actions which looked like a.) being curious, b.) collaboration or c.) perseverance. Short prompts to clarify expectations were given, echoed verbally. Some children trialled doing the same through taking no more than 6 photos. Children were briefed in a snatched few minutes before a session (typically opportunistically engaging early arrivers to school). These revealed competent observational skills and at times – where snatched discussion about what had been noticed could be reviewed - a refining awareness of what learning looked and sounded like. Sometimes peers coached each other effectively too.
- Two schools engaged Teaching Assistants (TAs) in observing pupils for curiosity and perseverance. The researcher on site offered written prompts that were accepted and used. Occasional live reflection occurred between, researcher and teaching assistants and evidence was passed to the researcher, but there was no opportunity to discuss or build on observations by teachers who were hands on in sessions and less directly engaged in owned evaluation activity in process. However teachers did connect the project to other classwork – using journals or other tasks to record and reflect on what was learnt and in one school, writing a persuasive letter to Imagineer to persuade them not to continue with a fictional plan to stop working with schools (see appendix).

- One school proposed but did not compete designing and conducting their own baseline and post assessment of 'teamwork' and 'perseverance' for all students involved.
- Teachers and Imagineers were offered journals, which were variously completed by Imagineers and not by teachers or engineers – possibly a more natural practice for artists. Those shared with the researchers showed a clear focus upon the key change area, which they had determined at the evaluation planning meeting. .

4. What we learnt

The pilot had a number of positive outcomes and revealed some interesting insights into how such projects featuring an Imagineering approach might be of value. This can be considered in terms of these interrelated aspects

- ***arts-rich contexts***
- ***professional contexts***
- ***embodied learning across the arts and sciences***

and their impact to

- engage and give voice to learners' creativity
- stimulate learning across the arts and sciences
- give insight into professional practices underpinned by the arts and sciences
- raise aspirations
- promote interest in engineering through the arts, which has particular potential for girls.

4.1. Arts-rich contexts

4.1.1. Engaging through an imaginative context

The employment of an imaginative context for the project played a significant role in generating excitement and interest. The arrival of the costumed, Imagineers on the travellator, role-playing time travel and looking for children with imagination, was a novel entry that captured the imagination of the majority of children.

> *When you drove the ..travellator round and I found out that it was for our class and you had lots of boxes to take to our classroom – I found that really exciting. Something was going to happen!*

I was walking to school when we saw the travellator coming along and [the Imagineers] started asking me questions and then it came into in the playground!

When the Imagineers came in .. they had the bikes and … they were dressed in Englishmen's clothes. They were really friendly as well and that boosted us up… and they had a treasure chest and I was thinking what was inside and that made you really excited

I was like really eager to like find out what was going to happen and like what we were going to do in the process.

The talents of professional performers, able to invent and improvise fictional interpretations from the maps they were poring over maps (of other cities), introduced a playfulness and an urgency to the project. Children were excited to take on the challenge from the City Council. 83% of children rated this beginning to the project as 'very interesting' – the highest possible rating. (In fact in interview several said there needed to be a higher rating of 'brilliant' for this project). The arrival of the travellator and five unknown 'Imagineers' setting a challenge was novel but also generated concern about what was expected. Given such anxieties, which were echoed in a number of journals after the first session, it is interesting that there were no negative ratings for this session and only two children remained 'unsure' about this session when answering this question after the project. This suggests that children recognised that anxiety was often an aspect of, or closely connected to excitement but is usually worked through.

I felt excited because it was a new thing. And I felt a bit anxious because it was a new thing as well.

I've never done such a big project with engineering before and … I was really excited … I was a bit anxious as well because I didn't know how it was going to go and what would happen next – if you had to know something before, or they were going to ask you lots of questions … what the Imagineers would expect from you

Children relished discovering more about the characters and professional fortes of the Imagineers: the repartee between them, their expertise, personality and know-how. The costume played a role here, as was evidenced on occasion, for example by the children noticing the headwear missing from an Imagineer's costume during a post delivery project visit. Likewise during visits to the Imagineerium 'uncostumed' Imagineers were sometimes seen - and had to be explained away - demonstrating that imaginative engagement played a key role in maintaining commitment to the work.

4.1.2. ***High quality making processes in arts and beyond***

The project gave children an insight into the elements and stages of an art-making process, enriching their understanding of how an idea might be realised, how the choice of materials and the tools might influence its development and the choices, challenges or decisions involved.

> *Before we thought about something a bit simple but when we found the different materials it started to* change quite a lot and look quite different
>
> *We had different ideas and … then we had to use the idea to make it like a 2D shape of it. Then we moved it on and the 2D shape was a prototype and we used it to make the 3D shape of the dragon with different parts of it.*

The mechanised Godiva puppet provided an aspirational common reference point of a product created by a process similar to their own: an idea, sketched, prototype testing of possible structural frames and of mechanisms resulting in a working dressed model and finally a build.

Children were awe inspired by seeing her 'for real' – her size and movement being most commented upon. 97% rated this experience at the highest level, with 37% considering this the most inspirational aspect of the project and a further 20% rating the use of materials and model development experience at the Imagineerium as the

most inspiring aspect. These two quality arts processes were unique in having most profile (most other aspects were personal or were selected by less than five children).

The significance of experiencing a quality art-making process is echoed in interviews where children identified aspects of the process development which particularly inspired them. One child spoke of how the presentation made by the company CEO, (an example of a pitch) had given her an idea of how an idea was developed, been sketched, drawn, materials gathered, a model made and then built for an event. Models, costumes, structures and headdresses from previous events which were on display in the Imagineerium attracted children's attention and fed curiosity about the properties of materials and different making processes. Sometimes they were used by Imagineers to illustrate possibilities or by children to test a possible idea for making their own models.

4.1.3. *The arts as a learning medium; (embodied learning)*

The embodied process of art making was central to the success of the project – both through physical movement and model making. Movement based approaches to making theatre were identified by children as engaging, fun and educational, both in relation to learning about scientific concepts and ideas underpinning the project. Many reported that the experience of being part of an imagined story intrigued and engaged them to think about and get inspired by the messages of kindness and equality which Godiva represents and especially the idea of perseverance from the hummingbird story. Working in the media of artists: the body in movement; ideas in

image or manipulating new materials and using new tools in making processes, produced periods of both intense individual concentration and collaboration. There was a sense of the experience being out of the ordinary, 'not like school' or everyday life, which enhanced their engagement and the quality of the artwork and designs produced. The freedom of an arts project, expressed either in their journals or simply in the way they behaved in new spaces, and particularly in the great sense of ownership reported, was clearly significant.

These aspects of art-making processes are discussed further below as part of a fuller discussion of embodied learning processes which embrace the arts and sciences.

4.1.4. ***Developing creative behaviours***

Before the project, teaching staff had identified an increase in children's curious, collaborative and resilient behaviours as desired change.

Most children (80%) considered that the project had made them more curious about the arts and engineering (in almost equal measure – 1% difference). Girls reported having a slightly higher degree of curiosity than boys.

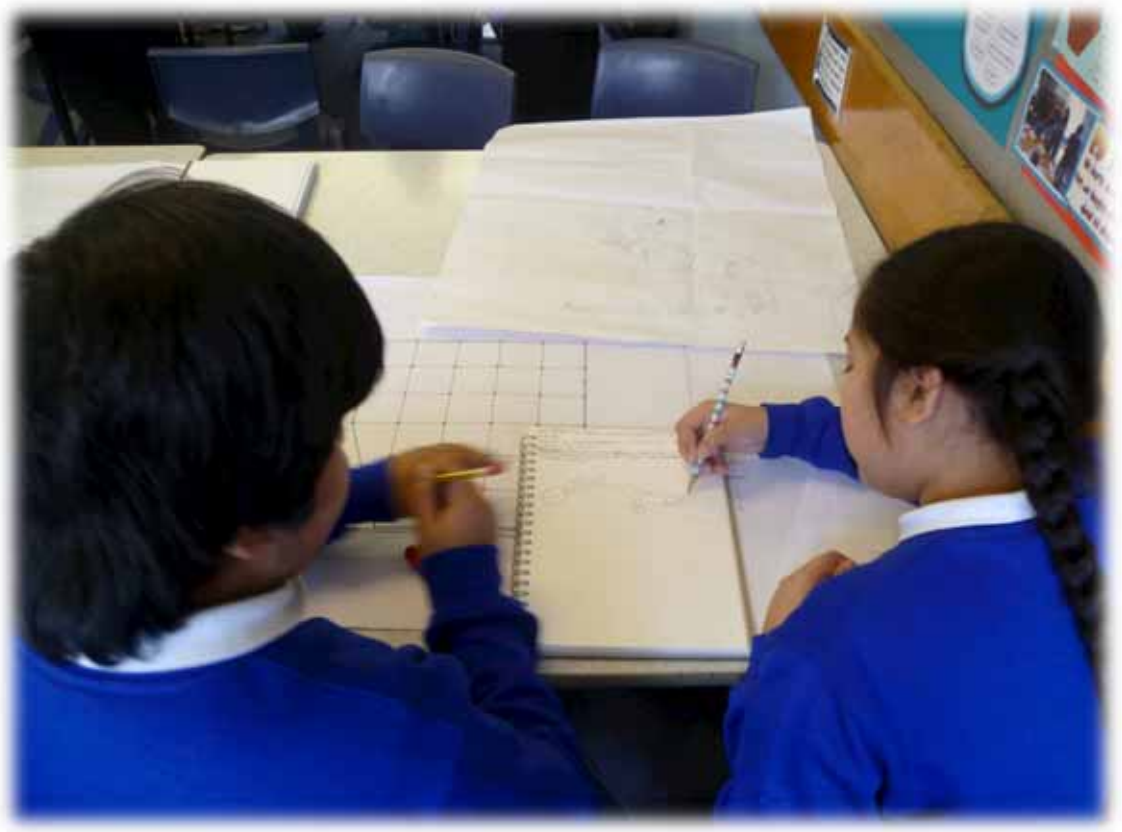
During the project observational session records kept by teaching assistants, at times by children and also by a researcher recorded examples and frequency of particular behaviours demonstrated. Whilst there is variety in what is recognised as 'curiosity' by the four adults and eighteen children involved, the use of common simple prompts and examples was helpful in developing a common language. Peer evaluation demonstrated a sound basic understanding of what being curious looks like and why it matters to learning, but the ability to be able to sustain or see a sustained line of curious behaviour was less developed.

The project design appeared to be particularly effective in generating curiosity: observation notes record a regular stream of questions and observed 'tinkering': practical exploration and testing. Children's self-evaluations likewise suggest this is an increase on typical learning behaviour. 58% reported more questioning and possibility thinking during the project than normal.

Observations:
- *It's smooth* [feeling the surface on a wheel of a pulley] *why's that?*
- *It was floppy it needs to be rigid* [attaching sticks to the tail on a horse].
- *I think the wheel might move if we add this* [piece of dowling]
- *What is this? . How do you use a lathe?*
- *This is blue – it would be good! [shows material to another child who replies] Yes! [They manipulate it around the structure with difficulty] It doesn't move right.*

Structural and mechanism builds typically involved more boys than girls who often sought to work with engineers, but girls were using similar processes and skills in

making items of costume or accessories and used each other and their awareness of the specialisms of Imagineers to consult with engineers and makers to help them solve the problems they were experiencing. This suggests a real potential for the arts rich context of the Imagineerium to develop more enquiring, problem solving and scientific thinking in girls.



The demand of group work also increased as the project developed, especially so in the Imagineerium where the collective task setting of responsibilities created an urgency and the use of professional resources, tools and spaces heightened the need to collaborate. Many children in interview spoke about the value they perceived in working collaboratively and a sense of responsibility and urgency towards their group.

> *I find everyone's ideas helpful because …. no-one thinks the same as anyone else so you can learn from other people as well.*
>
> *I think I work better when I work together than when I work independently.*
>
> *I like learning from other people and helping them …. if you work as a team you can do lots of things together and you can get the job done.*
>
> *The teams have come together. They've used the best skills of the team … and we were testing a range of skills*

The intensity of the project, addressing a range of objectives, happening in set times and with a required output, created a time pressure. One teacher felt this meant that 'there wasn't really enough time for them to find it difficult and then persevere'. However interviews with children suggest that a number did experience setbacks and struggles. As one child said: 'we had to communicate well and we had to persevere when we were stuck'. Nonetheless a relatively high adult to child ratio, plus the desire by professionals for children to achieve, meant that when children did experience frustrations adults often deployed their adeptness for re-directing and re-energising. So whilst there was little 'giving up' and a predominantly 'can do' ethos throughout the project, there is limited evidence that this was the result of children's perseverance. There was a suggestion that inexperience in working in an open and exploratory way may be a factor in limiting perseverance.

> *They had free rein to find out things for themselves – which we don't do enough of in school. They could investigate, find out it doesn't work and change it … letting them take the lead.*
>
> *A lot of them didn't like making mistakes .. so everything would have to be right straight away.*

4.1.5. Fun, voice and idea generation

Observations and interviews reveal a high level of enjoyment – of feeling purposeful and playful. This is reflected in the very frequent use of the word 'fun' to describe the project and 'happy' to describe how they felt about the project.

> *We got to let our creative side out*
>
> *We get to have fun*
>
> *Making the real model was fun*
>
> *I got to move around, enjoy myself and have fun*
>
> *It wasn't like a normal class … it was much funner*
>
> *I was really happy when we dressed up as devils and we did the dances*

Although not typically rated by adults as a word, fun is strong in the children's language as a positive marker in their experience of learning.

The freedom of an arts project, being 'not like school' appeared to have fed this feeling. The significance of being invited to imagine and of having one's ideas

valued came across from questionnaires, observations and interviews. It generated a personal sense of value for the work, an affirmation of self and a sense of ownership. Children relished this opportunity.

The journal – although perhaps underused in the project – appeared to have a symbolic as well as practical use for children. Unlike all other schoolbooks this was private – full of plain rather than lined paper and personal ideas were invited. Whilst analysis of the journals might not always suggest the journal as a personally expressive medium, 17 of the 18 children interviewed were very clear that the journal was important to them to record and develop ideas with freedom – it appeared to be a strong motivator. Many children spoke also of the whole project as developing their creative impulses and that they particularly liked and valued that.

In the journal we can draw, and it doesn't matter if you get a mistake

I like that you can write anything down and it's yours …and you don't have to show anybody

As soon as I got [my journal] I thought I can put all my ideas in it like if I want to be a person who invents stuff when I grow up I can put all my ideas in there.

We were able to sketch our own stuff and we were able to put what was on our mind.

We had to be more creative and use our creative thinking when we were doing it. …. we don't usually get to be that creative and think of ideas like that.

4.2. Professional contexts

4.2.1. *A real commission; authenticity*

Children were engaged from the outset in a commission that would be built for a real event. This was an element within the excitement experienced on the first day and a significant factor in the project for children. 83% reported that it mattered to them that they were creating something to be built for a real event.

> *We get to do some work outside from the school. Like make our ideas. Make it for real*
>
> *It was a real thing we were doing*
>
> *It was taking it outside the classroom environment*

Additionally the professional skills and context for the project opened up a real world context - and the possibility that working in these ways, making things in these ways was an authentic way to work.

4.2.2. Professional products and processes

The professional arts context was very significant for the project: the spaces, resources products and expertise across design, making and performance all

featured heavily in questionnaires, interviews and in observed behaviours as being important to the children. 100% of children rated seeing the 6 metre tall animated Godiva puppet as of interest, with 97% rating it at the highest level. This was their first experience in the Imagineerium, after which they saw the electronically operated hummingbird prototype – rated as very interesting by 79% of children, then the workshop and rehearsal spaces full of resources and costumes which they used in developing their model and performance idea – rated as very interesting by 85% of children. The products of a professional imagineering process and their makers were noted repeatedly as inspirational by children – both the major ones and other structures, models, costumes they witnessed throughout the Imagineerium workspaces. Working with professionals: designers, performance or visual artists and engineers was rated highly important by children – as 85%, 84% and 74% respectively.

It's inspiring because Nick is a professional – he's been doing it for quite a long time and you can see what he's been doing. And you can know the life and art of an engineer - and things you do in the Imagineerium.

I think they were all inspiring because [they] knew a lot about everything and … each Imagineer … showed us interesting things

Roger has had a lot of experience in engineering and … the way they showed us everything it looked really fascinating …. It was really inspiring.

You made the Godiva - which is amazing because normal people would think … how are you going to make a 3 metre Godiva?

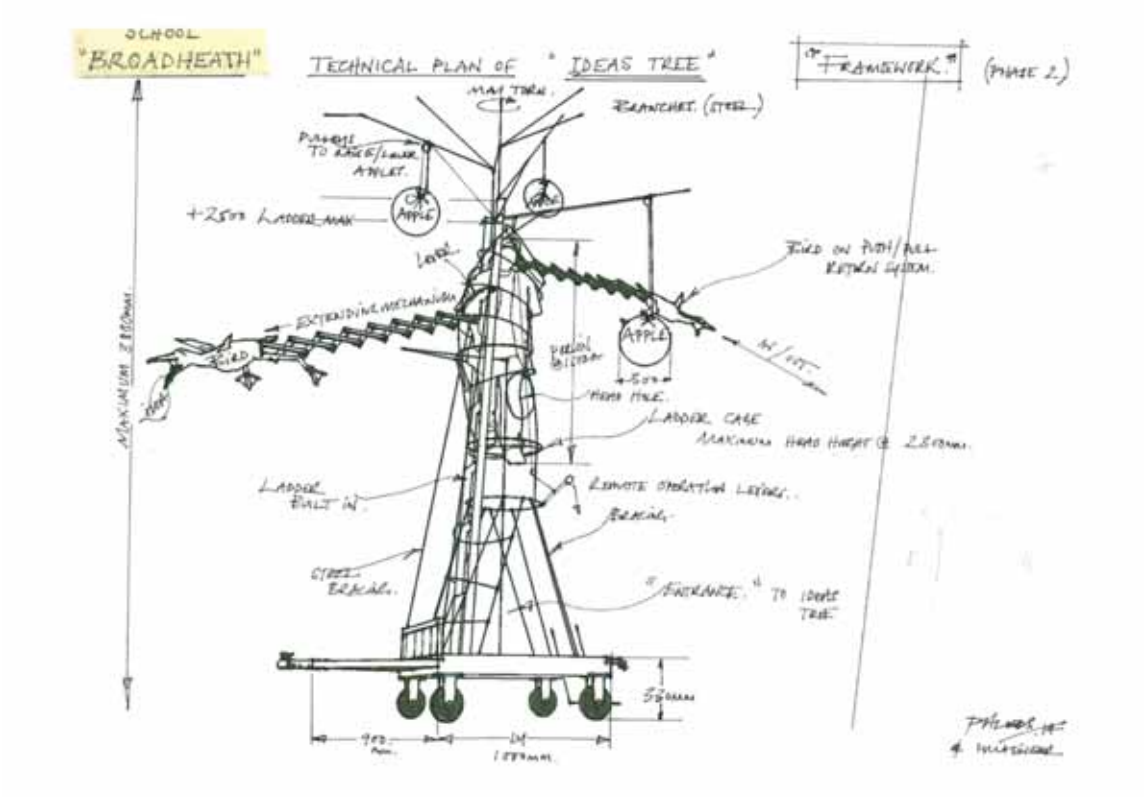
It was very cool seeing how they made the helicopter [hummingbird prototype] …. - how you fly it and how it looked and finding out things you didn't know…

4.2.3. Experience of specialist spaces

The Imagineerium as a space was valued by children for offering 'more room', 'different ways of working', 'choice' of resources - of a range and type they 'normally don't have', and for being 'a professional working space' with 'professional tools'. Adults commented on how purposeful children were when set to work in their teams using professional practices. Having agreed tasks and responsibilities, children had a heightened sense of responsibility and showed a heightened ability to explore, solve problems and seek help in order to meet challenges set. Certainly 89% of children considered that making in the Imagineerium was important to them. For a number of children, the role they took was instrumental in this: of developing the structure to scale; or of developing the look and feel of the finished structure; or

developing a performance idea to accompany the structure.

> *It offered an opportunity for children to see professionals at work: seeing engineers, seeing designers, seeing a team at work*
>
> *I think it was just evident from experiencing the Imagineerium day with the children that … it put everything into context … visually seeing [Godiva] … and it was taking it outside the classroom environment*
>
> *I didn't see any moments of tension or children being unpleasant to each other [in the Imagineerium], which I did in the classroom. There was always something else to do – so they were engaged.*



It is worth noting that children's experience of the Imagineer Technologies space was different across the three classes: with two classes it focussed upon a demonstration of the hummingbird prototype and with a third (which was also a half class size) if involved seeing the hummingbird designs and prototype as well as looking at tools and tasks of the space in small groups. The latter was revealing in generating increased fascination in these children. The opportunity for students to listen and question in small groups with one adult, but also to roam a little and pursue aspects that interested them was highly effective. This suggested potential in future to better explain some key processes in the design, experiment and make

process and – as was the original ambition - to create more fluid models of practice to ensure access for smaller groups where Imagineers can be more responsive to as well as feed interest.

4.2.4. ***Working as a professional team: roles and responsibilities***

Operating as a professional team required children to take on particular roles for the team. The roles children took in their group gave them a responsibility but also an authority over that particular aspect - which was typically relished. It allowed children who enjoyed leading or supporting to have a legitimate outlet and ensured that everyone was listened to or valued for what they brought. Additionally, in most

groups, the idea for each structure evolved through the collaboration of group members. For some one strong idea was recognised, in others there was a tussle between two or three, on others no one clear idea was apparent, but an amalgamation happened. Children listened, challenged and affirmed ideas, almost always with the eventual support of team members, but not without difficulty. The facilitation of Imagineers was important to guide potential ad also to ensure the process of working together improved on but did not distort the heart of the original idea.

> *We had lots of ideas – but we had different ideas and sometimes it was hard to put them together … we all wanted our ideas to be put in*
>
> *I felt they were improving my idea because the hands never really had a meaning until the group started talking about it and … I was thinking that we should have more ideas*

Choice was mentioned repeatedly in interviews with children as being important – of what role to take, how to approach a task, what ideas to develop, what resources to use. This freedom fostered new working partnerships and different kinds and levels of engagement.

> *We were allowed to use whatever we want, because sometimes we get to do art at school but we're not allowed to choose what we want to do we were allowed to use different materials and not just drawing*
>
> *We got to decide what we would do*
>
> *We – only us, me and one other person, we only get to choose the colour and design .. we were choosing them.*
>
> *[The project] helped me work with new partners – some people I don't generally work with….*
>
> *I got involved more than I usually do*

4.3. Embodied learning

4.3.1. Movement arts as a learning medium for engineering

Two of the Imagineers were physical theatre practitioners who, following interest in approaches developed through the Creative Partnerships programme, had previously created an imaginative, physics-based performance and workshop experience for primary school aged pupils. They drew heavily upon this experience

in devising movement-based activities and demonstrating particular physical theatre lifts to engage children in learning about forces, the properties and application of materials. Engineers especially were delighted by the power of 'putting engineering into your body' but the potential of this embodied, experiential approach was widely recognised.

Sarah and Mark helped me because I just connected [how braces work] from push and pull … because if you hold and lean back, your arm is like a brace (*points to own sketch of two people, feet together, holding hands and pulling against each other*) …

You taught us science in [the project]. I felt like you mixed them together and when you mixed them together they were both really fun both of them … it wasn't like a normal class

I'd have liked to spend more time on learning about forces through our bodies

At first we did push where we had to join arms with a partner and push from both sides and our legs were quite wide apart, they weren't touching…Next we learnt to pull each other back so this

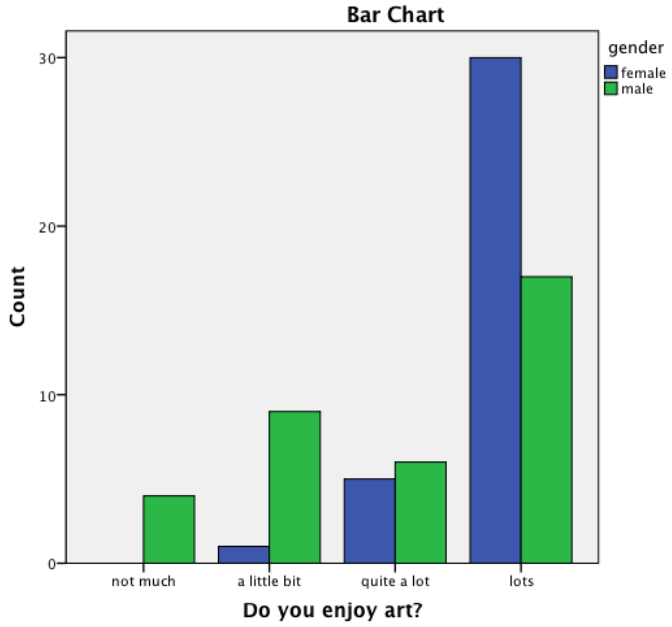
time how to pull each other back so this time our arms were quite far apart but our legs were quite together and we were kind of leaning backwards and we learnt that the person who is smaller and lighter they have to pull more backwards so they wouldn't fall ..

They did more action: doing - like building structures, or with our bodies then also explaining it again but in a different way - that's what I liked …..

4.3.2 Existing context: the potential of embodied and arts rich learning

Before the project, children demonstrated overall positive attitudes towards learning in each of the subjects the project addressed art, science, design technology, and drama with maths and literacy being underpinning skills. Based on a rating of enjoying learning - either 'quite a lot', or 'lots', the highest enjoyment was recorded in arts subjects: 84% enjoy design and technology, 81% art and 78% drama. 76% of children reporting enjoying maths and 73% literacy. Lowest enjoyment was recorded in science at 62%.

Analysis through gender revealed some interesting differences.



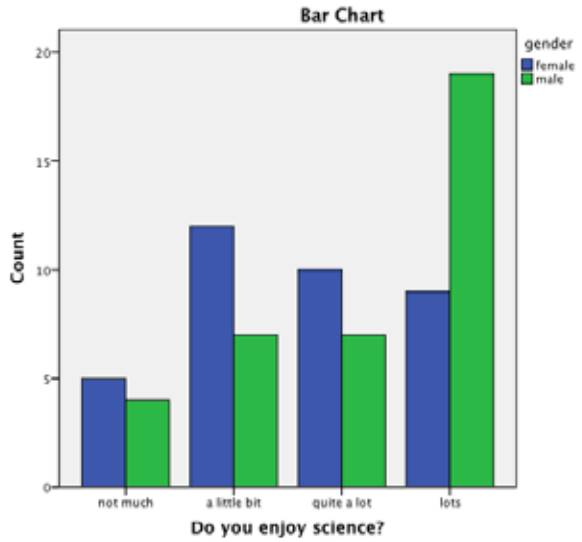
The most significant was in art, where only 1 girl recorded a negative: enjoying art 'a little' (resulting in a 97% positive rating) and 83% (30 of 36) gave it the highest rating. By comparison 13 boys recorded negative attitudes towards art (resulting in a 64% positive attitude and 47% of boys giving it the highest rating). A similar comparison in drama reveals much more equal figures (see below).

Table: How much do different genders enjoy drama?

		gender		Total
		female	male	
Do you enjoy drama?	not much	1	5	6
	a little bit	5	5	10
	quite a lot	10	11	21
	lots	20	15	35
Total		36	36	72

Boys enjoy maths more than girls. 82% either enjoy maths ‘quite a lot’ or ‘lots’ as opposed to 69% of girls. 6 more boys than girls rated enjoying maths ‘lots’. 11 girls as opposed to 6 boys rated ‘not much’ or ‘only a little bit’ of enjoyment. However given the size of sample, this cannot be considered significant.

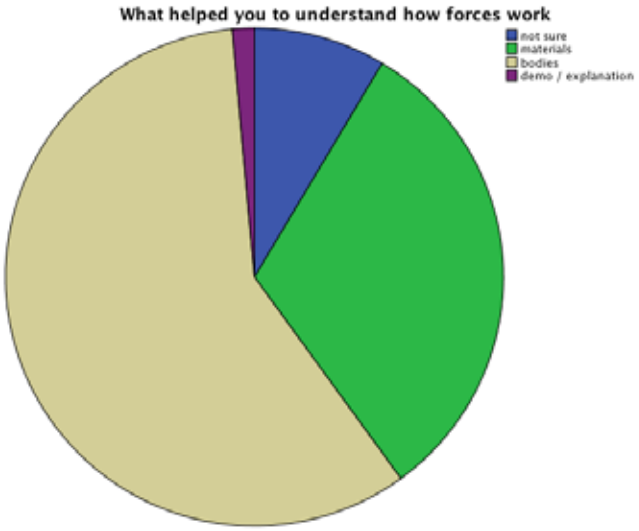
More boys than girls reported favourably on science, with 51% of boys (19/37) as opposed to 25% of girls (9/36) saying they enjoy science a lot. Reported enjoyment of this subject was more spread than for other subjects and, unlike all other subjects surveyed, 12% (evenly spread over boys and girls) recorded the lowest possible score of ‘not much’ enjoyment. 47% of girls recorded an overall negative attitude (‘not much’ or only ‘a little enjoyment’) as opposed to 30% of boys. Such figures reflect those which led to the recent ASPIRE project (Archer et al 2014).



This context suggests a potential for a project using arts-based, embodied and practical approaches to engage scientific and artistic thinking and practices and build ‘science capital’ (Archer et al 2014).

4.3.3. Embodied STEAM learning

Over 80% of children thought that working physically with their bodies was an interesting way to learn how forces operate (either ‘very’ or ‘a bit’ interesting) with 59% attributing understanding forces to the this approach (31% thought manual work with materials was more effective and 10% were not sure).



Interest in embodied learning increased for the sessions looking at the properties of materials and their application in making structures strong, with 85% of children finding an embodied way of learning interesting. 91% also thought the manual task of creating structures with sticks and potatoes an interesting way to understand how to build strong structures. There was a pretty even spilt between experiencing the kind of active learning which helped learning, with 45% attributing it to a physical approach and 44% a manual approach (potatoes and sticks structures or model making). Only 2 children suggested a demonstration had helped.

There was a strong correlation between interest in drama and interest in embodied learning. In interview some children suggested that more time to physically manipulate the life-size mechanisms and to explore the body itself as a mechanism would help. Imagineers recognised the potential to develop this understanding further in the future, focusing on the body as a mechanism and translating this into explaining and manipulating model mechanisms necessary for a desired animation. Where a physical embodiment was not the highest rating, kinaesthetic means still remained the most popular form of learning.

These findings tie in with Claxton, Lucas and Webster (2010), who draw upon a range of research to argue, ‘research shows that we think not just with our minds but with our brains and the rest of our bodies’.

> *a cam went up and down .. and to make it work we had to done the pulling and pushing*

They explained about the triangles: how we could make our models steady so they won't fall down. We also learnt about keeping it level ... about the gravity point.

First when we had the cardboard rolls at the same height we weren't able to balance the bottle that we had on top of them so we had to … tilt the front legs and the back legs were straight so it would actually balance

We had to brace I all together – it was really hard to do in the amount of time.

Interviews revealed a recognition across the Imagineers that, with earlier clarification of focus and content, the project had greater potential to address a range of aspects more fully: creative and collaborative idea development, mathematical learning about scale, place…, technical science, engineering and persuasive communication. All partners would welcome more practice based exchange and planning time.

There was a lot of scope for maths – and scale … different units of measurement, calculating the force on the platform

The science we did was very dramatic, very conceptual … we could do more on in the limited collective planning time and practice based

Sometimes they were learning very little apart from dexterity… [they needed to]come to the Imagineering day knowing that they can make a lever and get a physical understanding – know it works

4.4. STEAM Impacts

4.4.1 Deeper understanding of the arts and engineering

Adults were unanimous in the view that everyone had learnt from each other. Adults too had developed enriched views of artistic and engineering practice.

I have a wider knowledge and deeper insight into what engineers do … I've had to think a lot more about what an engineer is myself

There were so many different materials, different tools, so many things on the shelves they could use, …. It would have opened their eyes, opened their imaginations as to what the possibilities are

Children's insight into engineering and the arts as professions grew significantly. Views were ascertained through the use of before and after postcards on which children wrote freely in response to the questions 'What do artists do?' and 'What do engineers do?'.

Before the project 38% of children did not know what an engineer was. Of those who had an idea, 48% described an engineer as someone who fixes things (cars, mechanical and electronic). 18% thought engineers build cars and 16% thought they makes thing. One child thought an engineer might design as well as build.

A week after the project, 93% were able to explain what an engineer does, only 19% suggesting that an engineer is a mechanic like fixer. The most common view was that an engineer makes things (66%) – with the term 'builds' being most commonly used and 'creates' sometimes. 29% suggested that engineers design and invent and 19% that they might fix things. The reference to cars was minimal. Additionally 15% newly suggested that engineers are imaginative or creative with one suggesting that they make beautiful things.

Engineers build structures, models, buildings and much more, [They] think about materials like waterproofing'.

Engineers make the models and find out what the structure and texture will be and how it will work.

An engineer makes things, creates things and thinks of many ways to invent something unique.

An engineer creates models which are 3D. They use mechanical objects such as screws and bolts. Unlike artists their models are technical rather than detailed.

An engineer builds, makes and designs things which look amazing.

Engineers make the idea move or glow etc. They breathe life into an idea.

An engineer builds and imagines things of beauty.

Before the project began 92% of children considered an artist to be someone who draws or paints, 32% thought they make works of art (but rarely with an explanation of that idea in terms of varied materials or 3d form), 16% thought they decorate or illustrate and 8% thought an artist might work in a form other than visual.

Afterwards the focus upon drawing and painting had reduced to 46% with a new notion of design being introduced by 29% of children. Some children had mentioned artists' qualities before - particularly using terms such as 'creative', 'imaginative' and very occasionally being 'original'. After the project there was a greater frequency and a more situated sense of an artists' qualities - with 'create' being used as a verb to describe their activity, some articulation of their work involving idea generation and of designing across different media.

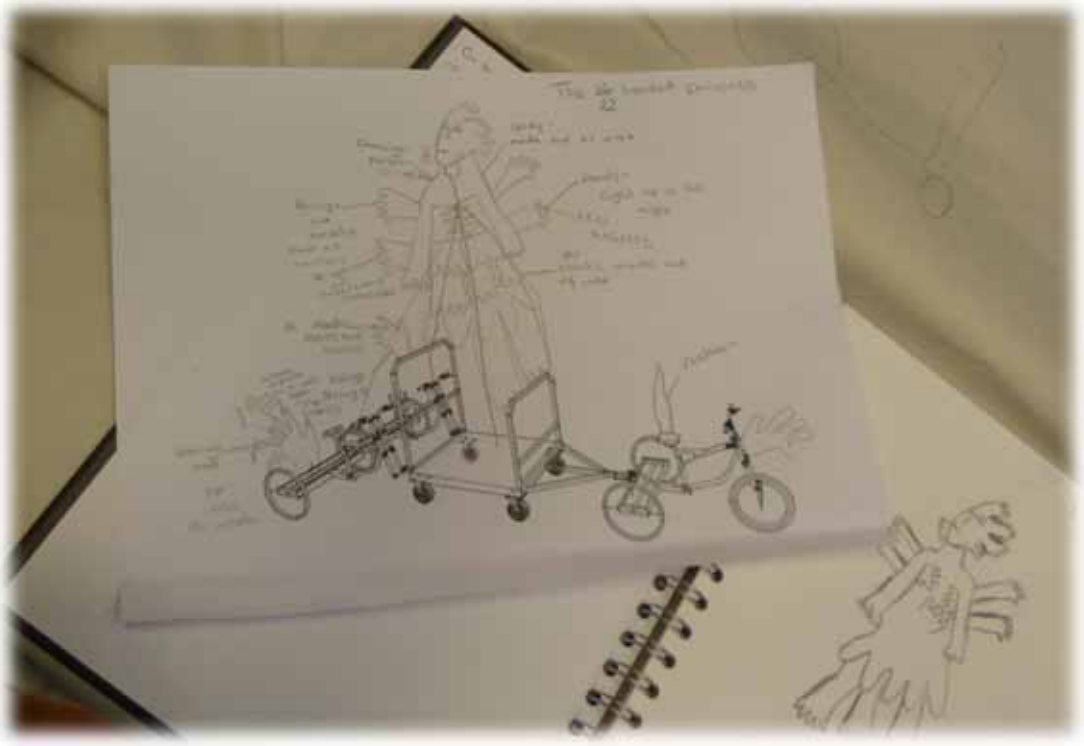
An artist is creative and imaginative

Artists do lots of creative thinking

An artist is someone who has creative ideas and thinks of things that other people wouldn't think of

Artists are people who are creative and build stuff that has [its] own style

An artist is someone who has creative ideas and thinks of things that other people wouldn't think of.



Interestingly, given that the project involved work with performance and design artists, a sense of artists working in multiple forms reduced from 8% to 2% of children describing an artist as working in different art forms – when perhaps an increase might have been expected. This possibly reflects more specialist use of terms for arts practice than a narrowing.

4.4.2. Artists and engineers – Imagineers?

A number of children sought to make sense of the relationship between artists and engineers in their responses, identifing a complementarity or similarity.

> *Artists design models and decorate them using lots of materials to make it look different to others. Engineers make the models and find out what the structure and texture will be and how it will work.*
>
> *An artist designs the idea and adds colour and breathes personality into the idea. Engineers make the idea move or glow etc. They breathe life into an idea.*
>
> *An artist takes control of more of the costume of a model.*
>
> *I think an engineer does and controls all the mechanisms of any structure or model.*

An engineer creates mechanisms and builds. An engineer and an artist might seem different – however they're not. Due to the fact that they both create, it makes them quite similar.

These perceptions are significant in the context of the 'Two Cultures' divide of arts and science, coined by C.P. Snow in 1959, which results in children's aspirations being channeled from an early age and which still persists. A recent investigation into science aspirations of 10-14 year olds led by Kings College, advises intervention from primary school age and suggests a 'more holistic culture … combining both depth and breadth' (ASPIRES, Facts and Fiction 2014 p. 7).

4.4.3. Raising aspirations

A week after the main project engagement, 60% of children stated that they would like either to be an Imagineer, artist or engineer when they grew up, with 23% (16) stating Imagineer, 18% (13) engineer and 18% (13) artist. More boys than girls wanted to be engineers and more girls than boys artists and imagineers, but both genders were represented in all three career choices, suggesting that the arts appeal of Imagineering might have drawn in some children to a connected arts and science field.

Imagineers themselves, imagineered products and the process of imagineering which drew upon arts and engineering practices were mentioned as significant in children's aspirations.

Now I want to become an engineer like Nick.

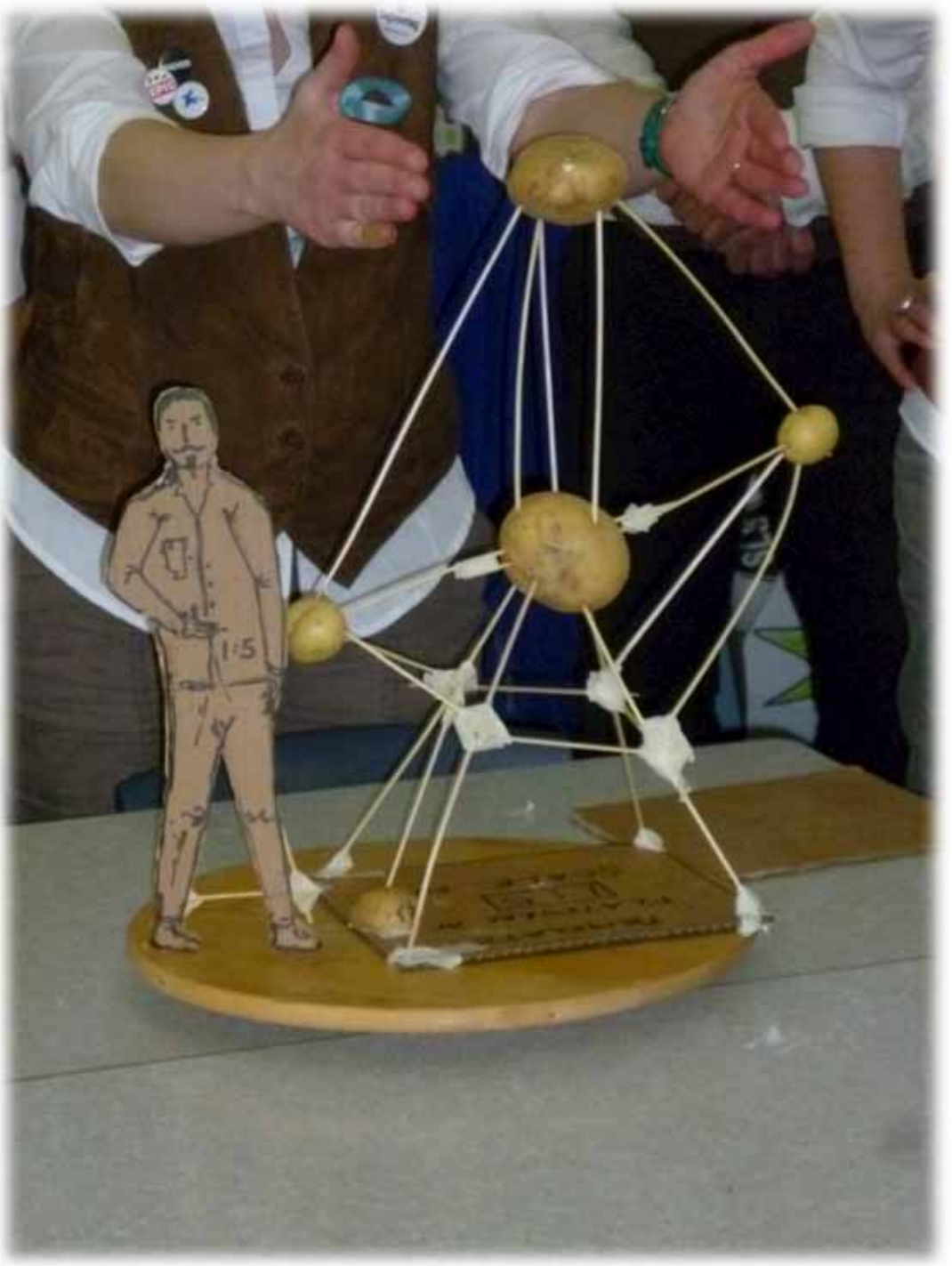
It's quite an exciting world when you're an Imagineer because you can learn – you can go through something you've never experienced before and find out about art and engineering

You can make things like …. Godiva which is .. amazing'

When I sorted the wheels problem out I thought I'm enjoying this .. and I'm quite good at engineering

Even though my parents don't want me to do engineering, I might change their mind because I really want to do engineering

I didn't exactly know what an engineer is – I was getting mixed up with the mechanics and engineers, so I didn't really understand but … when I saw what they really meant by engineers and what they were doing, it made me want to be like them because they like design stuff, they develop objects, they like run their own business.



Parental views about the the arts and engineering, project value and their child as a learner were ascertained through pre and post project postcards.

In our pre-project online survey, which 80% (59/74) parents completed, there was an equally divided view of engineering. 50% said they would encourage their child to pursue a career in engineering whilst 9% of parents suggested they would discourage their child and 41% were ‘not sure’, (so 50% would not advocate for engineering - and 50% would). We cannot know what prompted the ‘not sure’ choice: it may disguise a negative view expressed tactfully, a the lack of knowledge

about what engineering might involve or reveal more conditional considerations, such as the aspect of engineering or its appeal to their child.

The same parents were less supportive of the arts: 39% would encourage their child to pursue a career in the arts, 49% were ‘not sure’; and 12% would discourage.

At the end of the project a return of 40 /74 postcards were received from parents and revealed a view that the project had had a positive impact on learning and expressed an improved attitude towards both the arts and engineering. 62% of parents would now encourage their child to pursue a career in engineering a figure 12% higher than before the project (28% were not sure; 10% would discourage). 49% would encourage their child to pursue a career in the arts – 10% more than before the project (36% were not sure; 16% would discourage).

These figures suggest that through their children, parents had developed a greater insight into and positive view of both the arts and engineering. Certainly the project generated interest at home. 85% of the 40 parents who returned postcards said that their child had talked about the project at home – either after a session or more frequently. 93% thought their child had enjoyed it. This is identical to the pupils’ self report where 93% of children reported enjoying the project overall. 54% thought that it had improved their child’s attitude to learning – either quite a bit or a lot. Children were more positive than this – 96% thought it had helped their learning.

4.4.4. Promoting interest in engineering – especially for girls

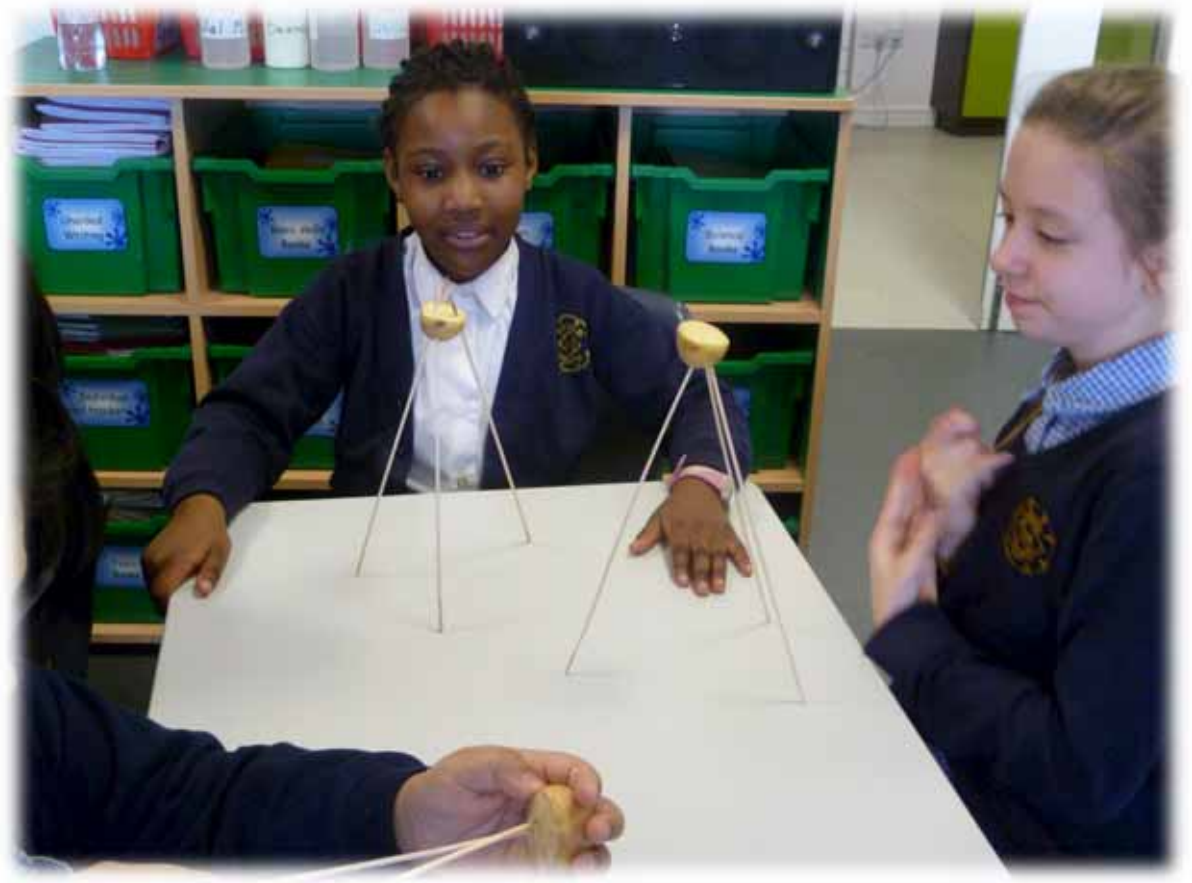
The ASPIRES report (2013) highlights the significance of identity in learning science – especially for girls. It suggests that interventions should focus upon developing ‘science capital’: building awareness in children and families to be

> ‘*comfortable and knowledgeable about science and .. see its relevance to their everyday lives and futures’.*

The reprot highlights that addressing how peripheral science is to young people is a particular challenge for girls as science creates a challenge to feminine identity, evident by upper primary school age (8+) in girls.

The Imagineerium appears to have been appealed to girls as an arts-rich space, with which they could identify. As a space which also draws constantly on scientifically grounded engineering practices, it suggests real potential to address attitudinal and identity based challenges for girls who may be engaged enough to naturalise science as relevant to their interests. Two girls in the project, who previously knew little of engineering suggested that they might want to pursue it as a career, yet one reported that her mother was resistant to the idea due to her perception of engineering as being ‘dirty and greasy’ as well as ‘not really being for

a girl'. She is keen for her mother to come and visit the Imagineerium as part of the August workshop and see that this need not be true. Indeed as she spoke another girl echoed that she had expected it to be dirty and mechanical, rather than the 'exciting arty space with materials and things'.



More girls were interested by the hybrid and potentially holistic notion of an Imagineer. Perhaps, this echoes the sense articulated by one child that both 'create', albeit playing different roles or bringing different capacities to the process. In debating what answer to give to the career question, some girls said that they were unsure – they liked the arts best but liked the way Imagineers used engineering. This suggests how the Imagineerium might realise one way in which the arts might help to re-shape perception and practice, growing artists whose practice is underpinned by an understanding of science and engineering and engineers whose practice is likewise shaped by the expertise in the arts. The idea of STEAM learning is a relatively new one which the uk government supports

> '*We believe that the crucial role of arts subjects in a modern education should be recognised and that art subjects should be added to the STEM subjects [science, technology, engineering and mathematics], changing STEM to STEAM'*. (Culture, Media and Sport Committee - Third Report 'Supporting the creative economy' 6:117 2013)

Boys also responded to the arts rich context. As one suggested, the project had 'let

our creative sides out'. Several were inspired by the knowledgeable and capable engineers who they sought out to help them. Some developed interest in engineering through discovering pleasure and aptitude for hands-on practical nature of learning about engineering.

5. Developing the partnership: engineers, schools and artists

This was a new partnership of artists, teachers and engineers. The partnership worked effectively to deliver the activities planned. Partners were also committed to a high level of review and debate throughout, appropriate to the project as a pilot and pilot of the ACWM evaluation strategy. Overall, partners felt that the project content and practices were finalised closer to the delivery than ideal and that they ideally required greater opportunity to witness and exchange practice insights into each sector's processes. This was particularly true for aspects such as facilitating and questioning learning, especially scientific learning.

A complex partnership between schools, teachers, Imagineer Productions, artists and engineers was needed to make the project work. At the start of project planning we asked partners to identify things needed for the partnership: 90% said that 'clear communications' was the most important factor. We asked again at the end of the project, in interviews and an online survey. What was interesting was the in-depth reflection on the partnership these questions revealed: we feel that this illustrates one way that the pilot helped consolidate this unusual working team. Eight out of ten partners rated the partnership as 'effective' at the start of planning – by the end more than 20% had re-valued it as 'very effective'. The success of the partnership was initially linked to communications (including listening), but, looking back, partners identified 'understanding each others' purpose' as much more important than previously realised. Nevertheless, 'time for planning and reflection' was rated among the least important issues. This was not echoed in the interviews where all delivery partners recognised the value of being able to show and discuss their ways of working and collaboratively test ideas before delivery. It appears that the next step in strengthening partnership work will be to support the re-valuing of planning and reflection as part of the process of understanding mutual aims, roles and purposes.

Before the project, partners identified the qualities of artists as:

> confident, exhibitionist, flamboyant, outgoing, open, expressive, sensitive, reactive, neurotic, emotional, instinctive, wacky, odd, unusualness, random (not methodical), adventurous, free thinking, impulsive, obsessive, compulsive, single minded, disciplined, technically inept

After the project these were different in character, refined, shared and focusing positively upon capabilities and potential:

see deeply into concepts and visions, explore new possibilities, synthesise processes, open, sharing, bank of knowledge and resources

Likewise before the project partners identified the qualities of engineers and suggested:

sensible, quiet, creative, focussed, devoted, passionate about their work, disciplined, determined, pedantic, studious, put up with boredom and routine, patient, logical, practical, understand the real world, unorthodox, inventive, crazy, independent but able to work in a team extrovert, creative,

After the project these were also were refined to key skills and capacities, with qualities both shared and distinct from artists – much like the children's experience.

synthesise process, visualise 2d/3d, time managers, reflect to overcome problems, ask questions

6. Reviewing the Pilot

Summarising so many discussions and different forms of feedback can never adequately reflect the richness and diversity of the reflections from all participants. These discussions were sometimes informal and sometimes structured, and represented a high level of time commitment and thinking, often carried out in the interstices of busy project delivery with children. Nevertheless, overall, partners' main conclusion was that the project would have benefitted from a longer, developmental lead-in, during which new collaborative approaches could emerge.

- ***Partners raised a number of questions about core purpose:***
  What are the Imagineerium initiative's priority aims? These clearly included STEAM learning, but should it go beyond separate roles for teachers, artists and engineers – to something new? Should the project look for altered practices across arts and engineering? (Arts minded engineers? Engineering knowledgeable artists?) As an interdisciplinary project the Imagineerium can address a range of targets, so it is especially important that any future projects have a clear role in the strategic development of the initiative and a focal purpose.

- ***A STEAM partnership behind the Imagineerium.***
  The Imagineerium pilot project, led by Imagineer, operated to the model of production used to date by Imagineer to create events. The shaping principles for this new initiative need to be guided by a partnership of engineers, artists, educators, enablers and innovators not least to allow partners to focus upon their fortes – Imagineer as a cultural organisation, developing innovative arts practice. It may be that the steering group for the

Imagineerium Initiative can be developed into this new partnership. This will also be necessary to attract the credence of STEM educators and professionals. With their support the guiding principles which will underpin future Imagineerium projects need to be clarified. Time needs to be allowed for new ways of working to be developed, to reflect on and articulate tacit processes, challenge and explain existing ways of working and honestly evaluate whether a new kind of partnership, a new kind of practice, or some slightly altered processes for engineers and artist are at the heart of the project.

- ***Earlier clarification of aims, core content and personnel roles***
  For any future project this is needed. This will allow all partners to suggest what approaches, resources and connections they can bring to a project. For schools this is a minimum of two terms in advance, so allowing for the negotiating / recruitment of school partners, future Imagineerium projects should begin planning a year in advance. The challenge for Imagineer, even when funding is secured is the lead-time on commissions which are necessary for an authentic engagement. This presented a challenge to the pilot. Recognition of this amongst partners might generate the development of a more strategic approach to the Imagineerium through public engagement / arts in society routes.

- ***Collaborative professional development across STEM and ARTS.***
  Future Imagineerium project require the opportunity for partners to witness and exchange practice-based insights into each sectors' processes outside of the demands of project delivery. They might then plan collaboratively and develop the embodied approach more integrally. Funding permitting, by initially developing a bigger team of Imagineers than the particular project in hand demands might also develop a more shared resource bank and flexibility to be responsive in future.

- ***A pedagogy for the Imagineerium***
  Training for all partners, teachers, artists and engineers, in facilitating and questioning and in the signature pedagogies which foster artistic creative and engineering habits of mind, and in embodied learning, is needed to improve the quality of creative and engineering thinking and talking in children. STEM education experts, participatory arts and educationalists may complement the existing expertise of artists, engineers and teachers. The pedagogy should strengthen and clarify the imaginative role of the arts-rich context of Imagineerium.

STEM expertise operating within and alongside
Engagement of other STEM partners can deepen the experience of engineering: Imagineering clubs, engineering students and STEMNET

ambassadors. The city has a wealth of partners who could potentially enrich the project. Clear communication about the Imagineerium principles, approach and pedagogy will be needed to ensure that these complement and do not distort the Imagineerium vision.

- **Imagineerium Space**
  Greater use of the Imagineerium as experience of a professional resource and working space was recommended by partners on the pilot. This needs considering strategically as there is both a cost to such Imagineerium experiences and a geographic limitation to the initiative. There is potential for digital developments to complement access to the professional resource adding 3D access into Imagineering processes to date (Godiva, Hummingbird; MAD UK); an evolving hybrid arts and engineering search facility and a game based exploration of engineering principles situated in cultural contexts with particular social scenarios. Discussions begun with a digital partner might resume in this light.

- ***Professional team model: feeding interest and responsibility***
  The success of this model suggests making greater use of group roles for children to give responsibilities that challenge children to work from their interests and also to deliver systematically. Such a model might also allow for Imagineers to work more responsively to children's curiosity, for example about tools and processes and to test particular approaches with girls.

- ***Arts as context: review the model***
  Review and strengthening of the Imaginative frame and the professional arts context for the project as motivation, inspiration and social practice is needed. The role of the imaginative frame as a learning medium, links the Imagineerium vision to its pedagogy. Further practice-based research is necessary to clarify its purpose and capacities. Attention should also be given to the anxieties inherent in new practice development for young people.

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#createevaluate

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Appendix:

A letter to persuade Imagineer to reverse a fictitious decision to stop working with schools

Dear Kathi

I am writing this letter to inform your imagineering company ...[that] this decision cannot be made! The reason why many people, including myself, are asking your Imagineering staff to reconsider is because of children's learning. Think about what you're doing and try to come to your common sense.

Secondly I would be delighted to talk all about children learning Kathi. Since you and your group of Imagineers ... stopped, surveys have shown that children's attention span has gone poorly low. As well as that children's subject knowledge is growing weaker by the minute. Even though there are teachers to teach children, your team made learning interesting and first class. Surely your Imagineers agree that your team wouldn't want to be the cause of all of this damage and poor impact now, would you? So I suggest you reconsider your decision.

It is a fact that the community need you ... I'm a child and I'm asking your staff to come back. So please look at which steps you are taking and make a reasonable one....

Thank you for listening.

Yours sincerely

Maliaka