Collapsible structure --- Mechanism of Time and Space-saving Principle

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MArch II
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1.0 Introduction

1.1 The Nature

The world is ever changing. All the creatures living in the earth is adapting to shifting circumstance in new environment. We all adapt of ourselves to meet physical and spatial needs. Nature has its own method to adjust to environment in flux, this is also according to natural selection, where ability to adapt is necessary to continue survival.

Organisms have ability to change its form and size so called kind of dynamic adjustment to live their live. An example is a predator and an aggressor, which they are mutually acting with each other. Predator hides to make themselves not visible to the aggressor, and the aggressor does the opposite.

Human do the same. In case of the heavy rain, Human unfolds rain coat or umbrella. Since Human are capable to use tools to help them live suitably to environment.

Man is a tool-using animal... Without tools he is nothing, with tools he is all. That is what Thomas Carlyle said in 1833.

2.0 Synopsis –

2.1 The appealing mechanism of collapsible.

Man-made things are tools; they are extension of man’s natural capacities. Tools are a supported function. Function could be one or more. Collapsible may be useful or even necessary. A foldable knife can be unfolded to cut with. For convenience means, it may be necessary to fold it in case it will cut the pockets.

Size adjustment to meet functional requirement is a time saving principle in nature. It alters to suit itself to new change and alter to suit others. Smart man-made objects have capacity to adjust its volume to meet practical needs. They grow, shrink, expand, and contract to function well. Usually they work as to doubles with 2 opposite state. Let’s say folding, one folded to a passive state, and one unfolded to an active state.

Collapsible and expandable are basic form of size adjustment principle. Collapsible structure expands by several hundred times its original size and improves drastically in appearance. Clever type of collapsible perform one function when collapse, and quite another when expand. An example is a wicker chair fold up for seat and a vacuum cushion at the back and fold down to be a hand bag.

Size adjustment to meet functional requirement is also a space saving principle. Collapsibility must have impractical shape and size so that it could be classify as collapsible. It would be hard to think a small object like a stamp that could be regards as collapsible, since it...
Special study

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could not be anymore compact. Big object like a car engine did not have unused space so cannot be qualified. Impractical space redistribute to one way or another

However, it is not necessary to be smaller, even though it seems to be, in case it was just redistributed to become more portable and less practical space.

Practical space means the free up space for some other purpose. It aim at space saving and size reduction. It redistribute of object’s volume.

To adapt to social change, designer could think of meeting what kind of condition.

For example soft measuring tape, it occasionally need to make measurement and when not use, it fold for convenient storage. Purpose of redistributing of volume is economically sensible, i.e. economic to practical space, economic to transportation.

Conditions to be considered of collapsible:

1. Volume change
2. Occupation of practical space, internal and external volume
3. Degree of space saving
4. Measure of convenience
5. Number of type of use

Collapsible could be arraying of function, fulfilling the multiple requirement, both primary and secondary and so on. Let’s say the system of function:

A car have certain amount of tools, wind screen wipers, indicator, headlamp, roommate looking- but it is no use if it does not drive.

The Ottakringer ladder chair have two multiple function, primary a chair and secondary a ladder.

3.0 System of collapsible structure – classification & application with Icon Key

Every list of things has likeness and difference. To classify related phenomena enhance the understanding of nature. It also process structural thinking and communication help for later study.

Collapsible can be classified into assembling, bellow, concertina, creasing, fanning, folding, hinging, inflation, nesting, rolling, sliding, stress. Some are very alike, the classification of creasing and folding are obscure. Whereas some system will have applied more than one of these principles, a tent unrolls, unfold to erect. Sometimes one principle would be dominating than the other, and some become more interesting. Creasing and nesting are belonging to how an object collapse, assembling and fanning are how an object expands. Sliding is both expand and collapse.
3.1 Stress

It works as compression and expansion and result from pressure and tension. This principle normally acts as a compress state for storage and relaxes state for action.

The above is a photographer’s collapsible light reflector. When twisted, the spring coils itself into three similar rings, making it compact enough to stow away in a small bag. It works as a stress principle.

Elastic band does the opposite, its works as compression and stress system. It compresses for action and relax for passive state.

3.2 Folding

Folding generally apply to soft material, like cloth and plastic. This principle allow for directionless flexibility of soft material. Softness can be strength for collapsibility. Normally it folds to storage and unfold to expand.
The above is a portable washing machine. This shower connects by pipe to tap or water basin at the top and deliver waste water from pump at the bottom. Unlike a flexible wooden bowl which is not normal use as the mechanic, which it is fold for active state and unfold for storage.

3.3 Creasing

Instead of being randomly wrinkled, creasing is a method to fold along the preset line, to produce a neater appearance. Creasing facilitate an art of folding. Origami is creasing. This principle would have some chance to break along the crease. Pop corn case when fold along the crease makes them as handy as possible.

3.4 Bellows

It works as to contract and expand with a soft bag. It has flexible sealed connection between the two planes. The flexibility allows it to be used as a pump and make it adjustable in active use. It was sometimes reduce size for...
storage. But it is not necessary. A ball pump contract for function and expand back for storing air for pumping. A Musical bellow is shown with collapse state are both active and passive.

3.5 Assembling

Assembling is a time and space saving principle. When an object is used, one can assemble separate parts into a whole, and then later to dismantle that whole again into its part for storage. The assembling products are very wide range, from industrial to everyday use to product for kids. A lot of toys are using assemble principle.

The Evantgarde motorized wheel-chair collapses partly by folding, partly by dismantling.

3.6 Hinging

Hinge covers a wide spectrum of flexible joints from long joining lid and body of a Steinway grand piano to the multiple small joints connecting a folding ruler. Hinging generally consists of two or more metal parts while modern hinge made of single piece of plastic. The difference between creasing and hinging is quite blurred, but architectural speaking; hinging will be more popular than creasing because of structural means. The supporting structure of umbrella is hinged.

3.7 Rolling

Rolling is a completely different mechanism to folding and unfolding again and again. That rules out reels of yarn but rule in reels of fishing line or hoses. It does not
normally leave trace for changing of mechanism; it does not provide crease and hinging joint which means it very suitable for appearance, while you can roll from the other side. Rolling could save space and also for protection.

3.8 Sliding

Sliding expand and contract as their parts slide. It open and close to save space and sliding up to use and sliding down for storage. Sometimes product contains diminishing parts, and it is not necessarily tube shaped, which it could slide or twist into each other.

3.9 Nesting

Nesting is a grouping principle. Two or more nesting objects occupy a less practical space than they do individually. To classify as a nesting object, one must have the capacity that can be occupied by another object. Less space is produce and it follows:

\[ 1 + 1 = 1 \frac{1}{2} \]
3.10 Inflation

Inflation produce creative product which could be very scientifically related. Inflation trap air for floating with low density of air and air trap particles to keep warm. It structure also fulfilled entertaining purpose. Inflation is sometimes not economically favorable.

3.11 Fanning

Fanning is a very feminine principle. A true fan has a pivot that holds its leaves together and allows multiple leaves to be view at the same time. Fanning has two uses one is that it could be for display and for storage.
3.12 Concertina

Concertina have a no of equal rods connected by pivot to form a string of Xs or XXX, it could be expand and retracted by changing its angle between them. The classification between the concertina and the bellow is blurred. The musical book stand is a principle of concertina.

4.0 Everyday use to architecture application to system of collapsible

4.1 For survival:

4.11 Fire fighters:

From fire station to fire engine and finally the fireman to the ladder are all in a system of kits of parts. The fire station system purposes to redistribute the volume. It works economically use of practical space and economically to transportation for use in urban environment.

![Fire engine has adjustable ladder and hose. (Collapsible, 2002)](image1)

![The ladder doubles in its fold states as battering ram. (Collapsible, 2002)](image2)

![Fireman suit are a case of folding. Packing clothes for firefighter with creasing them is a time saving principle. Unpacking the coat take seconds, while packing the clothes may takes minutes. (Collapsible, 2002)](image3)

4.12 Army weapon and tools:

War is all about change, changes create the need for collapsible device. Soldiers learn to assemble and dismantle mechanical implement s from weapons and tents to bridge and vehicles, if necessarily in total darkness.
National flag is royalty, dignified. A flag is most beautiful in head wind goes an old saying. Flag are folded when storage. The American Stars and strips is folded down to triangle of blue and white. The Danish Dannenberg is often folded and rolled to hide and protect its white cross. (Collapsible, 2002)

The Bailey bridge is named after Sir Donald C. Bailey. It is a prefabricated bridge constructed from small number of standard component. The basic element is a lattice-work panel. With certain amount of these are fasten together end to end bolt and are locked by split pins. One panel carried by 6 snappers and all parts fits into a standard three-ton lorry. (Collapsible, 2002)

The RNAF gannet, by Fairey in the UK is a three-seat shipboard early-warning aircraft that was designed to take off and land from an aircraft carrier. Its wing is folding for compact on-board storage. Next diagram shows the aircraft carrier is folding to save space for aircraft carrier. (Collapsible, 2002)

The Bantry Bay Longboat is a reconstruction of quarter boat attached to an 18th century French man war that was stranded in Bantry Bay Ireland. It is fitted out with foresail, mainsail and spanker. Bantry Bay Long boat is more collapsible than any other sailing boat, which they all could be collapse folding insofar as the sail can let out and taken in to meet changes in the weather. It masts can be dismantled altogether to turn it from a sailing boat into rowing boat manned by thirteen men. (Collapsible, 2002)

The Wellbike foldable motorcycle was design in UK. It was small and can be folded out during transport and collapsed before and after. It is suitable for urgent and immediate need. (Collapsible, 2002)
Tent with pneumatic structure design for civilian first aid in disastrous Zone, which was first assembled by 4 people and four arches are inflated by compressors or manual pumps. (Collapsible, 2002)

For saving his life from the break down jet, soldier may sometimes need to be a parachutist. Sloppy folding is very fatal. (Collapsible, 2002)

The military use Betts’s Portable globe for looking at places. It consists of eight linked leaf shaped section. When its strings are pulled together, the tips of leave can meet to form the pole. The leaves folded along preset crease to meet in a ring around the equator and the whole forms a three-dimensional sphere-like shape. (Collapsible, 2002)

Old British compass uses collapsible idea. Hinging is making it more protective to the body. (Collapsible, 2002)

Hinging is used again. The U-DIG-IT folding hand shovel of stainless steel is aesthetic and also meets practical needs. (Collapsible, 2002)

Used by the arm forces but also the camper nowadays is the commissioned innumerable specialized knives. They have ingenious design and multiple uses. The Swiss Army knife has inspired many manufacturers of pocket tolls. (Collapsible, 2002)

Rolling is used for measuring tape, from Army & Navy Stores Catalogue of 1970. (Collapsible, 2002)

Telescopic protection used to protect ones body from bullet in War and it could be folded down to a belt. (Collapsible, 2002)
4.13 Camping in wild:

Pocket knife of the third millennium widely used as a cyber tool. It has red handle until 1965. Generally it includes blade, can opener, small screwdriver, spike, bottle opener etc.

The compass function as that it hinges for convenience.

City map folded out for inspection of the map handed out free for backpacker visiting other countries.

Using inflatable principle, it blows up as a washing up bowl.

Backpacker always wants to minimize the volume of the gear. To reduce the volume they could stow a sleeping bag in a compression sack, by stress pressure.

Tent has been invented from biblical time and new design is still developing. New form and shape by tension and compression is an inspiring idea to architectural purpose.

4.2 For living:

4.21 Interior design and product design: IKEA
The storage bag is used as a mechanism of bellows. Shoe-shelving is also bellow collapsible rack hangs from the bar in a wardrobe to keep the footwear collection in order.

Many kinds of folded along is creased to make them handy as possible for user. Utilitarian creases generic cardboard box that folded and unfolded along presorted lines. Storage box sold in IKEA is assembled with Velcro and itself fold flat for storage.

Storage of furniture is a very popular category. The function of storage of furniture would sometimes be folding of object. Nesting of table is used for exhibition and sometimes could be used for interior design, when it comes to space saving issue.

Table has an occasional need for the elevated surface space of a table, and collapsibility is also technically possible. It folds way completely. Space saving for homes in Hong Kong is always a very essential issue. Foldable furniture seems to be very useful.

Photo stand is made up of a frame and some strips and support the frame at the back. The assembling structure is useful of adjustment and space saving. The wooden strip can act as an external structure.

Retractable shaving mirror uses concertina principle allows wall-mounted adjustable mirror to be maneuvered. The concertina principle is a misnomer: the musical instrument. Concertina has a number of equal rods connected by pivots to form a string of Xs-xxxx which can be expanded and retracted by changing the angle between them.

Foldable lamp favors for different location where needs light. Their hinges and flexible joint allow only flexible direction within a fixed joint, but the joint is also rotated that produce much variety.

4.22 Product design: MUJI
Make-up bag from Muji is using folding principle to save space with storing much different kind of smaller bags filling each kind of make-ups. It also fold for displace of make up when unfold in flat.

This ruler from Muji has hinge that could be adjustable to form 2 hinge-connected rulers but could also produce different angle. Two lines with specific angle could therefore produce.

Compact hole-puncher is using several hinge purpose that could fulfill the requirement of punching two kinds of holes between to side of this product.

The clever design product the card holder of Muji is using Hinging principle to protect the cards inside and fanning for display of cards. Folding is also good for protecting the paper inside.

Scrap papers are fanning so it is easy to handle and shown item by the owner.

Say any cutter is using the principle of sliding for horizontal slide which is very applicable to user. And this knife is found in Muji

Measuring tape from Muji also has rolling principle as of all the typical measuring tape.

Assembling furniture: Both IKEA and MUJI provide assembled furniture which allow people to combine component into L- or U-shaped unit.
4.3 For leisure:

4.31 Kit of Part’s toy

Children’s construction kits and toy bricks such as Japanese Robot, Meccano and Lego are an early encounter with an assembling principle that some quite grow out of. These studies relate adult construction in large scale, such as temporary scaffolding and a number of exhibition systems.

Wooden plate is being laser cut in various shapes which joint are being carefully considered, and so could make up an authentically spinosaurus skeleton. (Collapsible, 2002)

Wooden brick could be combining with different numbers, and could be able to form a large variety of different shape. These fixed same kind of modular produce whatever that we could think the outcome could be.

House of Cards illustrates texture and printed many kind of different pattern of image which allow creativity of children to different combination from several flat piece of cards. (Collapsible, 2002)

Study of how Robot is being transform is an interesting process for kit of parts work in a large scale.

[Fig.64] Transformers® RX-8
http://www.mazdausa.com/MusaWeb/NA_Autoshow/transform_big.html
The Meccano construction kit is a sum of its parts. It seems that it was not as educational but rather a more industrial toy. It was probably a recreational construction system. The basic kits consisted of perforated metal strip and plate, and nuts and bolts are used to fasten up. (Collapsible, 2002)

Lego in Latin mean I combine. The basic Lego building block is a plastic brick with eight knobs on one face. These units combine in a vast multitude of ways—exactly how many could be calculated of mathematician. Lego brick are sold in basic set from which builders can construct any number of objects.

Klikko

lincoln logs

Knex

Capsela

Robotix           Rokenbok
Many other are assembling toys which include Capsela, Klikko, Knex, Lincoln logs, Rokenbok, Robotix, Zoob, Expandagon, Erector, Brio.

4.32 Origami the folding art

Origami is the Japanese art of folding paper into shapes. It could be going into very complex issue when consider the shape in different situation. When shaping a boat, a plane, the hardness of paper and the toughness of paper to withstand wind need to be consider respectively. These could also apply to architectural issue.

5.0 Architectural application to system of collapsible:

5.1 Markies:

A Caravan is folded out by a motorized device to triple its floor area. The side wall is descending to create two new zones. The folds out rooms are with sleeping area on the left and living area on the right. The living area is with fold out furniture, with two skins, one is transparent and one with semi transparent when privacy issue is needed to be considered. (Collapsible, 2002)
5.2 TurnOn – urban. sushi:

This innovative dwelling consists of a range of interior segments that fit together in any combination to form a cylinder of an infinite length. Each segment has different type of facilities. The assembled cylinder, capped with end panels, can be shipped in different location.

5.3 Expandable living container: Italy: The New Domestic landscape

The house is placed in exhibition of museum of modern art. This expandable living unit has a movable bellow mechanism and the side wall could be pull down and the bellow works as to cover up. This key feature liberates the occupant from a restrictive small physical situation.

5.4 Dessert Seal

Dessert seal is an inflatable tent for extreme environment. It folds, roll and stress to save space for backpacking. And apply technologies that could be use in aerospace where parachute sewing and emergency inflatable mechanism is being used.
5.5 Miele ruimtestation (Miele space station)

Miele ruimtestation is made by recycling washing machine. For this whole architectural installation, five segments are assembled together. Each segment could be transport individually while assembled to a caravan. One module could be roll through a standard door.

5.6 Mobile Porch

Mobile Porch is used in urbanity environment for facilities public mini activities. It is made of aluminum drum clad in triplex. The drum sits on two wheels, and would allow 2 people to move. The panel can be folded out for making inner space larger as a booth.

5.7 Zevos kiosk

Zevos provided a Kiosk in outdoor festive place to indoor shopping mall, with the mobile installation in within and allow for wide-ranging flexibility of use. It has high mobility with its wheel base which also provides bicycle repair station. Its wing is used for display when open up and protect when fold down. Computer at the side is acting as a cycle meter and battery charger. It shapes is unique and original provide an aesthetic propose.

5.8 The e-HIVE

These are private housing with the module plugging-in and partition is made by soft material which is flexible. It could slide and folded within the units to allow the occupant to create physical separation between mediated and unmediated spaces.
6.0 Conclusion

The objects are extends of the capacities of human bodies. Fire fighters, soldiers, and backpackers are functionally offering them light weight and space spacing principles while live could be in the case of vital. Interior and product design from IKEA and Muji provide convenience and different type of mechanism within one tool for practical and aesthetic reasons. Mechanisms of toys provide excitement.

According to everyday and architectural application to collapsible, we found that all the principle could apply to one piece of objects that facilities different type of function, include primary, secondary and so on.

Spontaneous creativity and practical planning work together in what extend that human being will of choosing his way of living. The circumstances under which man lives change, and could satisfy the desire but also fulfilled and improve standard of living. Aesthetic and elegant are form of invention which could efficiently light up the life of human. Mechanisms are all strategies.

Possibility of innovative dwelling is limitless. Different kind of new product using the above 12 categories of collapsible provide many kind of variety.

\[ 12 \times 12 \times 12^n = 12^{n+2} = \infty \]

One method: that is a matrix of mathematical application when considering a product logically. Different combination will form different type of out come where it will suitable to a specific object. Where equation is applied, aesthetic will come to decide what the form needed. And that could also be function and form work together.

Further invention of strategies would be needed so more and more combination could be produce with fascinating excitement to suit the actual needs. Combination itself could also be inventive. Life is on the move.

Tools extend man’s natural capacities. (Collapsible, 2002)

Building is a tool. When considering of architecture, as an architect, we would be developing a unique method which is applicable to different situation more seriously in different way, according to the condition for collapsible, external and internal factors and more importantly, consider the occupant. Architectural product is work in progress. Change, as appreciate in nature, and as well as being human in this surrounding world is needed for intelligent and creative humanist thought to adapt.
7.0 Bibliography:

Liesbeth Melis, Parasite Paradise, A Manifesto for Temporary Architecture and Flexible Urbanism, Nai Uitgevers Pub, Rotterdam, 2004

Mathias Schwartz-Claus, Alexander von Vegesack, Living in Motion design and architecture for flexible dwelling, Weil am Rhein: Vitra Design Museum, 2002

Jennifer Siegal (EDT), Mobile: The Art of Portable Architecture, Chronicle Books Llc, 2002


Ian Davis, (1978) Shelter after Disaster, Oxford Polytechnic Press


