Use of SketchBook Pro with Tablet PC (Tab-Sketch™) as a Design Thinking Tool in the Teaching and Learning of Design and Technology

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Abstract

This paper shares the preliminary findings from the first two phases of an exploratory study on the potential of Tab-Sketch™ as i) a design-thinking tool for design and technology (D&T) teachers and pupils in secondary schools; ii) a teaching and learning tool for D&T teachers; and iii) a platform to document design-thinking in the form of digital design journal. Tab-Sketch is an acronym derived from Tablet PC and SketchBook Pro, a computer software. The study, which is naturalistic in approach, was initiated in Nov 2004 and has evolved into three phases. Phases 1 and 2 were completed. Phase 3 has commenced in Aug 2006 and will end in Dec 2007. The insights and experiences gained from the first two phases include:

- the concept of 'growing ideas' conveniently and dynamically;
- the potential of the software for quick sketches and editing via features like layer and the range of rendering tools available;
- Tab-Sketch as a tool for the teacher-designer to dialogue with self and to practise rapid visualisation;
- capturing design conversations graphically and digitally between teacher and pupil; and
- ease in manipulating images and ideating presentation drawings.

These preliminary findings have shaped Phase 3 of the study which is still on-going.

Key words

tablet, design, thinking, drawing, sketching, tool

Introduction

One primary feature of the Tablet PC that suits the D&T teaching and learning environment is its inking capability. Tablet PC is designed to allow users to interface with the computer via a pen stylus directly on the display screen. It is primarily a digital pad built into a computer notebook. With appropriate computer software, the Tablet PC allows for digital sketching, drawing and colour rendering. This opens up a whole new world of possibilities and potential in pushing new frontiers of teaching and learning of D&T.

This paper aims to share some insights gained from the first two phases of the Tab-Sketch™ study. The work is still on-going. It will attempt to address the notion of how teachers use the Tablet PC by suggesting five Tab-Sketch pedagogical approaches for the teaching and learning of D&T. Other creative uses that evolved from the study will also be discussed. These uses will be further dealt with in Phase 3. The researchers would like to emphasise that it is not the intention of this paper to promote the exclusive use of Tab-Sketch but to share some findings and insights into its use to facilitate teaching and learning in D&T, and how one could exploit the potential of Tab-Sketch. It is also hoped that this preliminary sharing would support D&T teachers who are keen or are currently using similar technology to teach D&T.

Literature Review: The anchor pedagogy vis-à-vis Tab-Sketch Drawing, freehand sketching, doodling, colour rendering, thumbnails, etc. are part and parcel of visual representation and visualisation skills that support the designing of three-dimensional objects. These skills help a designer communicate with others, generate design concepts, 'grow' ideas, dialogue with oneself, capture design thinking, create, visualise, and externalise one's mind's eye (Edwards, 2001 & 1986; Kosslyn, 1980/1983). Designers are constantly having a conversation with themselves through the cycle of sketching, inspecting, and revising (Ning et al, 2004). This is not new and is well practised in the creative industries, and in creative related training at the tertiary level. Study shows that a stunning 67% of all drawings done over the course of a typical design project are freehand sketches (Ning et al, 2004). In the teaching and learning of D&T, the use of drawing and sketching skills is also substantial.

Research literature on the role of sketching in designing often regard the 'back-of-the-envelope' sketches, the 'napkin' sketches, the 'scrap paper' sketches as important phases of designing, aiding design problem-solving (Garner, 1987/1988; Goldschmidt, 1994). The importance and potential of sketches and doodles in facilitating design thinking and creative work cannot be overemphasised. Generally, D&T teachers agree that it is important to learn how to draw and sketch, and are aware of the importance of drawing and sketching. However, there was little evidence of explicit emphasis or intimate articulation

of the use of drawing, sketching and/or doodling to design, think, create, shape, interrogate, form, figure out, or grow design concepts and/or ideas. The researchers felt that the important role of doodling, sketching and drawing, and how it supports creative work in an intimate way ought to be fully grasped and internalised. This is important as it underpins the use of Tab-Sketch. The essence of creative potential of doodles and sketches could be articulated as – *residing in all these doodles and sketches are likely or potential concepts and design ideas waiting to be uncovered, grown, progressed, unfolded or evolved*. As Cheng et al (2004) put it – 'sketches can contain the seeds of ideas, but the process of germination is usually obscured in the final document'.

It is this ability to translate three-dimensional thoughts on paper, and consequently how the concrete visual representation continues to transform spatial thoughts (Gardner, 1983) and *grow* design concepts or design ideas that need to be understood in-depth in order to anchor another crucial pedagogy for teaching and learning of D&T. This may be understood by many D&T educators but seemingly under explored. It is a form of or it is itself rapid visualisation (Hanks & Belliston, 1990). The potential of rapid visualisation (Hanks & Belliston, 1990) in design activities maybe underestimated by many D&T educators.

Cheng et al (2004) studied how digital pen aids the teaching of drawing skills to design students. They claimed that the ability to record and replay graphic marks with a timeline is a '*great asset to understanding and teaching drawing, and that it opens up new kinds of classroom interaction*'. In another study, Ning et al, (2004) presented a software tool – InkBoard built on the Tablet PC platform. The study showed the tool's potential in enhancing design-oriented education experience of the students, especially in peer-to-peer collaborative design work. With advancements in graphic technology, the possibility of recording and replaying the act of design sketching and doodling opens up the possibility or likelihood of seeing a person's mind's eye in action. This is another step closer to understanding the designer's way of thinking and visualisation in action, and a somewhat real-time design thinking in action. From the teaching and learning of D&T education viewpoint, it also opens up new forms of pedagogical potential.

With Tab-Sketch, a somewhat 'primitive-hi-tech' way of recording and replaying graphic marks is made possible and affordable to the schools. Rapid visualisation may take a more dynamic form and be propelled further in terms of speed of sketching and drawing, and versatility of manipulating visuals. The discussion thus far sets the stage for a grounded understanding of the role of doodling, sketching and drawing - the fundamental building block for the use of Tab-Sketch effectively. With the ease that

Tab-Sketch offers in terms of doodling, sketching and drawing, the pedagogy would continue to evolve as the practice grows and matures. The researchers would like to restate that the main thrust of the research is on the effective use of Tab-Sketch platform to evolve teaching and learning pedagogies for D&T.

The Research Method

The research approach is naturalistic in nature. It started with a six-week design programme for a group of Sec 3 pupils. The objective was to understand the degree of user friendliness of the software, and how pupils take on to Tab-Sketch. The experience gained provided the researchers with interesting experiences and insights. It evolved into three phases of study. The three phases in the Tab-Sketch research were:

Phase 1 How pupils react to Tab-Sketch
Period   Nov/Dec 2004
Sample 10 Sec 3 pupils from two classes in Dunman Secondary School were volunteered by their D&T teachers. [Three interested pupils from the 10 volunteers continued with Tab-Sketch for their coursework the following year at Sec 4].

Activities
- A six-week exploratory design programme was conducted for the pupils at their school. Pupils attended a three-hour session per week for six consecutive weeks.
- Each pupil was issued with a Tablet PC for the whole six-week duration, 24/7.
- Pupils were given a half-hour briefing and demo on Tab-Sketch at the start of the first session.
- The rest of the programme focused on raising design awareness and engaging in design activities and a simple design project on 'handles'. No structured teaching was imposed. This was intentional for the purpose of observing how pupils take on the use of Tab-Sketch.
- Three interested pupils continued to use the Tablet PC for their Sec 4 coursework the following year. The pupils were left alone with their D&T teachers with no intervention from the researchers.

Phase 2 How the researchers and pupils react to Tab-Sketch
Period   Dec 2005 - Apr 2006
Sample 14 GCE O Level pupils from seven secondary schools. These pupils sat for the GCE O Level examination in Nov 2005 and were waiting for the release of results. They were identified by their D&T teachers to participate in the research. [Four very keen pupils continued to work on some conceptual design work.]

Activities

- Pupils were given a half hour briefing and demo on Tab-Sketch at the start of the first session.
- Pupils were exposed to design-related activities and went on field trips. For example, visit to Red-dot Design Museum, Nanyang Polytechnic Industrial Design Department, concept shop – Molecule; outdoor drawing trip; and attended a talk by designer from OSIM.
- Discussion on their GCE O Level design work.
- Discussion on problem identification, SCAMPER, idea borrowing, research.
- Discussion on a pupil's project 'EZ' and further designing.
- Four pupils continued to do some conceptual design work till Jun 06.

Phase 3 How a class of pupils react to Tab-Sketch
Period Sep 2006 - Dec 2007
Sample 20 D&T teachers and their pupils
Focus

The main focus of Phase 3 is for D&T teacher-participants to understand and appreciate the insights and lessons gained from Phases 1 & 2 with the following broad terms of reference:

• Teacher as learner

- developing drawing and rendering skills via the Tab-Sketch platform;
- exploiting Tab-Sketch as a teaching & learning tool;
- collaborative design work with reference to pupils' work (which will be the key platform for Phase 3 research work);
- sharing by teacher-participants on their experience in facilitating D&T pupils in their coursework;
- resource building by researchers and teacher-participants;
- pre- and post-test for work carried out by D&T teacher-participants.

• Teacher-pupil coaching

- developing their pupils' drawing and rendering skills via the Tab-Sketch platform;
- teaching their pupils the finer 'tricks' to exploit Tab-Sketch for design work;
- Tab-Sketch as a learning tool for pupils;
- data management and research observation norms.

For the purpose of Phases 1 and 2, pupil-participants did not receive any formal training on drawing and sketching from the researchers. Pupil-participants explored the use of Tab-Sketch after a quick demonstration on its use. Their drawing and sketching competency entry level was what they had acquired

from their schools. Any discussion on quality of work was incidental and was carried out with two primary focuses namely i) the researchers' personal exploration and learning of Tab-Sketch from both teaching and learning perspectives; and ii) by way of demonstrating to pupil-participants the basic Tab-Sketch tools and potential to improve their quality of work. Pupils were observed on how they take on to Tab-Sketch in terms of their usage of the SketchBook Pro software and the way they handle the Tablet PC. All works produced by the pupils formed the main raw data for comparison and analysis.

Findings from Phases 1 and 2

The findings take the form of experience gained and lessons learnt from the work generated as the researchers facilitated the various activities designed for the respective phases. They were derived qualitatively and visually from works produced by the pupils, and observations made by the researchers on pupils' attitude, interest and motivation towards Tab-Sketch. Excerpts of pupils' and researchers' work are included in this section labelled as 'Exhibit' for the purpose of discussion, and as illustrations of insights gained.

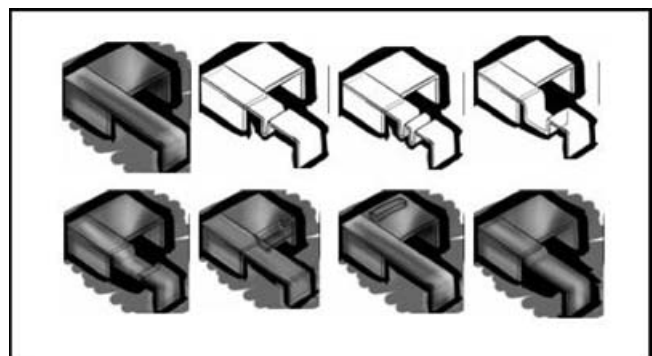### Phase 1: How pupils react to Tab-Sketch

Exhibit 1

A pupil-participant was able to independently generate design ideas for part of a design solution using Tab-Sketch. He did it in his own way without any instructions or discussions with the researchers. It was observed that design ideas and details were generated quantitatively. Format and approach were entirely the participant's choice and preference.

Exhibit 2

A pupil-participant's first attempts at designing handle using Tab-Sketch (six-week design project on 'handles'). Pupil-participants were able to make use of the software features readily and freely at a basic level on their own with minimal instructions or guidance.
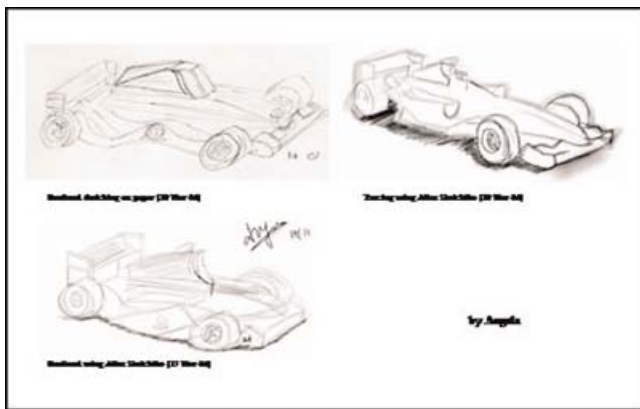

Exhibit 3

Drawing activities using i) pencil and paper (top left); ii) Tab-Sketch (bottom left); and iii) underlay with Tab-Sketch (top right). Drawing (ii) saw a shade of difference in terms of quality of sketch, pupil-participants were quick to use grey air-brush feature to enhance sketch. Drawing (iii) seemed to inject fun into producing dynamic outcome and pupil-participants demonstrated a sense of pride.
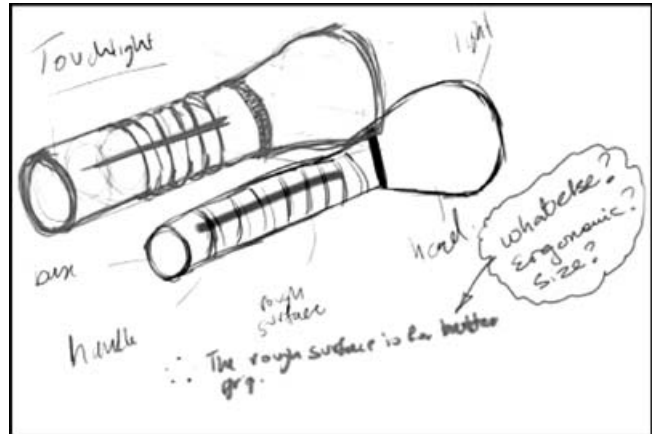

Exhibit 4

Tab-Sketch was used to give immediate feedback on pupils' work in an interactive manner. The platform allowed real-time visual dialogue between pupil-participants and researchers when the latter attempted to illustrate improvements on pupil-participants' work. The dialogue of sketches and annotations were digitally captured and transferred from pupil-participants' Tablet PC to that of researchers' via the thumb drive. 'Live telecast' of such designerly dialogue could be viewed by the whole class through projection on screen! This is not feasible when it takes place via pencil and paper.
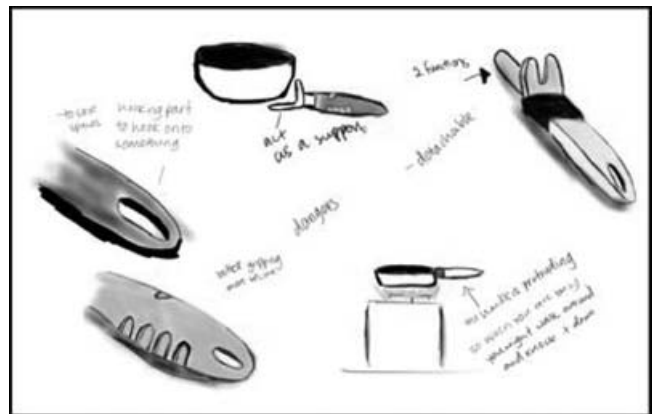

Exhibit 5

Ideation sketches done by pupil-participants for the 'handle' project. Colours and shading were used readily to define the design idea. There was a natural tendency for pupil-participants to colour render sketches without any instruction or prompting. Air brush, paint brush and marker features were convenient and easy to use. Like any graphics software, editing was made simple and non-threatening. Pupil-participants were observed to be daring in making mistakes as the 'redo' feature allowed them to make adjustment, modification and improvement to their sketches.

The findings from Phase 1 involving the 10 Sec 3 pupils from Dunman Secondary School were found to be positive. Following were some insights gained:

a) Design activities in D&T require pupils to show their design thinking process and action of researching, conceptualising and developing ideas through sketches and short notes. It was observed that pupils generally needed a lot of encouragement to get started with their work. This is especially so when it comes to design sketches. During the preliminary study, the pupil-participants seemed to show less inhibition to drawing and rendering, and were able to use the Tab-Sketch intuitively for designing and discussion. However, other factors like sustaining interest and motivation would need to be looked into. It was observed that when pupil-participants' competency in producing visual images peaked, struggles set in and interest seemed to drop.

b) From the researchers' perspective, Tab-Sketch has great potential as an efficient tool for graphics-related lesson preparation, teaching, and classroom discussion. Real-time interaction with pupil-participants to engage them in design visualisation and to critique their work could be carried out with ease. The digital platform also allowed the researchers to translate their thought processes into visual representation. This can be projected on screen immediately for a class to view and to follow the thought processes.

c) The amount of visual representations generated by pupil-participants, in terms of quantity, seemed large. This was an unexpected major insight gained in terms of a tool for 'productive design thinking'. This could be the result of a platform for design drawing and sketching which is fun, convenient and less intimidating. The ease of use, speed and flexibility of navigating between visual images and software features could have supported the generative work. (Note: the quantity of visual images produced does not imply quality work. However, the generative design act observed is valuable in the context of designing. This could be capitalised to encourage rapid visualisation and ideation.)

The above insights offered opportunities for one to tap on the immense potential of Tab-Sketch. This may redefine the traditional design sheet environment into a more dynamic, interactive and productive platform. The potential is almost without boundaries and it is entirely up to the imagination of the user or the designer. The notion of effective use of design sheet (Denton, 1993) to learn and support design thinking may be bridged from the perspective of 'real-time' generative doodles and sketches, and more importantly speed and 'volumes' of generative design sketches could be achieved.

Phase 2: How the researchers and pupils react to Tab-Sketch

Phase 2 was somewhat a natural extension of Phase 1. The pupil-participants have completed their GCE O Level and were waiting for the release of examination results. The setting was natural and the context was anchored on design awareness in general. Field trips and design talks were organised for the participants. As in Phase 1, the participants were equipped with Tablet PC, 24/7. Exhibits 6 to 8 are snapshots of work done by the pupil-participants and researchers in Phase 2. All works were documented for analysis. These took the form of work done during drawing and sketching skills practice; pupil-participants' reflection log on their experience with Tab-Sketch; observations of pupil-participants in action; and informal conversation with pupil-participants on work done and experience with the researchers.

Sketch 1   *Sketch 2*
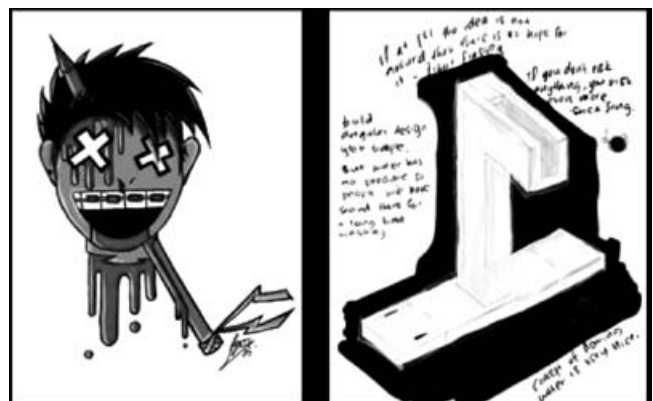
Sketch 3   *Sketch 4*

Exhibit 6

The above four sketches were drawn by a pupil-participant. Sketches 1, 2 and 3 were mainly 2-D visual representation with complete colour rendering. There is a good degree of quality in the illustration work. The pupil-participant was a self-professed avid graphic designer and had engaged in similar

work during his school days. This was the first time the pupil-participant used Tab-Sketch. Sketch 4 was a 3-D drawing of a designer's water tap. Exhibit 6 shows a gap in the quality of visual representation between 2-D and 3-D, imaginative and observation drawing. Similar observations were made in other pupil-participants' work. Initial 'rush' of motivation and excitement towards using Tab-Sketch was observed. This seemed to hit a plateau once pupil-participants were unable to cross the barrier of sketching and rendering 'good' 3-D visual representation. Interests started to wan. There may be other factors that contributed to this waning interest after the initial 'rush'. The noticeable gap was the lack of quality and confidence in 3-D visual representation as compared with 2-D. However, there was good potential demonstrated in 3-D visual representations by other pupil-participants. (See Exhibit 7.)

Before

After

Before

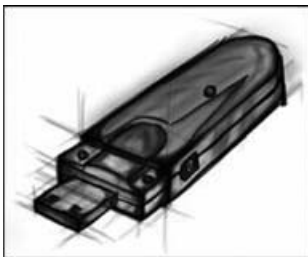*After*

Before

After

Exhibit 7

The 'Before' sketches were drawn by pupil-participants using Tab-Sketch. These sketches demonstrated pupil-participants' sketching and drawing ability which was either acquired from their respective schools or self-taught. The level of competency seemed high. The 'After' sketches were touch-up made on pupil-participants' work by the researchers. This was to demonstrate to pupil-participants the potential of Tab-Sketch. It was also intended to motivate pupil-participants to immerse in the use of Tab-Sketch and to encourage them to use it independently. Drawing skills demonstrated during the study were purely incidental. The touching up process was an important ongoing learning experience for the researchers to re-learn and mature his graphic skills on a different medium – Tab-Sketch environment. It was also an integral experience to understand the interactive potential of both the hardware and software towards what the researchers claimed as 'technological intimacy'. This would not have been possible without constant indulgence in using the digital platform.
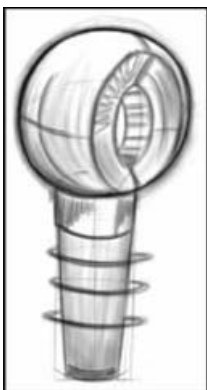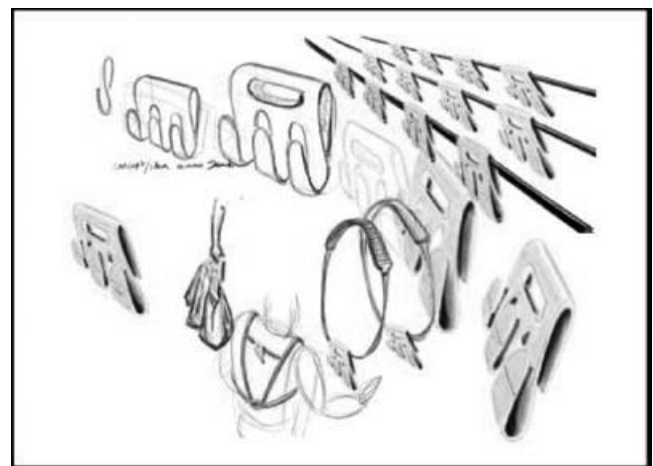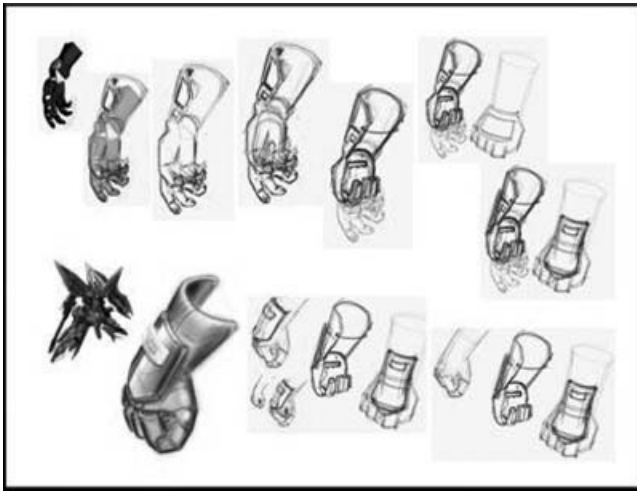

Sketch 5

Sketch 6

Sketch 7

Exhibit 8

Sketches 5 to 7 are sample compilations of design concepts and design ideas generated by the researchers as resources for teaching and discussion with pupil-participants. The design situation used for the purpose of this design activity was chosen from one pupil-participant's GCE O Level coursework. The researchers found that the Tab-Sketch platform was very useful as a teaching tool. The researchers' competency level has also grown and matured further. The 'technological intimacy' has allowed a deeper level of appreciation of what Tab-Sketch could offer, e.g. the high quality rendering work achievable, ease of learning sketching with the aid of underlay, multiple duplication of images, record of stages of drawing via the layer feature for 'replay' as a teaching tool, ideating presentation drawings, ergonomics application in design decision making, import of sketches and generation of design sheets.

Some insights and experiences gained from Phase 2 were:

a) Pupil-participants' interest and motivation though noticeable were short-lived. Some possible reasons are: there was no accountability imposed; pupil-participants have left school; pupil-participants were committed to part-time jobs; limitations in drawing and sketching skills; pupil-participants were volunteered by their teachers.

b) Researchers' personal *practice and immersion* in Tab-Sketch in order to facilitate pupil-participant activities resulted in a more 'intimate' understanding of the potential of Tab-Sketch. Through these design practices, the Tab-Sketch platform has evolved new pedagogical products (refer to Annex). Generation of design concepts, ideas and development have taken a new dimension of dynamic manipulation of visual forms and details digitally, while maintaining the absolute integrity of traditional pen-and-paper visualisation approach. More importantly this can be easily managed by secondary

school or even primary school pupils. All these digitally dynamic manipulations are embedded in i) the ease and complete flexibility of manipulating digitally-sketched images; ii) the speed of working and re-working of digitally-sketched images; iii) the luxurious availability of the full range of digital rendering medium; and iv) the interface-ability between other graphics and computer-aided drafting software.

c) The ease of using digital underlay similar to graphics software like Photoshop, CorelDraw, ArtRage, etc. facilitates the learning of drawing and rendering via tracing technique.

d) Designing in the context of ergonomic studies using photographs could be easily achieved.

e) The ease of interfacing with peripherals like digital camera via USB port or Bluetooth technology to facilitate design images manipulation in real time.

f) A convenient platform for ideating presentation drawings.

Concluding Remarks

Based on the experiences and lessons learnt from Phases 1 and 2, five pedagogical products using Tab-Sketch were recommended as follows:

- Demonstrating a process of concept idea generation with focus on ergonomic considerations (Annex, Exhibit A).
- Demonstrating a process of concept idea generation with focus on modular design and ideation of presentation drawing (Annex, Exhibit B).
- Scaffolding pupils' learning through designing (Annex, Exhibit C).
- Generating ideas using Sketchbook Pro layer feature (Annex, Exhibit D).
- Preparing teaching resources for sketching and rendering (Annex, Exhibit E).

From the discussion and evidence illustrated thus far, Tab-Sketch is able to offer various teaching and learning benefits. These include:

- effective graphic-related lesson preparation and presentation;
- versatile drawing tools;
- Tab-Sketch as a motivating tool; and
- ease of information management between pupils and teachers.

Tablet PC together with the right software could be used for:
- demonstration of drawing and rendering techniques;
- drawing and rendering skills practice;
- real-time design activities, design idea generation and development;

- preparation of lessons that involve lots of graphics and illustrations;
- discussion of design ideas interactively – teacher-to-pupil, pupil-to-pupil;
- provision of instant feedback on pupils' design work sheet 'interactively';
- direct research input, comments, annotations and highlights on research materials; and
- easy preparation of presentation drawings.

Phases 1 and 2 have provided the researchers very good insights and understanding of the Tab-Sketch platform. Phase 3 would take a somewhat different approach in terms of reaching out to a bigger sample base and involving D&T teachers directly. Observation and measurement of pupils learning will be studied in-depth. The tentative terms of reference for Phase 3 are as follows:

- **Teacher as learner**
  - developing drawing and rendering skills via the Tab-Sketch platform;
  - exploiting Tab-Sketch as a teaching and learning tool;
  - collaborative design work with reference to pupils' work (which will be the key platform for Phase 3 research work);
  - sharing by teacher-participants on their experience in facilitating D&T pupils in their coursework;
  - resource building by researchers and teacher-participants;
  - pre- and post-test for work carried out by D&T teacher-participants.

- **Teacher - Pupil coaching**
  - developing their pupils' drawing and rendering skills via the Tab-Sketch platform;
  - teaching their pupils the finer 'tricks' to exploit Tab-Sketch for design work;
  - Tab-Sketch as a learning tool for pupils;
  - data management and research observation norms

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Annex

Following are five exhibits to illustrate pedagogical approaches via the Tab-Sketch™ platform for teaching and learning of D&T.
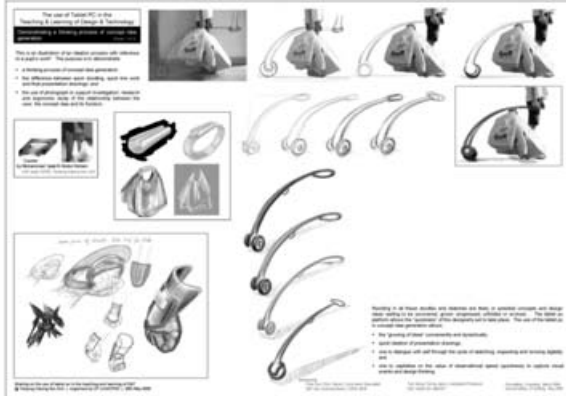

Exhibit A Demonstrating a process of concept idea generation with focus on ergonomic considerations
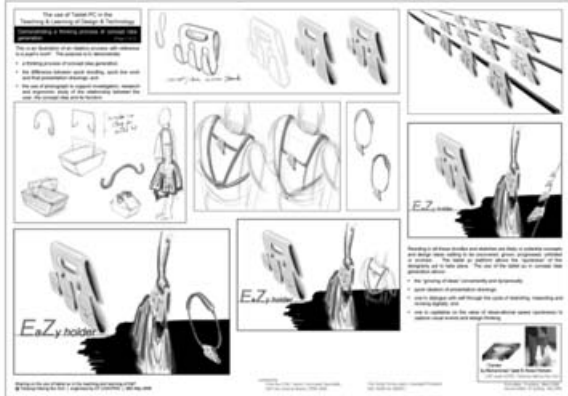

Exhibit B Demonstrating a process of concept idea generation with focus on modular design and ideation of presentation drawing

These products served as illustrations of an ideation process with reference to a pupil-participant's work entitled 'EZ'. The purpose is to demonstrate:

- a thinking process of concept idea generation;
- the difference between quick doodling, quick line work and final presentation drawings;
- the use of photograph to support investigation, research and ergonomic study of the relationship between the user, the concept idea and its function;
- the ease of ideating presentation drawings; and
- the concept of modular design made simple.

As discussed in the literature review, residing in all these doodles and sketches are likely or potential concepts and design ideas waiting to be uncovered, grown, progressed, unfolded or evolved. With all the design illustrations of the EZ project put together, one could see how the pupil's original design solution has evolved into many possible and creative design concepts. The Tablet PC platform allows the 'quickness' of this designerly act to take place. The use of the Tablet PC in concept idea generation allows:

- the "growing of ideas" conveniently and dynamically;
- quick ideation of presentation drawings;
- one to dialogue with self through the cycle of sketching, inspecting and revising digitally; and
- one to capitalise on the value of observational speed (quickness) to capture visual events and design thinking.
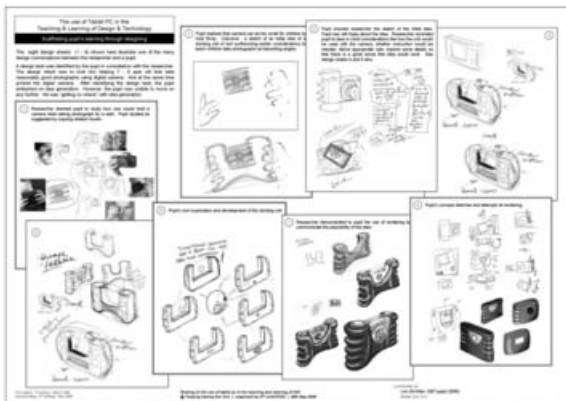

Exhibit C Scaffolding pupil-participant's learning through designing

A design task was identified by the pupil-participant in consultation with the researchers. The design intent was to look into helping 7 - 9 year old kids take reasonably good photographs using digital camera. Specifications like protecting the digital camera, appealing to children, etc. were discussed. After identifying the design task, the pupil-participant embarked on idea generation. However, the pupil-participant was 'getting no where' with idea generation. The 8 design sheets (1 - 8) illustrate one of the many design conversations that happened between the researchers and the pupil-participant with the following flow of design activities:

i) Researchers directed pupil-participant to study how one would hold a camera when taking photograph for a start. Pupil-participant studied as suggested by copying related visuals.

ii) Pupil-participant realised that the camera can be too small for children to hold firmly. The outcome was a sketch of an initial idea of a docking unit of sort.

iii) Pupil-participant showed researchers the sketch of the initial idea. Pupil-participant was still fuzzy about the idea. Researchers reminded pupil-participant to bear in mind considerations like how the unit would be used with the camera, whether instruction would be needed, what were the appropriate size, what were some details in order for the idea to work. (See also design sheets 4 and 5.)

iv) Pupil-participant's own exploration and development of the docking unit.

v) Researchers demonstrated to pupil-participant the use of rendering to communicate the plausibility of the idea.

vi) Pupil-participant's concept sketches and attempts at rendering.

The process of scaffolding pupil-participant learning was rich and 'fluid' in the flow of discussion. Real-time design sheets evolved quickly with the help of 'scale' and 'layer' computer software features. The use of images to support ergonomic understanding of how children hold an object (in this case a camera) was dynamic and fast. The pupil-participant seemed to be able to carry out the ergonomic study readily and with ease. There is potential in studying this pupil-participant's outcome in more depth to understand pupils' designerly cognitive development in the context of D&T.

Exhibit D Generating ideas using Sketchbook Pro layer feature

This is an illustration of an approach to engage a class of pupils in idea generation. The objective is to 'loosen up pupils' mind' to generate as many ideas as possible. The approach allows a sizeable number of quick ideas to be generated visually, and in real time. It also allows triggering of further ideas. The illustration here was an outcome of a lesson conducted with a group of Sec 3 pupils. The design situation of 'how to wake up a boy sleeping in his seat during lesson' was offered to the class. The layer feature was used to immediately capture pupils' suggestions. It was observed that the 9 ideas were generated in under 10 minutes. The group of pupils participated actively in the ideation process and had full view of the process in-action projected on the OHP screen. The element of fun and excitement was

generated as ideas offered by pupils were immediately sketched on layers. The steps were as follows:

- A sketch of a boy sleeping in his seat was used as the design context for the ideation process.
- A new layer as a canvas for sketching was added to capture an idea suggested by a pupil.
- Comments on the idea from other pupils were documented using a different colour marker from the built-in palette.
- Next, the layer was hidden and another new layer added to capture the next idea.

This activity was carried out to get a sense of how pupils would react to such an interactive platform. For this approach to be effective and dynamic, teachers need to be able to exercise some form of rapid visualisation skills as he/she needs to engage pupils in an active design dialogue and discussion. A certain level of 'fun' performance is therefore expected. The level of facilitation has to be anchored on design thinking strategies or techniques. The above simple activity suggested a potential of Tab-Sketch™. The advantages of such an IT-based approach for idea generation are as follows:

- it allows the pupils to be fully engaged as they participate in the process and watch ideas 'grow' before their eyes;
- the use of features like layer, lasso and cut-and-paste saves time;
- the convenience of the range of digital sketching and rendering tools available to enhance communication;
- it allows ease of managing the interactive nature of teaching; and
- the real-time idea generation or idea-growing™ could be illustrated with ease. Pupils could be taught to utilise this idea-growing™ technique.
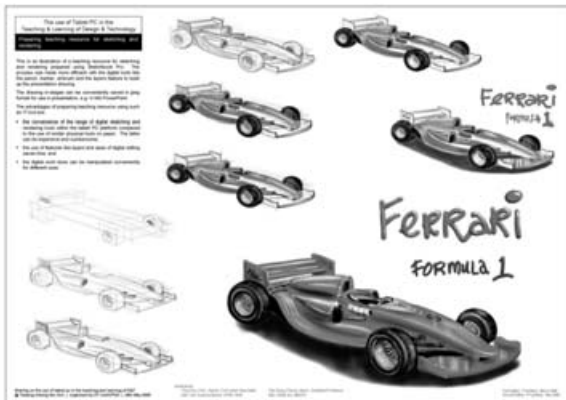

Exhibit E Preparing teaching resource for sketching and rendering

This is an illustration of a teaching resource for sketching and rendering prepared using Tab-Sketch™. The process was

made more efficient with digital tools like pencil, marker, airbrush and the layer feature to build up the presentation drawing. All these made it possible to record the stages of building up a sketch. A structured ordering of layers could be organised to capture the stages of sketching or rendering. This could then be presented in stages to show how a sketch was built up. The drawing in-stages can be conveniently saved in jpeg format for use in presentation, e.g. in MS PowerPoint.

The advantages of preparing teaching resource using Tab-Sketch™ are:

- the convenience of the range of digital sketching and rendering tools available within the tablet PC platform compared to the use of similar physical tools on paper. The latter can be expensive and cumbersome;
- the use of features like layers saves time;
- the ease of digital editing;
- the digital work done can be manipulated conveniently for different uses; and
- simple sketchy animation can be created to illustrate movements.