

# RSFF: Hybrid Design Tool

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## Abstract

*This paper is aiming at the identification of essential voids in the support of design processes offered by commonly available methods and tools.*

*Some remarkable results were obtained during design sessions with novices and experts by engaging them in tangible experiments that were designed to trigger and enhance their skills, tacit knowing and creativity that enable them to represent their ideas and concepts in an intuitive way. We explored the differences in designer's behavior during use of "analogue" and digital representation tools. We will explain our laboratory experiments, test results, educational embedding and creative opportunities that emerge from hybrid design tools. Furthermore we propose an exciting hybrid design tool to bring back the tacit and tangible elements of design processing into CAD systems.*

**Keywords:** Intuition, Tangible Interaction, Tacit Knowing, Virtual Design Assistant, Hybrid Design Tool

## 1. Introduction

As we know, 'The hands are the instrument of the mind' or to paraphrase McCullough, 'Hands are underrated because they are poorly understood'. To work with tangible materials allows the designer to investigate and explore ideas physically, feel the constraints of materials, tinker intuitively and create insight and interact with artifacts that are manifested through manipulation and tacit knowing. We focus our [re]search on the intuitive design of products and tangible representation through two-handed interaction assisted by ubiquitous computing leading to virtual models created by tangible interaction being transformed into virtual mesh iterations.

## 2. Tangible Experimentation in Education and Laboratory

We use our conceptual interaction framework, including data from our technology scan (see Fig.1), for analyzing tangible interactions as a function of a few of parameter dimensions, trying to create insight and understanding of the different levels of abstractions, and the similarities and differences between the physical and digital modelling activities.

This framework enables us to explore various aspects in the user interaction domain, user intuition, device handling, tool functionalities and investigate underlying program directives of CAD systems. The preliminary results and datasets from our experimentation procedures show that for ideation and conceptualization tacit and

tangible iterations are easier, more direct, intuitive and faster than commonly available tools or methods.

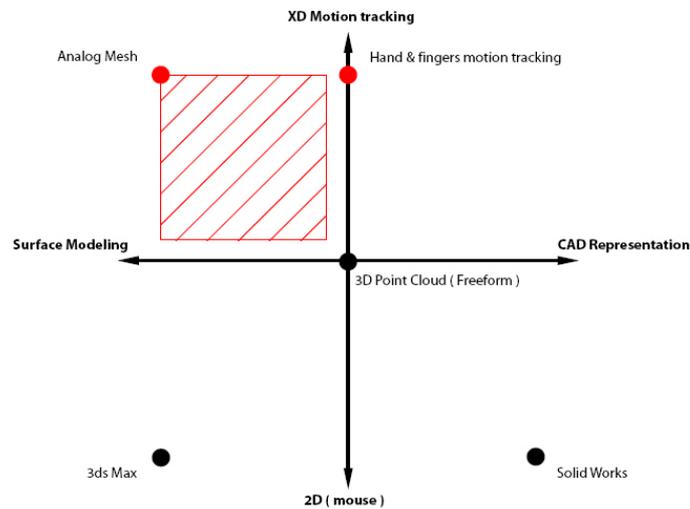


Figure 1. [Re]search framework comparing various CAD design interaction tools

### a. Educational Experimentation

Size-change (scaling) from orthogonal projection of an artefact and 3D transformation into tangible wire frames. It is a very complex assignment because of the interpretation and transformation of two-dimensional elevation drawings into three-dimensional wireframe representation. Various materials, multiple solutions and idiosyncratic choice architecture emerge from this assignment (see Fig. 2).

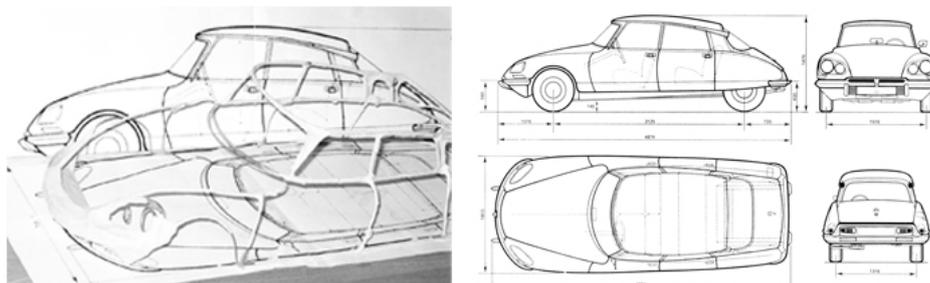


Figure 2. Size-change (left), orthogonal drawing DS (right)

### b. Nine (9) Representational Design Experiments

We introduce nine (9) haptic representational configurations and set-ups for testing purposes. The participants are given an orthogonal projection of an artifact, a perspective template (size constraint) and a specific design tool. After a brief set of instructions they are asked to make some kind of 2D sketch, 3D model or rendering

thereof with the particular tool provided. For all these tests, there is a five (5) minute time limit, unless otherwise stated. The aim of the experimentations is to measure, explore and quantify the effectiveness of un-tethered and tethered tool use, stall, apparent routines, mediation of restraints, signs of flow, gestural and skill development. The following benches were used in our research laboratory: 1. Pencil Sketch test bench; 2. Sand Sketch test bench; 3. Sculpting test bench; 4. Wire Plying test bench; 5. Steam Sketch test bench; 6. Solid Works test bench; 7. Virtual Clay test bench; 8. Blindfold Tacit test bench; 9. Blindfold Tangible test bench (see Fig. 3).



Figure 3. Nine (9) haptic set-ups

We assessed 208 participant tests by students and experts. We videotaped 41 hours of interaction during a 5 months period, which resulted in a great amount of data. All the participants were made aware of the video recording but no further reference was made to the video camera during the assessments. Since we engage in ongoing experimental research, we decided for this paper to use a quantitative selection of 79 participants (see Fig. 4) and drew provisional conclusions from the selected raw data.

	pencil	sand	steam	sculpting	plying	3d solid	virt.clay	b.tacit	b.tangi.
number of participants	25	38	40	34	28	22	21	79	79
total high speed video test time edited [mm:ss]	26:00	16:00	20:00	25:00	24:00	34:00	46:00	n.a.	n.a.
real total video test time [h:mm:ss]	3:28:00	2:08:00	2:40:00	3:20:00	3:12:00	4:32:00	6:08:00	7:13:00	7:04:00
average test time per participant [mm:ss]	08:19	03:22	04:00	05:53	06:51	12:22	17:31	05:29	05:22

Figure 4. Mapping and result chart VIA (selection)

We used Video Interaction Analysis (VIA) (Jordan & Henderson, 1995) to investigate the gestures, expressions, actions, immediacy (context), iterations and interactions with hardware and software. Video recording enables us to make qualitative

evaluations of the various tests. Data was extracted from the video footage from the various test benches.

### 3. Towards Tacit Tangible CAD Systems

We set out to combine all our gathered data, [re]search findings and explorations to devise a system that hands-back control to the designer, without substituting or replacing the computer! We now consider the computer as an assistant to support our tinkering, modeling and design processing. During ideation or creation of concept the ability to create, to imagine and to associate freely with abstract or tangible materials are considered crucial factors for an effective design process. Bringing back tangible interactions, and allowing tacit knowing and designer skills to emerge, will lead to more creative output in a shorter time span. The Virtual Design Assistant (VDA) (see Fig. 11 and 13) stores the captured iterations as polygon meshes (listing) by mimicking the tangible representations, and storing them in a database as time-stamped snapshots. By creating such a timeline of the evolving tangible object manipulations captured by means of a vision system, the hybrid tool allows the fusion of different polygon meshes with subsequent optimization.

The RSFF design process chart indicates how the active and passive interactions are embedded in the hybrid design tool (see Fig. 5). The tool could be an excellent addition to the current and emerging design tools and methods and assist designers.

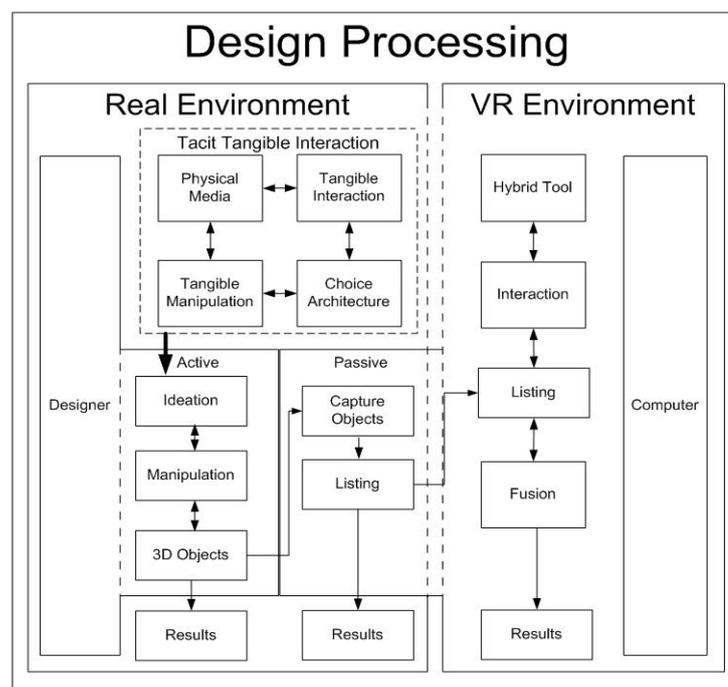


Figure 5. Design processing using physical and digital representation as envisioned in Raw Shaping Form Finding (RSFF ©2008)

### a) Tangible Workbench and Virtual Design Assistant

We propose a new method of design conceptualization and ideation based on intuitive skills, tacit knowing, reflective praxis and tangible augmented representation. The method entails the creation and development of a two-handed material representation Workbench with real-time or near-real-time vision-based

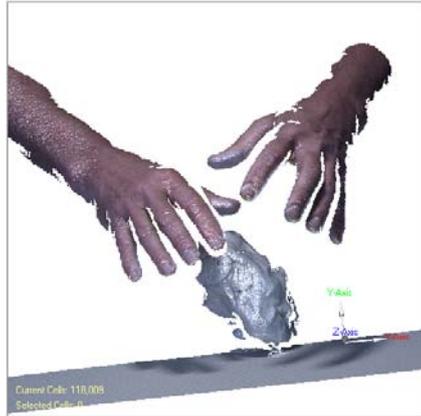


Figure 6: Two-handed interaction

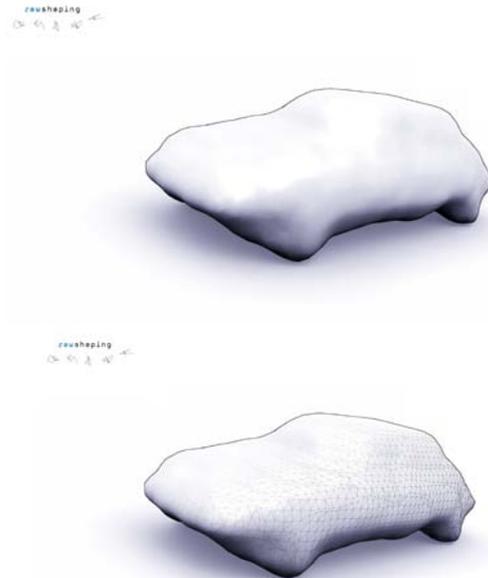


Figure 7: Virtual model from tangible interaction (above), VR model with polygon mesh example tool-output (bottom)

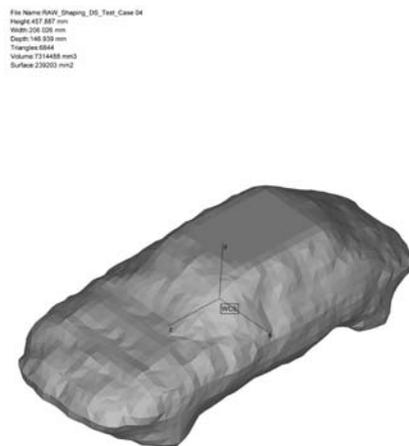


Figure 8: STL model from VR model



Figure 9: 3D model multi-layered manufacturing

components that generate polygon-mesh iterations as possible design solutions (see Fig. 6 and 7).

Another strong feature of the Virtual Design Assistant (VDA) is the insertion of raw functional elements (i.e. mechanical parts, PCB's) in the mesh iterations to assist the designer in design engineering the product. Fitting the shape to the functional and technical requirements to explore and simulate the variety in solutions and trade-offs.

The mesh iterations are easily exported to produce tangible models with multi-layered manufacturing (see Fig. 8 and 9).

### **b) Explaining the Prototype Hybrid Tool**

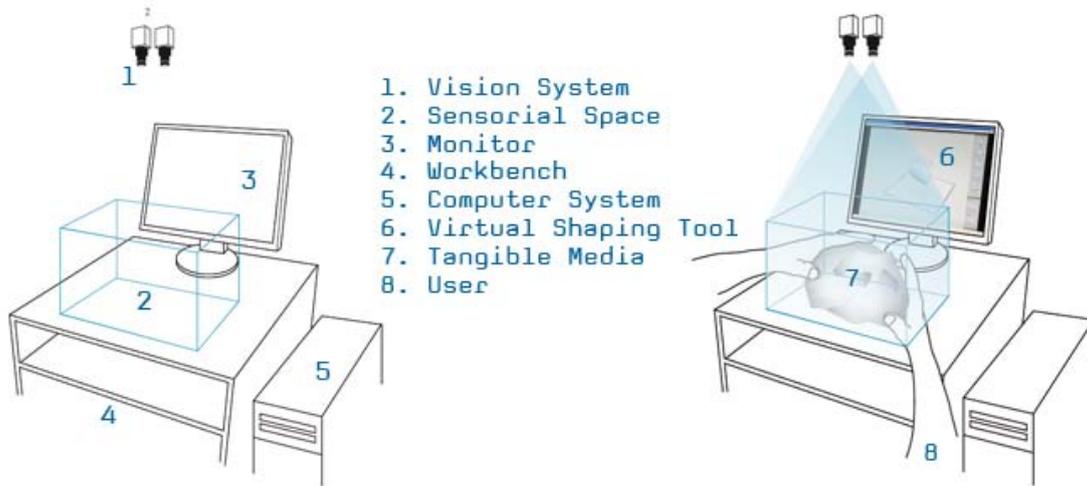
We designed and created a prototype of a two-handed physical representation Workbench (see Fig. 10) with vision-based components that capture the iterations during design processing. The designer standing at the Workbench is tinkering, thinking and designing physically, processing ideas with tangible materials to shape and form possible solutions. (see Fig.11)



*Figure 10. The Workbench*

There is no need to look at the monitor during the execution of the design task. The designer is un-tethered and can freely manipulate materials, create various physical models and concentrate on the work (see Fig. 12)

The RSFF-method creates room for re-shaping, styling and applying geometrical corrections with other CAD tools while at the same time leaving the idiosyncratic mark of the designer.



*Figure 11. Set-up Workbench and Virtual Design Assistant*



*Figure 12. The designer engaged in physical interaction*

Various stages of the design evolution are captured as raw polygon meshes (see Fig. 13). They are also stored in a database that is shown as a listing (history) and is also directly visible on the monitor in a separate solution space window.

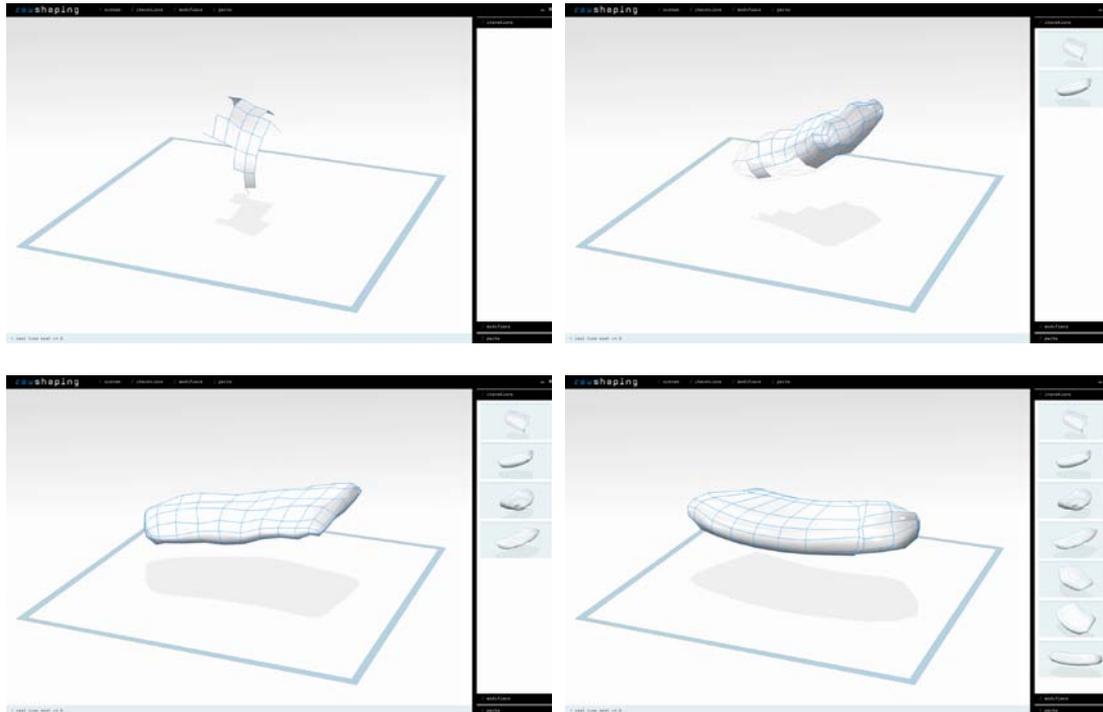


Figure 13. A sequence of an evolving design on the Virtual Design Assistant (VDA)

When the designer decides that sufficient tangible results have been generated and the outcome of the design processing is deemed satisfactory, the hybrid tool will be used in a new mode. The stored shapes (poly-meshes) are reviewed and ranked as to which of them fit the requirements (see Fig. 13) They can then be combined and used to synthesize novel and more refined solutions (see Fig. 15).

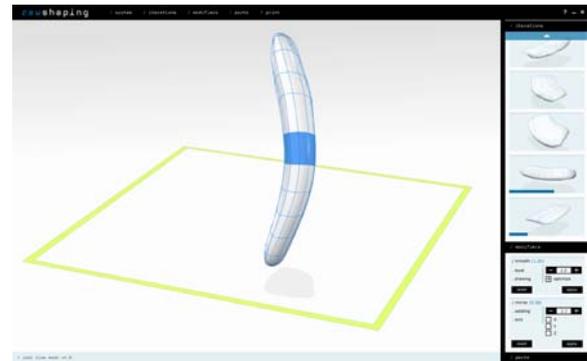
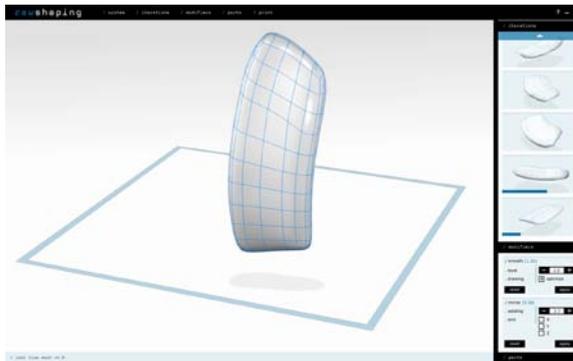
Again, the designer is in control of this choice-architecture. To enable this interaction, the system incorporates a multi-touch screen to support the designer during this step in the process (see Fig. 14).

The suggested feeling of real touch stems from virtually touching on screen ‘your shape’ or ‘product form’ and augments the real with the virtual environment. It reconnects the designer with the virtual artifact and reinforces the feeling of engagement. Besides it could stimulate enjoyment to work with synthesized design environments.

To hand the designer the feeling of control over his virtual shape by means of on-screen two-handed interaction the engagement with the virtual artifact becomes hyper-mediated. Hyper-mediation suggests in this context, not so much “being immersed” as “being interrelated or feeling connected” (ibid. Bolter and Grusin, 2000).



*Figure 14. Interaction with the Hybrid Design Tool*



*Figure 15. Virtual shaping tool in action – polygon mesh iterations*

The polygon-mesh iterations can also be used in cyberspace through Virtual Design Gaming between designers or design teams. For example, having VDA's on different locations with designers sharing multiple mesh iterations and engaging in conceptualization contests could bring out interesting possibilities.

#### **4. Conclusion**

We find that our educational experimentations, design method and system could provide a useful platform for the development of new and more sophisticated design representation tools. Our aim is to bridge the voids between the physical and the virtual worlds by making use of tacit skills and traditional tools. An intuitive augmented workbench and common sense provided us with a huge amount of data and information on design processing. The findings and results of our fundamental research in the educational field and laboratory tests show that intuitive physical raw

shaping and form finding are instrumental in the creation of understanding and insight, while performing a design task.

The design process in the ideation phase will be enhanced and improved significantly through the assistance of a virtual computational device.

We continue working on synthetic computer environments that will enhance the designers' seeing-drawing-feeling-sculpting activities, and extend the repertoires of physical and virtual prototypes. Our goal is to create an environment that helps the designer to discover and reflect upon his/her own design knowledge and experience. At the same time bring this know-how and experience in contact with other designers, stakeholders or environments.

Our approach to create a Virtual Design Assistant (VDA) recognizes the importance of computational design and the idiosyncrasies of the designer to pair them, but not to confront them with digital modelling constraints and perceived affordance (ibid. HCI, D. Norman, 1988).

The next step will be ... Our Loosely Fitted Presentation System (LFPS) soon to be introduced ....

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