Homes for Strong Families, Children, Seniors and All Others. How Universal Design, Design for All and Forty Principles of TRIZ Enforce Each Other.

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Accessibility is a "must" in architecture and building industry. In TRIZ jargon accessibility is one feature of the Ideal Final Result. The concepts, tools and principles of TRIZ can be used to increase accessibility. This paper tells how "accessibility recommendations", like Universal Design and Design for All, get stronger when they are used together with one important TRIZ tool, 40 innovative principles.

Necessity to Use Together 40 Innovative Principles, Universal Design and Design for All

In Summer 2004 I visited an annual Housing Exhibition in Finland. I saw both good solutions and designs far from the best. Often there were no financial reason not to select the best solution.

A house had no footsteps but a nice ramp. One could go in also with a wheelchair or with a walker without difficulty.

Another house in neighborhood had two or three footsteps.

There were houses with no thresholds. There were other houses with a threshold in the middle of the room.

Let's imagine now that architects and other designers always check the possibility to "eliminate the need to raise or lower objects" or "use curved or rounded forms". A check list containing good principles would be not bad.

Fortunately, a list exists. "Eliminating the need to raise objects" is "the equipotentiality principle", or principle number 12 in the list of 40 principles in TRIZ [1]. Principle number 14 advises to use curved forms.

True, there are design recommendations specially aimed to remove barriers and make the environment accessible for all:

"The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design."

This is how the Center for Universal Design, North Carolina State University, defines the concept of "Universal Design" or UD [3]. Another, practically synonymous, concept is "Design for All" or DfA.

Why, then, good instructions so often are ignored? Perhaps they are simply forgotten. There are so many designs, Design for Assembly, for Manufacture, for Recycling, for Environment, for many other purposes.

From other side, forty principles is a universal list of good design principles. They are easy to remember.

The conclusion appears itself. If UD or DfA, and 40 Principles, and other TRIZ tools, are used together, both win. Engineers and architects and others who are already familiar with accessibility solutions get more power from TRIZ.

For TRIZ users experience on making buildings and houses accessible gives plenty of new examples that enrich the theory.

Examples of the Use of the 40 Innovative Principles in Universal Design or Design for All

The following list contains all 40 principles with one or more example how each principle can be used to increase accessibility.

Nearly all examples are available solutions used and proved somewhere. The collection of examples doesn't claim be original. Contrary, the idea is to transfer ready inventions across industries.

This list doesn't claim to be comprehensive. It is rather a template. You can add your own examples, which will expand to list for others, and will add to your learning

1. Segmentation

- Modularity and prepared components, as in automotive industry, help to improve quality and decrease costs. Today a one-hundred years old idea gets real. Segmentation allows mass customization in building industry, too.

2. Separation

- A hidden lighting device. We need light, not a device.
- Distance home services, say, food services, addition to, or instead of the kitchen.
- We need comfort, safety, universality, accessibility and other features, not the house as such. We should provide features, not only walls. According to the RESNA Technical Assistance Project [3] houses should be "accessible", "adaptable" and "visitable"- these are examples of needed features.

3. Local quality

- Kickplates help to open the door.

- A house should have different features in different situations. For example, adjustable shelves give different quality, height, for children, grown-ups and disabled.

4. Symmetry change

- "Lever handles are easier to use than round doorknobs for people with limited strength." [2]
- Unsymmetrical lighting makes a room seem bigger.
- Both symmetry and asymmetry are needed. Two asymmetrical water closets can mirror each other.

5. Merging

- A straightforward example is tandem latches.
- If you have one accessible house or a building, add second one, third, and so on. A new quality appears. "The block is a significant level when building socially sustainable environment. A varied neighbourhood can reduce travel needs and provide safety for the residents. Functions placed in one single quarter can serve local residents, customers and associations. Furthermore, it is easier to provide services an a block of houses than in a single building." [4]

6. Multifunctionality

- Universal Design or Design for All gives many examples of the multifunctionality principle. An elevator can be used to enable to move the wheelchair, and also carry luggage and a vacuum cleaner. An initial, single function of accessible technology is often to help just people with impairments. Then appears a pleasant surprise. Accessible environment is good for all others, too. In a family with four children a bright an comfortable room was made for a disabled child. Other three children, too, wanted to play in this room!

7. Nested doll

- Pocket door slides into a hollow cavity in the wall; it is easy to use for everybody.

8. Weight compensation

- Accessibility "lifts" the value of the real estate. See also nested doll (7) and the pair of "strong oxidants" and "inert atmosphere" principles (38 and 39).

9. Preliminary counteraction

- Many experts give a following recommendation:"... design an elevator shaft into your home and use the space as closets until the elevator is needed..." [2]

10. Preliminary action

- Movable walls increase the value of the house in future.

11. Beforehand compensation

- Safe stoves and kitchen ranges that get automatically off even if the user forgets to switch them off.

12. Equipotentiality

- Use one-story design if possible. Use ramps. Remove thresholds when possible.
- Elevated electrical outlets, around 50 cm or 20 inches off the floor, are more easy reach than typical ones. [2]

13. The other way around

- Look at opposite solutions. We speak of Universal Design, but sometimes specialized design is needed. UD gives room and resources for specialized design when it is really needed. Removing doorsteps and thresholds is good for all, wheelchairs for a few. See also pairs of equipotentiality (12) and dimensionality change (17), Symmetry (4) and asymmetry, curvature increase (14) and curvature decrease (rectangular parts are easy to manufacture).

14. Curvature increase

- All "transitions in doorways should be smooth" [2].
- Smooth ramps illustrate also the curvature increase principle.

15. Dynamic parts

- Folding doors
- Movable walls and shelves

16. Partial or excessive actions

- An old engineering principle says to allow for future changes. There should be options for changes and additions-examples include unfinished "bonus rooms" in houses, or utility stubs so that water and power can be provided easily if an additional room is added to a building.

17. Dimensionality change

- 3-D design technology is already used. Add fourth dimension: time. Consider the whole life cycle of the building.

18. Mechanical vibration

- Literally: electro-mechanical film (EMFi) can detect the movements of a person and give alarm if needed.
- Metaphorically: Life cycles of humans and buildings should "resonate".

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Periodic action (19), continuity of useful action (20) and hurrying (21) principles work often best when used together. Improve accessibility continually and periodically, and, when possible, make

big changes in very short time. Further, the principles can have physical meaning, for example, lighting can be changed continuously.

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19. Periodic action

- Incremental improvements are practical and often only possible.

20. Continuity of useful action

- From on-off switching to continuos change of the light.

21. Hurrying

- In a fresh paper on inventive principles in marketing Gennady Retseptor gives a following example: "Getting through money losing processes (e.g. discounts, sell-offs) quickly" [7]. Some home improvements can be expensive, but making them quickly, one can get money back quickly, too. An elevator, installed into the old house, may immediately, and drastically, increase the price of the house.

22. Blessing in disguise

- For example, we get older and the nature doesn't ask, whether we like it or not. Why not to make "lemon from lemonade" and design houses good for all, from children to seniors?

23. Feedback

- Feedback from different users, not only from strong and young people, should be increased. Deaf, blind and disabled people can give much help. See more in the earlier article on deaf people as lead users in the TRIZ Journal [6].

24. Intermediary

- Exhibitions and media are good intermediary carriers of the ideas and principles of universal design.

25. Self-service

- Automated doors, lighting, air conditioning.
- Home robots.

26. Copying

- Virtual prototypes help to design environments for all.

27. Cheap disposable

- Use disposable floors and walls, if components cannot be reused or recycled

28. Mechanical interaction substitution

- Use remote control to open and close doors, and also to control kitchen appliances.

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Pneumatics and hydraulics (29), flexible shells and thin films (30), and porous materials (31) constitute a group of principles. Curious enough, there are not very many examples so far. Here principles forecast future. There are much talk in the education of architects and civil engineers.

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29. Pneumatics and hydraulics

- Elastic threshold
- Pneumatic structures and parts of structures-temporary inflated walls that can be removed to increase access, or replaced to increase privacy. Hydraulic systems for elevators/lifts to assist people with mobility problems using conventional structures.

30. Flexible shells and thin films

- Self-cleaning surfaces. Self-cleaning windows will make it easier for everyone to do maintenance, but will particularly help those who can't reach the windows.

31. Porous materials

- Rough floor surfaces and coatings that are non-slippery even when wet.

32. Optical property changes

- Increase light.
- Use contrast colors to mark steps and other important places.
- Back-lit switches are easy to find in the dark. [2]

Homogeneity (33)

- Use light near to daylight.

34. Discarding and recovering

- Energy recovery cuts the cost of air-conditioning. HVAC systems (Heating, Ventilation, and Air-Conditioning) often recover discarded thermal energy. In the heat exhanger stale air pre-contidions or warms incoming air flow. Filters for air purification can be easily added. All inhabitants benefit, particularly those suffering from allergy.

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Parameter changes (35), phase transitions (36) and thermal expansion (37) refer to physics.
We can, however, understand "changes", "transitions" and "expansion" metaphorically, too.

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35. Parameter changes

- Universal design is a new paradigm, or "parameter change".

36. Phase transitions

- When repeated, universal design solutions lead to qualitative leaps.

37. Thermal expansion

- Great changes cause conflicts and tensions with old ways of design and construction. These conflicts are fruitful and enable progress-we can view this as the HEAT of the dabate causes EXPANSION of people's thinking.

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The last three principles in the list: strong oxidants (38), inert atmosphere (39) and composite materials (40) can be understood also metaphorically: emotions and facts that can be combined into strong "composite" solutions.

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38. Strong oxidants

- Metaphorically, the role of the oxidant is to excite a reaction. To excite the discussion of accessibility, add the moral angle. Accessibility is also a human right, not only business.

39. Inert atmosphere

- The role of the inert atmosphere is to prevent chemical reactions with the atmosphere. By analogy, to prevent emotional arguments, use cold economic facts. Accessibility also improves business, not only makes live better and society more fair. Young buyers want accessible homes, to improve future resale value, since they could sell anyone.

40. Composite materials

- Combining moral values (principle 38) with economical facts (39) we can add AND make homes sweet for all: children, adults, elderly people.
- Let's talk again about mass customization. We can understand mass customization as combining mass production with individual craftmanship.

Principles plus something more

The improvement of accessibility should not decrease other useful features or cause new harmful features. The floor closer to grade level makes access easier, but can cause the moisture problem. Water and ice get access to the building, too. Additional barriers protecting the foundation and constructions, removing water, may be needed.

Another example is the controls of a stove. Front controls are convenient for persons in wheelchairs but hazardous for young children. Controls far from children are hazardous for adults

since they have to be reached across heated burners. Perhaps here is a proper place for remote controls?

"Simplified TRIZ" [5, pp. 91-101] contains the evaluation table, based on the Ideal Final Result. When considering implementing a solution ask first: **Do the harmful features disappear?**

For example, we consider removing a threshold. A harmful feature, a barrier to the user of a wheelchair or walker disappears.

Second: **Are the useful features retained?** Perhaps even new benefits appear? Everything useful is retained if we move thresholds. A new benefit is that it is easier to clean doors.

Third: **Will new harmful features appear?** Usually not, but some doors may need sealing. In that case flexible, rubber-like thresholds can be used.

Fourth: **Does the system become more complex?** No, removing thresholds makes a building more simple.

Fifth. **Is the inherent, primary contradiction resolved?** The contradiction here means that for some reason, there should be a threshold, and for accessibility there should NOT be any thresholds. The reason for thresholds was that they have worked as sealing between the door and the floor. Often the door can be tight enough without the threshold. We have no threshold AND we have a "threshold" since the door seals itself. If necessary, we can use elastic, collapsible thresholds. Here, too, the contradiction is resolved. We have the threshold when necessary AND not have the threshold, or it disappears when needed.

Sixth: **Are idle, easily available resources used?** Yes, the threshold that is removed is a free, available resource.

Seventh: **Are there possible other criteria that should be fulfilled?** Usually "other criteria" are different standards, laws and regulations. Fortunately, not often there are rules that require you to use thresholds.

Always, speaking of principles, is important to remember, that they are most powerful when used together with other concepts and tools of TRIZ.

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