Project Digital Manual
SUP: Keys to Design And Making

Introduction

Project digital manual is a research project by Material Architecture Lab at UCL Bartlett School of Architecture which investigates methods of fabrication using different composite materials, exploring new ways of manufacturing architectural components while, in parallel, questioning their technological context and in the sphere of social sustainability.

Digital Manual investigates hybrid design and fabrication techniques in between the computational and the analogue; explores the importance of human skill-based techniques in an increasingly automated manufacturing industry.

The digital input here refers to the numeric phase of structuring geometry, assembly, simulation and instruction for fabrication.
The manual counterpart is human input regardless of the skill level required. Digital design can only exist in the digital realm, any physical manifestations thereafter involve manual input in one form or another. Each project undertaken for Digital Manual explores degrees of workmanship as a measure of human input including not only traditional material-based grouping of crafts such as carpentry or pottery but also less conventional digitally augmented manual work. This is a research project about innovation and experimentation with sustainability of crafts and materials.

This article reports on the exploration of the SUP is a modular building system of interlocking pieces produced from recycled plastic that slide and slot together, allowing users to create and recreate endless structures. The components come in sizes small, medium, and large.

In the months leading up to the the Sit and Play: Keys to Design and Making exhibition at Buckinghamshire County Museum which would showcase SUP, Grymsdyke Farm and Material Architecture Lab worked with St John's Primary School to research the potential for the uses of SUP as an educational toy, and its digital and manual possibilities. The workshops led by Rachel Jones ran throughout the Spring Term of 2020 and the exhibition and program of events at Buckinghamshire County Museum were scheduled for May-July 2020.

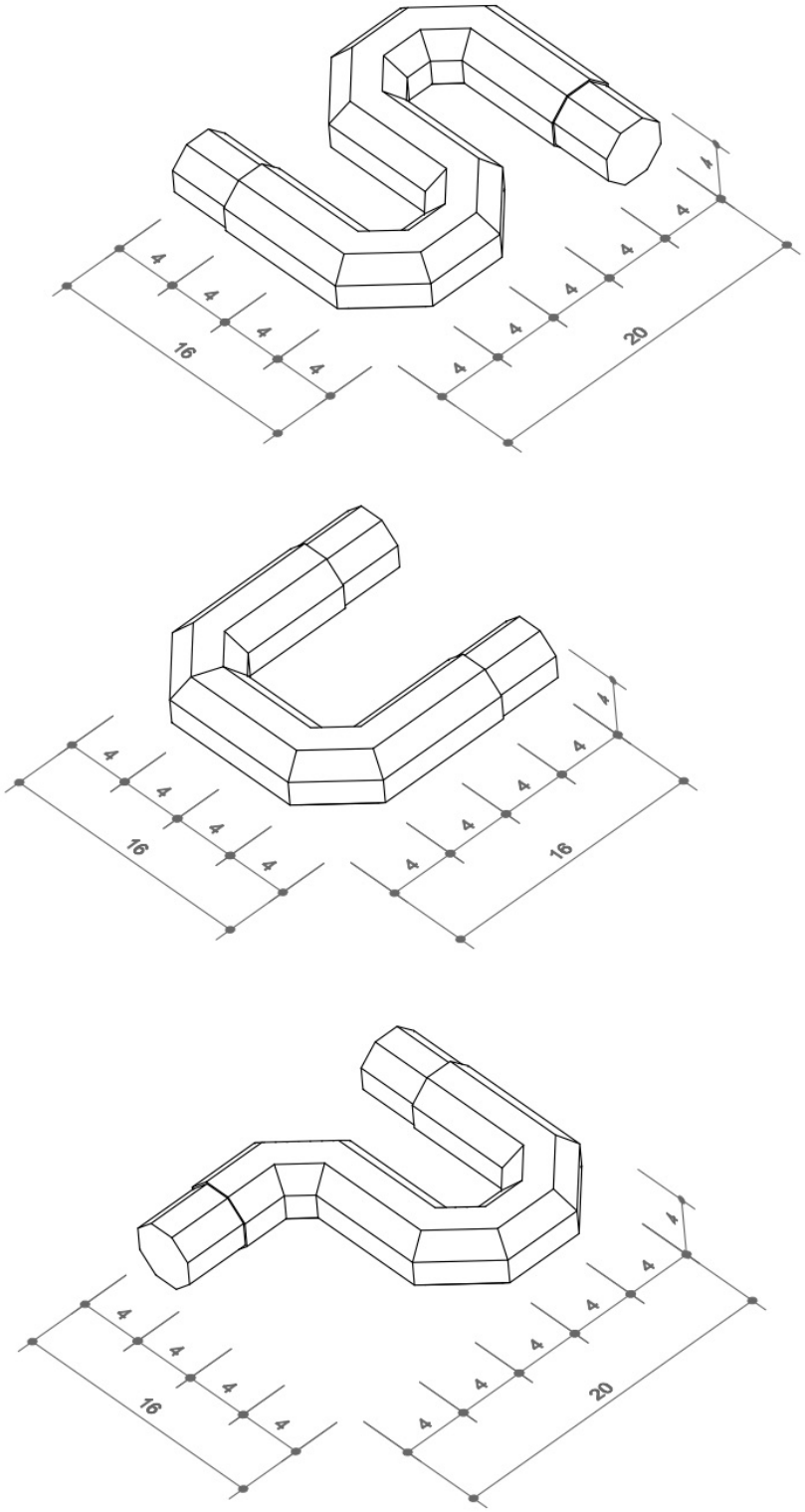

FIG.1 *SUP Components Large Dimensions*

What We Learned From Year 5 At St John's School

The format of the workshops was designed to be child-led to amplify the voices and ideas of the children. The SUP system was introduced and it was explained that the purpose of the workshops was to learn from them and that their feedback was valuable to us. The idea was to encourage the sharing of comments and thoughts, and to communicate that there was no wrong way to use SUP. The aim was for the children to know that they were essentially going to be the teachers of how to use the components manually.

In preparation, the MAL team and the workshop leader participated in some informal and open-ended SUP workshops. It was evident that all three members of the MAL team (Guan Lee, Daniel Widrig and Adam Holloway) had a shared and established understanding of the logic and repetition that they applied to these components. This logic had come from their digital Voxel system which MAL developed in tandem with the SUP components. The Voxelisation is a way of modularising the system into blocks that can be pre-assembled and then linked together. Interlinking at multiple scales allows this standarised module to approximate any abstract geometry.

Having had no understanding whatsoever of the Voxel system at the time, workshop leader Rachel Jones's initial logic and approach to SUP was visibly different to theirs. Once the workshops at St John's began, it became evident that Jones's logic had much more in common with that of the children. This may suggest that the children's way of using the components was not as a result of something inherently childlike but that it had something more to do with the manual intuitive approach, as opposed to the predetermined logic of the Voxel system.

The children developed their own logic systems while they observed and borrowed their classmates' techniques, adapting and developing them along the way. From week to week they would continue to elaborate on these techniques and build forms representing figurative and functional objects as well as those which were somewhat more abstract.

To gain insight on their thought process, the question was often asked "what's on your mind while you're making this?" as opposed to asking "what is this supposed to be?". This was to imply that this creation does not necessarily need to represent the figurative and that it may be purely a result of imagination and experimentation. The children would usually have a very clear idea of their end goal and vision, but occasionally there would be answers more along the lines of "I don't really know, I'm just building". At times the children would build without intention, but then discover along the way that their creation had taken the form of something they recognised, an animal, building or a crown etc. It was interesting to observe the various stages at which they would decide what their creation was going to represent.

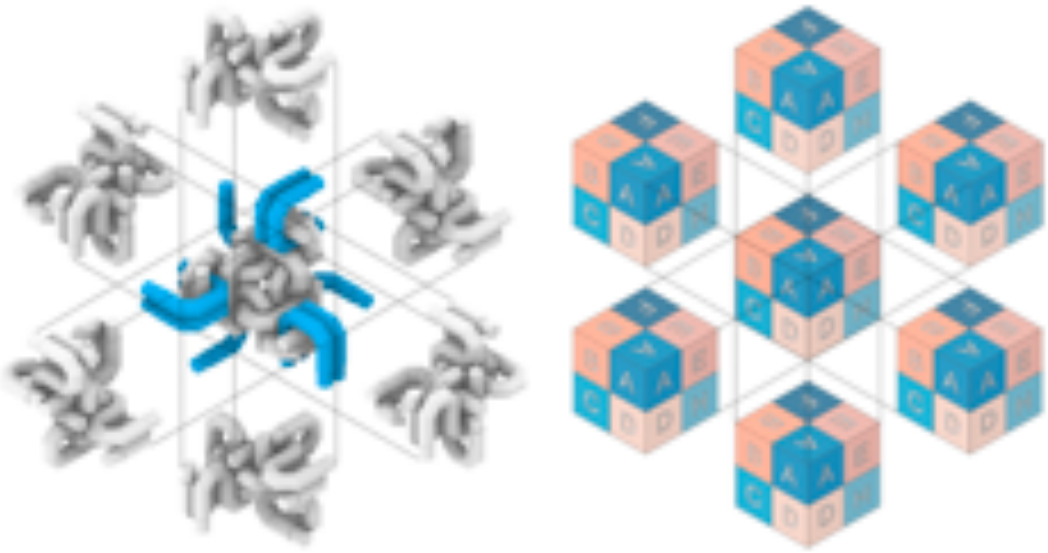

FIG.2 *Voxelisation of Components*

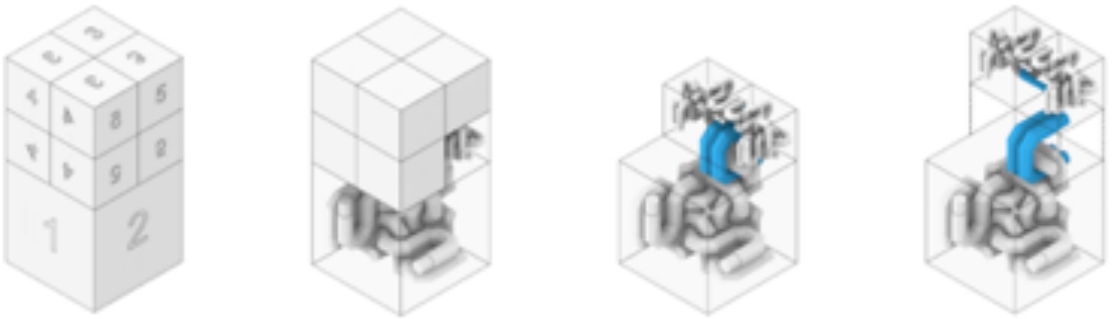

FIG.13*Multiscale Connection of Components*

The question of “what’s on your mind while you were building this?” was also asked when pairs or teams worked together. Despite their seemingly close cooperation while collaborating, they would often have entirely separate ideas of what it was they were building.
Some children were focussed on the idea of building “digital” apparatus, with one child in particular very keen on building a virtual reality headset which they had even developed branding and product names for, as well as explanations of its various functions. They were in essence using this manual material to imagine a digital outcome. Each session, this child would express a clear focus on developing this headset, with talks of later building a Tesla car, among other ambitious and elaborate inventions.

Inevitably there was some repetition from week to week: the train track and the rollercoaster proved a popular use of the SUP system. Children of different groups would communicate with each other between sessions and pass on instructions. From week to week the logic seemed to develop and solidify as the children worked out ways to make SUP work for them. The childrens’ manual skills and muscle memory for using these pieces markedly developed, however it was clear that these skills needed to be adapted for the use of SUP’s larger and smaller sizes. While some children were in their element using the smaller scale components, others found the larger components a much more effective vehicle for the imagination.

The first few workshops were focussed on using medium and then small components as the necessary dexterity needed to use each size was assessed in order of ease of use. While using these smaller components the children would often plan what they would make when they could finally use the large components, which I had briefly demonstrated to them in the initial session. They would express excitement about the large components and had great plans to build houses, playgrounds and cars. They would be “real” because of their size, e.g. “we’re going to build a real house, with different rooms”.
The approach to scale was very varied as some children built life size objects (jewellery, wearable technology, laboratory apparatus) and others built models of a much larger and more structural nature (bridges, roads, theme parks). One child observed that “you can slot one piece into another and that keeps opening more possibilities”. This summarises the idea of taking each piece at a time instead of building a predetermined design. The need to assess what the next step is as you go along makes SUP in its manual context more like chess than lego.

FIG.4 *SUP Crown*

FIG.5 *Year 5 Discover SUP*

SUP in the Classroom

In reflective discussions at the end of workshops, the children often described their experiences of using SUP as “relaxing”. One child even had the idea of a sensory room filled with SUP components to play with. Through avoiding instructive predetermined goals and instead using this opportunity for immersive play, expressive participation is encouraged and the children seem to benefit from this low pressure creative outlet. Another child stated that “It feels good when you build it” indicating that the motion and thought process involved in slotting these pieces together and building up forms and structures is ultimately enjoyable and user friendly.
The class were asked how these sessions related to the rest of their learning, One child said that “year 5 is probably the best year for this because we have more understanding of puzzles”.

Year 5’s teacher, Mrs Moss was asked the same question and she explained that it is useful in supporting and developing skills in maths, particularly in calculating perimeter, shape, rotation, reflection and translation and generally good for developing problem solving. She added that it would also be helpful in a science context in developing an understanding of the properties of materials.

Other skills that she observed the children using and developing throughout the workshops were dexterity, teamwork, spatial awareness, hand-eye coordination, speaking, listening and discussion.

These skills are categorised as non-verbal reasoning (the ability to understand and analyse visual information and solve problems using visual reasoning as opposed to language). This includes: identifying relationships, similarities and differences between shapes and patterns and recognizing visual sequences and relationships between objects. Children at St John’s School are tested for these skills in their 11+ exams in Year 6 to evaluate the use of critical thinking and logic to solve problems. The questions are based around mathematical concepts such symmetry, rotation, mirroring, shape, size and direction.

FIG.6 *SUP VR Headsets*

FIG.7 *SUP Table Extension*

FIG.7 *SUP Rollercoaster*

FIG.8 *SUP Bridge*

FIG.9 *SUP Dragon*

FIG.10 *SUP Staircase*

Sit and Play: Exhibition at Buckinghamshire County Museum

The exhibition plan for Buckinghamshire County Museum is divided into two parts:

Gallery 1: a grid of 24 digitally designed chairs constructed from SUP, and Gallery 2, a large table where visitors can play and interact with SUP components.

The series of 24 chairs in Gallery 1 is intended to demonstrate SUP's design and structural possibilities. We will invite visitors to take a seat on the computationally designed chairs, compare them for size and comfort and observe the construction patterns.

In Gallery 2: hundreds of loose pieces of SUP components are left on a large table for visitors to use. The outcomes from the St John's School workshops are displayed alongside as examples of intuitive approaches to SUP.

Throughout the duration of the exhibition, students and visitors of different ages are given the opportunity to manually build predetermined computational designs. This is made possible by following visual instructions from a Microsoft HoloLens (an augmented reality headset). The HoloLens acts as the tool which slowly strengthens the link between the digital and the manual.

The aim was to understand how the children of Year 5 at St John's School would use the skills and muscle memory developed through intuitive immersive play to build the predetermined computational designs using the HoloLens. The assembly of digitally designed voxels by MAL are by no means intuitive. They follow a very particular logic that is built into the component itself. This differs from the lego brick which is built in layers to approximate an overall shape. While one could argue there is no such thing as a dead-end in lego, the SUP system determines that one piece in the wrong place can cause exactly this.

This is a crucial difference between the digital and the manual uses of SUP. If followed correctly, a dead end could not occur when using the predetermined digital Voxel system.

The manual construction skills of dexterity and intuitive design can be further enhanced by visual instructions from the HoloLens. By completing the steps provided by the computational logic of the Voxel system, the user can gain an understanding of further sign possibilities and an expansion of height, width and breadth that could be considered counter intuitive.

These reveal certain assemblies and variations which may not be immediately obvious. The digital and the manual approaches in SUP are mutually beneficial, and together they can offer a deeper understanding of the digital and the manual of SUP.

Some of the school workshop outcomes were positioned around the workshop at Grymsdyke Farm when the MAL were developing the designs for the chairs for the exhibition. The team found themselves intrigued by the different approaches used by the children that they had not previously considered. They then sought to combine these discoveries with their computational designs.

What is intuitive for the designer of the SUP component is not necessarily intuitive to the manual user. MAL are designing for SUP with maximum preconception while the children work with what the components invite and suggest. The flat assembly used by the children for their rollercoasters and roads was not something that MAL imagined. The children responded to this nature of assembly that never existed in any previous design. Their ways of extending the material as a surface was imagined and interpreted entirely differently to the ideas of MAL.

These findings demonstrate the ways in which SUP allows for both a complex computational logic as well as another logic calculated by intuition and mental arithmetic.

FIG.11 *SUP Gallery 1 Layout*

FIG.12 *SUP Chairs for Gallery 1 Assembled at Grymsdyke Farm*

FIG.13 Draft of *Sit and Play Exhibition Poster by Johannes Spitzer*

FIG.14 *Sit and Play Social Media Publicity by Johannes Spitzer*

Buckinghamshire Cultural Strategy

In preparation for the dissemination of SUP, Material Architecture Lab and Grymsdyke farm worked closely with the Buckinghamshire Cultural Strategy team and Buckinghamshire County Museum as well as its education department. There was a clear focus on attaining a broad reach of visitors to the exhibition and participants in the workshops.

The aims of the exhibition were in close accordance with that of the Buckinghamshire Cultural Strategy, which is “to revitalise historic town centres by enhancing their role as hubs for cultural activity as part of a wider and richer mix of uses.”

The strategy describes culture as “museums, galleries, cinemas, music venues, theatres, libraries, festivals and events: it is how we record, collect, curate and present our identities and how we understand others’ identities. It is how we preserve and bring to life our stories.” The county is historically known for its furniture design and production, the SUP exhibition was designed to reference this through SUP chairs designed for the exhibition, highlighting digital possibilities in approaches to furniture production.

With the Government’s new Sector deal for the Creative Industries, Buckinghamshire can play a much more pronounced role, complementing London’s position as a global creative city. The Cultural Strategy team worked with MAL and Grymsdyke Farm as partners to organise and deliver high quality and inspiring activities for the people of Buckinghamshire.

Social, Health and Wellbeing

Through the design dissemination of the SUP: Keys to Design and Making exhibition there was a marked intention to benefit the wellbeing of local communities and all visitors to the exhibitions and participants in the workshop. We aimed to achieve this through an accessible and engaging program of events to accompany the active participation inherent in this interactive exhibition. Arts Council England’s research on the Social, Health and Wellbeing benefits of engaging with the arts helped to inform the formulation the aims for these benefits the exhibition set out to achieve and facilitate.

“Participation in the arts can contribute to community cohesion, reduce social exclusion and isolation, and make communities feel safer and stronger (Arts Council England 2014)”

“Seventy-six per cent of older people say art and culture is important in making them feel happy; 57 per cent say art and culture is important in helping them meet other people; and 60 per cent say it is important in encouraging them to get out and about” (Arts Council England 2014)

“Arts and cultural intervention can have a positive impact on specific health conditions such as dementia, Parkinson’s and depression” (Arts Council England, 2014)

“Engagement in structured art and culture improves the cognitive abilities of children and young people” (Arts Council England, 2014)

“People who had attended a cultural place or event in the previous 12 months were almost 60 per cent more likely to report good health compared to those who had not” (Arts Council England 2014)

Educational Development

Bucks and Thames Valley Local Enterprise Partnership (BTVLEP) are key partners for the Cultural Strategy, with their focus on ‘the creative and digital economy with Pinewood Studios at its core’. Through guidance and cooperation with the Cultural Strategy team, SUP: Keys to Design and Making aims to support the drive to achieve BTVLEP’s strategies in these respects:

- Meet skills shortages in creative-tech careers
- Enable inspiring work experience opportunities creative, space, digital health and high value manufacturing sectors
- Make the towns in Buckinghamshire attractive to businesses and employees in the creative and digital sector
- These strategies will be met by the development and delivering of programming and coding workshops in relation to project Digital Manual to schools, colleges and the museum.

The SUP: Keys to Design and Making educational program focuses heavily on the aforementioned non-verbal reasoning that is of significance in the schools curriculum at different levels throughout Buckinghamshire. The program seeks to support the advancement of these skills both digitally and manually.

Dissemination and Reach

Due to COVID-19, the SUP: Keys to Design and Making exhibition was unable to go ahead. However it is possible to speculate approximately on the reach of this project as well as outline ways the project was disseminated despite COVID-19.

There were 22 classes from 12 schools and colleges scheduled to participate in the workshops that were scheduled to run in parallel with the exhibition; these were to be groups of 15 participants per workshop, resulting in a reach of approximately 330 children and young people attending.
The approximate footfall museum is 45 people per day on average. Between the opening and the closing of the exhibition, the estimated reach is 2,700 visitors. SUP Sit and Play kits had been developed for sale at Buckinghamshire County Museum throughout the duration of the exhibition. These will now be on sale upon the reopening of the museum.

The following are the contingent ways in which SUP: Keys to Design and Making is disseminated:

- Serena Avery of Buckinghamshire County Museum's Education Department circulated writing and images associated with SUP: Keys to Design and Making amongst the many schools she works throughout the county.
- Buckinghamshire County Museum is to publish text on SUP: Keys to Design and Making permanently on the museum website.
- Buckinghamshire Cultural Strategy are to publish text on SUP: Keys to Design and Making for their many partners in the local cultural industries.
- Mr. Ian Newton, headmaster of St John's Primary School will include text and images of the work carried out at the school via the school's newsletter which is sent to all parents of children at the school.

FIG.15 *SUP Sit and Play Kit*

FIG.16 *Packaging for SUP Sit and Play Kit*