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Decision Making in Design Process

By

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Abstract

In design process, decision making with a great choice is very difficult, and we need some kind of criterion. Sense of value, image, conceptualizing, goal and others are musually interwound, and they can not be unified. If a man acts logically, the normative model by von Neumann-Morgestern is useful in decision making. However, it is impossible for a man to act logically always. The convex dependence theory which seems to compensate man's illogicality can not also solve the actual problems.

Decision making in design process is the bulletin of his total personality, and it must possesses a synthesis. The most important key-word of the synthesis is circulation. We must stop the production system with waste which can not be circulated. The authors propose a circulated production system and countermeasures for the waste.

1. Decision Making and its Difficulty in Quantification

In the sense that before any act is carried out, it is first worked out in the mind. One can say that all human acts are like designs. Some types of machine structures and projects today are too complex and divergent to draw up an image in the mind and directly commence the manufacture. Therefore, before production or manufacture, the image is first conceptualized and then defined, and a clear definition of the goal is made. Then, only after the process of design such as design guidelines —blueprint— method of design, etc. have been clarified can production and manufacturing begin to commence.

However, this is not an easy process. Firstly, if one conceptualizes the image, that is formalizes it through verbal expression, although the image is clarified, through the workings of the characteristics and segmentation of language, one is given a restriction or limit. This tendency is further fostered by the addition of definition.

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Secondly, the image held by the designer is varied and is not limited to one, and conceptualizing and defining are varied. If, on top of this, there are different designers as well, that number is further increased. Of course, if the designer is different at the image stage, then it is possible that the image itself is already different. However, as this is not elucidated through verbal expression, this can not be ascertained. The ascertaining stage is the stage when conceptualizing and defining through verbal expression take place. Of course, there is no problem if diagramming, and systemizing through artificial language are included.

The more designers there are, the more varieties of conceptualizing and defining there are. However, it does not stop here. Even though there may only be one designer, there could be several kinds of conceptions and definitions through verbal expression of the image.

Thirdly, if the goal was, to a certain extent, defined, then the possibility is that function too, would, to a certain extent, be logically established. However, then there would be a difference depending on what basis the goal is to be determined. For instance, whether it was to be determined by the aspiration level $\hat{f}$[1], or whether it was to be determined by the optimization of the functional design. However, this optimization is not simple, as will be explained later. It is at this point that the previously mentioned aspiration level appears.

At each of these stages, that is, conceptualizing, defining and determining the goal, the designer must choose the ideal. However, with this act of selection, the designer, as the determinist of the intention, must then make a value judgment. If one's sense of value is different, then so is the value judgment. For instance, the standards of value that would be set would be completely different, between, for example, the designer who introduces the point of view of an entropic circulatory sense into design, and the designer who doesn't. Through value judgment, the non-inferior solution can be different.

Furthermore, conceptualizing, defining, and determining the goal of a design are mutually intertwined. When the goal is to be determined based on a certain value judgment, if this is different, then it is likely to influence the conceptualizing and defining. Therefore, as the designer's value standards are infiltrated into the act of design itself, choice is not simply a matter of choosing one item from several multiples. The decision is truly the bulletin of the total personality of the designer, and the demonstration of his intention.

The above mentioned were to be diagrammatically expressed in Figure 1. In Figure 1, although the word "image" is mentioned, since the mental image of humans exists as a verbalized image, it can be easily conceptualized and defined. At this stage, the subjective values have already infiltrated the image. It appears

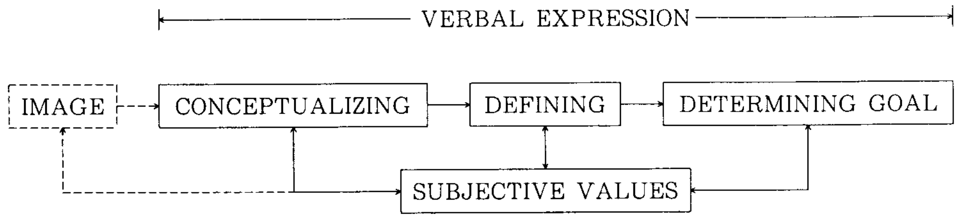

Fig. 1 Design Process

in a lucid form during the determining of the goal. However, its standards of value are influenced by political or social norms or the tacit understanding of technological limitations, etc. Hence, a certain amount of change to image, conceptualizing to defining process becomes unavoidable. In this sense, subjective values, image, conceptualizing, defining and determining of the goal form a feedback loop. Under such conditions, the designer makes one decision, that is, carries out one act of choice. In such a complex series of stages, choice is the action taken by the designer, and therefore the term "Pareto solution" is not a very suitable form of expression.

If there are many designers, then the goal of each is different, and even if this was to be shown as the goal function $f_1(\chi)$, ..., $f_r(\chi)$ naturally no solution exists to maximize them. Of the many designers, if the top designer was to act as the sole determinist of intention, (Even then it does not necessarily mean that there is only one goal function.), although the goal function $f_1(\chi)$, $\cdots$, $f_r(\chi)$ does not have a solution to maximize them all, it would probably take the form of an assembly of conditions which is Pareto optimum. To choose one suitable solution from amongst these Pareto solutions would be simple as the sense of values which integrates them is already included in the goal determination. There is no problem at all in calling this selected solution the non-inferior solution.

However, if there exists no decision maker in designers with a different sense of values, a competitive relationship would be formalized amongst these designers, leading to the appearance of a tradeoff problem, not easy to solve.

As H. Simon stated, if through solution χ in which aspiration level $\hat{f}$ satisfies

$$f(\chi) \geqq \hat{f} \tag{1}$$

it is realistic to determine the possibility that the problem would be whether the aspiration level $\hat{f}$ could be socially brought together into one.

Through TV commercials, etc., if the aspiration level $\hat{f}$ was within a definite territory, it would be possible to attain a satisfactory Pareto solution through $\hat{f}$, and although not quite optimum, a solution of some kind would be obtained.

However, at present, peoples' subjective values are said to be diversifying. This means that it would probably be very difficult to bring them together within a certain territory, let alone trying to unify the aspiration level. It is at times like this that the difficult-to-solve trade-off problem arises, and it would be virtually impossible for one group of designers to carry out a single choice.

In one group of designers, if the designer with the leadership is to advance a proposal, and when the other designers or assessors then advance several alternative proposals, then the act of decision is transformed into a competitive relationship, disputing over leadership.

Furthermore, the following kinds of conditions further complicate this problem. Even though it may be one designer's proposal, depending on the subject, it is often difficult to determine the goal function itself. Even though the goal function $f_1(\chi)$, $\cdots$, $f_r(\chi)$ was determined, there are many cases where the existing optimizing method cannot be utilized. When the same can be applied to alternatives, it is likely that one cannot logically say which is the best. Under such conditions, the only method that can be used is the method of attempting a certain type of compromising solution through the use of methods to heighten the group's power of intuition, such as the brain-storming method. However, as brain-storming is a method in which ideas are freely conceived and then proposed and debated, it is distinct from assessing. This is because the stages of conceiving are more of a free diffusion of thought rather than something theoretical, and assessment must be carried out theoretically. However, since the language is not only vague but also logical, a really strict distinction between conception and assessment is not really possible. This is because, as was illustrated in Figure 1, in the same way that a sense of values is inter-flowing between the defining of the goal and the image, assessment is tied to the sense of values and yet cannot but help being influenced by conception.

2. Subjective Values and Utility Theory

von Neumann-Morgernstern proved, under several defined axioms, that the maximum utility of expectation forms the model for human logical action, and proposed a "normative model." When man's principle for behavior is logical, this "von Neumann-Morgenstern's" normative model can be applied effectively. However, man's principle of action is not always logical with regards to large-scale projects (e.g. international airports). In many cases, several groups have a variety of preferred structures. There are also many different types of expected utility varieties within each group. In such cases the situation becomes complicated and inscrutable. No one, under their expected utilities can move, and to act logically, in itself, would probably only complicate things further.

In other words, here, the normative model can not be utilized, and one can only depend on the descriptive model. However, with the descriptive model, the science of human behavior which describes and analyses principles of human behavior becomes necessary as its premise. However, this science is yet to be developed. Therefore, the next attempt is to follow von Neumann–Morgernstern's theory of utility and to actively measure human subjective values. Next, express these as a multi–attributed utility function, and then attempt to solve it.

Let us presume that $\chi \in X$ is strengthened by n units of property X_1, X_2, $\cdots$, X_n. This property is equivalent to each of the items of assessment related to design. It can be expressed as an adaptation against

$$\chi=(\chi_1,\ \chi_2,\ \cdots,\ \chi_n)\quad \chi_1 \in X_1,\ \chi_2 \in X_2,\ \cdots,\ \chi_n \in X_n \tag{2}$$

X, the total of all the possible results, is expressed as a Cartesian set $X_1 \times X_2 \times \cdots \times X_n$.

In order to directly attain an n property utility function $u(\chi_1,\ \chi_2,\ \cdots,\ \chi_n)$, above this n property utility set $X=X_1 \times X_2 \times \cdots \times X_n$, it is necessary to make a preference decision which considers multiple properties at the same time, and this is close to impossible. Hence, with regards to the preference of the determinist of the intention, it becomes necessary to establish a variety of independence or dependence amongst the multiple properties. Also, it is necessary to seek a resolving expression to lessen the dimensions of the utility functions' properties.

For the additive and multiple resolving expression, the additive and utility independence is presumed. However, the supposition of the above independence becomes a problem, not only in cases where the designers are in several groups, but also in the case of an individual. Although one group may think logically, and the utility function of that group was sought, it would conflict with the utility function of the groups with a different sense of values, thus marring independence. Even in cases where there may be only one individual, humans, whilst stressing the importance of certainty, at the same time tend to want to carry out highly risky adventures. When this aspect is expressed in the plan, then that person is not necessarily always thinking and behaving in a logical manner. Therefore, it is difficult to say that independent axioms can be realized among several properties.

Therefore, a method being considered is to introduce a convex dependence and to use this as a basis for resolving expression[3,4]. In other words, against the arbitrary $\chi_1 \in X_1$, $\chi_2 \in X_2$, when the disparate $\chi_2^j (j=0, 1, \cdots, m)$ and $\lambda_j : X_2 \to R (j=0, 1, \cdots, m)$ exist to satisfy

$$\left. \begin{aligned} u_1(\chi_1 \mid \chi_2) &= \sum_{j=0}^{m} \lambda_j(\chi_2) \; u_1(\chi_1 \mid \chi_2^j) \\ \sum_{j=0}^{m} \lambda_j(\chi_2) &= 1 \end{aligned} \right\} \tag{3}$$

then one can say that property X_1 satisfies the m-th order convex dependence for property x_2. Therefore, the 0 order dependence becomes the utility independence at $m=0$. In other words, by taking $m>1$, one attempts to introduce mutual workings between attribute X_1 and attribute X_2.

However, at this stage, this is no longer a normative model but a descriptive model. Therefore, there is not the numerical accuracy of von Neumann-Morgenstern's theory. In other words, it is merely the product of a certain type of compromise or an indication in the manner of the von Neumann-Morgernstern normative model.

Let us consider this problem from the point of view of the formation of mutual agreement between the enterprise body (determinist of intention I) attempting to construct an international airport, and the surrounding residents (determinist of intention II) who through such an action would end up as the victims of the effects.

When the spaces of the utility functions of determinist I and II are U_1 and U_2 respectively, it is possible to express the multi-property utility functions of determinist I and II as $u_1(\chi_1) \in U_1$, $u_2(\chi_2) \in U_2$.
As in equation (3),

$$\left. \begin{aligned} w_1(u_1 \mid u_2) &= \sum_{j=0}^{m} \mu_j(u_2) \; w_1(u_1 \mid u_2^j) \\ \sum_{j=0}^{m} \mu_j(u_2) &= 1 \end{aligned} \right\} \tag{4}$$

when the disparate $u_2^j (j=0, 1, \cdots, m)$ and the real value function $\mu_j : U_2 \to R (j=0, 1, \cdots, m)$ on U_2 exist, then the m-th order convex dependence exists between the utility space U_1 of determinist I and the utility space U_2 of determinist II.

However, what is this convex dependence? When the preference construction $w_1(u_1 \mid u_2)$ of the utility of determinist I changes flexibly adapting to determinist II's utility level $u_2 \in U_2$, then the situation model of the above convex dependence is probably useful. However, if $w_1(u_1 \mid u_2)$, regardless of the value of $u_2 \in U_2$, displays a convex function (concave, toward risk) and the individual utility level u is not sufficiently high, and presuming that the group utility is not high either, then the mutual intervening model based on this convex dependence will fail.

In actuality, in many cases, the preference construction of the enterprise body (determinist I) is both adamant and authoritarian. Often, voicing social and community morality, it uses strength to suppress the wishes of the surrounding residents (determinist II). Even when it introduces a standard of measure, the problem would be the method of deciding this. Even if the bothersome and most obvious theory (utility theory) is used, and even if a further overlapping of the standard of measure is considered, in actual fact, it is no different in the sense that determinist I, through the form of compromise and scientific pretense, is still forcing its will on determinist II.

Therefore, in the decision making and assessment with regards to the real design, even though it may seem that by bringing up convex dependence, the problem is being logically dealt with, it actually does not mean much. There seems to be no real method apart from considering the von Neumann-Morgernstern normative model as a standard of reference.

Of course, the utility function of von Neumann Morgernstern's, model satisfies the following equation for the alternative proposal $\tilde{x}$, $\tilde{y}$.

$$u(\alpha\tilde{x}+(1-\alpha)\tilde{y})=\alpha u(\tilde{x})+(1-\alpha)\ u(\tilde{y}) \tag{5}$$

It is a linear model for human selection under risk. From this is born the effect in the sense of expected utility, and the value of utility becomes as a fundamental number. Since reality is a complex and non-linear model, and furthermore, when considering that humans do not logically think out nor carry out to the optimum its contents, the Von Neumann Morgernstern's utility theory can be said to be no more than a standard of reference.

At this point, let us take up Narita Airport as an example of the international airport problem. The reason for this is that even now, it exists as a classical example of a formation of a mutual agreement problem relating to the determining of intention. It has already evolved into a political problem, and to take it up on an academic level would pose many difficulties. However, let us attempt to theorize this problem within academic bounds as far as possible.

Today, as quite a few directors of the Department of Transportation will agree, it appears that it would have been much more judicious to fill in the offshores of Tokyo Bay and extend Haneda Airport, using it as both an international and a domestic airport, rather than constructing an international airport at Narita.

The reason for this is that, firstly, access to Narita Airport from the center of Tokyo takes two hours. This problem is further worsened when traffic is heavy on the access road. Secondly, turbulence often occurs in the air space above the environs of Narita Airport, meaning weather conditions are not good. Thirdly, the air space around Narita Airport is often in close contact or actually overlapping with the air space of the U. S. Air Force base and Self-Defense base, with the result that there have often been near-misses in the past between civilian planes and military planes. By contrast, the proposal to improve and expand Haneda Airport would have meant that access time from the center of Tokyo would not have been increased, and that problems such as weather conditions and air space would not have been on the level of Narita. Above all, the cost of construction would not have been nearly as much as that of Narita Airport.

If that is the case, then why was an airport constructed at Narita? It is generally thought that when the Government Department of Transportation and the International Airport Construction Corporation decided to construct an international airport at Narita, the plan would have come close to being frozen at an early stage due to the enormity of the project and the resulting massive amounts of time and preparatory costs involved. In addition, the strong protest movement of the farmers of Narita whose land was being forcibly taken from them added to this situation. The Narita area has always been an extremely fertile area, and the farmers of Narita were relatively well off. Although terms such as social co-operation were used when negotiating with these people, it is only natural that, threatened with the loss of their source of living, they would react through protest movements. Confronted with this, the government-group reacted with an attitude of increased authoritarianism, and their already hardened attitude further hardened. At this stage, the farmers of Narita were not even slightly included in the determinists. Even if they had been included, the multi-level utility function $w_1(u_1 \mid u_2)$ (let us assume that this exists) of determinists I (government and corporation) did not change towards a softening attitude by the utility function $u_2 \in U_2$ of determinists II (farmers of Narita and Sanrizuka) by convex dependence. Indeed, the preferred construction took the form of a further hardening of attitude and it can be assumed that, having lost any scope to consider the alternative proposal (=expansion of Haneda), they then rushed towards the construction of Narita International Airport.

When considering the above, the convex dependence of the theory of utility, in relation to achieving a solution of a real problem, can be said to be completely ineffective. When one considers that this did not even prove useful as a criterion, then in attempting to solve the problem of determining the intention of humans who, right from the beginning, have not necessarily always behaved in a logical manner, a mathematical model could only be applied to a limited domain.

Fortunately, at present, Haneda Airport is being extended by filling in the offshore areas. In contrast, if, from the cancellation of Stage Two of the construction of Narita Airport, the direction to be taken is one of reduction, then one could say that the post-event assessment and pursuit assessment are functioning effectively.

3. The Design with Synthesis

It was mentioned previously, that the design is the bulletin of the total personality, and that it is the expression of one's intention. If so, the decision in design must possess a synthesis. Therefore, when attempting to construct and design a factory, not only is it necessary to pursue the completion of a certain goal, one must also make a pre-event assessment. For this pre-event assessment, in order to introduce elements which have been formerly discarded as external economics, it is probably necessary to also consider entropy and circulation.

Of course, for a single machine facility and project, it is necessary to establish the optimums of reliability, safety and, if it can be given, the utility function as pre-event assessments. However, the most important thing is to stress the circulation. Through this, not only is the environmental pollution greatly minimized and the safety of the human race guaranteed, but it would also help towards the maintenance of the many living forms that co-exist with humans, and this beautiful green earth can be continued. In other words, the maintenance of circulation is the ultimate in safe design.

The disposal system of basin sewage disposal plants on a large scale, has a low level of circulation, and therefore the safety factor is poor. For example, the standard value required for biological oxidation demand (BOD) eliminated from disposal plants is established at below 20 PPM for even the worst areas, but, in actual fact, cases where the level is far higher than 20 PPM are not unusual. Apparently, this is due to the fact that, apart from raw sewage and miscellaneous domestic drainage, poisonous factory drainage (containing poisonous chemical substances and heavy metals) also flows through the general sewage system. This results in weakened bacterial activity in the sewage disposal plants and, consequently, treatment is insufficient. By contrast, the joint management disposal septic tanks where both disposal and supervising are carried out by individuals 1) does not contain factory waste, 2) in the former single disposal tanks which treats only raw sewage, the nitrogen level is so high that it is beyond the ability of bacterial treatment. Therefore, in contrast to the fact that the BOD of post-treatment waste is as high as 70 to 90 PPM, as domestic miscellaneous waste and raw sewage is mixed into this and thus activates bacteria, with only secondary treatment of anaerobic fermentation and aerobic fermentation (addition of oxygen), the BOD falls below 20 PPM. In some cases, it even falls below 5 PPM. This has been attracting much attention during the last 2, 3 years, with the resulting situation that each of the local governments: cities, towns and villages, prefectures and nation, are providing money for assistance.

Whether it is large scale basin sewage disposal systems, or a jointly managed septic disposal tank, neither are circulatory in nature. However, in contrast to the fact that the above mentioned are mixing factory waste, the waste of the latter is only organic, and furthermore, as its strength is within the set limits, it is producing remarkable advantages in regards to treatment of water.

However, one can not help but say the latter are inferior to a type of circulatory disposal system which feeds pigs with leftovers from the family meals, and disposes of human and pig raw sewage with bacteria, thus producing methane gas, and uses odure cakes for fertilizer. Naturally, this type of disposal system is easily carried out in hot areas such as India and South China, where methane bacterial activity is high. However, in Japan, not counting summer, in a colder season such as winter, the activity of methane bacteria becomes sluggish, and so there would be a problem in utilizing this system. However, if concentrated on a community level of hundreds or thousands of homes, then this system might be possible. This is because, in such cases, the disposal plant would be of a medium-size, and so a suitable heat maintenance construction can be used. This would probably be economically viable as well. Furthermore, due to its medium-size, in some cases treatment might be able to be carried out to the third stage, and the disposed water could have a favorable quality.

From the above, one can see the necessity for scientific and technological directivity to move away from large-scale basin sewage disposal systems to community-level jointly managed sewage treatment tanks. With the community -level circulatory disposal system, in the sense that, together with making use of methane gas (energy) and odure cakes (organic fertilizer), favorable water is also ensured. Also, synthesis is achieved and it is also safe in that it does not affect the water circulation of earth, nor does it upset the eco-system. To carry out a design which is also synthetic in nature is the goal for this type of circulatory disposal and treatment system.

Factory waste ought to be treated within the factory grounds, and poisonous chemical substances ought to be made non-poisonous. Constant supervision should be carried out on poisonous heavy metals, or alternatively, a method of re-using should be carried out. When viewing it from this angle, there is definitely a problem in the present form of legislation where products containing high levels of poisonous heavy metals, for example mercury batteries, are handled as general waste products. Whether these are mercury batteries or fluorescent light bulbs, there should be a system where any products containing poisonous heavy metals are sorted, collected and returned to their factories, where the mercury only is concentrated.

The total amount of the demand for mercury in Japan in 1985 was 186.6 tons, but of this 126.0 tons were used in batteries, a share of 67.5%. Therefore, by simply sorting and collecting the used batteries would mean a big drop in the amount of mercury which is poured into the environment. The selection of a design system which follows both the flow of products which are manufactured at a factory and the factory itself, is a design and decision with a synthesis.

Due to the insufficient treatment of water of large-scale basin sewage treatment systems, and because of polluted water flowing into the rivers, a result of the spraying of chemical fertilizers, the use of water from large rivers in the Kanto plains such as Edogawa, Arakawa, Sumidagawa, Tamagawa and a little further away, Tonegawa, has gradually become a problem. Although it is somehow used for drinking water by adding large amounts of chlorine to disinfect it. Possibly, in the near future, as in Europe, this water will no longer be suitable for drinking. Using chlorine as a disinfectant also produces and breeds a carcinogenic substance called trihatometron, making continued addition difficult. Also, water treated in this way is highly odorous and unpleasant to drink. And so, water collected directly from mountains is beginning to be sold as mineral water. Sales are increasing steadily every year, and recently, such weter is even starting to appear in vending machines.

A problem which has recently arisen, to be added to the many causes of river pollution, is the spraying of chemical fertilizers and weed killers on golf courses which has resulted in the pollution of nearby rivers. This is because large amounts of chemical fertilizers and weed killers are necessary for the growth, maintenance and management of the fairways of golf courses. On an average, the amount used to maintain and manage the greens is 3 to 4 times that used in agricultural fields. In some cases, it is close to 10 times that used in the above. This is to prevent the larvae and the presence of insects such as gold beetles which multiply in large numbers in the thatch level below the grass. Furthermore, unlike agricultural fields, the types of fertilizers used on golf courses are not limited. Any chemical fertilizer can be used.

The life chain in the eco-system, that is, the eutrophic matter which is eaten by bacteria, which in turn is eaten by microbes (worms and insects), which, if this is a lake, becomes food for fish, which in turn becomes food for the birds... This chain is being disconnected because of the chemical fertilizers and weed killers which are used for the maintenance and management of grass. Further, through the constant use of large amounts of chemical weed killers in order to maintain a single variety of lawn grass, the diversity of plants is also being endangered.

The average size of a golf course (18 holes) is 100 hectares. Of this, grass makes up about 40 to 50%. There are four of these golf courses in Itakuma city in Saitama Prefecture, which used to be the source of water for Tokyo. Further, if the golf courses either under construction or being planned were to be included, the total number would rise to 8. Golf courses are also being constructed near river areas. The results of this phenomenon is that even large rivers become completely polluted. It has been estimated that eventually they will not be able to be used for drinking water.

The number of people who use a golf course in one day is estimated to be about 200. One questions the validity of polluting rivers simply for the sake of 200 people a day. Unfortunately, modern civilization ignores this type of problem. If the rivers which flow along the Kanto plains become un-usable, then there is a plan presently under way for a dam to be built in the upper reaches of Shinanogawa which flows into the Japan Sea (Niigata). By directing this water into another dam to be built in Gumma Prefecture, this water will then be directed into the Kanto Plains as well, to be used as drinking water. It is certainly an enormous plan, but there are also certain questionable aspects about this construction plan. Furthermore, it is obvious that even these artificial rivers will eventually become polluted too. The real nature of the problem is related to the existence of a structure in this modern industrial civilization which severs the chain and the circulation of the eco-system. This means that a change in direction must be made towards a form of design which lays emphasis on circulation which accommodates the eco-system.

The design by a human is an ecological one which does not damage the natural environment, and the key word for this is circulation. When one considers that once circulation is achieved, then that design system will finally possess a synthetic quality. This should also be considered when selecting the materials in a design.

Materials which contain both acid and an alkaline-resistant and do not rot, may seem to be extremely convenient. On the other hand, it means that they will never "dissolve" into nature, and never be restored back to nature. It will in fact change the nature of the natural environment itself.

For example, asbestos, which has now become a problem, has the properties of being highly acidic and alkaline-resistant. Considering that its lightness, its durability and its non-flammable and heat insulating properties are superior, it has been widely used both as a building material and material for industrial products. However, the properties of this type of superior material is at the same time a big problem. This is because, during installation and demolition of and friction from asbestos, the powder is absorbed into the lungs, and remains in the lungs in the form of several microns of fiber-like substance which never changes, and which becomes carcinogenic. Because of this, therefore, the use of asbestos has been treated as a problem, and even materials which have asbestos mixed into them have been removed. However, this process of removal is not an easy task. One must attach suitable protective equipment for the face and carry out the task with extreme caution so as not to absorb the asbestos powder.

Different plastic substances too, made a first appearance as a revolutionary new material, and it has continued to be used in every area. However, a law has been passed in Italy, whereby, from January 1, 1991, there will be no manufacturing whatsoever, in that country, of any plastics such as vinyl and polyethylene. The reason for this is the discovery, in May 1983, of a dead sperm whale, 7 meters long and weighing 3 tons, which was washed up onto the Adriatic coast. The cause of death was due to the presence of 50 vinyl bags inside the whale, it could not absorb any nutrients. The people of Italy were highly shocked by the news of this incident. From the resulting controversy, the Italian Parliament established a statute "to pass laws which prohibit the production and sale of wrapping material made from substances which do not naturally and organically dissolve." This is very far-sighted. Japan should learn from this example. In any case, vinyl chloride is an enormous problem. Not only does it not dissolve naturally and organically, but when it is collected as garbage and burned, a poisonous gas and chlorine gas are produced. Furthermore, an extremely high level of heat is emitted at the same time and so quickly damages furnaces. The result is that it is often simply buried in the ground with its contents, as garbage. In other words, the disposal of vinyl chloride is even more of a problem than other plastic products. For this reason, certainly the best way would be to begin by prohibiting the manufacture and sale of vinyl chloride.

The disposal of the organic chlorine group is a problem. At times it is used as a fertilizer, whilst at other times, it is used as an industrial material or flon gas for air conditioners. As it is an artificial substance which is almost non-existent in the natural world, it is extremely stable. Stable means that in cases where it has been used as a fertilizer, its poisonous properties never disappear. As mentioned previously, it pollutes many rivers, and causes both deformation and cancer in fish. When it is utilized as an industrial material and then disposed by burning, depending on the heat conditions of the furnace, large amounts of extremely poisonous dioxin are produced, to the extent that it has become a serious social problem.

Flon gas is even more of a problem. The reason for this is that, because of its stable nature, it reaches the stratosphere without any change whatsoever, and there, destroys the ozone level. It is used as a chilling and spraying agent, and the amount of flon gas emitted into the atmosphere, and the amount of ozone layer which has been destroyed as a result is said to be exactly the same.

If the keyword for design is to be circulation, then the entropy is emitted outside the system, but the entropy which is accumulated in products, waste matter and manufacturing systems continues to increase. The heat disposal emitted into the sea and rivers from nuclear energy plants is massive, and therefore upsets the life cycle of fish etc. However, an entropic substance can not be easily transformed into entropic heat. It is not connected to the entropy emitted outside the atmosphere through utilizing earth's moving and constant system of release to the outside ozone level, therefore accumulating on earth and continuing to exist.

In contrast, waste such as iron, rusts in the environment to become oxidized iron. It is then restored into the earth as one of the soil's elements. Therefore, it is not a big problem. However, specialized steel which contains chrome, etc. (stainless steel) does not easily rust, and there is a likelihood that problems may arise later on.

The above are to be compiled into the following two tables for easier comprehension. The present situation is shown in Table 1. The design with synthesis proposes the counter-measures for the disposals of waste is shown in Table 2. By this system, organic substances are circulated. Moreover, we have to find methods to convert material entropy to heat entropy.

Table. 1 The Present Conditions of Waste Materials
(ΔS_{out} ; heat entropy released into space, ΔS ; increment of resouces' entropy, σ ; entropy made in production)

	Properties	Form of Disposal	Circulatory	Problems
ΔS_{out}	Heat waste	Released into atmosphere and oceans, and finally radiated into space	Non-circulatory	Slight
ΔS	Gaseous waste	Chemical poisons→(filter)→atmosphere	Non-circulatory	Great
		Radio-active matter→(filter)→atmosphere	Non-circulatory	Great problem
	Water soluble waste	Factory waste→(filter)→enviroment	Partly circulatory, removal Finally non-circulatory	Problem
		Domestic drainage→(purifying tanks)→sewage		Problem(**)
	Powder	(filter)→atmosphere	Non-circulatory	Problem
	Non-corrosive waste	abandoned and buried in environment	Non-circulatory	Problem
	Chemical poisons	partially disposed and burn→organic chlorine dioxin	Semicirculatory	Problem
	Radio-active waste	dispose by glassing in and abandoned after placing in drums	Non-circulatory	Great problem
	organic matter which breaks down in the soil	sewage disposal systems→rivers, ocean	Non-circulatory	Problem
	Re-use as natural resource possible	partially recycled, the rest incinerated	Semi-circulatory	Slight
σ	Used nucleactors	dismantle, lock in	Non-circulatory	Great problem
	Machinery constructions	dismantle, bury	(semi) circulatory	None
	Steel mills	dismantle and dispose	(semi) circulatory	Slight
	Chemical plants	dismantle and dispose	(semi) circulatory	Slight
	Electrical goods factories	dismantle and dispose	(semi) circulatory	Slight

* ( ) indicates that some cases are whilst some are not
** In actual conditions, there is a problem because factory waste is mixed in disposal

Table. 2 Counter-measures for Waste Disposals
(ΔS_{out} ; heat entropy released into space, ΔS ; increment of resouces' entropy, σ ; entropy made in production)

	Properties	Countermeasures	Circulatory	Problems
ΔS_{out}	Heat waste	Release into the atmosphere and ocean	Non-circulatory	Decrease numbers of Heavy pressure and large scale industries
ΔS	Gaseous waste	Chemical poisons→filter→atmosphere	Non-circulatory	Regulate to make filter use compulsory and general control
		Radio-active matter→controlled release	Non-circulatory	Regulate
	Water soluble waste	Factory waste→filter→environment	Circulatory, separate from flow of domestic drainage	Circulate, dispose as much as possible
		Domestic drainage→purifying tanks→fertelizer	Circulatory	Community level circulate system
	Powder	Filter→atmosphere	Non-circulatory	Control to make filter use compulsory
	Non-corrosive waste	Stoppage of manufacture and sales	Non-circulasory	Re-use (e. g. mercury) unavoidably manufactured
	Chemical poisons	Minimalising of manufacture of organic chlorine	Non-circulatory	A section to be chemically disposed
	Radio active waste	Stoppage of manufacture	Non-circulatory	
	Organic matter which breaks in the soil	Return to soil and liquid manure	Circulatory	
	Re-use as natural resource possible	All to be re-cycled through re-cycle routes (re-use)	Semi circulatory	Re-use as much as possible as it will finally end up as garbage
σ	Used nuclear reactors	Stop manufacture of nuclear plants, seal	Non-circulatory	
	Machinery constructions	After dismantling, re-cycle as scrap iron	(Semi) circulatory	
	Steel mills-	From large scale steel plants to mini mill	(Semi) circulatory	Use scrap metal
	Chemical plants	From high temperature high pressure chemical industry to biochemical industry	Circulatory	
	Electrical goods factories	Re-use repaired electrical goods	(Semi) circulatory	Maintenance of parts

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