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HUMANIZING ENERGY

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MODELS
ENERGY COMMUNITIES
& COLLABORATIVE LANDSCAPES

Powered by the People
Human-Powered Energy Generation as Lifestyle Choice

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Abstract
The problem of energy consumption, resource depletion and global warming has moved in fifty years from a fringe campaign to the mainstream of politics, scientific research and the media. However, the need to reduce consumption conflicts inexorably with the life-style demands of consumers who continue to buy more, use more and waste more, and who are growing in number in the world's emerging economies.
This paper documents an investigation into the following research questions: How can we as designers turn the need to reduce energy and resource consumption into an attractive lifestyle proposition? Could we exploit the increased interest of consumers in health and sporting activity by harnessing their body energy to drive appliances? Could we turn this into a win-win proposition?
The investigation took the form of two design development workshops at the University of Bologna in 2022 involving 60 participants. Drawing inspiration from the wake-up calls of 20th Century Modernism and the designer activist Victor Papanek circa 1970, concerned with provoking mass behavioral change for societal benefit, participants were tasked with developing product proposals to generate decentralized energy and store it for use in the home, office or community. The activities culminated in a panel discussion of experts in the field, who expressed their own view based on the workshop input, offering their own speculative reflections. The challenge for designers within such a process is to propose the initiative as a positive lifestyle choice, to be embraced willingly by consumers and citizens in order to bring about a shift in awareness and habits.

1. Introduction

> Tempting as it is to think of the transition to a clean economy as a huge leap, it is in fact a trillion tiny steps – the steps that each of us take, many times a day, all around the world, when we decide how to live and what to buy. (Harford, T., 2022)

In the light of impending environmental catastrophe, now almost universally recognized as resulting from global resource consumption, a research project was conducted at the University of Bologna to examine ways of mitigation the problem by converting human-generated energy for certain tasks.
A design-led approach was taken in order to imagine ideas for products and systems that could be promoted as positive lifestyle choices that consumers could willingly embrace. The project was entitled 'Energy Consumption and Lifestyle' and ran during March 2022, just as, coincidentally, the price of energy was more acutely felt following the previous month's invasion of Ukraine by Russian forces.
Participants in the project were drawn from the Industrial Design department. They comprised digital native students with an age range between 20 and 25 years, by and large unfamiliar with the hand-powered appliances that were once typical of daily life in Western societies pre-1960. Any lack of acquired wisdom would be offset by a fresh outlook in the ideation process.
The design concepts, created in two separate workshops, were put in discussion in a round table with three practicing professionals who have their own connection the topic, examining and provoking further reflection for an ongoing debate.

In the light of "innocent" design approach of young generation designers, a panel discussion with particular critical approach to the real-world situation has brought up a counter vision to an idealized, and by virtue of inexperience, a very simplified vision of the problem during the workshop.

1.1. The Conceptual Starting Points for the Project

Firstly, the problem of energy consumption, resource depletion and global warming has moved in fifty years from the fringes to the mainstream of politics, scientific research and media. the Intergovernmental Panel on Climate Change has stated that today's levels of global emissions must be halved by 2030 in order to limit temperature rises to 1.5°C, yet current emission rates are increasing (Shukla, P.R. & Skea, J., 2022).

The message is clear: a significant change in policies and practices is needed for humans to survive on Earth. However, the need to reduce consumption conflicts directly with the lifestyle demands of consumers who continue to buy more, use more and waste more, and who are growing in number in emerging economies.

Design has been punctuated historically by occasional wake-up calls, such as the birth of the Modernist movement in the 1920s and Victor Papanek's 1971 book Design for the Real World a half century later, both of which sought to use design to address the real social and environmental problems of their times. Both demanded the abandonment of applied style in favour of honesty, empathy and long-term problem solving. 50 years later, what might today's wake-up call be that designers should respond to?
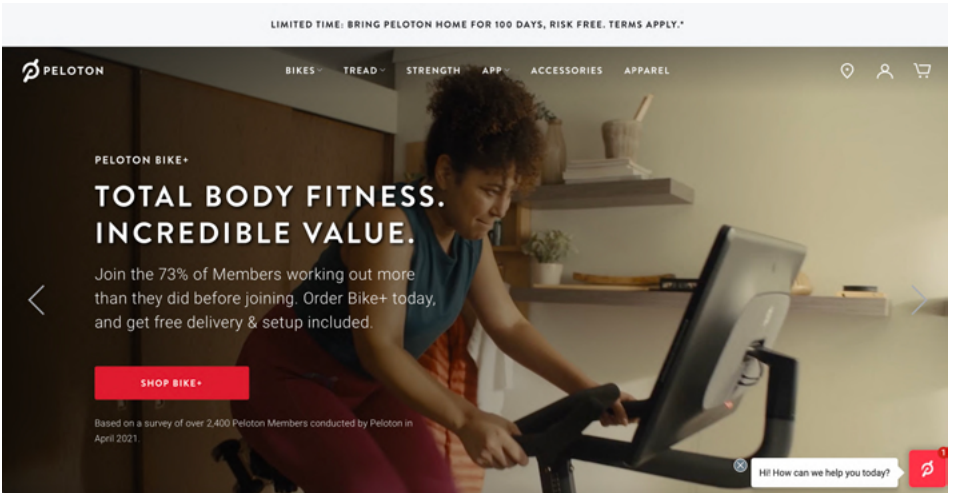
Figure 1. Peloton homepage (2022). https://www.onepeloton.com.

Figure 2. Demonstration of cyclette driving foodmixer, Berlin, 2017. Photo: Adrian Peach (2017).

The 2008 book Nudge by Richard Thaler and Cass Sunstein (Thaler & Sunstein, 2008) investigated the phenomenon of mass behavioural change for societal benefit and how it is stimulated. According to Tim Harford, the authors inspired a new behavioural science movement that found its way into government policy (Harford, 2022). The authors of this paper intended to explore how design can be employed as a stimulant for change.

Vaclav Smil (2017), cited in the article "Our World in Data" by Ritchie et al. (2020), calculates that world energy consumption from all resources increased exponentially from 5000 TWh in 1800 to 170,000 TWh in 2017 – a factor of 34, with renewable sources supplying around 20,000 TWh of today's total consumption.

In Figures 1 and 2, individuals are seen generating energy on machines that are linked, in one case to a food mixer, in the other to the world wide web. Could the desire of these individuals to use their own body energy for the purpose of personal (even selfish) fulfillment be employed to mitigate in small measure our problem of energy consumption?

1.2. Project

The project was designed to view the problem through two prisms, exploring both the physical science of energy generation and the behavioral science behind human stimulus for change, to identify new opportunities that benefit society and the environment in the long-term.

The core task was to investigate how we can turn the need to reduce energy and resource consumption into an attractive lifestyle proposition. Would it be possible, for instance,

to capitalize on consumers' increased interest in health and sporting activity by harnessing their body energy to drive appliances, thereby creating a win-win proposition? The investigation embraced the science behind energy consumption and generation methods (including mechanics and storage in fuel and electricity) as well as the social and psychological factors related to physical activity and lifestyle. Historical precedents as well as new technologies were to be taken in consideration. The new product concepts were required by the briefing to combine *usefulness* and *function* with *lifestyle* and *desire* to create an effective, attractive, commercially viable product concept.

1.3. Project Guidelines

The project briefing stipulated the generation of imaginative but realistic solutions to generate energy through the movement of the human bodies, energies that can then harness at home, at work, in the private sphere and in the community, to reduce the overall burden on the energy infrastructure. Various contraptions and techniques already exist, ready to be applied, but they remain on the fringe of the mainstream consumption model because they often do not correspond to current aesthetic and lifestyle trends nor to consumers' different expectations of cultural, social, personal fulfillment.

Sport and physical activities are considered by many to be attractive and fashionable. Fitness is a standard driver of personal and social fulfilment, as evidenced in the media and clothing built around such activities. The project required a bridging of the gap between this pleasure principle and the

duty to reduce resource consumption. The project participants, 104 individuals ranging in age between 20 and 25 years working in groups of 4, were encouraged to be idealistic, provocative, humorous, and to push accepted boundaries. The workshop activities were carried out quickly over the course of two days, leaving little room for deep research into viability or for detailed design development, so as to encourage imaginative, original thinking around the problem.

The concept ideas were to be presented internally before being passed on to three professionals practicing in architecture, design for industry, research and academia, for comment and discussion. Additionally, these professionals were asked to offer their own views and experiences related to energy generation, resource conservation in the light of pressing environmental issues.

2. Project Results

2.1. Input

The project coordinators facilitated the early fact-finding efforts of the participants in order to establish some basic historical and scientifically proven facts regarding energy consumption. In this way, the ideation process would build upon solid foundations. The bulk of the benefits and comforts enjoyed by the individual in a developed industrial society are derived from processes requiring a high level of energy consumption, far greater than humans could hope to match with their own physical strength. At small scale, for example, the energy required to boil a kettle for making a cup of tea is equivalent to that expended by a human performing a half hour fitness run.

Concept

L'idea è quella di inserire all'interno in un parco per tutti, compresi i bambini con disabilità, una giostra inclusiva alimentata dall'energia prodotta dalle giostre meccaniche (ad esempio dondolo).
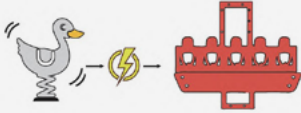
La giostra è composta da un reticolo di dondoli e corde che consentono ai bambini di arrampicarsi. Al centro, invece, è collocata una torre con dei seggiolini che si muovono verticalmente; il movimento di questi ultimi è azionato da un cilindro oleodinamico. L'energia meccanica generata dalle sollecitazioni sulla piattaforma sottostante la giostra spinge l'olio all'interno del cilindro azionando, dunque, il pistone.
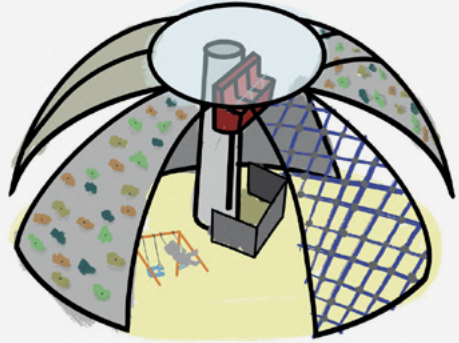
Figure 3. Concept. Authors: Marella de Santis, Maria Sabrina Losito, Davide Magi, Lavinia Marinelli.
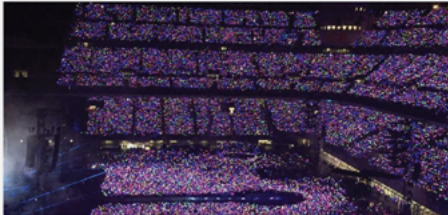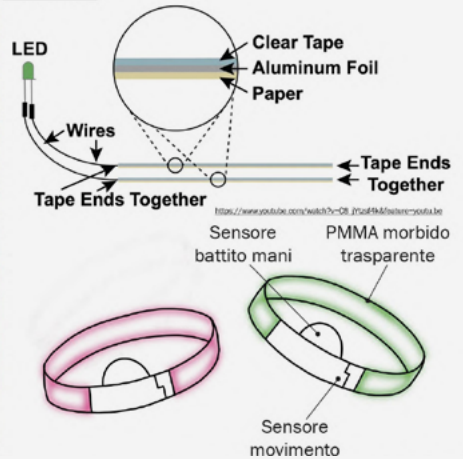
Figure 4. gloWrist. Authors: Maria Giulia Camillo, Martina Conforti, Benedetta Gaeta, Erica Potesso.

At large scale, in Europe, households consume just under 30% of all energy from various sources (renewable and non-renewable), as does transport, with industry consuming just over 25% (Eurostat, 2021). From these and other related facts, participants could build a picture of energy consumption in perspective and in proportion, and envisage the potential contribution that human power could make to overall consumption.

2.2. Project Elaboration and First Findings

The results of the two days of workshops revealed, as could be expected, different levels of critical thinking ability and design development performance between the different age groups, resulting from the respective levels of study experience.
The fast nature of the workshops meant that the results achieved would emerge mainly from the existing knowledge and understanding of the student participants, and less from new research they could perform.
The authors sorted results into four groupings, for the purpose of interpretation, and sample projects from each category include:

- Daily use for the community. Societal/environmental benefit (Fig. 3-4)
    - A railway station escalator whose downward movement (under the mass of the users) is used to power the station information boards;
    - Bracelets illuminated by kinetic arm-movement worn at stadium events for audience participation (initially judged as "new application" but proven part of existing socially useful functions);

- – Children's playground equipment used to illuminate/irrigate the park area.[1]

- Daily use for the individual. Partial societal/environmental benefit (Fig. 5-6)
  - – Desk lamp powered by foot-bellows under the desk;
  - – Jogging pants that generate light through leg movement (for safety at night).

- New Application. Surplus energy is captured but used to drive a new product (no overall saving in energy consumption)
  - – A reading seat with pedal-powered cooling fan.[2]

- Low/negligeable energy yield (Fig. 7-8)
  - – Piezo energy generated by typing at the keyboard;[3]
  - – Energy converted from a fiddling action in the fingers;
  - – Fan installed in ski-tips to produce electrical energy.

The results must be seen holistically in the context of educating contemporary designers to understand the world of energy and consumption. It was noted that some hand-operated household appliances hypothesized at the ideation stage were inadvertently reinvented to imitate pre-1960 products. Another misconception emerged that the only means for storing energy was via electrical battery.

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1   A number of groups identified children at play as a boundless source of energy to be exploited.

2   Only one group found its way into this category, as the consultation process successfully steered most participants away from such results.

3   A number of students identified "fiddling" type activities as potential energy sources. The concern of this author is that they could never generate sufficient quantities of energy.
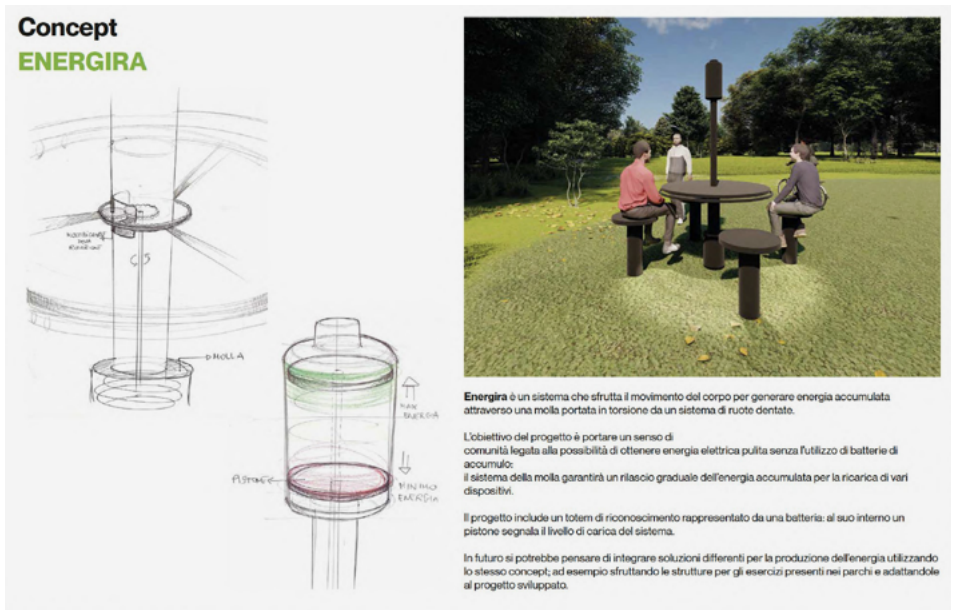
Figure 5. Energira. Authors: Luca De Scisciolo, Giacomo Pala, Elena Rossi.
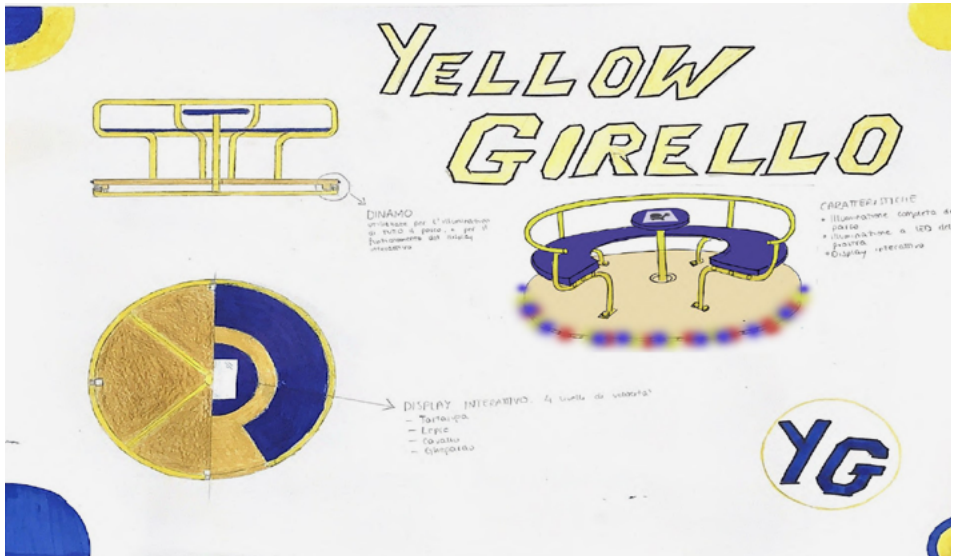
Figure 6. Yellow Girello. Authors: Emanuele Brighi, Sara Camporesi, Marco Giangrandi, Cristiano Merlin.

WaterSwing concept

Il sistema di WaterSwing si pone l'obbiettivo di irrigare la vegetazione in aree di verde urbano escludendo totalmente l'utilizzo di elettricità. Sfruttando l'energia dei bambini e un oggetto ludico presente nella maggior parte dei giardini pubblici, l'altalena è in grado di contribuire autonomamente all'irrigazione delle piante all'interno del parco in cui è posta.
In particolare un sistema composto da un "albero" collegato tramite catene alle sedute, viene fatto ruotare durante la fase di movimento discendente dell'altalena.
Da qui un ingranaggio, simile al mozzo di una bicicletta che permette la rotazione in un solo senso, trasmette il movimento all'interno del terreno ove l'altalena è collegata alla pompa.
Infine, da quest'ultima un normale sistema di tubazioni trasporta l'acqua alle singole piante.

■ Pompa idrica ⋮ Punti di irrigazione
■ Fonte d'acqua ▮ Tubature

Figure 7. WaterSwing. Authors: Alberto Bonazzi, Anna Fedele, Tommaso Gabrielli, Giacomo Ghelfi.

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I pantaloni da running a led sono pensati per tutte le persone che si allenano la sera in zone buie o poco illuminate, garantendo in questo modo la visibilità di chi li indossa e una maggiore sicurezza.

I pantaloni sono realizzati con un tessuto ipertecnologico composto da nanotubi di carbonio, chiamato Power Felt, il quale sfruttando le differenze di temperatura tra l'ambiente esterno e il corpo, riesce a creare una carica elettrica che viene utilizzata per alimentare una rete di led posta al di sopra dei pantaloni in tessuto.

Il calore necessario per alimentare i led è compreso tra 1 e 11 Watt all'ora, mentre il calore emesso da un un adulto a riposo è di circa 100 Watt, quello emesso da una persona che cammina è il doppio o il triplo invece svolgendo esercizi più faticosi da sei a dieci volte in più.

Figure 8. Firefly. Authors: Emanuele Agresti, Alexandra Bucciarelli, Alice Gagliardo, Ludovica Gentili.

The participants' generation has grown up in the digital age, in a highly automated world. It has developed a different understanding of the basic physical principles of energy transfer, mechanics, action and result because their experience of the physical world is dominated by a minimal physical action instigating a battery-driven result (i.e. touch screen command by pressing or swiping).

3. Discussion

3.1. Round Table Discussion and Projects' Evaluation

The project results were shared with three practicing professionals, and a roundtable event entitled "Powered by the People" was held at the university, and workshop participants were present. The practicing professionals brought in to analyze and comment on the project were carefully selected to explore the opportunities this project could have opened up beyond just the workshops in a critical vision.

The analysis yielded some unexpected new insights, which departed radically from the initial concept of the workshops, whose aim was to achieve an overall reduction in energy consumption. The audience received a stark reminder from the panel that the promotion of energy-saving initiatives[4] places itself in direct opposition to an ever-present trend throughout history. Human evolution has been characterized by the harnessing of technological resources outside the body to generate energy and to improve the efficiency of energy conversion. Design-led solutions to avoid the impending environ-

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4   See possible references for an optimistic approach in: Lamb et al., 2020; Abrahamse & Steg, 2011.

mental catastrophe must adopt a speculative and, above all, realistic approach to this problem.

The first, Lucy Salamanca[5] drew upon her experiences as a designer working from the early 2000s in the "Fair Trade" movement, which has shifted its focus from fairness towards human stakeholders in the global supply chain (workers, women, children) towards a broadly holistic approach which looks to protect natural habitats as well, which in turn benefits the inhabitants.

> Design has moved away from its original definition "Industrial Design" (of attractive products to induce consumption) to a hybrid profession uniting diverse poles.

Referring to the project ideation, she affirmed a shift in Western consumer's consciousness towards an understanding that individual benefit is intrinsically linked to social and environmental benefits, citing the diffusion of bio-products into the mainstream marketplace.

However, she warns that the ideas in Western consumers' minds about what constitutes ecologically and ethically sound consumption can often be misguided, as exemplified by the demand for soya, which led producers in Brazil to fell large swathes of forest, radically altering the agriculture in favor of a mono-culture cash crop.

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5   Lucy Salamanca is a designer from Colombia, based in Milan since the 1980s. Art Director and designer for several Italian companies, she has participated in the development of projects in different craft companies in Latin America, Asia and Africa. Her project research ranges in many fields: design, art and traditional craft techniques, identifying the harmony between the roots of the past and the look to the future.

Salamanca believes that to find the answers to the future energy challenge, we need to draw on the lessons above and avail ourselves of interdisciplinary studies and professions that can address the complexities of systemic change.

In the second interlocution, Simone Giostra[6] began by stating his intention to challenge the project's premise. In his view, we should not aim to consume less energy.
Historical energy consumption statistics reveal a flat line up until 20 thousand years ago with the arrival of agriculture, followed by a steady increase in reserves of energy obtained from sources outside the human body until the industrial revolution, which led to a near-vertical graph of increased energy production and usage. This ability to harness surplus energy afforded us, according to Giostra, the opportunity to think and deliberate and ultimately develop our civilization. Despite the resolutions of the 2005 Kyoto Protocol, the consumption line has remained vertical, and "we don't want to change this for an important reason: that we consume so much more energy than other species has determined our success on the planet […] the more energy we capture and burn, the more we consolidate our presence."
He cited the Jevons Paradox from William Stanley Jevons' 1865 book The Coal Question, which addressed an apparent shortage of coal at a crucial point in the Industrial Revolution.

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6   Simone Giostra is an architect and associate professor with Tenure at the Politecnico School of Architecture in Milan, where he leads the Energy/Form Lab. At the intersection of design, technology, and the environment, his research work explores the relationship between the use of energy and the notion of form in architecture at 3 distinctive scales: construction component, building and landscape.

There has never been an increase in efficiency that has brought a reduction in energy consumption – we just do more. Every time a machine consumes less, we buy two machines. And every time we have an energy crisis, we find new ways to procure energy and then consume even more of it.

Giostra notes that so-called green technologies bring ecological and socio-economic problems into the equation. Having embraced solar technology 25 years ago, he realized it could not be produced "cleanly". Procurement of the necessary resources has led to "two wars recently".

So, in addressing the student projects, Giostra concludes that two important themes are emerging: Firstly, capturing dissipated energy for further use. "This is what nature does – it leaves energy to be used in the next cycle until it eventually leaves the planet as radiation". Secondly, energy is an ornament. Again, in the natural world, animals and plants use energy first for metabolism (survival), then as an ornament. In our evolution, "who had more ornament? The chieftain". The Renaissance turned surplus high energy into high culture, thus elevating us from essential metabolic function.

Giostra was drawn to those projects that combined real energy efficiency with a strong message to their user, noting that the small excesses of energy that would otherwise go to waste can be used to send information, as in the participant proposal for an office chair that signals periodically to its user to take a break, thus inciting the user to use their energy for wellbeing. Examples are the proposal that suggested harnessing the energy from body heat that would otherwise be dissipated and lost and the bracelets worn by concert-goers

that enable audience participation (the latter belonging to the surplus-signal-ornament-culture camp).

This last point conveniently leads to the third participant, Mario Fedriga[7], head of design of a leading Italian sports equipment brand, whose products conform in many ways to the principles identified by Giostra. As a practitioner in the production of fitness equipment for individual as well as community use, Fedriga was able to offer valuable insights into the project's themes, as seen from the cutting face of the production industry and the market.

> We get people to move while standing still, to lift weights without constructing, and we have passed from the concept of fitness to well-being, from individual to social benefit.

If before, as individuals, we "ran around the filling station to burn off our energy, then filled up, and continued to repeat the cycle", now our focus is on a holistic, balanced vision of well-being comprising exercise, diet and positive mental attitude. If we can get this balance right, we reduce "social damage", such as the burden on health care systems. In this sense, the ethos of the company, along with the perception of fitness in the public imagination, has moved from the individualist, the "hedonistic", towards an understanding that the individual lives in a social and environmental context.

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7   Mario Fedriga is visiting lecturer and industrial design manager at Technogym. He co-ordinates "look and feel" of products, formats, customer touch points, ensuring the appropriate level of design innovation through the identification and analysis of consumer trends and market needs.

Our consumers are ambitious, concerned about their appearance in the mirror, and therefore about the impression they make in their social context. From this understanding we derived our advertising slogan "Let's Move for a Better World".

Fedriga illustrated a fitness product launched already in 2010 under the slogan RRR:

- Reduce – energy consumption by 30%;
- Recycle – an integrated dynamo returns energy to the machine;
- Renew – harvest energy to reintegrate into the electrical grid.

The equipment informs the user of their achievements and sets challenges "in an entertaining way" using gamification principles. This information is mapped and shared, thereby creating a community of users and a "virtuous cycle." In this case, the action of humans using the machines is motivated by an information signal, the low-energy impulse setting a higher-energy action in motion, as defined by Claude E. Shannon in 1948.

3.3. Discussion Findings

In forecasting future solutions to the current energy problem, all participants recognized the inevitability of certain behavioral tendencies, driven by evolutionary development, that have manifested themselves in history, even those that fly in the face of common sense or environmental expedient. These can be defined as follows:

- Humanity will continue to explore procuring more (surplus) energy from new resources using new technologies, so that the reaction (feedback) from a machine or service will always use more energy than the human impulse provided. Where historically the source of extra energy was visible to the user (for instance, an open fire or a steam boiler), today the energy is increasingly imperceptible (the whirring server storing data on another continent or the near-silent electric vehicle). Any contribution from humans using their bodies will be symbolic only.

- The drive for efficiency will lead to more consumption not less. History has shown that societies, producers of goods and services, and consumers will always demand more. We will continue in the direction of complexity not simplicity in our energy infrastructures. There will be no turning back. Information will be integral to new technologies, processes and products. The message will be the driver of development, just as it always has been.

While some of the project work by participants followed the course prescribed in the proposal and briefing, some unexpected results led the project into new territory, broadening the scope even further for the round table discussion. This freedom of scope allowed participants to recognize some basic unavoidable truths about human evolution, the human condition, and our future relationship with energy and the planet.
The direction of discussion is supported in scientific literature and in the media. Tim Harford, writing on governmental energy policy in 2013, states:

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> The broadest version of the Jevons paradox is that energy efficiency, in a very general sense, makes economic growth possible, and this in turn creates new demands for energy that swamp the initial energy saving. (Harford, 2013)

Simon Kuper also reinforces the observations made about consumers' demand for energy:

> […] as William Jevons pointed out in 1865, when fuels become cheaper and more efficient, we use more of them. Note the global rise in car sales, increased ship speeds and the growing numbers flying each year. About four out of five people on earth have never taken a flight. Many of them cannot wait. (Kuper, 2019)

> No electorate will vote to decimate its own lifestyle. (Kuper, 2019)

4. Conclusion

4.1. Observations on the Findings
In the light of invaluable contributions to this project from participants and practitioners in architecture and design, a clear directive emerges. What sounds like a mere provocation turns into truth based on evidence: humanity must steer its vision of a sustainable future away from a low-tech, "return to green" model towards a hi-tech, high consumption model that will be more efficient, cleaner and safer than those in current use. The future solutions that emerge will embrace human desire for more yield, for even where in Western economies the idea of consuming less and wasting less has been embraced in certain quarters of society, developing economies are

busy increasing their wealth, the wellbeing of their citizens and consequently their resource consumption (Kuper, 2019). We will continue to behave as social animals, motivated by a deep desire to procure and communicate. If we can find a solution that halts global warming in time, we will survive as a species. If we fail, the planet may well find a way to regulate itself to survive, as the well-known proponent of the Gaia theory, James Lovelock (2019) points out, but there may not be a place reserved for us on it.

Since at no point in history has there been a reduction in energy consumption, instead only an insatiable demand for the benefits and comforts afforded by energy conversion, then viewing our current (and still increasing) consumption as "over consumption", to be somehow capped or reduced is surely a dead-end avenue of research. The aversion to catastrophe will lie in a new technology-based yield that meets humanity's insatiable need while proving to be more efficient and environmentally cleaner.

4.2. Relevance of the Project

Despite the minimal contribution that human power can make to our future energy generation needs, the symbolic relevance of this endeavor remains strong for the flowing reasons:

- The introduction of more physical exercise into daily life can increase overall physical fitness in the population, leading to more effective performance at work and in family life, less strain on health infrastructure, and a greater sense of well-being.

- The introduction of a decentralized system of energy generation at the domestic or small community level can effectively relieve a small proportion of the burden from natural resource consumption at this scale. More importantly, it can increase the individual's sense of agency and autonomy in society, as well as that of the small community within the greater collective. Human-powered energy generation, therefore, becomes a tool of empowerment.

- Ultimately, by fostering a holistic understanding of our place as humans in the environment, human-powered energy generation fosters a greater respect for the precious planet we depend on for survival.

Finally, this project, in effect a thought experiment, has shown the importance of certain baseline arguments and the fact that they must be addressed in the education of a new generation of designers who will, in the future, shape our society and environment in their professional practice.

Acknowledgment
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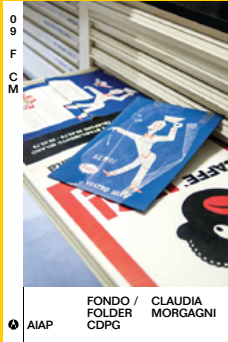francesco.zurlo@polimi.it

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