Ageing and Innovation

Matthias Göbel

Department of Human Kinetics and Ergonomics
Rhodes University, Grahamstown South Africa
m.goebel@ru.ac.za

1 The Classic Innovation Paradigm

Innovation is mostly associated with young people being open to new things and enthusiastic to try out something different. Even though an innovation might not be advantageous , most young persons are prepared to spend time to find out, and they are not disappointed if it does not work out as expected. This experience is considered as learning about different options and getting inspired, thus the innovation is rather an exploration tool to spark creativity.

In contrast to this, with increasing age people are becoming more cautious about spending their time efficiently. Thus, experiencing something at the risk of failure is seen critical. Further, elderly persons consider failing to use a new product as a negative experience. This explains a rather negative attitude of elderly persons with respect to be confronted with innovations. As a consequence innovation has a mostly negative connotation for elderly persons.

2 The Demand of Innovation Paradox

Innovations offering new features and new functions that are mostly focused on young users (see previous section), such as social media. This is likely motivated by the enthusiasm that can be achieved from young people. So in terms of testing the acceptance of new products young people appear to be much more attracted, and thus attractive for developers. However, the need of serious innovations is mostly for elderly persons. This refers to advances in user interface design as well as to new supportive functions. Innovations are essential for the elderly in order to benefit for their daily life. This is particularly true for functions enabling to participate to professional and social activities, which would not be possible or very much restricted without having that support. So, innovations for elderly persons go far beyond the 'nice feature' aspect often prioritized by younger users. So young people are much more open for innovations, but elderly people are in need of innovation.

3 The Economic Paradox

Similarly the budgets for affording innovations are mostly available for elderly. Young persons often have a very limited budget, particularly for fancy items. So

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spending for one item is often corresponding to cuttings for other items. Further, prestigious aspects do count quite a lot for young users. This is true for elderly users as well, but here aspects of practicability do play an important role as well. As innovations are most expensive in the initial stages (due to the need for writing-off the investments for development), the practical value becomes an important justification.

In contrast to young people, many elderly persons do have spare budgets, and the essential value of innovative items and functions for elderly does justify corresponding investments. So from an economic perspective, elderly have much more potential to fund innovations than younger persons. However, the willingness to spend depends on the expected benefit.

4 Innovations for Elderly

For a long time, innovations for the elderly in the field of HCI have been focused on the user interface. On the physical side this is mostly related to the size of interaction elements (display and buttons), contrasting the general trend towards small and mobile equipment. On the software level easy usability was (and still is) considered a key feature to allow computer-illiterate users access to modern technologies. This is mostly to compensate physiological, cognitive and habituation deficits of elderly users. Basically those challenges are met to a large extent. However, the increasing complexity and mobility of modern devices put new challenges.

Some challenges for usability are still to be resolved by future technologies, such as displays with integrated lenses that make reading glasses redundant.

Another area of innovation is the provision of supportive functions for the elderly, helping to overcome barriers occurring due to the ageing process. Typical examples are remote and supervision controls that help to cope with physical immobility and a decreased cognitive reliability (Helander & Ming 2005).

Those technologies mostly result from the attempt to overcome typical bottlenecks of ageing. As a matter of fact, such an approach will create distinct features for elderly, contrasting the needs of younger users. This often results in stigmatizing product features, that are considered being not attractive, as specially made for elderly. Despite objective needs, elderly persons are keen to have products that are fancy and attractive for young users as well. So, innovations must at the same time consider usability benefits for elderly and and attractive appearance for younger users.

Today, most acute bottlenecks of elderly in standard products are met. This raises the question how to create further innovations for elderly that go beyond acute handling problems or age-specific deficits.

5 Elderly in the Innovation Process

Most innovation processes do stem from empathy, as deductive approaches are normally successful only for pure technological progress. Empathy might origin from developers and from users, ideally from both. However, innovation for the elderly faces two challenges with respect to the origin of empathy:

1. Professionals involved into the innovation process are mostly rather young, thus developing empathy for elderly is lacking the life experience. Hence it becomes difficult, if possible, to step into the toes of an elderly person for anything beyond the obvious restrictions of ageing. This is a particular challenge for the mental and emotional stages of ageing, an experience that is mostly excluded for empathy of younger persons (Darses & Wolff, 2006).
2. Elderly who could provide the requested empathy from a life experience point of view often lack the technological experience and awareness of current and upcoming technologies. So they face difficulties to look beyond their current life. This is particularly the case for real innovations, in other words: future applications and technologies that are not a continuation of current state-of-the-art.

The both aspects mentioned before are the essential for innovation. Even using random or brut force creativity methods requires appropriate filtering of upcoming ideas, and at this point the both above-mentioned factors become relevant.

A rather simple and common approach of meeting the need to bridge the gap between the both points of view addressed above is building a work team consisting of members of both groups. This rises however another conflict (apart from the practical challenge of time requirements to enable constructive communication), as one creative party normally faces a critical party that needs to be convinced. This constellation rather induces compromising than a real innovative working atmosphere.

In addition to the need of both groups to participate to this process, a systematic creative process would be required. Considering the specific needs of elderly a step by step approach was developed by Göbel (2012) that is based on identifying potentials for support by innovative technologies.

A three-dimensional matrix is created that specifies lacking or scarce resources (requested functions and services of a product which disable or at least impede the fulfillment of a task) against available resources. This is performed separately for the different tasks to be considered for the designed product. Those resource categories entail personal resources, the social environment and the technical environment, thus aiming for a holistic approach even if not all types of resources need to be considered in any case.

For the different fields built in this matrix a creative process is then performed with design professionals striving for ideas or concepts that link available resources to lacking resources. Not all matrix fields have to be filled, one field per column is sufficient. By far not all ideas will be innovative by nature. A second filtering process is then required in order to forward those ideas that are considered productive in terms of creating new products and services economically successful.

The basic concept behind this approach is to translate the user's perspective to an engineering design scheme. However, this is still a creativity tool.

This concept was basically intended to generate product ideas helping elderly persons to sustain an independent lifestyle while making use of available capacities as much as possible.

Empirical testing against the application of brainstorming as a universal creativity methods showed that the created innovations are more specific and more rational than the ideas created by brainstorming.

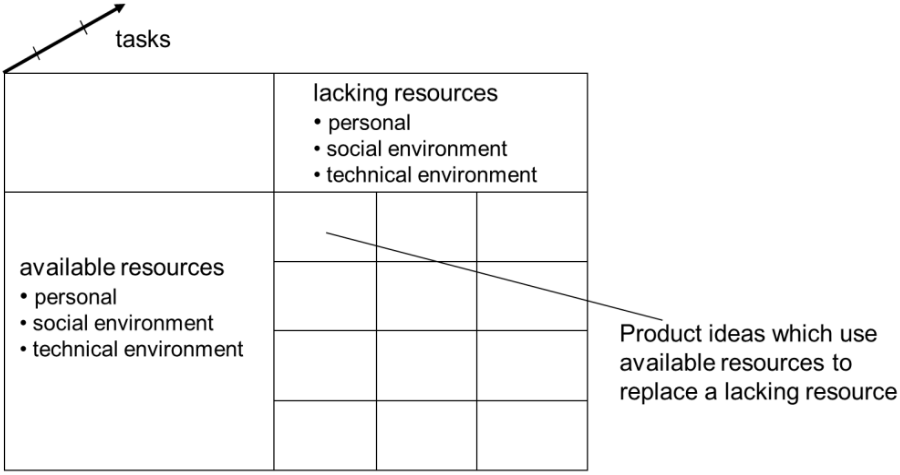

Fig. 1. The basic matrix of the Resource Transformation Approach (from Göbel 2011)

6 Modeling of Complex Human-Environment Systems

The aforementioned approaches relate very much to creativity, powered by empathy. A more engineering type of approach to create innovation is the identification of bottlenecks in a functional structure. This is not necessarily qualitative in nature, as creative methods mostly are. System modeling often raises quantitative bottlenecks in terms of lack of time, lack of competency, incompatibilities etc. Thus, less revolutionary innovations might be expected from system modeling, but rather optimizations. This is equally important for product quality, even if those aspects are not striking selling points.

Figure 2 shows the basic model of a human environment system as suggested by Emery (1959), Luczak (1997) and Carayon (2006).

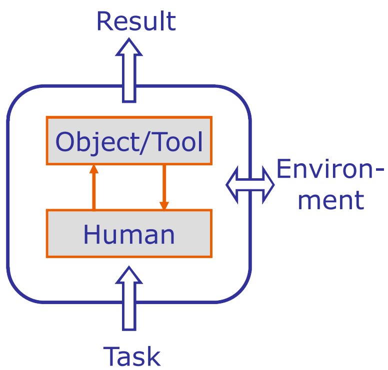

Fig. 2. Basic structure of a human-environment system

The identification of innovation potentials from a system model will however require a system model that allows outlining deficits in a functional structure. Hence, such a model is required to represent all relevant detail aspects. This is a trivial requirement, and such a strategy is commonly applied for technological systems. However, human-environment systems are complex in nature. Apart from the sheer number of elements required for detailed modeling, the following aspects of human-environment systems are not easily addressed by standard Systems Engineering (such as described by Pahl et al. 2007):

- Non-monotonous characteristics of humans: Technical systems normally have monotonous or even proportional characteristics, such as the relation between forces and masses of a machine. This is however not the case for the human factor, who is often described via a U-like or an inverted U characteristic. Often this is caused by complex substructures, balancing between different optimization aspects.
- Memory effect: Any conscious human response is linked to an individual learning process in a way that a response is necessarily based on previous learning. Complementary, any voluntary reaction affects the individual's experience on an endogenous and an exogenous level. Those constituents of personality validate the complexity attribute of any system that involves actively performing humans.
- Real and virtual representation: Human system elements have a physical (or biological) representation on the cell, bone, muscles etc. level. Many human system elements have a virtual representation at the same time, storing and conducting information. This is true for all brain and central nervous functions. The both types of representation interact as any virtual representation is based on a physical representation. This is for example relevant for human fatigue.

As a consequence a system structure is not directly accessible (despite a valid system structure might be developed). Meister (2000) identifies the invisibility of the relationship between the human and the environment being a central obstacle for ergonomic design. Physiologists can extract cells and study their contribution to the function of the human body, engineers may compute the relationships between the different components of a machine, but ergonomists will never be able to see or feel the human-environment relationship. They can only measure its effects and try to deduce the nature of the relationship from its effects.

Göbel and Zschernack (2012) suggested some formal extensions to the Systems Engineering approach in order to accommodate the required aspects of a functional human- environment system. Those encompass:

1. A basic description of a human-environment system on the base of five dimensions:
   - (a) *Elements* (objects, resources),
   - (b) *Interactions* (activities, operations, processes),
   - (c) *State* (effect, objective, outcome),
   - (d) *Sequence* (order, time), and
   - (e) *Localisation* (position, direction).

2. An open and hierarchical system structure, ranging from a basic cellular level up to social system. This requires a formal compatibility and consistency of all levels.
3. State variation of system elements: System element do not only store energy or information (like in imaginary system elements), but also change their state on a higher level (e.g. due to fatigue). This again feds back on the system characteristics.
4. Three different behavior characteristics of system elements. System elements may act
   (a) Schematically (with a uniform type of reaction), or
   (b) Algorithmically (with a flexible but reliable reaction), or
   (c) As a problem solver (creating new types of responses).
5. Flexible order and sequences of actions: Depending on action strategy the performed order of actions may be:
   (a) Necessary to perform a task correctly, or
   (b) Pragmatically chosen (e.g. to obtain maximum efficiency), or
   (c) Random (is the order in fact is irrelevant).
6. Synthesis of different objectives: For the development of action strategies not only task-related objectives require consideration, but resource-related and individual objectives as well. All three types of objectives have to be balanced.

The afore-mentioned components of an extended systems model do not make use of fundamentally new theories or concepts, but, in this form, allow integration of the most important factors of work systems modeling and work systems design in a formally consistent frame.

One might argue that such theoretical considerations have little practical value because they are too abstract to apply and do not provide quantitative output as pure engineering models would do. However, although there are numerous limitations to consider, such a type of modeling might be helpful to integrate and to structure different relevant human factors approaches.

7 Conclusions

Creating innovations for the elderly is somewhat different to other technological innovations, as the user group is rather skeptical, but in need for innovations and having a strong purchase power. Creating innovations for the elderly faces challenges for not stigmatizing. Thus, such innovations most be attractive for young users as well.

The innovation process needs to links the creative power of young people with the empathy of elderly. In order make such a complementary team successful a systematic creative process is suggested.

An alternative way is creating innovation is suggested by modeling the human-environment system and concluding deficits from this perspective. Despite the engineering effort such a consideration may outline handling deficits and potentials in the abstract phases of a product development process and, hence, save a lot of investments for product development and prototype engineering.

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