Living in cybernetics: Polynesian voyaging and ecological literacy as models for design education

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Abstract

Purpose – The purpose of this paper is to learn from successful educational frameworks how to inform a possible framework for design education that includes ecological literacy, systems thinking leading to more sustainable and ecological designs.

Design/methodology/approach – The author comparing two models for education, the first being that of the Polynesian Voyaging Society which re-emerged as a cultural and educational framework in Hawaii. Second that of the Center for Ecological Literacy in connection with the edible schoolyard. Both frameworks involve systems thinking.

Findings – Certain elements that may inform design education. Among these are attention and vision, values, care for nature, culture, community and learning based on systems thinking, exploration and perception of the environment. Language, traditions and a strong local grounding also play a role in the Hawaiian framework.

Research limitations/implications – The sources are from personal observations in design education and documentation material provided by educators. The groups with which these principles were enacted are children, whereas my goal is to inform a framework for higher education.

Practical implications – The shared characteristics used in the two frameworks might be used to inform curricula for design education from both theoretical perspectives and practical applications.

Originality/value – Polynesian voyaging and ecological literacy have both been very successful as educational frameworks since their implementation. Designing is necessary and design education can possibly learn much from these two examples to adapt to future changes. Ecological literacy, an educational perspective, incorporates ideas around sustainability, networks, nested systems, circularity and flows, and using this knowledge to create "sustainable human communities." Traditionally this is not part of design education.

Keywords Design, Systemic thinking, Ecology, Learning, Education, Social change

Paper type Conceptual paper

Introduction

In recent decades design education, especially that of product designers, graphic designers and interaction designers, had to adapt to a changing environment, technological changes as well as changing consumer needs. From designing products that work well and are perceived as aesthetically pleasing, today design curricula additionally consider the application of human-centered design techniques, designing with sustainability in mind and also the design of experiences and services. There also is an awareness to consider where materials are coming from, under which conditions products are being manufactured, and also what is happening with them once they are discarded. Designers and consumers also have become aware of globalization and the distributed negative effects of consumer culture such as resource depletion and pollution, among others. There appears to be a growing awareness of a systems perspective, that "living systems are nonlinear and rooted in patterns of relationships, understanding the principles of ecology requires a new way of seeing the world and of thinking – in terms of relationships, connectedness, and context" (Capra, 2007).

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However, since the beginning of the environmental movement in the 1970s the negative effects of industrialization and consumer culture have been increasing instead of decreasing on a global scale (Drexhage and Murphy, 2010, p. 15). There appears to be a disconnection between theory and practice, between knowing and making informed actions. Although these are the responsibility of policy-makers, designers play a role in the environmental crisis as to some part, some of these negative effects are driven by the production, transportation and consumption of consumer goods. Most of these goods, from necessary washing machines and refrigerators, to less useful fashionable and disposable items, are being designed by educated designers.

At the same time there are some educational programs that appear to be successful in leading to a deeper understanding of ecology in view of systems and networks, a curiosity for natural phenomena guided by care and active involvement in the local community – perhaps leading to a more balanced relationship within the ecological system and the use of resources.

In the following text I will be reflecting on how elements of two educational frameworks, one of the Polynesian Voyaging Society (PVS) based on the Hawaiian Islands, and another, of the Ecological Literacy Campaign based in California, might complement design education to ameliorate this situation or at least lead to more conscious, fulfilling and reflective ways of designing.

The question that drives this enquiry is "What may design education learn from other educational models that lead to thinking and acting with sustainability in mind?"

Design education

Learning to design is not achieved through reading books. Students learn in a very practical and applied manner, solving real-world problems with empathy, skill and ingenuity. They often are taught to structure this process sequentially, beginning by defining the problem, researching history and context, looking at related solutions, and continue to conceptualize, ideate, prototype, choose, implement, test and learn, possibly using some of the gained insights in a subsequent iteration. This pertains to designing artefacts as well as designing processes and services. Additionally design students are often exposed to marketing theory, design history, design theory, design semantics, inclusive design principles, human psychology and theory of perception. They learn to design well.

In a human-centered design approach this also involves techniques such as interviews or observation, among others, to get a better understanding of how people might use a product or service. Design schools also encourage students to consider designing with a sustainable perspective in mind, e.g., to consider longevity and efficiency of their designs. It is expected that designers are able to listen to stakeholders with the intent of understanding the design task from their various "cultural" perspectives. As a design professional they might encounter a different client-culture and vocabulary several time a year. One client may be a bank, the subsequent one a kitchen utility manufacturer. Also often the scale and complexity of a project requires designers to work together in interdisciplinary teams. With growing experience designers should develop the ability to switch between different cultures, languages and viewpoints. When encountering a new design project they sometimes have to take a research approach, not knowing in advance what the appropriate outcome might be. It also may happen that what a client wants is not actually what is needed in view of solving their problem, for example a short video may serve a particular purpose better than a requested printed brochure. Shifting perception and perspective is a continuous part of designing.

However, learning to design with sustainability in mind is taking place in a culture that is living in a highly unsustainable manner, especially in industrialized countries. In their everyday experiences students are surrounded by designs that do not adhere to the standards they are being encouraged to adopt as part of the curriculum. The designerly values adopted from educators and the everyday experience are often separated in a cognitive-dissonant "value-action gap." Usually these "values" focus on principles of designing but also concern aesthetic qualities and usage. Often these principles are not transferable. They add a layer of "philosophy" to an often utilitarian outcome. Think of Mies van de Rohe's "Less is more" or Dieter Rams' "Good design is useful." Bryan Lawson describes these as "guiding principles" (Lawson, 2005, p. 159) and that "each design problem enables the designer to learn more about the guiding principles and express them ever more clearly" (Lawson, 2005, p. 179). Klaus Krippendorff writes that competing schools of thought in design had lost their distinctiveness and momentum. "Most educational programs include a little bit of everything in what they offer their students. No compelling manifestos exist." (Krippendorff, 2006, p. xvi) Perhaps it is time to not only rethink the values that inform designing but also how these values are expressed in the curriculum?

Such a theoretical perspective connected to designerly values could be informed by systems thinking and second-order cybernetics. Systems thinking takes into account that the design problem forms part of a system and the solution has to be viewed within a larger context to develop good enough solutions. Second-order cybernetics both take into account the role of complexity, that an observer becomes part of the system she observes, learning and uncertainty. Glanville argues that "cybernetics can act as the theoretical arm of design, while design acts as the practical (active) arm of cybernetics" (Glanville, 2007).

In order to steer design education toward a clearly defined sustainable direction, a comprehensive vision of a desirable future might prove helpful, grounded in meaningful values. From a bottom-up perspective it might even be more effective to strive for design education being taught from a cybernetic perspective, hoping that a mindset of sustainability and human-centered design emerge as insights of the process.

In the current state of sustainable design the industries are in a more powerful position than designers as they provide the design jobs. Commitment to "sustainability" is often little more than a lip service and companies truly adhering to a sustainable agend as are the exception to the rule.

PVS

One organization with an educational program that fosters an awareness for ecosystems is the PVS on the island of Oahu, Hawaii. Central to this program is traditional Polynesian navigation as an inspirational metaphor. Polynesian navigation was the ancient Polynesian practice of navigating the vast pacific ocean without instruments, only using the sun, moon, stars, swells, clouds and birds as orienting cues to travel vast distances between Polynesian islands.

People living on islands are highly aware of the limitedness of their resources, the precarious balance of their natural environment and the long wearing negative effects of unsustainable actions. In order for their isolated society to survive Hawaiians had to learn a sustainable way of life. Learning from experience and observing the consequences of actions in a limited and confined environment necessarily lead to a sustainable culture in order for such a society to survive. Anthropologist Jared Diamond argues that a remote island being inhabited for thousands of years was evidence that its culture had succeeded in living sustainably (Diamond, 2005).

On a larger, planetary scale the experience of being on an isolated island appears to be more difficult to convey. The "island earth" is too large to be identified as an island and once unsustainable actions have led to undesired consequences there remain other places to migrate to.

During colonial history European administrations prohibited the building of long-distance canoes on some Polynesian islands and also banned interisland travel (Lewis, 1972). Also during colonial rule Hawaiians were prohibited from speaking Hawaiian (McGregor, 2007). As a result the people's knowledge and skills, language, customs and culture were gradually being lost since the nineteenth century. To learn about Polynesian navigating in the 1970s, navigator Nainoa Thompson had to learn from books, spend hundreds of hours in a planetarium and finally travel to the island of Satawal in distant Micronesia to find a qualified navigator to teach him traditional navigation skills (Speidel and Inn, 1994). In 1980 Thompson successfully navigated a long-distance voyaging canoe from Hawaii to Tahiti using only traditional techniques. This voyage inspired a generation of Polynesians and resulted in a renaissance of Hawaiian culture. Today this navigation culture is thriving again with many apprentices learning the traditional way of navigating, which also effects Hawaiian society as a whole. It is intrinsically linked to the culture and inseparable of it, leading to perceptiveness of natural processes if not to a reverence of nature. How did this culture re-emerge?

In 1984 the first pre-schools and schools were established teaching in Hawaiian (McGregor, 2007, p. 278). The educators did not only want to teach in Hawaiian but also convey Hawaiian culture, as language and culture are deeply intertwined. They began with identifying Hawaiian values they could base their curriculum on: "With the help of Hawaiian resource specialists, we explored those values which continue to influence the daily lives of our children: the values of 'ohana, or the extended family; the idea of kuleana, or area of responsibility; laulima, or cooperation; 'ike, knowing or recognizing; and kōkua, or helping" (Fink, 1990). These schools provide a strong sense of community by conveying Hawaiian language, songs, traditions, culture and values alongside other subjects. As a result a generation has grown up for which the re-established canoe culture is deeply embedded within a rich social framework, part of which consists of speaking Hawaiian, alongside specific rituals, songs, storytelling and gift giving ceremonies that bring different generations together. Central to these traditional customs is also a reverence for the land, the ocean, wildlife and nature as well as a strong sense of caring, community, and living in peace and harmony with all people. Inherent in speaking Hawaiian is expressing these values. Embedded in the language is a very particular way of being in the world.

McGregor (2007) writes in this context: "Native Hawaiian ancestors also named the various types of rain and wind of particular districts. The names of places and natural elements not only provide a profound sense of identity with the 'āina or land and natural resources, they also convey a sense of responsibility to provide stewardship of the area where they live" (p. 5). "[This] Native Hawaiian worldview is called "lokahi", or unity, harmony, balance. It refers to the unity, harmony, and balance in the universe between humans, nature, and deities or spiritual life forces. For personal well-being, we need to be in balance with the people around us, and with the natural and spiritual forces of life" (McGregor, 2007, p. 2).

By 2014 Hawaiian culture appears to have successfully re-emerged, with traditional navigation and canoe culture as strong symbolic and inspirational values at its center. Navigating and canoe culture encourage conscious perception of the environment such as the ocean, stars, wind, clouds and wildlife, but also of care for people and

natural resources. Additionally it creates a sense of community. Just as it requires many to build, maintain and navigate a canoe, it takes many volunteers taking part in communal activities such as transporting canoes onto the dry dock and maintaining them. On other occasions they help clearing trails in the countryside, maintaining shore vegetation or working on the land. For an outsider all these activities may appear to be traditional and timeless while in fact they are not. As communal activities they have only re-emerged since the 1980s as the result of the efforts of a dedicated group of educators.

The members of the PVS are well aware of the important role of the wayfinding tradition as an inspirational planning, problem solving, and decision making process. They have integrated their insights into an educational program that also is used to establish a basis for cooperative efforts in the community. In this framework learning is integrated with the values and needs of the social and natural environment.

For this educational program the PVS has identified eight key elements of education that emerged from Nainoa Thompson's reflections on traditional navigation:

The PVS's eight key elements of education

(1) Vision and values: "His vision tells [the navigator] where to go; his values tell him why he should go. […] [The vision] embodies a traditional view of the world by which native Hawaiians were able to sustain life in the islands for centuries."

(2) Exploration and challenge: "Add[ing] to existing knowledge through exploration and discovery."

(3) Observation and experience: "While the knowledge we teach includes reading and studying for preparation and orientation, observation and experience are an essential component of mastery."

(4) Application and practice: "We learn most efficiently and effectively by acquiring and applying knowledge to a project or a goal that is meaningful to us, rather than by being asked to memorize knowledge with little or no application."

(5) Outcomes: "Real and meaningful outcomes help motivate learning."

(6) Culture: "Pride in one's ancestral culture serves as a powerful motivation to acquire and master knowledge. While the knowledge in navigation and crew training includes Western knowledge, the PVS mission has been to recover and perpetuate indigenous knowledge and wisdom and apply it, through practice, in the modern world."

(7) Home – place and community: "The most relevant, meaningful, and significant context in which learners apply knowledge is the place and community that they are most directly connected to […]."

(8) Life-long learning: analyzing information, critical thinking, teamwork, agility and adaptability (cf. Polynesian Voyaging Society 2007).

The PVSs has several lists of values or themes concerning education, however, I consider these "eight key elements" most relevant. While they originate in traditional navigation they are inferred to other areas of learning. In my view the success of the educational program also demonstrates the value of long-term thinking and having a vision for a possible future. Before the success of the educational program could be evaluated one generation had to grow up experiencing it. Implicit to this framework is a strong connection to systems thinking, which is interested in understanding how

elements can be identified as systems. From this understanding emerges a perspective of the world around us as being based upon relationships, connectedness taking place within a particular context. Systems thinking takes into account how mental images (such as vision or values) can affect the outcomes, others include looking at the larger context (exploration, observation), taking on different mental perspectives (culture) and allowing for tensions of paradox and controversy without trying to resolve quickly (culture) (Booth-Sweeney and Meadows, 1995, p. 3). Exploration, application and outcomes strongly relate to learning how to design. Designing is a hands-on experience often with tangible outcomes, involving multiple levels of reflection.

Let us now look at another educational model, "ecological literacy", that also involves collaboration and community in a hands-on learning activity, from which insights into sustainability may emerge. Here explicit links to systems thinking and cybernetics are made by the educators.

Ecological literacy

Ecoliteracy is an educational practice which tries to create understanding for the principles of how ecosystems work. It emerged from the Center for Ecological Literacy in Berkeley, California, founded in 1995, and is based on ideas of physicist Fritjof Capra (Capra, 1996, 2007), environmentalist David Orr (1991, 2002) and also has links to Alice Waters' "Edible Schoolyard" project (Waters, 2008).

Ecoliteracy is not an additional subject added to the curriculum but a perspective through which any topic can be viewed. Central to it is an awareness of nested systems, complexity and understanding feedback, learned from nature. The means by which educators achieve this includes outdoor activities in the "edible schoolyard." In this garden students collaborate, working within a "living food system." They are planting fruit and vegetables and maintain the garden. While planting, caring for, harvesting and preparing vegetables, students also learn about biology, chemistry, mathematics, cooking, health and nutrition. The garden is viewed as a "living library" (Stone, 2011). Learning, in this application, is not abstract but concrete and literally tangible and, when the harvested food is jointly prepared in the school kitchen, edible. In the garden students learn through observing, acting and reflecting. At the same time the different "knowledges" of distinct disciplines are integrated within a meaningful holistic learning experience. Gregory Bateson (1979) warned "Break the pattern which connects the items of learning and you necessarily destroy all quality (pp. 8-11)." In this "living library" the otherwise disparate items of disciplinary learning are re-connected in an integrated curriculum, perhaps allowing for larger pattern to emerge.

The following lessons the educators learned over the years emerged from applied systems thinking seen in action in nature. Among their goals are to create several shifts in perception. For the teachers this requires different styles of teaching. For all involved it leads to different ways of engaging with one another but also to insights about different ways of organizing institutions as well as society.

These insights are as follows.

Seven lessons for leaders in systems change

(1) To promote systems change, foster community and cultivate networks. Communities with a critical mass develop networks.

(2) Work at multiple levels of scale. Systems are nested. Work top-down, bottom-up, inside out, outside in.

(3) Make space for self-organization. Self-organization leads to collaboration and encourages novelty, leading to development, learning and evolution.

(4) Seize breakthrough opportunities when they arise. Use points of instability to examine old structures, behaviors and beliefs.

(5) Facilitate change, let go of control. Nurture networks of connection and communication, create climates of trust and mutual support, encourage questioning, and reward innovation. Invite new conversations. Use different perspectives.

(6) Assume that change is going to take time.

(7) Be prepared to be surprised. Nonlinear systems have unpredictable and emergent properties and evolve. Often unexpected consequences are most rewarding (Stone and Barlow, 2011).

These insights appear somewhat scientific in their systematic and logical, albeit "hands-on" approach. Initially they provide an involved way of understanding the world as it is, confirming theories through acting and observing. This encourages reflection and critical thinking which may allow new theories to emerge. What is learned from nature is then transferred to new ways of thinking and acting. It is here where I see great potential for new ways of designing in at least two ways. First it encourages learning from nature through acute observation and relating theory to practice and vice versa. Then it might involve conceiving innovative design ideas observed in nature (of which biomimetics may only be one), a deeper understanding of bottom-up development in multiple iterations, the value of reflection and perhaps sharing this knowledge through clear communication. All these may become habitual and benefit the entire design process on multiple levels.

Both, ecological literacy and design, should be open for other perspectives and new thinking. The model also encourages self-organization and networks, inviting novelty and change. Disappointments can be viewed as learning opportunities. Ideally designers being educated in these systems thinking principles may expand this insight into a cybernetic way of life, a way of continuous learning, questioning and openness for change.

Discussion

Above I have briefly introduced the educational elements that inform the PVS's program, Ecological Literacy and Design Education. In the following section I will discuss how these principles may be transferred to design education and also acknowledge some of the complex interdependencies that arise by combining the diverse concepts.

Let us begin with adapting the "Eight elements" of the PVS. How might the PVS' elements introduced above inform design education and add to a model for a transition to a design culture that is more sustainable? Below an adaptation from the original "Eight elements" that were presented above:

(1) Vision and values: her vision tells the designer what a desirable future might look like; her values tell her how to design and also how her designs might affect users acting, with implications for the best of the environment, locality and community. This vision is not a fixed goal, but a continuous process, a transition toward a desired state, taking into account complex interdependencies within a dynamic

and changing environment. Design curricula are rarely explicit about their values. While designers reflect on concrete design problems and take into account other perspectives via human-centered design principles, reflecting on the implicit values that inform their designing is less often the case. Perhaps students should converse more about values, reflect and write essays to become more reflective and value conscious? Vision and values also point to the larger, situated context, the society, in which designing is taking place.

(2) Exploration and challenge: these are an intrinsic part of design education. Designing new solutions is research-based and learned through exploration and being challenged, e.g., by wicked problems (Rittel and Webber, 1984).

(3) Observation and experience: while knowing how to design includes reading and studying for preparation and orientation, also essential is the ability to observe oneself, others and the environment. Through reflection, such experiences may become deep learning experiences, e.g., reflection-in-action, reflection-on-reflection-in-action (Schon, 1987). From these experiences also new theories might emerge that may inform new principles of designing.

(4) Application and practice: meaningful goals aid testing knowledge through practice and learning through practice. These also are an intrinsic part of design education but might be made more explicit in order to make students aware of the importance of this relationship to learning. This might also lead to understanding the distinction between espoused theory and theory-in-action (Argyris and Schon, 1974) and a more balanced relationship between theory and practice.

(5) Outcomes: designing a product or service that will actually be used by people we know may help motivate to design with realistic applications in mind.

(6) Culture: identify local, historical, cultural contexts, crafts, materials and industries that designers can be inspired by. How can traditional, local skills, customs and techniques inform designing with contemporary applications in mind?

(7) Home – place and community: living and participating at the place of study. Learning to design by designing for local context, place and community. What is relevant here might be adapted to also be relevant within other contexts. This begins not with learned societies, but with the welcoming of the first-year students into the community of designers. The place of study should become a temporary home, and not a place of transition. Students should investigate their new environment: how is consumer refuse recycled? Where does the energy come from? Which watershed are we in? How may I get involved here and contribute through my design skills? Designers and community members design together for the community. This creates empathy and understanding.

(8) Life-long learning: analyzing information, critical thinking, teamwork, agility and adaptability are essential for designing and for life. Designing takes place within a rapidly changing and dynamic world in which a commitment to life-long learning is a necessity (OECD, 2008). Knowledge from own research as well as from other academic disciplines feeds into design, while markets, consumer needs, technologies and knowledge bases change (cf. Polynesian Voyaging Society 2007).

What about the limitations of adapting these principles to design education? While design is an academic discipline that tries to solve problems with ingenuity and empathy,

the PVS elements consider the whole of society and how it is affected by actions. While design is a profession, participants of the PVS activities are volunteers contributing to a shared goal. They share however, that designers often are driven by idealism, empathy and ethics, the intention to design well, contributing to a local community and enjoy working collaboratively.

While the elements "Exploration and challenge", "application and practice", as well as "outcomes" may be regarded as elements already integral, both to designing and explorative research, real learning happens when these are explicitly communicated in a double-loop learning process (Argyris and Schon, 1974) that re-evaluates and reframes goals, aiding understanding and contributing to a more reflective design community.

In my view the elements "Culture", "Home" and "Lifelong learning" might benefit design education substantially. Awareness of local crafts, materials, might aid in contributing a local and historical grounding to the idealism and motivation of the designer. They might also result in finding satisfaction in smaller design tasks that make use of local materials, techniques or traditions and benefit local purposes. On the other hand they urge the designer to explicitly make a distinction between how things used to be done, and how and why she is doing them in another way. In this learning experience they place themselves consciously within a context and a tradition.

Designs might facilitate adopting values that can become habitual cultural practices, for example, car-sharing, bicycle-sharing or the recycling habit in Germany, where apartment buildings (and some apartments) use up to seven different waste containers to separate waste: white glass, brown glass, green glass, compost, paper, plastics and metal, and "normal" refuse.

Now let us look at the insights of the Center for Ecological Literacy. From my experience design education might consider the following elements:

- To promote systems change, foster community and cultivate networks. Communities with a critical mass develop networks. To facilitate change encourage students to collaborate, to live locally, to participate and take on responsibility. Create conditions for participation.
- Work at multiple levels of scale. Systems are nested. Work top-down, bottom-up, inside out, outside in. Designers take into account not only the design process itself, but a different view upon framing the initial design problem, adopting a larger perspective, seeing how a design solution might be part of a larger wicked problem on another level. We could interpret this as that to change the world by designing begins with oneself in the personal environment, through acting, responsibility and conscious decisions – not only striving to change policy. Designing for sustainability begins thinking and acting local. Design begins in one's own home. How do you wish to live? For example in your own kitchen. How do you cook? What do you eat? Local produce, local materials, what does a sustainable life, a sustainable breakfast look like here in your hometown? Where do materials and produce come from?
- Make space for self-organization. Self-organization leads to collaboration and encourages novelty, leading to development, learning and evolution. Encourage students to initiate own projects in which teachers give guidance. They are free to express their own ideas and interests.
- Seize breakthrough opportunities when they arise. Use points of instability to examine old structures, behaviors and beliefs. This can include designing as well

as the educational structure itself. Encourage actively questioning, challenging and exploring boundaries on multiple levels.

- Facilitate change, let go of control. Nurture networks of connection and communication, create climates of trust and mutual support, encourage questioning, and reward innovation. Invite new conversations. Use different perspectives. Allow students to pursue own interests, collaboration and follow self-directed goals they manage themselves. As a result they might become responsible, economical and motivated actors in their own interests.
- Assume that change is going to take time. This encourages persistence and patience.
- Be prepared to be surprised. Nonlinear systems have unpredictable and emergent properties and evolve. Often unexpected consequences are most rewarding. Made explicit, letting go of trying to control but creating the right conditions for change might be a beneficial attitude for designing. Not trying to design for every eventuality but creating a design that allows conditions conducive of flexibility and surprise (cf. Stone and Barlow, 2011).

Implicitly systems thinking is integrated into the design-build model of architectural education. It is project based, focussing on relationships and community practice (Freear and Barthel, 2014).

Potentially all of the elements above might result in promising new directions for young designers to explore. Adopting some of these principles may lead to profound changes in designing, although these may require time to become visible as they might be subtle and emerge over time through social interactions as well as new designs. A shortcoming here might be the recent implementation of the relatively short three-year bachelor degree which results in a steep and stressful learning curve for design students. Adding more subjects to the curriculum might prove too demanding.

A contradiction appears to arise from the idea of fostering self-organizing processes and the metaphor of a navigator leading the course. In practice, however, this might be not a problem. Most collaborative activities that I participated in on Hawaii had no visible leader and appeared entirely self-organized. To me this was an unfamiliar concept and not without frustration as nobody was able to inform me what we were going to do next. A "plan" seemed conspicuously absent, although everybody knew their individual role and the final goal. People appear to be comfortable acting ad hoc, following a fluid and adaptable course.

The similarities that ecological literacy/systems thinking, design, and cybernetics share might be seen as practices of acting and understanding, as well as theoretical perspectives. In all models learning takes place in situated actions. Knowing is acting and acting is knowing. They also are perspectives that may inform a way of life, beyond disciplinary boundaries. In that sense all three models might be seen as anti-disciplinary.

From a systems perspective this invites critique on the current structure of design education on several levels. For example, learning from nature is rarely a central part of the curriculum. Apart from courses on biomimetics under-graduate students usually do not explicitly learn about systems, networks, or feedback. Perhaps, this would lead to a change of perspective, a "wide-awakefulness" that educator Maxine Greene (Lyons, 2010, p. vi) described as a "life project"?

All phases of designing involve constructivist elements (Glanville, 2006) and working bottom-up as well as top-down simultaneously. Much of this already is

implicit in how designers act, yet applying these concepts might help to add a reflective and explanatory layer to better understand, analyze and communicate the design experience, leading to design actions that are better grounded.

What remains unresolved is the question of designers interested in designing for sustainability having to cater for the needs of an unsustainable consumption society and an economy that is based upon continuous consumption. This might require to implement education for ecological literacy at schools, educating a new generation of more conscious and discernible consumers.

A "cybernetic curriculum" would also require teachers to adopt a different style of teaching and a commitment to life-long learning, as in the example of the "edible schoolyard", where abstract theories are linked to observation and experience. The question is whether design educators wish themselves to be perceived as learners. The traditional epistemology of the university is about knowledge being conveyed in a one-directional manner from those that know to those who do not know (Schon, 1987). This would involve a paradigm shift of collaborative learning based on an explorative approach. These are only a few of the challenges that should initiate a conversation around design education.

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"The key question is always 'How will this effort benefit the community and contribute to the health, well-being, and vitality of the land, sea, people and cultures of the islands?' " Nainoa Thompson, Polynesian Voyaging Society.

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