Chapter 5

Innovative Conceptualisation through Sense Stimulation in Co-lab Development

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5.1 Introduction

Should collaborative lab developments be based on technological or human preconditions? This paper initially suggests how complex human conceptualisation patterns can be described and modelled comprehensively in an innovation framing. A research-based metaphorical model, called the Plant of Collaborative Conceptualisation (PoCC), is summarily developed and visualised. The model is then used as a template for the following process development including evaluation and choice of new ICT tools that can stimulate basic human ideation patterns. The resulting *SimSam lab* is based on a 360 degree maritime simulator adapted to negotiating and elaborating several alternative propositions, and simultaneously displaying all relevant background data. Resulting ‘perception map’ formats secure easy comparability and integration of parts into new solutions. And ‘participative drawing’ and ‘display organisation’ are achieved through employment of multi-touch technology. The paper basically describes the principles and reflective design process behind its realisation.

5.2 New Contexts for Co-innovation

This project originally addressed cross-professional collaboration challenges in the Norwegian maritime sector and how industrial design thinking can influence this basically conservative environment towards enhancement of innovation level. Development processes for ships, bridges, machines and multiple crew are highly complex, involving several knowledge regimes. The R&D team had special competences which early brought the process out of the maritime sector as such and into a landscape of human capabilities. When generalised preconditions for all human actors were matched with knowledge and technology from the maritime and ICT sectors, new opportunities emerged.

How can human preconditions for collaborative conceptualisation be described - and how can updated tools be adapted to support basic human conceptualisation patterns? Innovation can be understood as idea generation, development of the idea into a product or service and marketing of the result. The definition suggests that ideation is an essential aspect in innovation. New conceptual ideas can be created individually by one or collectively by many actors. In collaborative ideation and development processes the actors are supposed to be different, which can involve differences in education, personality, values, priorities, action patterns and languages - or in short; dislike mentalities. Innovative interaction involves breaking mental barriers and seeing problems from new angles, and diverging approaches, backgrounds and views are accordingly highly needed. But for many reasons integrating human differences in shared scenarios invariably have a tendency to lead into problematic processes.

Many collaborative innovation and learning labs have been developed that are basing their process approaches on new technology support (www.lilan.org/; www.elearningeuropa.info/; www.creativelearningsystems.com/). The developments have, mainly through behaviour studies, reported numeral success stories. Behaviour studies or related design studies do not, to the knowledge of the authors, model the human preconditions for individual or collective creative processes understandably to an audience of design/innovation oriented professionals. This, of course, has to do with the complexities and professional controversies of studies involving human consciousness.

In Capjon (2004), which is reported and slightly revised to updated premises in Section 5.3, two main objectives were: (i) to describe individual and collective creative processes seen from perspectives of dislike human actors and (ii) to develop an easily understandable model of a cross-professional innovation process, which includes diverging mentalities of participating actors. Some human preconditions for interaction will be summarised as basis for the process modelling - through cognitive psychology, neurobiology and phenomenology triangulation.

5.3 Sense-stimulation of Central Human Capabilities

In design oriented fields there is general agreement that shared conceptual representations will support communication between innovation actors. Some examples are: Ehn (1989); hands-on-experience, Star (1991); boundary objects, Perry and Sanderson (1998); procedural artefacts, Brandt (2001); things-to-think-with, Boujut and Laureillard (2002); intermediary objects, Bucciarelli (2002); linguistic artefacts. The representations are supposed to represent mental ideas materially and thereby basically stimulate body-based senses. They can be drawings/graphs on paper, calculations, mock-ups, abstracted or detailed physical models or the like. But ‘conceptual representations’ will also in the following include ‘virtual’ visualisation on computer screens or projected onto display walls.

Cognitive psychology has outlined mental processing in conceptualisation as being based on *internal visual images*. Finke, Ward and Smith (1992) describe how much of everyday thinking is based on formation and transformation of visual images and how pathways of creative exploration are often opportunistic and unforeseeable. Kosslyn (1995) has specified four types of processing of mental imagery; *image generation*, *image inspection*, *image transformation* and *information retrieval* from long-term memory.

There are basic controversies, *e.g.* between neurobiology and philosophy, as to the nature of human consciousness and so-called Cartesian dualism. Velmans (2000) presents an outline of consciousness where updated proceedings of neurobiology are embraced if they are not misinterpreted as its ontology; “no discovery that reduces consciousness to brain has yet been made”. Consciousness, in his view, is restricted to situations where awareness or phenomenal content is present, and he specifies its three possible foci: space, body and ‘inside’. Engaged human experience then is where *conscious awareness* is focused at will, and not in the brain where its physical representation is. But these ‘locations’ are seen as *two fundamental aspects* of being in the world. They can together account for individual perception - which belongs to the encompassing world totality where all individual views are embedded. This *reflexive monism* framework reconciles phenomenology and neurobiology as two valid and inter-dependable approaches to human action - and is seen as highly relevant for development of design oriented theory.

Lakoff and Johnson (1999) describe the neurobiological view of embodiment of experiences through synaptic brain cell connections. But in creative conceptualisation *breaking down old* embodied patterns through *forming new* embodiments of new solutions’ advantages, become central objectives. Merleau-Ponty (1962; 2002) with his *intermonde* concept (between-world) describes a state of being between subject and object where wholeness can be immediately experienced. Ornstein (1986) describes between-world scenarios of *deautomatisation*, where movement, dance, play, rituals, music, aesthetics, contemplation *etc.* can break habits to achieve intuitive opening of the mind. Böhme (2002) likewise describes how *atmospheres* have high importance for communication through the connection they produce between actors, and how immediate perception of atmosphere and wholeness comes before separation of *I-pole* and *thing-pole*. Husserl (1900) basically describes how engaged experiences must converge repeatedly over time to achieve stable *understanding or meaning*. All these aspects contribute to the resulting description of a humanly foundation for a conceptualisation model.

5.3.1 Developing a Conceptualisation Model

Conscious attention can be focused at will between ‘internal’ and ‘external’ perspectives. Much used terms for these dialectic ‘positions’ are mind/world, subject/object, mentality/materiality, I-pole/thing-pole or spirit/matter. In a human ideation/conceptualisation process the consciously focused attention will be alternated between the poles, where each position is seen as a representation of the other. In innovative action a material model can be made to represent the internal perspective (idea) and a mental model, in turn, can represent sense-stimuli from the external model. A generated idea can be seen as a mental model resulting from dynamic interaction between internal and external foci. In emotional experiences the attention can be focused on wholeness instead of polarities.

Figure 5.1 depicts an (individual) ideation or conceptualisation process, where conscious attention (dotted spiral) originates in a between-world experience and gradually converges towards a matured relationship between internal and external representations through dynamic and interactive cycling between the two.

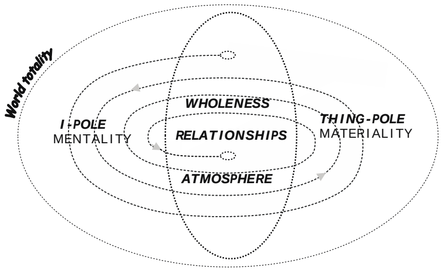

Figure 5.1. A basic conceptualisation pattern describing conscious awareness flow towards understanding

Figure 5.2 on the right side models the Process of Experiential Learning (Kolb, 1984), which alternates between the mental foci Concrete experience, Reflective observation, Abstract conceptualisation and Active experimentation, of which 1' and 4' are external and 2' and 3' are internal. On the left side is attached a model of a 'design cycle' agreed upon by four students (unfamiliar with Kolb or philosophy) reflecting on their own design work - which includes a material representation of their conceptual idea. Since Kolb focuses cognition (intellect) and the students focus aesthetics (emotion), the dislike aspects are seen as interdependent modes of design conceptualisation (called adaptive and formative respectively) - and connected through the material representation, representing both modes.

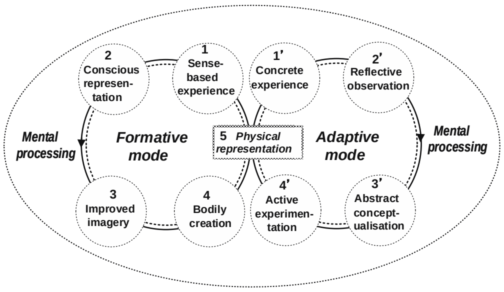

Figure 5.2. A cyclic design process showing interconnection between awareness on forming or adaptation aspects

Figure 5.3 expands the Figure 5.2 pattern by integrating the Figure 5.1 dynamics. Conceptual learning achieved through iterative mentality/materiality cycling converges towards an understanding (meaning) represented in the visual/physical model. The conceptual representation (model) in this scheme is supposed to represent (absorb) the actor's mentality - *e.g.* a vision of a conceptual solution.

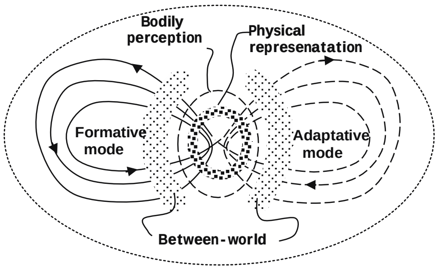

Figure 5.3. Model of an individual design conceptualisation process

Figure 5.4 further expands focus from an individual conceptualisation process to a collaborative process where several actors (three in figure, but many more possible) cooperate towards shared understanding or meaning. Dislike individual formative and adaptive capabilities give differently depicted patterns for each actor. Here the fact that the (physical) conceptual representation can be shared (whereas the mental representations are private) produces a unique opportunity for negotiations between diverging minds - if it is produced in such a way that it basically can represent all the individual mentalities.

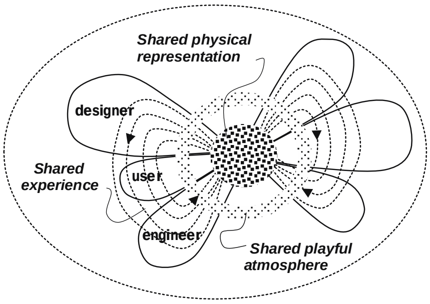

Figure 5.4. Model of a collaborative conceptualisation process with three collaborating actors

Figure 5.5 finally assembles the repeated efforts of a collaborative innovation team to reach shared understanding or meaning - or a conceptual solution where all individual actor views are represented and integrated. Individual mentalities are depicted as 'leaves' resulting in 'junctions' representing collaborative efforts, which can be evaluated (level) since they are modelled and shared by all actors through individual senses. Several efforts are made, evaluated, experimented with, negotiated and improved iteratively - some resulting in breakdowns and other bearing new ideas for improvements as basis for the next iteration. Ideation thereby becomes a process in dynamic focus flux between minds and world - and depicted as a (measurable) stem with leaves and a flower as the resulting solution (with seeds for next generation). The resulting metaphorical *Plant of Collaborative Conceptualisation (PoCC)* model suggests new terminology for central junctions: *Visiotypes* for early visions, *Negotiotypes* for collaborative draft models, *Prototypes* only for finished concept models and *Seriotypes* for market-test models. Like a plant, which adapts to the conditions where it grows, each PoCC model will have individual form. The five models are built from complex patterns of human consciousness. They are developed for professional innovation actors, basically uneducated in psychology, neurobiology and philosophy. The depictions can thereby serve as example of how vision sense stimulation can facilitate simplified understanding of complexity. The metaphorical PoCC model displays human preconditions for innovative conceptualisation - can it also prescribe principles for how a collaborative lab shall be organised and equipped?

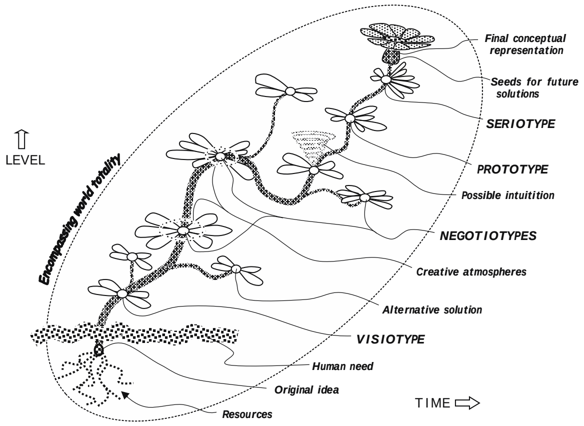

Figure 5.5. The Plant of Collaborative Conceptualisation (PoCC) model

5.4 A Lab for Perceiving Complex Conceptual Contexts

The PoCC model advocates: a) dynamically repeated external sense-stimulations of conceptual aspects as the basic principle for internal idea generation (mind/ world interactions), b) iterative idea representations based on shared learning from stimulated experiences, c) development of alternative concept suggestions which can be collaboratively experienced, d) the inclusion and elaboration of all the actors' different mentalities in the iterations and e) the importance of evaluating the alternative concept solutions in framings of wholeness. The model was originally developed from case studies based on material Rapid Prototyping. A new research question was now formulated: How can the above principles be further enhanced through implementation of new digital visualisation technology? In search of relevant answers some problematic characteristics of collaborative innovation processes were addressed - based upon many years of own experience in Norwegian industry:

a) *Complexity:* Updated co-innovation projects are based upon a multiplicity of data-file information formats,
b) *Anarchy:* As the amount of data tends to 'explode', typical projects have a tendency to achieve a chaotic structure, and
c) *Overview:* If the design aspect of alternative conceptual solutions is an issue of concern, detail implications have a tendency to demolish critical understanding of wholeness.

Therefore; in scenarios involving shared perception of actors with different backgrounds and schooling, the *visualisation principles* become highly relevant for a lab. The PoCC model prescribes alternative and iterative solution models. And the interaction between the co-actors will involve actions like evaluating different propositions, studying part-solutions, tentatively integrate part-suggestions, visually experiment with new combinations - and eventually trying to come up with radical concepts. *Comparability* then becomes a major challenge, including how data should be prepared and processed. This will involve aspects like the organisation and presentation of data aimed at:

1. Achieving and maintaining basic overview of complexity scenarios,
2. Developing visual comparability between different concepts,
3. Understanding the process stages behind each conceptual suggestion and
4. Organising and displaying data according to their basic nature.

Wodehouse and Ion (2010) have analysed the use of integrated groupware and digital libraries in collaborative design projects. They found that employment of such formalised procedures are basically considered as inconvenient in practical conceptual design work, not the least because they have emerged from librarianship rather than design - "and do not lend themselves to creating an explorative experience". Instead they suggest a number of flexible approaches like fast browsing for information sources (Internet, *etc.*), emphasising the use of sketching, physical modelling and tagging of specific applications - "to allow the information to be used freely as stimuli in the generation of ideas". The analysis supports many of our basic intentions. But their premises were found to be based on employment of small data screens for information displays, thereby limiting the possibility of functional overview and fast data access.

Our analysis ended up with a strategy at the opposite extreme, in accordance with the PoCC prescription of wholeness contexts. *Large screens* have a capacity to visually display large amounts of relevant background data. And it eventually emerged that displayed relevant data can be made *instantly available at a twist of the head.* The challenge then becomes how to organise data displays aimed at 'intuitive' perception - or so that it is instantly obvious for actors where to look for the support data of the problem in question.

To evaluate and compare between alternative conceptual propositions, each backed by much data, it appeared as essential to perceive the differentiated data as *ensembles* - in the sense that all data related to a particular solution should be presented as *one visual unit*. In evaluative discussions it would thereby be easy to distinguish between the conceptual alternatives.

Then came the problem of how to organise the display of each visual unit in an ‘intuitive’ way. It was found that the PoCC model can represent a relevant answer. It is built on an ‘archetypical’ concept for visual displays, at least in the western world, where the vertical axis represents *level* and the horizontal axis represents *time*. Gradually increasing conceptual level is thereby displayed visually along the diagonal. This invites to using this region for visual presentations of conceptual drafts - eventually leading to a negotiated concept proposition (*e.g.* 3D modelled) at the top right corner. But how should supportive data be displayed? Supportive data can be categorised in several ways, but hard-to-understand categorisations were seen as contra- productive. It was agreed that two simple categories will suffice: *abstracted* data and *concrete/visual* data. The lower right corner was assigned for abstract data (lower visual level) and upper left for visual data (higher visual level). Supportive data will then be perceived visually as supporting solution proposals which can be iteratively displayed along the conceptual diagonal. Figure 5.6 depicts an outline of one development story with relevant data and stages. It is intended as an easily understandable, or ‘intuitive’, visualisation of a basically complex conceptualisation process; a *perception map.*

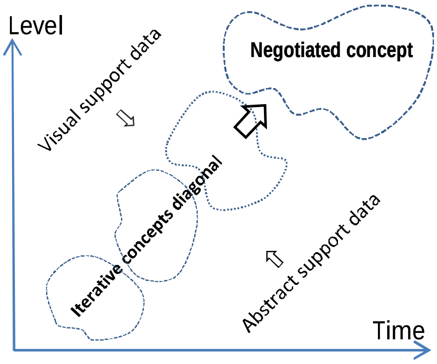

Figure 5.6. Easily understandable structure of one ensemble screen image, a *perception map*

How, then, should appropriate comparability between different perception maps be solved? It was agreed that a commonly shared experience from PowerPoint presentations should be avoided: the removal of slides after each display leads to ‘wasting’ focus on trying to remember data instead of using mental capacity for conceptual processing of the data. If perception maps of alternative solutions are placed *beside each other* instead, then instant comparisons between the central visualised aspects of each proposition could be easily facilitated - for all actors to see at a twist of the head. What aspect to focus could be achieved through equipping the actors with some pointing device. How could such a large-screen scenario be practically arranged?

Maritime simulators were eventually found to have potential attributes to comply with the specified functional characterisations. They consist of (split-up or coordinated) central projectors displaying visual projections on a large circular vertical screen - up to 360 degrees. Several conceptual perception maps (Figure 5.6) can be displayed consecutively, one at the time, beside each other. Each visual unit is then easily distinguishable from the alternative concepts represented on the neighbouring projections. And neighbour projectors can additionally be coordinated, *e.g.* for aspectual 3D modelling. A highly flexible arrangement thereby results.

For the realisation of a co-lab according to these specs, a 360 degrees barrel-shaped geometry of 11 metres diameter and 4 metres height and seven projectors was chosen (eventually called the *SimSam lab).* As a SimSam case example can serve a co-design process involving elaboration of three alternative concept propositions. One projection displays the design brief/framework, three separate projections display perception maps of each concept, one projection can display new concepts-in-the-making and two coordinated projectors display 3D simulations of selected details, one at the time. Coordinated projections are also appropriate for static/dynamic simulations of selected design issues.

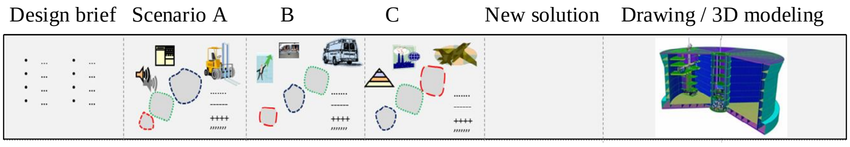

Figure 5.7. Outline example of unfolded 360 degree barrel screen with seven split-up or coordinated projections displaying perception maps. See Figure 5.6 of three conceptual propositions plus work spaces for co-creating new solutions.

The actors are placed on the floor near the screen centre. All screen images (Figure 5.6) are simultaneously comparable beside each other to optimise visual understanding. Simply in turning, standing or sitting on rotatable chairs, and pointing with laser pens all displayed scenarios are available, instantly and easily perceivable, for on-the-spot shared elaboration by all the actors, see Figure 5.8.

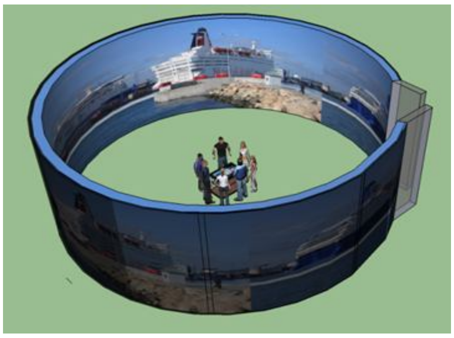

Figure 5.8. The resulting SimSam lab outline with coordinated or split-up projectors

Understanding from the PoCC model has thereby led the development to a physical arrangement where the need for large screens can be seen as a consequence of the need for rapid comparisons and integration between complex visual data of alternative concepts. Through further real-time 3D simulation experiments it was found that large screens can have additional perceptual advantages, particularly in early-phase developments. 3D CAD tools have eventually become crucial in product development of construction and animation industries. But the tools are not basically designed for creative cross-professional design processes, where “changing existing situations into preferred ones” (Simon, 1981) is at stake. Rhea (2003) describes how visualisations and models are created to simulate future scenarios that are often used in the final presentation of concepts – and *not as creative tools* in the conceptualisation phases when designing. As an improved strategy Turkle (2009) has suggested how employment of simulations can stimulate body/mind experiences of future conceptual scenarios in context, and visual *immersive systems*, like The CAVE (Cruz-Neira *et al.*, 1992), have been developed accordingly. By using a 360 degree panoramic view screen for both simulations and specificities, the team’s intention was to achieve a creative tool setup according to Rhea *and* immersive scenario displays according to Turkle. In an experimental collaborative workshop of future scenarios for Uddevalla harbour (Figure 5.9 left-hand side), it was efficiently demonstrated that perceptual limitations could be challenged through combination of large screens (3 coordinated projectors) and interactive simulation software (CryEngine was used). Figure 5.9 right-hand side shows a following health-care workshop based on ensemble projections of alternative concepts in accordance with Figures 5.6 and 5.7. Hopefully a powerful process can result from further development, with ability to simulate lifelike scenarios where ideas are visualized and animated to their use or action in realistic contexts – dynamically and instantly comparable with perception maps displaying basic conceptual aspects displayed in Figure 5.7.

Figure 5.9. 3D harbour simulation (left) and *healthcare co-development* (right)

A new challenge then becomes: How shall the scenarios be organised in terms of operational visualisation characteristics and tooling?

5.5 New Sense-stimulating Conceptualisation Technology

Support data will generally be of diverging visual expressions that are not appropriate for supporting a Figure 5.6 outline, whereby *reorganisation* becomes desirable. Central perceptual aspects with importance for choice and capacities of appropriate support-tools were specified accordingly:

a) *Organisation:* data-based statistics, graphs, quantifications and pictures, should be properly organised for comparable discussions,
b) *Categorisation:* data should be grouped according to their conceptual relevance, *e.g.* functional, quantitative, qualitative, detail and
c) *Scaling:* files should be easily scalable to comply with perceptual claims.

Supportive controls and drawing tools were evaluated for their visual conceptualisation support, including:

a) *Participation:* Capacity for new or add-on sketching contributions by all actors regardless of drawing competence,
b) *Speed:* Time compression because of a tendency to loose mental focus fast,
c) *Changeability:* Capacity for fast changes of visual representations,
d) *Inter-changeability:* Capacity of flexible altering between different software
e) *Simulation capacity:* Potential for static and dynamic 3D simulation.

Could technology be found which is adaptable to these perception-based operational characteristics? New touch- or multi-touch technology builds on perceptual stimulation as such, and it was early considered to be highly relevant. The technology employs scanning of touch impulses on a screen (*e.g.* fingers), where the registered signals are digitised and can be employed for sense-stimulating facilitation. See Figure 5.10.

Figure 5.10. Participative drawing on multi-touch table

In up-front testing and evaluations touch technology was found to comply with the above specified operational preconditions. It was found highly appropriate for rapid and effective organisation of data files, in particular for visualised files including graphs, figures, photographs, statistics *etc.*, but also for abstracted data. It was easy and fast for data manipulation, including categorisation, grouping for relevance and scaling. And it was found exceptionally well suited for arrangements and presentations of ensemble screen images, or display organisation, in accordance with Figures 5.6 and 5.7. So-called bi-directional (BiDi) technology has possibility of recognition of objects on the surface (‘tagging’), which involves that material objects, hand-operated upon the screen, can interact with data models through digital addressing. Physical models can be moved and played with (*e.g.* by role-playing actors) in sense-stimulating digital landscapes.

Multi-touch screens were also evaluated, with different software, for their ability to become a functional platform for digital drawing. The test showed that touch-screens employed for drawing exercises and combined with large-screen displays, appear to have a high potential for enhancing conceptual understanding according to the above specified claims. Screen employment can be time-efficient, rapid sketching can be easily facilitated, fast changes between wholeness and detail aspects can be easily achieved and changes between software packages can be done effortlessly - with high capacity for 3D design and simulation.

An important finding was that a touch table is appropriate for allowing several actors to participate in drawing actions towards shared understanding (Figure 5.10).

Actors can easily assemble round a table and contribute to *participative drawing* through finger-touching or with a touch-tool, to stimulate integrated contributions by all participants - regardless of drawing competence. This level of participation cannot be achieved in traditional drawing, which is basically dependent upon the skills of one drawing actor and her ability to interpret others actors’ mentalities.

The efficiency of the described visualisation scenarios is, of course, highly dependent upon the capabilities and competence of an operator. It was accordingly specified that SimSam lab activities should be led by a *facilitator*. A facilitator should have high competence in operating all the tools including several appropriate software packages. One important operational aspect will be, in advance of collaborative workshops, to prepare alternative conceptual ensembles in accordance with the pre-established outlines of Figures 5.6 and 5.7. Another important assignment will be to stimulate engagement between the actors through visualisation and integration of *their* mental images - in addition to her own.

Supportive materialisation tools were additionally found desirable for fast and functional facilitation. In accordance with Capjon (2004) 3D Rapid Prototyping tooling and 3D laser scanning were integrated for their ability of physical sense stimulation and features like speed, specificity and reversibility. Also workbench facilities for mock-up production were integrated, with materials like card-board, wire, clay, foam, *etc.*, for additional enhancement of sense stimuli. See Figure 5.11.

A project assignment was to establish a network for collaboration-at-a-distance between project partners in Sweden, Denmark and Norway. For this purpose so-called nodes were developed and used throughout the project. They were based on the same principles as the large lab, but equipped with two large flat screens and an internet-connected video/audio system – all at affordable costs.

Figure 5.11. Early full lab model equipped with large screens, touch-table interface, 3D printing, mock-up facilities and 3D scanning

5.6 Conclusions

Humans conceptualise ideas through active perceptual stimulation of their senses - as elaborated and displayed in the metaphorical PoCC model. The model was used as a template for an analytic design process of a new collaborative lab concept.

Perceptual complexity problems of current co-development processes were solved through PoCC-like *perception maps*, where easy comparability between alternative concepts is achieved through standardised graphics. Immediate access to diverse data for elaboration purposes and integration between alternative concepts were solved through *large screens* of a maritime simulator with side-by-side map arrangements and laser pointers for all the actors. Large screens were also found appropriate for *simulation* of future conceptual scenarios in context. Sense stimulation in collaborative conceptualisation was achieved through employment of a large *multi-touch table*, through which *participative drawing* and *display organisation* were facilitated by a facilitator with appropriate visualisation competence.

Table 5.1. Summarised features of a SimSam-supported co-innovation process

Developmental phase	**Sense stimulation**	**Physical realisation**
Organisation of premises	**Visual preparation** of data	**Laptops** before meeting
Arrangement data availability	**Immediate access** to data	**Large screens**, 360 degree simulator
Grouping in alternative conceptual ensembles	Simultaneous **comparability** between concept suggestions	**Side-by-side displays**
Intuitive arrangement of each alternative	**Conceptual diagonal** displays + supportive data from sides	Immediately comparable **perception maps**
Rearrangements of part solutions	Model developments + **Participative drawing**	**Mock-up facilities** + fast digital drawing with software
Elaboration of new concepts	**Simulation**, rapid 3D models + physical realisation	**Touch-table** with software + 3D printing (RP)
Verification of best concept	**Sense-based experimentation** with alternatives	**Facilities** for simulation and physical experiments

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