# Art's task for science

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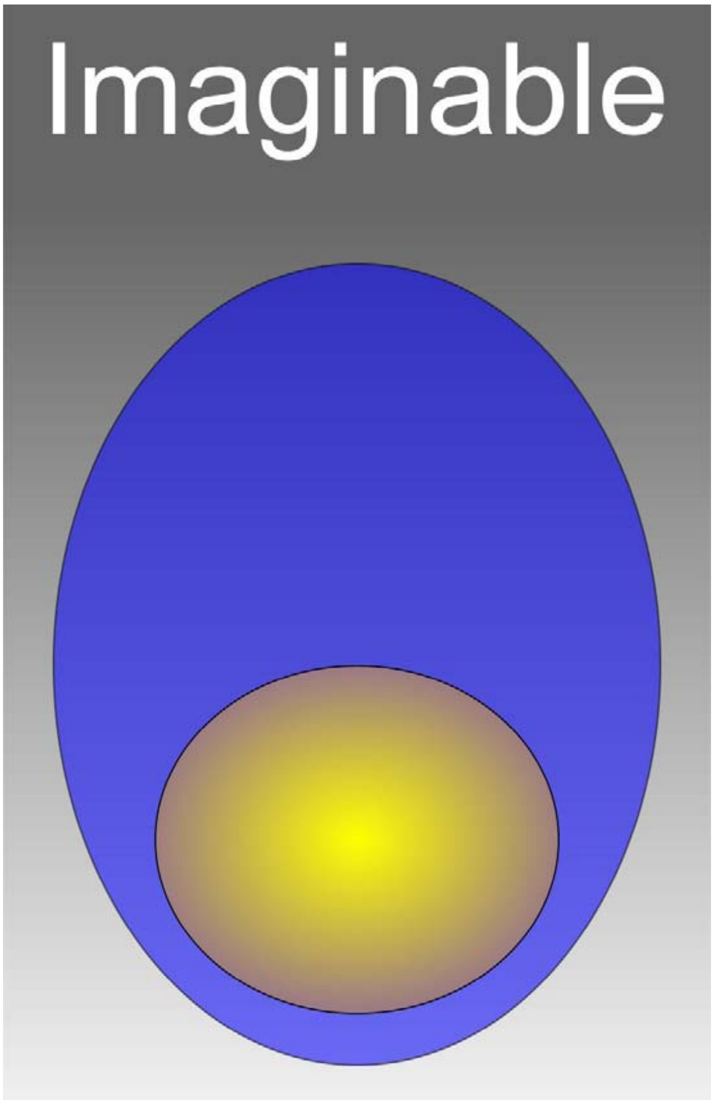

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# 1 Introduction

## For example: Architecture at a University

At any University of Technology, Faculties of Architecture everywhere and always struggle with the scientific justification of their research and study. Some experience in that battlefield may be of use to clarify Art's task in science. In Delft the question of scientific justification of Architecture culminates every decade in a debate about the role of mathematics in its education. "Mathematics is the basic language of technology! The academic engineering title 'ir.' would devaluate without a proper mathematical background!" the other faculties argue. So, in my career at Delft University as a student in Urban Design and as a teacher in Ecology I witnessed the introduction of mathematical courses by the Faculty of Mathematics at the Faculty of Architecture three times, eroding by a gradual silent removal of its components within five years after introduction. "It's useless for architecture! You never use it in practice! It takes too much time!" teachers of the Faculty (without that background themselves) complained.

## Context sensitivity

The deeper background of that debate is methodology. Teaching to find convincing ways to study and justify architectural, urban and related technical *design* is something else than teaching how to execute empirical *research*. Empirical research is based on clear-cut (isolated) problem statements producing 'ceteris paribus' solutions. Environmental designs for the long term are case studies 'ceteris *non* paribus'. They are even *intended* to change the local conditions of human action at many levels of scale. So, even partial problems and solutions in an always unique spatial context are difficult to generalise for application in other contexts without modification. Buildings, neighbourhoods or towns are more sensitive to governmental, managerial, cultural, economic, technical, ecological and spatial contexts at many levels of scale than any other kind of design teached at a University of Technology.

## Other categories describing design issues

So, modelling any part of the design concept requires to take many external variables into account apart from the internal ones shaping architecture. Every assignment is a 'wicked problem' with many vague aims and problems stemming from many local stakeholders and specialists, always varying in the composition of any installed building team. They even can change their priorities facing a first design concept. So, problem isolation (as an empirical research requires) is the end of any design career with the ambition to integrate categories still no empirical science can cover, into a convincing context sensitive concept. Something seems lacking in the usual scientific categories to be fully useful in Architectural, Urban and related technical design.

## Methodology to make use of each others progress

I also witnessed the set up of a methodology committee for the Faculty of Architecture twice (1990 and 2000). I had the honour to be the secretary of both. So, with a *real* empirical scientist Theo van der Voordt with a different view (see *Fig. 2*) I edited a book[a] summarising the conclusions of both committees and collecting examples of empirical *research* and design related *study*. Study is a useful English word to include the narrower categories of research and design related study. That book reported the contemporary ways to study and research by 48 authors from our Faculty. By doing so it tempered the methodology debate for 5 years. Moreover, it temporarily succeeded to convince the other faculties that Architecture has a scientific basis and ambition, even though that basis may be still primitive. The complexity of the subject still leaves many questions open, but the book produced a temporary scientific justification of Architecture at a University. It was integrated in all educational phases during that period. However, its influence eroded. Not everybody recognised their particular way to study in the book. Not many took the time to read 57 chapters in 550 large pages with 600 images, schemes and tables, 600 references to literature and 10 000 key words. So, not

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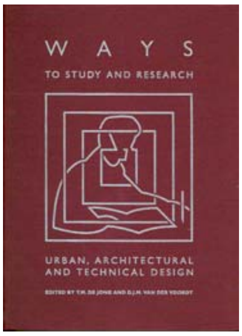
a Jong, T.M. de; Voordt, D.J.M. van der [eds.] (2002) *Ways to study and research urban, architectural and technical design.* (Delft) DUP Science many became aware of the methods of their colleagues, realising they were not the first ones to invent the way to study they practiced or looked for. In five years, many creative newcomers started to invent the wheel anew and there was little accumulation, scientific progress based on mutual fraternal criticism as I hoped to receive after publication.



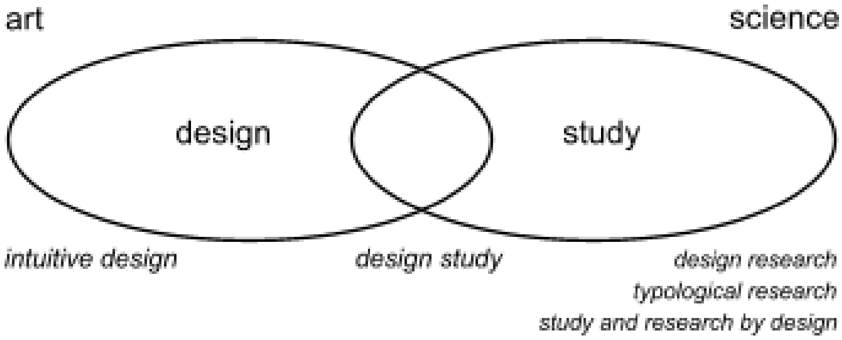




*Fig. 1 Ways to study* *Fig. 2 A usual view of scientists: opposition of art and science (Voordt)*

### Scientific justification

The question of scientific justification will emerge also if a more extended practice of Art enters a University like Art Science in Leiden. That entry seems to indicate that art can be part of science. I would like to demonstrate here the other way round, that science is part of art. Art is not science, science is an art. The power of imagination is tacitly supposed in science. So, art does not require science, but science may need art as a source of imagination. The task of science for art is limited. Art primarily has a task for science. Why? To question continuously its limitations, suppositions, categorisations, generalisations, to extend its imagination of reality. Reality is more than truth or probability. To explain that, I would like to start with the more simple relation between empirical research and technical design. Extrapolating that discussion may offer useful matter to justify the presence of art practice at a University.

## 2 Science tacitly supposing design

### Probability supposes possibility

The difference between empirical research and technical design is primarily the difference between exploring probable and possible futures.
Taking a closer look at the difference between probable and possible futures before we have to descend into modal logic, we simply can conclude that anything probable is per definition possible, but not the reverse.

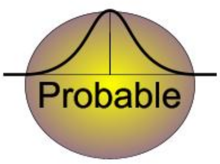



*Fig. 3 The task of empirical research*

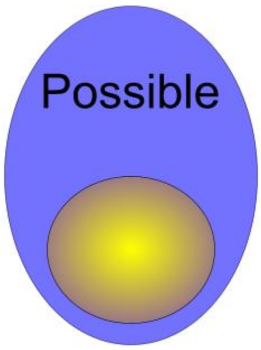



*Fig. 4 The task of technical design*

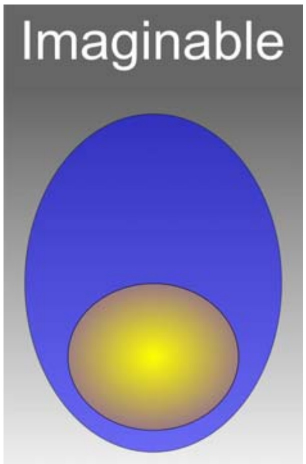



*Fig. 5 Art's task*

So, there are improbable possibilities. The probable ones can be predicted, explored by usual ways of empirical research simply because they are probable. But how to explore *improbable* possibilities? That is precisely the task of design. A designer imagines improbable possibilities that do not exist. If designs were probable they would be predictions, not designs. Designs are not 'true' or 'probable', but 'imaginable' and 'possible'. Since empirical science aims at *truth* or at least *probability*, from that viewpoint a designer is a liar. So, design cannot be empirical science.

## Design *uses* empirical results but *produces* something else

That does not mean designers do not use the *results* of empirical research. Probability is part of possibility after all. It solely means it is not their competence to *deliver* such results. Their core business is developing unpredictable possibilities. The predictable components of design are delivered by former empirical research. Designers choose and use them on location balancing them in a context-sensitive composition by improbable combinations, components and details to create new possibilities. Designers are not assigned to make predictions based on causal suppositions (hypo-theses) as empirical scientists are. So, concluding causal relations eventually following statistics and probability calculus, based on existing data can not be the way of study they are assigned for. However, without knowing how that kind of conclusions are reached, designers are vulnerable in a team of specialists using these generally accepted scientific methods. So, they have to study methods of empirical research to be able to criticise the results of empirical generalisations in the specific context at hand. That critical ability is needed to balance often contradictory empirical advices of many empirically educated specialists in a planning team to be integrated in a composition. That criticism nowadays fails *between* empirical specialisms.

## Science supposes design

However, science itself is a conscious human creation. And a conscious human creation supposes design. So, science supposes design (imaginability and possibility).
Art supposes *imaginability* as such. But imaginability is necessary in any conscious practice. For example policy supposes *desirability*, as far as the desires are imaginable and possible. Imaginability, desirability, possibility and probability are different *modes* of practice and reasoning. In design education and practice they appear as different *modal futures* to be distinguished properly. That distinction makes explicit the problems and aims motivating any practice. Probable futures as far as they are not desirable contain a field of problems for study and design, and desirable futures being not probable show a field of aims.

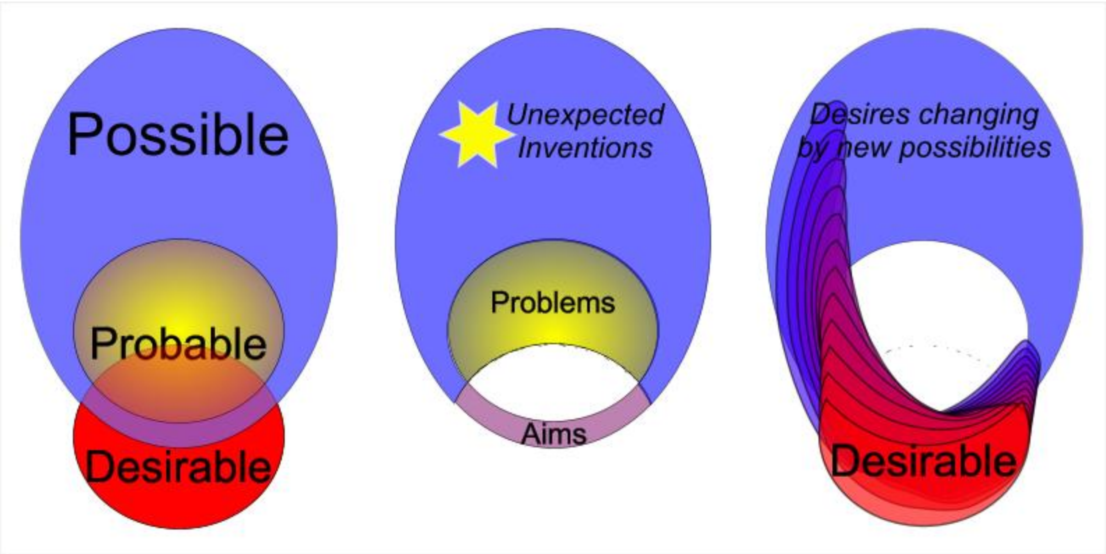



*Fig. 6 Desirable futures determining fields of problems and aims, changing by new possibilities*

## Imaginations and designed instruments precede scientific progress

Anything true or probable is by definition possible and imaginable. If the content of a drawing or a text is not imaginable or possible, it cannot be probable let alone true. It cannot be object of science before it is made imaginable. Leonardo da Vinci and Vesalius had to draw our inner organs properly before Harvey could even *imagine* our blood circulation.

*Fig. 7 The heart by Leonardo da Vinci in 1509*[a]

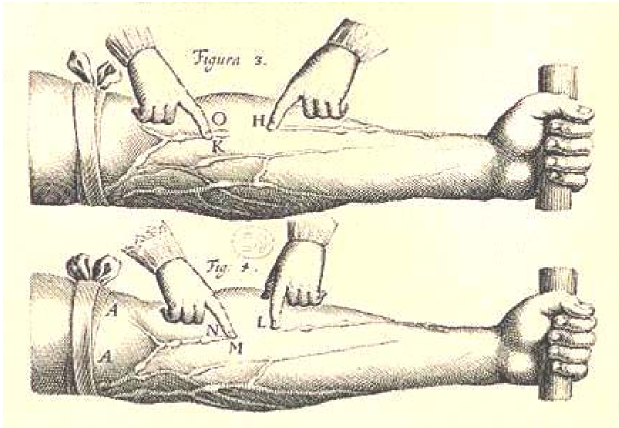


*Fig. 8 The proof of blood circulation by Harvey in 1628*[b]

The telescope had to be designed and realised before Galileï could see the moons of Venus and imagine they were continuously falling in a circular movement, confirming Copernicus' assumptions and Kepler's measurements. The steam engine had to be designed and realised before Clausius and Boltzmann could develop thermodynamics a century later imagining entropy as the key to its efficiency.

## Science is not necessarily part of design but of its realisation

So, imaginability and possibility are preconditions for science. Design is *supposed* in science, be it often has a hidden supposition. Scientists themselves speak about the *design* of a research programme, the *design* of research tools like a telescope, a microscope, a cyclotron, an inquiry or even algorithms, the *design* of an organisation. So, if design could be *part* of science (and design education part of scientific education) is the wrong question. The right question is, if science (as a *sub*set of design) always should be part of design. If not, the complementary question is, if there is still a task for design study beyond empirical science (probability study, research). If so, many questions emerge about that task. Let us first answer the question: 'Should science *always* be part of design?'

If we look at the remarkable results of designers without any scientific education we are inclined to say "No!". But, even designers without any scientific concern implicitly use the empirical experience of preceding examples (precedents) proving the possibility of design principles: types, concepts, models and programmes. Moreover, materialising and *realising* their designs these days, they use the scientific results of other people (for example: 'this kind of brick will hold the required pressure'). So, the final answer is: "The *results* of empirical science are always part of *realising* designs, but not necessarily of design itself."

## Advantages of scientific education for design

So, design education does not always need a scientific input. Scientists defend that input because of the many avoidable design mistakes appearing in realised designs. However, in practice many empirically educated specialists judge the growing design in many stages, filtering out such mistakes beforehand. In that company the designer has an other task and no education can simulate all occasional specialist's evaluations. So, avoiding mistakes hampering the very beginning of design is not a strong argument for science in design education. A better argument is: a designer without any scientific experience will be

[a] Windsor Castle, Royal Library RL19112r
[b] Harvey (1628) Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus

vulnerable in the middle of these specialists. (S)he cannot reject their arguments or ask the right questions about their hidden suppositions.

## Natura Artis Magistra

However, there may be another advantage. Science activates our senses. It forces imagination into areas not accessible for the naked eyes, ears or the other senses, as they are used to, and shaped for everyday life. The exploration of microscopic and macroscopic scales unveils phenomena you could not imagine before. How rich our human imagination may be, it is poor compared to reality. In particular biology is an ongoing realm of surprise. “How is it possible? Could you imagine?” we exclaim in amazement. Many innovations nowadays are based on the incredible achievements of micro organisms, plants and animals. There is no technical university able to design even a mosquito. Its achievements in flying, in coordinating and synchronising its functions, in adaptation to the environment, in reproducing its concept with many modifications into offspring for survival of the species in changing circumstances are still unconceivable, sometimes suggesting intelligent design. Our imagination of extraterrestrial life in science fiction is still caught in representations of what we know as terrifying enlarged insects or mutants of humans. Even in creating toys like ‘transformers’ we apparently need something to recognise from everyday life, otherwise our impression would fall into chaos. At the other hand, if we recognise too much we fall into boredom. Our neural system needs stimuli, not too little, not too much. Perhaps that dynamic balance between recognition and surprise we call beauty.

## A design concept balances and integrates specialist’s advices

Education cannot offer all necessary evaluations by specialists on every student’s design. In practice, a designer confronted with many of such arguments by the many evaluations will become gradually aware of design limits by experience. Avoiding mistakes (s)he will become more and more limited in formulating concepts. Without scientific background (s)he has to trust specialists’ advices without objection. However, a designer with some scientific understanding will put the advice into the perspective of a specific context. (S)he can weigh the advices related to each other and to the architectural quality to be reached.

## Diverging specialisations result in an archipelago of sciences

Perhaps a designer even recognises the same structure in the advices, bringing different disciplines together in broader categories unknown in science and difficult to formulate. That broader interdisciplinary understanding by context sensitive design is urgently needed in science itself. Design has a message in the university context. Science increasingly breaks up in specialisations, increasingly inaccessible by their collective suppositions, jargon, instruments (paradigm), not criticized by their growing monopoly, their standards accepted by policy makers, convinced of their own generalizations, less and less aware of context, of each others’ object of study, their limitations. By lack of context awareness, fascinated by mathematical evidence, generalizations based on hidden suppositions, policy makers and designers get contradictory advices. So, they *choose* their specialists to support *their* opinions and decisions. Any decision can be supported by some specialist.

## Science falls in public esteem

The audience of television programmes, paying their taxes for education and enactments for example on safety, health and environment based on ‘scientific research’, looks at debates between professors with contradictory advices, hired by opinion makers. Expensive earlier enactments are questioned. Where did they pay for? They feel ‘there is something rotten in the State of Science’, being increasingly inaccessible for external critics. The university is no longer universal but specialised, struggling for survival in mutual competition. Specialised ‘peers’, authorities, censor scientific publications in expensive specialised periodicals. Three centuries of debate on the topic of authority called ‘Enlightenment’ seem to fade. Mediaeval times are back. Authority is a scientific argument again. The audience looks at debates between authorities without distinction, be it scientists or populists. They do not choose for complex arguments but for the common sense stemming from the everyday scale of personal experience. For whom are they going to pay taxes in the future? Anyway, they are willing to pay for identity, uniqueness, imagination, possibility, and design. Design products sell better than scientific articles. But they contain results of science.

### A demand for imagination

Design education remains attractive for students with imagination. And imagination is a prerequisite for science and policy. Architectural and urban design force to include managerial, cultural, economic, technological, ecological and spatial futures on different levels of scale, including but surpassing everyday scale. That is why they should include science within their education as a real university in itself, open for the depths of many specialisations, but broad, sensitive for context, putting them into perspective by the ability of proper criticism. Design extends science from exclusively probable futures into possible, imaginable futures. It offers hope in a world of depressing predictions. In their possible worlds designers make place for desires no one else could imagine before they were designed. Policy makers are freed from limiting suppositions about probable futures by possible futures imagined by design. The task of design education is to restore the University, not the accountancy of facts insufficient in the perspective of new, unexpected possibilities needed now.

## 3 Art's task

### A lack of imagination

I am disappointed in the current human ability to imagine the unfamiliar and I become bored. Students cannot imagine what you explain if you do not pre-chew it in many images, accompanied by jokes and anecdotes to open up their minds filled with the concerns of contemporary everyday life. Your lectures have to compete with the media to be not boring and that takes time, lost for the many subjects you would like to present.
Architects forced by time schedules of clients hastily copy-paste former solutions from their CAD archives into boring façades calling it 'architectural clarity', or even 'personal style' competing for space in architectural journals edited by failed designers. These editors determine what is architecture. Follow the leaders as soon as they can permit themselves something unusual you cannot achieve before you are famous. Building contractors do not like unusual solutions before they reach the media. Specialists force you to skip your extravagant imagination, because there are no empirical data about it.
Scientists distinguish ever more categories (variables) hoping to generalise the many particular phenomena left. To cope with this conceptual multitude they split themselves up in an increasing number of specialisms taking more and more time and money to explain these phenomena. By disciplinary limitations they loose a feeling for practical context. By doing so they loose insight in other disciplines and give up interdisciplinary critique, required to solve the increasing amount of contradictions facing a context-sensitive reality.
The man in the street watches television to receive hour after hour, day after day, year after year the prescribed images of a Hollywood lifestyle they have to copy in their clothes, homes, workplaces and holidays. Follow the idols to be popular before your friends do so! Trend-watchers predict the colours you have to buy next year.

### Global homogenisation

If you want to escape that predictable, increasingly boring environment you join the prescribed holidays. If you arrive at the last remaining boundaries of global culture looking at the dances of the last unspoiled tribes left, you meet them in the disco afterwards wearing Nikes. Your hotels anywhere in the world obey international standards of comfort reaching total homogeneity wherever you travel. You have to feel home after all, to recover from all that unfamiliar impressions. But what is 'home' if it is everywhere?
At a decreasing number of destinations you may discover that poverty has more faces than affluence. But it frightens you to face responsibilities you just tried to escape for a while. However, visiting these places fortunately contributes to local wealth and adaptation to the normal. Why bothering if it is convenient and you can not imagine anything else anymore? Within that declining number of really different references for living, details count. Cars look more and more the same. To distinguish your identity, a little difference becomes enough if you buy it in time.

### Decreasing awareness of real diversity

Assigned to teach ecology, I am inclined to study nature. To understand ecological literature with its extensive Latin nomenclature I try to name the plants I see going to my workplace. After many years, even that limited number of species I still can not recognise properly. Take

only the many species of grass. So, how ever to cope with the mosses, toadstools, insects or birds I see? I am increasingly confused by a diversity no generalising science can grasp. And if you can't imagine, then you skip it from your responsibility. Who cares? It is convenient. Globally, now we loose 1000 species winning 1 per year at average in evolution. You can't imagine, so skip it from your awareness. You daily life is complex enough. You like politicians promising to reduce that complexity of obligations. And you forget what they have promised, stressed by the pressing time schedules and the increasing number of choices. Our globalizing culture forces to choose every second. But the question is, if the alternatives offered are really different. You loose yourself in deliberating the difference of insignificant details. Two species of grass differ much more than two trademarks of coffee.
We loose a feeling of proportion.

## The combinatory explosion of possibility

The real diversity of nature may be inconceivable, it is only one of the very many *possible* worlds. If you limit your possibilities of designing to a flat surface with 16 times 16 pixels and 256 colours (an old fashioned Windows-icon), the number of possible combinations is $256^{265}$. The number of atoms in the universe estimated at $10^{110}$. That is less. It is inconceivably much less than $256^{256}$. And, making any piece of art offers more than 16 times 16 pixels to fill with 256 colours. However, we are imprisoned in the limitations of inherited categories. Science is imprisoned in verbal categories determining any set. Even applied mathematics has to obey distinguishing its variables. Images or pieces of music do not count so much in Science, because they surpass the laws of formal logic. They allow contradictions and vague boundaries between usual categories. They do not exclude the possibilities a scientific specialist likes to avoid. They allow ambiguity, referring to unexpected other domains. How often I cannot find words for my thoughts. So, I skip them, or I force them into the categories of the culture I live in, the language I learned to express myself. Sometimes I draw, play theatre or sing, but I will never know if the spectator or listener will ever share my thoughts. Even with verbal expressions I am not sure if the audience shares my categories supposed in the logic of verbal language. Sometimes I look for poetic expressions connecting scientific incomparable categories to reframe my world of thought. The Greek origin of the word poetry means the art of making.

## Exploring the incomparable

Architecture has to integrate three incomparable categories by design: strength, utility and grace. These categories already have been distinguished by Vitruvius at the time Jesus Christ was born. Strength, utility and grace have been cited to formulate architectural quality very often afterwards in many variants until now (for example: sustainability, functionality, image quality). However, nothing can be stronger than useful, more useful than beautiful or more beautiful than strong, otherwise than in a poetical sense. So, these categories are still rationally incomparable. Design has to surpass incomparable categories by *art*. There we are. *Art's task is to surpass usual categories of imagination.* Impressionism learned the human bodies do not have the homogeneous colour of human bodies the academies taught. Art science should learn and teach a 'theory of everything' will not cover the diversity of reality. Then the question will emerge how to cover the possible or even the imaginable.
But, let us start with reality since even science still cannot cover that fully.

## Combining different sensory impressions

Experiments with babies, reported by Piaget and Inhelder[a], keep me fascinated from the first time I read about them until now, because of the practical and design implications of the idea. Firstly, they gave the children an object to feel by touching behind a screen making sure they could not see it. Then they showed the same object, making sure they could not touch it. Piaget and Inhelder questioned at what age the children would combine these two totally different and incomparable sensory impressions into one concept. On the average it appeared to be on the age of one and a half years old. These conclusions were criticized later (it happens earlier) but the idea has remained the same.

[a] Piaget, J. ; Inhelder, B. (1947) *La representation de l'espace chez l'enfant* (Paris) Presses universitaire de France

## Concept formation
Combining different sensory impressions **synaesthetically** into a concept of any object involved, means more than a conditional Pavlov-reflex. Starting up your digestive system when a bell rings does not yet mean that you can imagine them as a concept, and they are not the same after all. It means that if you feel the object without seeing it, you can make a visual imagination of the object without seeing it. It is the very start of logical operations like 'not', 'or', 'if … then'. It explains the fascination of young children for the game of peek-a-boo or hide-and-seek: mother hides herself and calls you. You can hear her voice, but you do not see her. You now are looking for her, because you have the visual imagination you like to check completing your concept.

## Moving experience
In later investigations Piaget and Inhelder emphasized the importance of the **motor ability** for imagination capabilities and learning. You can change your visual impression by moving physically. This possibility causes continuous experiments by children. I remember my niece celebrating her first birthday. Grandma held her on her lap saying 'Quiet my darling, quiet!'. But she stayed crying all the time kicking her legs. I had been reading Piaget recently and said: 'Give her to me'. Grandma handed me the child and I helped her kicking legs to move her body up and down to see my face alternating with the background. She started laughing! Grandma, somewhat embarrassed, thought she loved me more then her, but I explained her the baby was experimenting parallax: changing object and context by moving up and down. She still did not see me as a person, she tried to understand the difference between my face and my background first. That is why moving on a seesaw is so fascinating for children.

## Object constancy
She should have experienced **object constancy** earlier: mother is not there; she appears in the door and walks into your direction. Her face enlarges until it fills your total scope of vision: is that large object the same object appearing as a small face peeping around the door? You throw toys out of your box, they bring them back. Repeating experiences like that show constancy of changing objects: different, gradually enlarging impressions link up to one imaginable object. That is why swings and merry-go-rounds are important. Later on you run away from your mother and look back. She became very small and to regain your safety you run back to enlarge her. Your mother is not yet a person, but 'something large and warm', like my at that time three years old daughters described their concept of 'mother' when I asked them 'What is a mother?'. The other way round dangerous things are 'large and cold'. A car is not dangerous when it is far away, because it is small. The discovery of perspective in art introduces movement

## Components and details
At any level of scale, a scene comprises components and details.

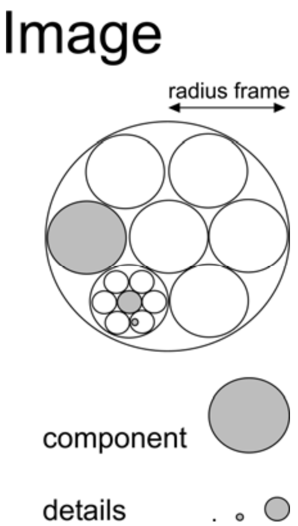



*Fig. 9 Components*

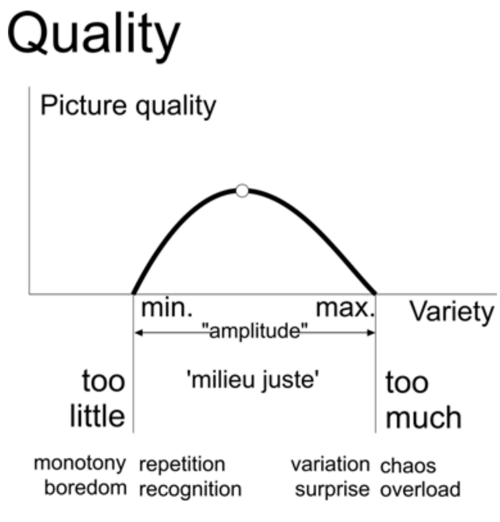



*Fig. 10 Quality as a working of variety*

To design a recognisable scene we have to make larger components externally *different* from each other, but internally filled with characteristic details recognizably *equal* to distinguish the particular component from the other components with other characteristic details, a paradox of scale. That art is called composition. *Fig. 9* shows a visual composition, but the inference is also valid for a musical composition with themes and variants or a theatre production with acts and dialogues.

## Different components

The components of an image can be more or less alike. If they are rather different, then the contrast is strong, otherwise it is weak(see *Fig. 11*).


*Fig. 11 Design means of variety*

In the range between the most contrasting components within an image, one can distinguish a smallest discernable and a largest discernable contrast. If all the components are similar (non-contrasting, repeating), then we call the composition homogenous, and if they differ heterogeneous. One can observe a relationship between compositions of similar components, a relationship that can be either balanced or unbalanced. For the same contrast, the same composition and the same relationship, it is still possible to discern variation in composition. Similar components in a composition can be grouped in a more or less compact form. These are the design means of variety. Any level of scale shows its own composition according to the distance to the object. At any level of scale components and details have new characteristics of categorization and orientation.

## Tension

If a scene has more levels of scale, partial compositions become components in the larger composition. The levels of scale can differ in heterogeneity. If level 1 is rather heterogeneous, then level 2, the composition of the level 1 compositions, may be homogeneous to restore the balance of recognition and surprise, equality and difference from *Fig. 10*. You may call that 'tension'. However, if you want to make diversity at any level of scale, you have to differentiate the means of variation for every level of scale to keep the components identifyable by internal homogeneity of an other kind, using other variables.

## Observable variables or differences

To get an idea of the realities that can be imagined in components and details at different levels of scale, the question emerges: 'Which observable variables vary on every level of scale to distinguish components and details at that level?'. I suppose a child discovers components and details at an increasing level of scale according to its age (see *Fig. 12*).

In your first year, your action space (R=1m) has hard and soft, movable and non-movable components in different colours. In your third year, your room (R=3m) has a door, corners to play, eat and store, different in light, material and visibility. These may be legends for designing at that level of scale. Later, your house (R=10m) appear to have differences of accessibility, control, light, noise, temperature, wetness, differently suitable for playing, personal care and rest. What could we use to distinguish components?

*0 year: radius R  = 1m*

*1 year:  radius R = 3m*

*3 years: radius R = 10m*

*5 years:  radius R = 30m*

*7 years:  radius R = 100m*

*9 years: radius R = 300m*

*11 years:  radius R = 1000m*


*13 years:  radius R = 3000m*

*Fig. 12 Growing awareness by scale*[a]

Then, your yard (R=30m) is differently covered, planted and lighted by the sun. There are components of the house extending in the garden or the street. You behave differently at the back or front side. There are formal and informal places, hard and soft places, places of

[a] Jong, T. M. de; 5 drawings by Jan Huffener (1978) *Milieudifferentiatie; Een Fundamenteel Onderzoek* (Delft)Thesis Delft University of Technology Faculty of Architecture

recognition and surprise. What is the difference between lawn and pavement, terrace and walk? Are there in-betweens to hesitate where to go, vague boundaries not forcing to choose (in-between realms, as the Dutch architect Aldo Van Eyck named them)?
Your school (R=100m) has spaces to sit and to run, compete, watch, play and learn. Your village or neighbourhood (R=300m) has spaces to buy, walk and ride a bike. Your district (R=1km) has spaces of living, business, traffic and parks. Your city (R=3km) has spaces to meet and retire, atmospheres and cultures to explore.

## Resolution

A field of vision comprises a largest observable radius in reality (frame, expressed as R) and a smallest visible detail (grain, expressed as r). Both change the observed composition if you approach an object or a scene. The distance from the observed composition is approximately equal to its frame. If the frame of a picture represents a reality of radius R = 10m and the grain a radius r = 10cm, the resolution r / R is 1%. You will call the result a ‘drawing’. If frame and grain differ less (say 3%), it is a rougher sketch, stressing the concept, leaving details and larger context to imagination. If they differ more, it could be a more precise blue print (0.1%), laving less details to imagination.

## Categories of design: the legend as a vocabulary of drawing

On every level of scale the map you draw may have a different legend, different categories to imagine (see *Fig. 13*).

| **years old** | **0** | **1** | **3** | **5** | **7** | **9** | **11** | **13** | |
|---|---|---|---|---|---|---|---|---|---|
| **m Radius of frame** | **1** | **3** | **10** | **30** | **100** | **300** | **1000** | **3000** | **learning** |
| **differences to experience:** | | | | | | | | | |
| hard-soft | x | | | | | | | | danger |
| movable \| non-movable | x | | | | | | | | operational abilities |
| colour | x | | | | | | | | recognition |
| windows \| doors | | x | | | | | | | orientation |
| light \| dark | | x | | | | | | | imagination |
| shelter \| corners | | x | | | | | | | to escape adult movements |
| function \| time | | x | | | | | | | every time having its own place |
| visibility | | x | | | | | | | hide-and-seek |
| accessibility | | | x | | | | | | rules |
| control | | | x | | | | | | other people |
| noise | | | x | | | | | | context |
| temperature | | | x | | | | | | kinds of clothes |
| wetness | | | | x | | | | | hygiene |
| ceiling \| shelter | | | | x | | | | | in-betweens to hesitate, to decide |
| plantation | | | | x | | | | | nature |
| sun | | | | x | | | | | nature |
| formal-informal | | | | x | | | | | different behaviour |
| recognition \| surprise | | | | x | | | | | initiative |
| run \| compete | | | | | x | | | | ambition |
| watch, learn | | | | | x | | | | to learn |
| possibility to buy | | | | | | x | | | expensiveness |
| possibility to walk | | | | | | x | | | interest |
| possibility to ride a bike | | | | | | x | | | ride |
| urban functions | | | | | | | x | | exploration |
| meet \| retire | | | | | | | | x | projection \| identification |
| atmospheres \| cultures | | | | | | | | x | identity |

*Fig. 13 Differences to experience, bounded in legends for design according to the scale of possible application*

For example, in a drawing with a frame R=10m, you can draw tiles in the pavement (r = 30cm), the kind of plantation, the furniture of the street and the entries of homes.

These are adult categories. Make a sketch to group them more roughly into less components, comprising child categories. But what do you choose as components and their legend units in other frames? You have to dissect or group them into components suitable for perception on different ages. *Fig. 13* gives an overview of variety per level of scale named before. You could interpret it as guiding principle for design: try to change softness every meter, light every 3m and so on. However, for example light and shadow could be changed successfully on other levels of scale as well. The table is only a starting point to be extended.

## Characteristic, crucial, connecting and marking details

A composition is not only determined by components, but also by details directing your fixation (focus). Above we mentioned *characteristic details*, characterising components. But there are also *crucial details* without which the composition would change substantially, *connecting details* determining boundaries and in-betweens and *striking or marking details* labelling the whole scene without being characteristic, crucial or connecting. That are the kinds of details verbal language distinguishes as far as I know.

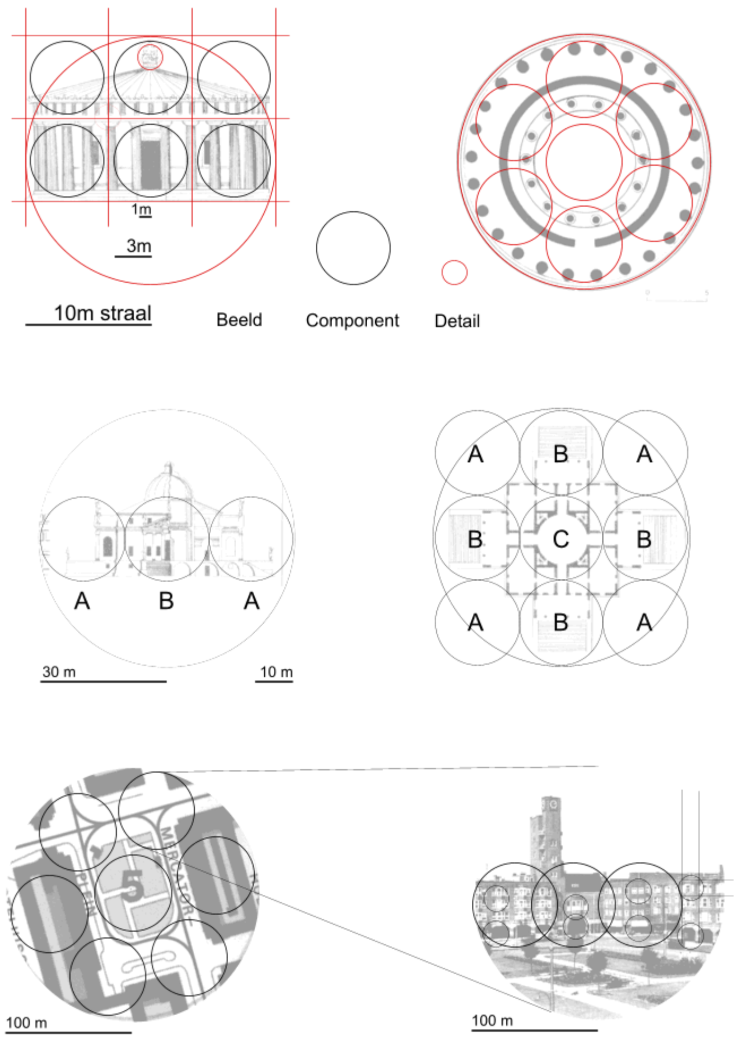



*Fig. 14 Components and details of images in a radius of 10, 30 and 100 metres.*

## Three examples of style and scale

In each period, and on each level of scale, components and details can be observed indicating to what extent one can talk about diversity or repetition. In Fig. 14, three periods of architectural style, and, for the sake of brevity, the three scale levels linked to them are shown. A *tholos* for Asklepios in Epidauros, with a radius of 10 metres; Palladio's Villa

Rotonda, with a radius of 30 metres; and Berlage's Mercatorplein in the district De Baarsjes, with a radius of 100 metres.
In the image of the map of the tholos, the components of a radius of about 3 metres appear as the central *cella* and the components of the *peristyllum*. When one looks at the vertical aspect, components appear to be an entrance section and the flanking parts of the pillared gallery, and the roof section and foreground laid out in a similar way. The pillars are characteristic details of some components. The capitals, triglyphs and other ornaments are connecting details. But the top ornament? It is not characteristic for any component. Is it *crucial* for the composition, *marking* as a strange body or perhaps *connecting* the temple to heaven?
The components of the Villa Rotonda differ more. The middle section is dominant. The special (B) is flanked by the common (A), repeating components following the classical scheme ABA. On the map, a large central section C appears, flanked by similar ABA schemes, in which, this time, the peripheral area can be included as the most common component.
In the image of the Mercatorplein, the area *is* the central component (30m in radius), flanked by an approximately equally large groups of house façades in the corners and along the lengthy sides. The details consist here of façade (10 m) window and entrance sections (3 m). The image of a block (of buildings) can also be described within a radius of 100 m.

## Exploring possibility, limitations of imagination

The treasury of reality is still not empty for imagination as the excursion in architecture above may show. Many other categories, different legends for imagination can be explored to get a new impression of the same reality. That realm of possible impressions has to be explored by new compositions, changing the engraved boundaries of their components. But imagination can explore a still larger universe of possibilities. The well-known categories, components and details can be re-arranged into new designs producing a combinatoric explosion of arrangements. However, that does not change the inherited categories, based on verbal limitations. It can at most change their relations. It will not cover many other possible worlds than we face. My concern is the verbal limitations imprisoning science and society. Any noun or verb is a generalisation of different phenomena in different contexts. The context produces different meanings of the same word. But the category indicated by a word has hidden suppositions we share in the language as part of our culture, the set of tacit suppositions we share. Poetry may free our words from some suppositions, but science bind them in definitions. And definitions replace the problem into other words with *their* suppositions.
Our imagination is limited by hidden suppositions of inherited categories, named by words. You can not explain a fish what water is by indicating something it cannot see. We cannot imagine the suppositions we share as a common culture of apparently self-evident categories. However, creativity requires to leave at least one commonly accepted supposition behind.


*Fig. 15 Little methodology of designing study*

Where are the boundaries of imagination? Many years I studied the hidden suppositions of words comparing them with the question: "Could you imagine B without A and not the reverse?". Then A is a hidden supposition in B. I compared some 200 words, common in science and technology that way, and published the result in 1992[a]. That required 40 000 comparisons, resulting in a tree of words starting with one hidden supposition: difference. Even equality, the basis of any categorisation and mathematics, appeared to suppose a kind of difference. Equality requires the supposition of two different objects before you can conclude similarity. But difference does not suppose anything: you can see, hear, smell or feel it at any boundary even not necessarily enclosing 'objects'. Without any difference no sense will report you anything. Without a difference nothing can be observed, chosen or realised. And there are different differences, some of which we call 'equality' because we cannot imagine less difference. But more difference we always can imagine.

And that is the task of Art: make a difference, but keep it recognisable.

[a] Jong, T.M. de (1992) Kleine methodologie voor ontwerpend onderzoek (Meppel) Boom

# 4 Conclusion

## Truth, probability, possibility and imaginability

Truth has been the main focus of science and philosophy since Thales of Milete around 624 - 545 B.C.. 'Truth' is reduced to 'probability' in the last centuries. But reality is more, and possibility is much more. Imagination is less, because it still does not cover reality, let alone possibility. In the confusing diversity of reality, empirical science only tries to name and describe regularities. Generalising categories and repeating forms of behaviour between these categories make predictions possible as long as humans behave according to the supposed rationality, without freedom of choice. But reality is more than generalisations and predictions based on repetition. Clarifying them leaves an increasing density of particular phenomena to study, not fitting in named patterns and processes. Moreover, design *produces* particular phenomena, not copies. Making a difference is the core of art.

## Improbable possibilities

Research has to be repeatable, design should not. If a design is repeated, then it is a copy and by definition no longer a design. The improbable images and sounds of designers and composers may be not *true*, they are eventually *possible* in the sense of technically realisable or anyhow observable, perhaps imaginable. Clarifying probability and possibility require different modes of reason and I tried to explain their relation to arrive at the core of this talk: imaginability. What is probable is per definition possible, but not the reverse. So, there are improbable possibilities you can not predict, *because* they are not probable. Improbable possibilities have to be designed. And the ecological crisis we face, forces to look for improbable possibilities.

## Science as design

From a viewpoint of empirical science a designer is a liar. A designer does not tell the truth but produces non-existing, improbable images and sounds. A design is also not probable by definition, because if it would be probable, it would be a prediction. And predictions, based on probabilities belong to the domain of empirical science. So, design can not be empirical science alone, because it extends that domain. The reverse, science itself is designed. It is not hidden in nature, to be found somewhere in the field. It is modelled by humans. Its categories and repeatable behaviours, sometimes modelled in mathematical functions, are designs. If I agree with anything Kant has written, I agree with this: "… das die Vernunft nur das einsieht, was sie selbst nach ihrem *Enwurfe* hervorbringt, …"[a]. The power of reason supposes design, not the reverse. So, scientists are a special kind of designers but designers are not always scientists. Scientists design real or thought experiments, and experiments require real or thought instruments. Mathematics is an instrument and it is designed by humans. Instruments have to be designed before science can make its progress. But that kind of designs are underexposed in the history of science. Perhaps Hacking[b] put the first steps to restore that omission.

## Instruments of imagination

Science requires design, not the reverse. Zacharias Jansen or his father designed and built the first microscope in Middelburg (1595) opening up a reality nobody imagined before. But, is what you see by an instrument reality or imagination, made by man? What does a kaleidoscope show? Could a design open up new realities? The design of the first telescope by the same Zacharias Jansen or Johannes Lipperhey also in Middelburg (1608) enabled Galileï a year later to see the moons of Venus continuously 'falling' around the planet. It forced to suppose more than we can see: an invisible centripetal 'force'. Newton defined force as acceleration times mass, and that are categories we can imagine. However, Newton never pretended to find a 'truth' as his successors did. He made 'force' imaginable. He simply designed quantitative relations between designed categories behaving comparable to the behaviour of many realities. And quantities is what we can imagine. Describing their relations we call mathematics, an instrument of thought, nowadays automated in physical instruments

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[a] Kant, Immanuel (1976) *Kritik der reinen Vernunft* (Frankfurt am Main) Suhrkamp Verlag
[b] Hacking, Ian (2005, 1983) Representing and Intervening. Introductory topics in the philosophy of natural science, (New York) Cambridge University Press

called computers. Are mathematical operations perhaps physical simulations, be it performing in computers or brains?

## Condition and cause

Archaeologists conclude the historical presence of humans if they find art or instruments, not to be explained by 'natural' forces causing them. That tacitly supposes 'non-natural' forces as privilege of humans producing artefacts. Since I have read Harrison at al.[a] I suppose that difference from animals is nothing more than the ability to imagine (or simulate) 'a larger series of actions of which only the first is directly executable'. The first action without direct profit may be to make an instrument (condition) for further action. But a hammer can be used for many further actions, it does not 'cause' a house, it is a *condition* to make a house, a bed, a table or a chair. It makes them *possible* and that is another mode than 'probable'. Imaginable *causes* simulate events as probable, *conditions* make them possible. Shaping conditions is the core of design in all of its stages. The first line drawn *conditions* the lines to follow. It does not *cause* them. Design is not necessarily aim directed, it opens up new possibilities. It can be means directed, a kind of playing with materials to see what is possible. A house does not cause a household. It makes many households possible. A piece of art does not cause specific emotions, it makes many emotions possible. If the emotion is predicable we may call it kitsch. However, any cause is a condition something to happen, but not every condition is also a cause. That looks similar to the relation between possibility and probability (see *Fig. 16*).

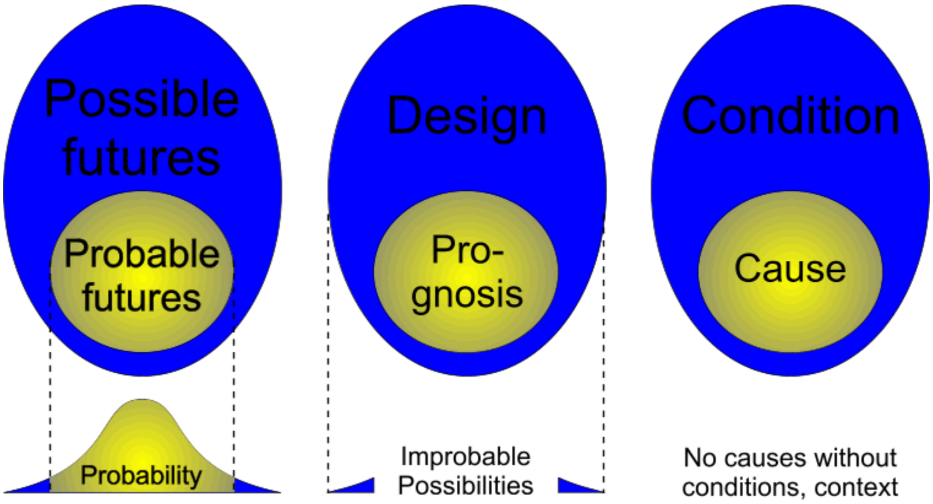


*Fig. 16 Possible futures include probable futures, condition includes cause.*

## Supposition and definition

Words are categories full of hidden suppositions buried in a culture we share (the set of tacit suppositions in communication) of which language is a part. Defining words by other words does not clarify the suppositions of the underlying (sub-posed) defining words. They are taken for granted as self-evident by inherited culture. The test "Could you imagine B without A and not the reverse?" clarifies an order of suppositions making concepts imaginable. Creativity and art are not part of culture, they *produce* culture at its rippling surface by removing and adding apparently self-evident suppositions. The test may help to become aware of hidden suppositions to be removed opening up new possibilities. That is the task of Art.

[a] Harrison, G.A.; Weiner, J.S.; Tanner, J.M.; Barnicot, N.A. (1964) *Human Biology* (Oxford) The Clarendon Press