# Making – Research
## About What and How

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"Making – Research" stands for a design research pedagogy that is used by the division of Architecture and Development Studies (ark3) at the Lund Institute of Technology (LTH). This article should be seen as a contribution to the current discussion about the new production of knowledge in Gibbons et al (1994) and developed in Dunin-Woyseth (2002) and Lundequist (1997).

"Making – Research" in design has its roots in real-life situations: in Africa, Asia and in space. The philosophy is centred on what architecture and design do, over time, rather than what they are. This is called a dynamic system's design view, and includes an emphasis on how we can contribute to development. To 'search' means to examine or inspect closely and this is exactly what students do in their design studios. Search originates from Old French, to go about a circle. However, to do research implies to search again to contribute to a more systematic investigation (Macdonald A.M., 1960). The aim is to place my own work within this discussion, by examining several case studies of design as a form of research.

The making disciplines, such as architecture and design, have a problem-oriented and synthesizing approach. Therefore, we need to articulate the dialogue between search, research, and implementation. The platform for creating knowledge must be designed and the making disciplines must be seen in their own right. Combining industrial design and architecture widens the perspective of our studies.

Environmental issues are of high priority, as are the use of participatory methods to ensure sustainable strategies and design proposals. It is our intent to work with the whole design process towards implementation of design solutions as well as their evaluation. The present article describes three cases to illustrate what new knowledge is produced, and how it is produced.

The first case, Kitchen Design research, uses mono-disciplinary methods to study aspects of the problem such as stove engineering, functional studies and indoor climate. For example we examine the energy efficiency of different fuels, the fire bed and the shape of cooking vessels. In the second case, trans-disciplinary research about marketplaces introduces level studies,

from city planning to detailed studies like a vendors stall. Healthy Marketplaces is a cross-disciplinary project that cuts across intellectual boundaries, subjects and cultures. The drainage system of a market is connected to city planning issues as well as to the vendors' cleaning system and behavior. The Space and Terrestrial Architecture Research Design (STAR Design) studio is the third case study. It is an educational platform for exploring various design problems of outer space and extreme environments. It is also a test-bed for trans-disciplinary projects like the healthy marketplaces project.

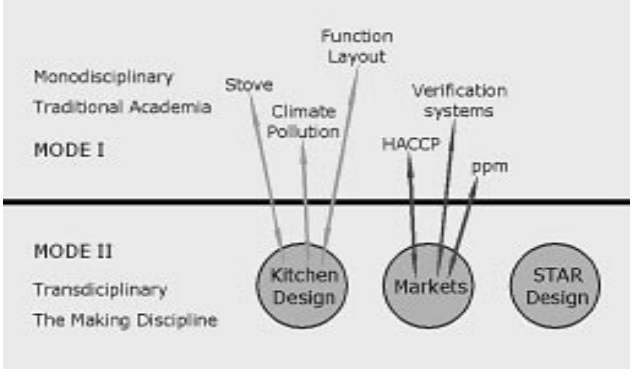
Systems design is the common language for design and is therefore fundamental to this work. The students are key producers of knowledge as well as testers of research models. For example the modeling tool for the marketplace projects has been used by students in Africa and Asia and they have helped produce significant design studies on this fairly unexplored area. Their work is based on a participatory approach from the first field investigations, to the production and dissemination of knowledge.

My work is relevant to "The New Production of Knowledge – The dynamics of science and research in contemporary societies" (Gibbons et al., 1994) and employs the terminology describing the two platforms for producing knowledge: Mode 1 and Mode 2. Mode 1 emanates from traditional academia and is mono-disciplinary in nature; it is assumed to represent a sound scientific practice. Mode 2 is

> knowledge-production carried out in the context of application and marked by trans disciplinarity; heterogeneity; organizational hierarchy and transience; social accountability and reflexivity; and quality control which emphasizes context-and use-dependence.
> (Gibbons et al. 1994:167)

The three cases are based on Mode 2 knowledge but there are useful connections to research according to Mode 1. Empirical phenomenon can be studied from different perspectives with mono-disciplinary methods and models to gain specific knowledge. But the design solution belongs to Mode 2 where the links between these subjects are made and disciplinary knowledge is synthesized.

Furthermore, the sector-based knowledge of Mode 1 can be used as a verification system to evaluate (ex-post or ex-ante) design solutions in Mode 2. This can be seen as an extension of Gibbons et al. 1994. Sector-based evaluation is used in the kitchen design to verify the fulfillment of building regulations, like indoor air quality and measurements from pollution from fuels. NASA uses quality control to test design solutions for various requirements like out-gazing, energy efficiency, or security. The World Health Organizations (WHO) carries out health inspections at market places by using the Hazards Analysis Critical Control Point (HACCP) evaluation method, identifying hazards and assessing risks associated with food preparation and storage. In each of these cases, the physical environment, or conceptual ideas belonging to Mode 2 are tested by mono-disciplinary methods from Mode 1.




The three Cases; Kitchen Design, Marketplaces, STAR Design

## Systems Analysis Approach – a language for design

The design disciplines belong to the generalists and their particular ability to synthesize i.e. to provide design solutions. The systems analysis approach addresses a holistic view and helps with the increasing complexity that planners, politicians and architects must cope with in society. The systems approach communicates between disciplines and levels, from micro to macro studies.

The three cases (Kitchen Design, Marketplaces and STAR Design) illustrate the systems analysis approach as a common language for design. A defined system,

part of reality, is represented in a model (iconic, computer, mental, full scale), which uses sector-studies to understand the system's architecture and behaviour. Various disciplines and their methods can be used in different situations as long as they accomplish the goal of learning about the system, its components, their relations and behaviour. The objectives of systems analysis are, according to Gustafsson and associates (1982), to start with real-life issues and to describe, analyze and understand them. The approach implies that reality is seen as a system of components and their relations. Churchman states, "all definers will agree that a system is a set of parts coordinated to accomplish a set of goals" (Churchman 1968). The crux of the matter is to make the model system reasonably representative of the real system. This is why the model, input, experiments and simulations should be identified with a defined vision of the future. Lundequist (1985) says that a dynamic perspective is assumed, which is to say that changes over time are interesting, and feedback to the original model is of central importance.

The present cases apply a participatory approach, which seeks to involve the citizens, households and actors in all stages of the project work, from the identification of needs to the assessment of completed projects. The social acceptance of a new technology or design is also a measurement of quality control. The process of change seeks to understand how knowledge gained can be disseminated to improve people's everyday life, including professional education (courses and curricula), mass media, building regulations, or health standards.

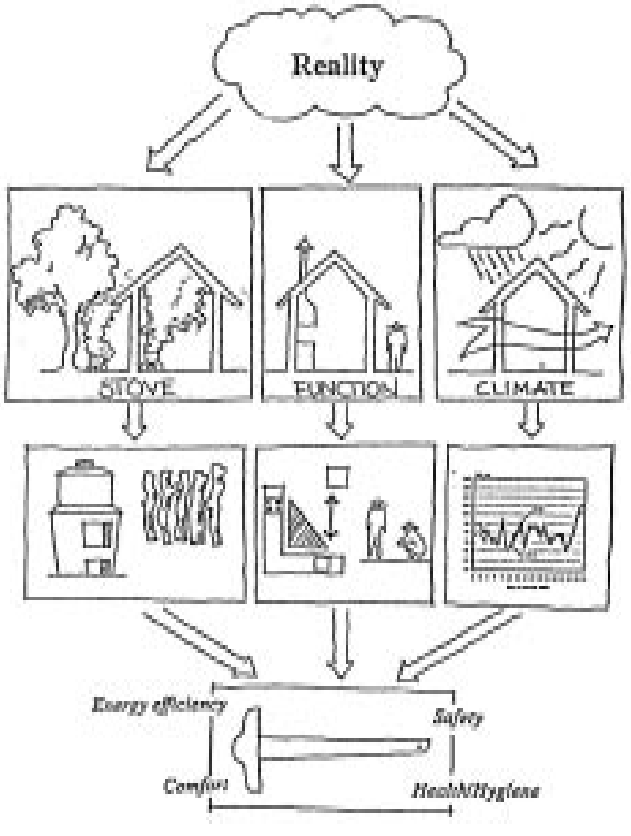
### Kitchen Design – stove, function and climate

Conditions like those described by VS Naipul persist today in many developing countries. Consequently, the culinary area, the kitchen, plays an important role in housing design. According to archaeologists, the fireplace is the core of a home; indeed it defines a human settlement (Scheffer, 1981). However, the role of the kitchen has been neglected by architects, engineers as well as by dwellers. It is often placed in a residual space, even in newly built houses. The kitchen space is commonly left to the users to design and organize themselves. Money and creativity may be invested in the main house, while the kitchen remains unnoticed, unchanged and unimproved over decades. (Nyström, 1985, 1988 B).

Why should the kitchen be given high priority in housing design? Because it plays a key role as the place where family meals are prepared and cooked, and where the energy and technology requirements of a simple dwelling intersect. It needs to be a safe and efficient place where the health and wellbeing of those who work there are not at risk. In reality, as noted by Mr. Biswas, neglect can make the kitchen a dangerous and unhealthy place for those working or spending time there. In the developing world, this is predominantly women and children.

I conducted my research on kitchen design in Vietnam in the mid eighties with the Hanoi Architectural University (HAU). The kitchen-in-use was studied mainly in terms of three elements: the stove, the function and the climate. These aspect studies were developed within different disciplines in engineering (stove), building functions analysis (function), and building sci-

ence (climate). The aspect studies used different methods (simulations and experiments) to gain greater knowledge within each aspect, like full-scale modeling, computer simulations, experimental building, field studies and field tests. Each aspect study had its limits (Nyström, 1994)




The energy-saving stove has been a significant issue since the sixties. Experience with previous stove projects shows that economic rationality alone will not persuade people to accept a new stove. People's cooking patterns often lie deep in tradition, and behavior cannot be changed overnight. The stove alone cannot meet priorities like time saving and energy efficiency. Technology change requires that the stove and its immediate surroundings, as well as the user must be included (Nyström, 1987). The function and layout of kitchens were tested in a full-scale laboratory, where women were invited to cook meals and arrange their kitchens. Sitting, standing, or squatting while cooking was a crucial question. (Nyström, 1985). Another important issue was the indoor climate particularly in an open building system when discussing the smoke evacuation systems. Specific knowledge becomes relevant from major research fields like indoor air pollution, ventilation, passive acclimatization, and comfort issues. In Hanoi we developed a water tunnel test bed and worked with iconic models to test the ventilation patterns. Indoor climate studies were carried out in controlled twin dwellings during winter and summer climate. The twin dwelling, comprising a reference flat and modified flat, was an important tool to verify the computer simulations (JULOTTA) with its relevance in reality (Nyström, 1988 A, Adamson and Nyström, 1993).

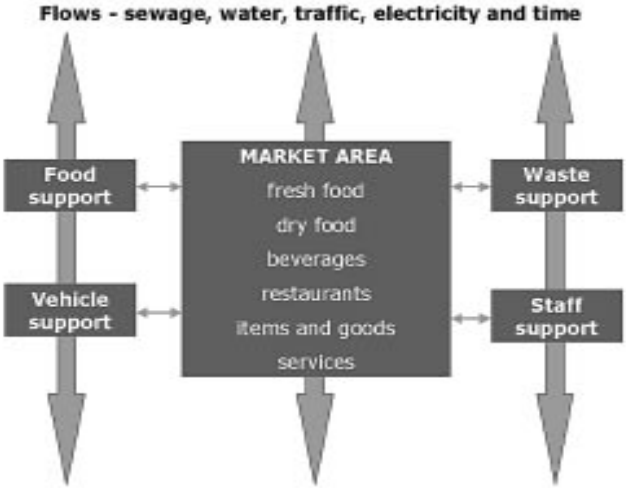
Dissemination – about knowledge transformation

The kitchen system was studied through aspect studies representing mono-disciplines; stove, function and climate. The aspects studies belong to Mode 1 but

the design work was developed through integrated studies in full-scale in experimental buildings. Based on this, Design Criteria are formulated from the user's needs and wishes for the stove and its setting the kitchen.

Since it is not possible to present a universal solution to the kitchen system, the standards and recommendations are based on sub-systems. The research was introduced as building regulations (TCVN 1996). However, design solutions based on building regulations were tested through mono-disciplinary methods such as verification systems using observations, measurements and calculations. For example to measure the ventilation rate in a dwelling a passive tracer gas method was used called the PFT-method (Passive per Fluorocarbon Tracer method) carried out by Nyström and Stymne (1993).

Through kitchen workshops in Vietnam and Nepal we reached out to extension workers, teachers, medical and health professionals. If the goal is to introduce improvements, it is important to create links between the different sectors in society and urban settings. We worked with educational programmes for television, and curricula for architectural education at Hanoi Architectural University.




### Healthy Marketplaces – microbes versus city planning

The market place is the core of a city or a village. Archaeology and history tell us that the market is a starting point of urban settlement. The hieroglyph for market places portrays markets located near roads or waterways, where business starts. The market is the node of a city and everyone depends on it.

The World Health Organization (WHO) developed the Healthy City Program. Its objectives are to improve the health of urban dwellers, especially low-income urban dwellers, through improved living conditions and better public health services. The Healthy City Program improves settings that include schools and workplaces, as well as markets. The Healthy Marketplace programme focuses on upgrading food markets especially in South East Asia. A major problem is often that an indoor market is a messy, overcrowded place, and that there is a lack of planning. The outdoor market, along streets or in between market buildings are often unplanned and unstructured. Flooding and fires are common problems and the food market typically does not meet basic safety requirements for fresh food. For example boiled and fresh meat is mixed, fresh meat and fish are not iced, or slaughter takes place in a parking lot. The vendors' behaviour suggests that their knowledge of hygiene is inadequate. The design issue was included in the Marketplace programme in 1999 (Nyström, 2000). It started with student projects at the old market in Hoi An, a town in central Vietnam.

The market is a complex place with many integra-

ted systems and flows. It has many functions: besides being a place for selling and buying, it is a major meeting point in the city. The market is also a key workplace, particularly for female workers[1]. For example: Dong Ba market in Hué, central Vietnam, has 4000 vendors and serves as a wholesale market supplying thirty other markets. The guidelines for markets and environmental upgrading are based on security, health and hygiene systems (Nyström, 2002).

Design criteria should fulfil the vendors' and customers' wishes and needs. The market should be a pleasant and safe place. The vendor and her behaviour are connected to the physical environment.

The design criteria operate at three levels:

1. Market site within the city.
2. Intra-market including buildings and spaces in between.
3. Detail design and sub-systems.

The food market area depends on support areas (vehicle, staff and rest rooms etc) as well as flows (water supply, water waste systems, transportation, and energy). Layout and zoning of the market is important: fresh meat must be situated far from boiled meat; vegetables belong to the wet area whilst the rice and staple foods are in the dry zone.

In a transectorial project, teams of researchers and specialists from different sectors generate knowledge; medicine, hygiene, construction, market management, retail. New working strategies must be developed if new technology and new behaviour are introduced to secure health and hygiene issues. Monitoring and evaluations, using the sectorial insights should be built into the systems.

### STAR Design – a studio for search

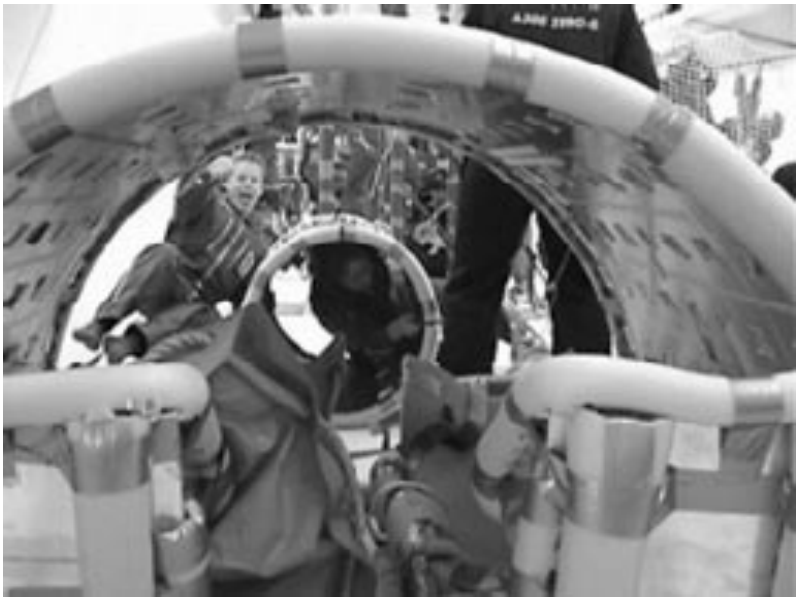
"To learn about other cultures is to understand your own", says Birgit Åkesson in Källvattnets Mask-om dans i Afrika (1983) (Spring water mask – on dance in Africa). She was a world famous modern dancer inspired by African dance and she is often referred to as the Picasso of dance. She points out that we shouldn't think that we know everything immediately because then nothing new is allowed to evolve. With continuous investigation it is possible to better understand the origin. A designer must be open and aware because in reality she is always a guest.

#### Exploring the Unknown through Experience Based Learning

By building models of living environments we can simulate different realities. We can simulate different situations with various input and output data, and general and site specific knowledge appear. The search in STAR Design should be seen as codified knowledge, which according to Gibbons et al (1994) is knowledge systematic enough to be written down and stored.

The STAR Design studio works in the seemingly divergent fields of cultures in Africa and Asia as well as with NASA and the habitation in space. In all these cases one works with solving elementary problems under extreme circumstances. Perhaps studying the conditions of a crew sealed in a capsule where they have to drink their own purified urine and water condensed from exhaled air can better prepare us for the problems of sustainable terrestrial planning for the future. Water purification, balancing of carbon dioxide and oxygen levels in the air, food production, composting of solid wastes and the thermal system all must function in a delicate balance together with the humans onboard. The crew cannot be regarded as consumers or producers but rather as co-dependents in a closed system. The psychological well being of those onboard must also be assured. Survival also depends upon the crew's ability to work well together as a team that can handle crisis situations. By examining and comparing different types of housing and societies we can learn to understand the architectural space where function, flow and movement in time combine to shape objects and spaces. Could a new approach and language help us to build the urban environments of the future?

The students are trained to read interacting sub-systems, like architectural, physical, sociological, biological, and technical systems. This method embraces systems mapping which focuses on defining different systems and their integration with each other and with the citizens.



One essential aspect of the STAR design studio is experience-based learning. To live and work in for example Tanzania for more than two months away from mainstream tourism is a profound experience that provokes many thoughts and insights. Very little is what the students thought it to be, and many basic concepts need to be redefined. To look for answers to basic issues generates new design options. A standard kitchen stove has no place in space, or on Mars and not even in remote areas.

It is pedagogically useful to bring students and teachers together in an alien situation because no one has the answers in such a "horizontal studio" which is based on equality. The students will start to search and be gradually trained to use research methods for systematic investigations, to formulate questions and define problems to solve. Project design is central and the students are expected to gradually be able to develop their own projects. I agree with Gibbons et al (1999) on the importance of definition and articulation in problem-oriented research. I have named the different steps as follows:

- Read and discover. Urban Systems Reading (USR) includes field studies. Studies on micro level create the platform for the work and links to other levels. The system input to a household might be energy, food and water and the systems are transformed and the output might be solid and liquid waste, and happy people.
- Project Area Definition (PAD) is formulating the issues of study and their boundaries. The area for investigation can be geographical such as the city boundaries, or can be based on an issue, which cuts across regions, like drainage systems.
- Design proposals are the synthesis of the work. They should include the design criteria i.e. the pre-design step before the actual design.

The students' different projects in a studio should be seen as sub-projects which together form a joint production of knowledge. Studio binders are produced, also in the form of a CD where links can be made between sub-projects by area or subject.

## Research Reality Revisited

The world's urban planners and developers face an enormous task: creating the cities of the future. Today more than half of the world's population lives in urban areas. Globalisation creates multicultural communities with inherent lifestyle and identity problems. The pressure comes from the imbalance between growing populations and limited resources in terms of work opportunity, space, water, energy, and food production. Expectations are therefore raising the need for innovations or interventions to solve the problems. This calls for careful analysis and genuine dialogue between policy makers, urban dwellers and specialists.

The three Cases can now be put in a Mode 2 context according to the matrix for Mode 1 and Mode 2 outlined by Dunin-Woyseth (2001:93). However, the Making Research is based on the systems analysis approach which serves as a bridge between Mode 1 and 2 and can handle subject specific knowledge such as sector studies within Mode 1. Mono-disciplinary methods are also used as verification systems (calculations, measurements and observations) of design solutions in Mode 2. This supports the vision of Gibbon et al (1994: 154)

> We believe that Mode1 will become incorporated within the larger system which we can call Mode 2 and other forms of knowledge production will remain dynamic.

### Context of Application and Quality Control

All three cases operate in societal contexts with defined aims and visions intended to produce knowledge and to apply design solutions to change reality. Kitchen Design is not only accepted among scholars in the field of energy and by the user, but is also introduced in the formal sector through building regulation, academic research and the institute established at the Hanoi Architectural University. In the informal sector, kitchen design is introduced through full-scale projects, workshops, educational programmes for television, and by global networks. Quality control is determined by whether people find the product useful or not. STAR Design uses field studies as points of departure and knowledge is produced through experience-based learning.

### Heterogeneity and Transdisciplinarity

The Healthy Marketplace project is trans-disciplinary by letting the context of application decide the use of theoretical structures, methods and practises. Marketplace design is a research topic that is newly discovered, addressing health issues from the perspective of environmental issues, market managing, and the construction sector. The vendor's perspective and behaviour is a part of the knowledge production and the link between food quality and the physical environment. The production of knowledge is a twinning process between model development in the R &D project together with the World Health Organization and by student work based in STAR Design. Processes are developed in Vietnam, and in other South East Asian urban settings and task force groups are established. The knowledge production process is made by multiple actors, various disciplines and "sites" (geographical and institutions) and illustrates heterogeneity in Mode 2.

Migratory Knowledge

NASA is working with a high fidelity mock-up, simulating the trip to the planet Mars that in total will take around three years. There is a possibility to transfer the knowledge from Mars simulations by using onsite purification systems for a market place. The marketplace could be an autonomous entity within a city and wastewater and recycling of organic waste can be taken care of within the market. Organic waste can be treated

This paper discusses the production of knowledge in design. This issue is discussed in light of the generic Research Mode 1, representing the research convention of mono-disciplinary academia, and Research Mode 2, the emerging research paradigm in trans-disciplinary environments. Three cases are presented:

Kitchen Design represents a design project in Mode 2, using Mode 1 research for mono-disciplinary studies within specific areas, and to verify design solutions by the use of established methods. The research took place mainly in Vietnam, at the Hanoi Architectural University. It started in the beginning of the eighties and was concluded with building regulations in 1996.

The World Health Organization (WHO) runs a global programme for up-grading Healthy Marketplaces. The author was involved during 1998 and has formulated the design guidelines for the physical environment for markets in South East Asia in 2002. From a design perspective it is a typical transsectorial project in Mode 2 based in practice. The project is underpinned by Mode 1 research mainly through specialists in health sciences. Studies were conducted for the WHO and in cooperation with local authorities in Vietnam and Laos.

The STAR Design started in 1998 as a studio for exploring extreme environments, in space and on earth, conducted on behalf of and in cooperation with NASA. STAR Design is an umbrella for my educational studios on space habitation, and in Africa. The studio includes architectural and industrial design students, diploma workers, teachers and researchers from LTH and NASA experts. The studio in Lund is in Mode 2, but at NASA in a Mode 1 environment.

Making – Research uses systems analysis as the common language for design to bridge over subjects, methods, and cultures bringing education and research together. Making Research extends the discourse about the production of knowledge by demonstrating the integration of Mode 1 thoughts in case studies, which are inherently based in Mode 2.

## Facts

LTH - Architecture and Development Studies (ArkIII)

The origin of ArkIII goes back to the late sixties. Professor Torvald Åkesson brought his students to East Africa, Vietnam and Algeria. Ark III was established in the eighties and professor Lars Reuterswärd continued the international collaboration. Student projects were set up in Tunisia, Nicaragua, Vietnam and Tanzania. The research and education took shape towards environmental aspects of the built environment. Pedagogy and methods evolved. Experienced-based learning was conducted in Vietnam (95,97,99), and in Tanzania (00,01,02) and the studio maintained a close relationship with ongoing research in the respective countries. STAR Design was born in 1998 and the studio has been set up at NASA every year since. The studio is a collaboration between the programs for industrial design and architecture.

Current research covers resettlement areas in Ethiopia, marketplaces in South-East Asia (WHO), cultural tourism in Cambodia and Tanzania, architecture and building climatology in the tropics, INTEGRITY (the Mars habitation simulator), and planning strategies for water and sanitation in Tanzania.

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in a sealed biogas reactor and the market is self-supported with energy.

Tacit Knowledge

To make tacit knowledge, i.e. knowledge that cannot be formally articulated in propositional terms, visible is of interest for Mode 2. Women who are cooking for hours every day in smoky kitchens feel bad but few improvements are made. A bad situation, like the smoky kitchens, might be perceived but not expressed when no better alternative is available for comparison.

Reflexivity

Tran disciplinary science is ambulant and new production of knowledge might arise outside the already located prevailing disciplinary map. All actors are involved and contribute to the production of knowledge. In STAR design a so-called "horizontal studio" invites students, teachers and experts to work under the same conditions.

The STAR Design search is used at NASA as well as in Tanzania as basic knowledge and methodology for developing solutions to complex problems. A student working in extreme environments (space or an unknown terrestrial situation with another culture, and climate) becomes skilful in searching knowledge, what I call making research, by breaking down complex systems in to sub-systems, parts and relations. Students are able to build conceptual models using the micro versus macro levels, and understand the relation between objects and room shaping. The model building can give enough distance from reality to permit new connections and unexpected design solutions. In Mode 2 the aim of knowledge production is realised and used, and innovations are encouraged. Both theory and practice are part of the same structure of knowledge, produced in circular or interactive fashions.

## Note

1. My work concerns South East Asia

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