3. Diversity, Survival Value, and Enrichment: Design Principles for Extraterrestrial Communities

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This subject is based on three fundamental notions:

(1) The basic principle of biological, social and even some physical processes is increase of heterogeneity and symbiotization.

(2) Diversity has a survival value for several reasons.

(3) Diversity contributes to a higher rate of cultural evolution.

The Three Basic Notions

Heterogenization and symbiotization as the basic principle of biological, social and some physical processes. So far there have been two phases of the development of mutual causal models in engineering, biology, operations research, and systems science, and the third phase is about to emerge. The first phase was characterized by deviation-counteracting, equilibrating mutual causal models by means of negative feedback loops. This phase began in full scale during the Second World War when radar, anti-aircraft artillery, and computers were hooked up in a mutual causal system. The second phase was characterized by differentiation-amplifying, heterogeneity-generating, evolution-creating mutual causal models by means of positive feedback loops (Ref. 136). This phase began in the 1960's and initially drew much interest from biological scientists because of the fact that these models could do what Shannon's theory of information could not do, i.e., increase structuredness and complexity. Shannon's information theory, similar to the theory of thermodynamics, was to proceed on a different paradigm which I call "random process paradigm" or "random influence paradigm", and it could only account for loss of information, but could never generate information, The most it could do was to combat loss of information by error-correcting methods based on various forms of negative feedback. As mathematician Stanislaw Ulam has pointed out (Ref. 137), complex patterns can be generated by means of simple rules of interaction (Refs. 136, 138), and it takes more amount of Shannonian information to describe the generated pattern than to describe the generating rules; i.e., the amount of Shannonian information increases in these processes. It is this feature of the differentiation-amplifying mutual causal models that drew much interest from embryologists and geneticists in the early 1960's. In the late 1960's some sociologists began applying these models to the study of social evolution and social change (Ref. 139). In addition to the creative and generative features of mutual causal processes, there is also a possibility of runaway situations. This feature was first pointed out by Gunnar Myrdal (Refs. 140, 141), and more recently received much more elaboration and publicity by Jay Forrester of MIT and his school.

The third phase of the development of mutual causal models, which has hardly begun, will have to deal with the mathematical methods or heuristics to hook up heterogeneous elements into symbiotic

networks. In the biological evolution, the species which are symbiotic survive more than those which are not, and unsymbiotic ones have a higher probabilty of dying off. By the way, "survival of the fittest" is not "survival of the biggest" or "survival of the strongest," as average Americans tend to interpret, but rather "survival of the most symbiotic."

But in the social process we do not wait for people to die off. We must identify which combinations are symbiotic and which are not, and recombine unsymbiotic ones into other networks in which they will be symbiotic. Suppose Individual A has three alternative ways, a_1, a_2, a_3, to implement his goal, and Individual B has five ways b_1, b_2, b_3, b_4, b_5, to implement his. Then there are fifteen combinations of a_ib_j, some of which may be symbiotic. If none of the fifteen is, then A and B must be separated into different networks. On the other hand, those who are now separate may be symbiotic if they are together. We do not yet have mathematics to deal with such combinations in a large society.

Regardless of whether we have mathematics or not, it is now recognized that the basic principle of biological and social processes is heterogenization and symbiotization. Even some physical processes have these characteristics. Recently there has been much interest in the phenomenon of self-organizing noise by means of resonance.

Survival Value of Diversity. Diversity has survival value for at least three reasons: (a) symbiosis; (b) resource utilization; (c) catastrophe contingencies. The traditional western (European and American) logic and paradigm preached ideology of unity by similarity, considering differences as sources of conflicts. This amounted to the ideology of homogenization, standardization, religious and technological universalism, missionarism, and ethnocentrism. On the other hand, the new scientific paradigm is "symbiosis thanks to diversity." For example, the animals convert oxygen into carbon dioxide and the plants do exactly the opposite, and by so doing they help each other. Incidentally, it is interesting to note that the philosophies of American Indians, East and West Africans (but not North Africans), Far East Asians, and Eskimos are similar to this new scientific paradigm. However, Islamic, Hindu and Chinese philosophies, which westerners often refer to as "Eastern" philosophies, are much closer to the western philosophies than to Sub-Sahara African, Japanese or American Indian ways of thinking, which are more markedly based on the principle of symbiotization of heterogeneity (Refs. 142-144).

Another example of the survival value of diversity is the heterogeneity of species in a coral reef or in a tropical rain forest. The heterogeneity enables maximum utilization of solar energy and diversification of food requirements. If all species ate the same food, there would be a food shortage. And diversity allows for a higher probability of survival in case of catastrophes such as radical change of environment.

Heterogeneity and Rate of Cultural Evolution. In 1931 Wright pointed out how the speed of biological evolution is related to the ratio between the mutation rate and the size of the population (Ref. 145). When the mutation rate is low and the size of population is large, the interbreeding between mutants and "normal" individuals, or between mutants of opposite directions, tend to cancel out the mutations, and the speed of evolution is very slow. When the mutation rate is very high and the size of population is small, there is much inbreeding effect, which tends to amplify the mutations rapidly, and evolution may take place so fast that the species has no time to adapt to the existing environment or to seek a new environment, nor time to work out new types of relationships between individuals. The whole species may become extinct. When the mutation rate is moderate and the population size is neither too large nor too small, mixture of stabilization and change takes place, and random drift occurs; a change may be amplified for a while, stabilization takes place, then another change in a new direction takes place, etc.

A faster rate of evolution occurs when the total population is divided into isolated independently evolving subpopulations, which are connected with occasional interbreeding. In other words, heterogeneity between subpopulations contributes to a higher rate of evolution.

Wright's theory holds true when the Mendelian law is operative. Cultural intercourse does not always follow the Mendelian law. For example, an idea can be communicated to many individuals at the same time; a new idea may be ignored by the receiver; the established persons may purposely suppress new ideas, etc. Nevertheless, the notion that heterogeneity contributes to a higher rate of evolution holds true even in the case of cultural evolution.

And needless to say, cultural heterogeneity enriches human life.

What We can Learn from Existing Cultures

There are many different patterns, forms, and styles of life in the world under different living conditions and different philosophies of social organization. Not to learn from them would be unscientific, and unwise and uneconomical as well. There are 13 areas for consideration:

(1) Effects of day, night and seasons.

(2) Shelter, clothing.

(3) Food.

(4) Proxemics.

(5) Time structure (working hours, week-system, etc.).

(6) Principles of architecture and landscaping.

(7) Different logics.

(8) Different paradigms of life.

(9) Principles of community structure.

(10) Family structure.

(11) Sex relations.

(12) Decision processes and administration.

(13) Matching between individuals, between individuals and jobs, individually optimal rate of communication, activities, etc.

Effects of day, night and seasons. Laboratory experiments have shown that many species of animals maintain diurnal and annual cycles in their biological activities and processes even if they are kept under constant temperature and light conditions. Humans who are transported from one time zone to another in a jet flight show some physiological disturbance.

However, there are human populations who live and have lived in geographic areas which lack diurnal or seasonal cycles. Eskimos who live north of the arctic circle have no nights during the summer and no daytime during the winter. On the other hand, those who live near the equator have no appreciable change in the length of daylight during the entire year. The Balinese calendars ignore completely the 365-day cycle, and instead use the 210-day cycle and 420-day cycle which are mathematically derived (the product of four prime numbers 2, 3, 5, and 7).

Traditionally, the Eskimo's life is not regulated by the 24-hour cycle: for instance, when they go to hunt, they often hunt four or five days without sleeping, and then sleep two or three days at a stretch. Likewise, they may hunt for a few days without appreciable amount of eating and with eating time unrelated to the 24-hour cycle, and then fast for a few days without interruption. This indicates that the 24-hour cycle is not an absolute necessity for the human species.

As for the seasonal cycle, the most extreme seasonal climatic variations are found in polar areas and in the inland areas of large continents in lower latitudes. These areas have four seasons, even though any of the four may be very short or very long. In these areas the life of people is regulated by the seasonal cycle: there are busy seasons (harvest seasons, fishing seasons, etc.) and relatively idle seasons. In many cultures the idle seasons were used for festivals or for organized sexual activities. There are also seasons of high intercommunity activities due to easier transportation, and seasons of relative isolation due to transportation difficulties. For example, for Eskimos the winter was the time for traveling because snow on land and ice on the ocean served as unlimited highways. On the other hand, summer was the time for camp settlement and less mobility.

Tropical areas lack the seasonal variations in the length of daylight. However, many of these areas have rainy seasons and dry seasons which form an annual cycle. This cycle is of importance in agricultural communities, but less important in fishing communities.

Shelter and clothing. Human adaptation to the climate by means of shelter and clothing has extremely varied forms. Traditionally, the Alaskan Eskimos lived in half-underground houses covered with dirt, which is further covered by snow in winter. This provided an extremely efficient thermal insulation, and a small seal-oil lamp was sufficient to keep the indoor temperature at 90°F (305°K). Most males lived completely naked indoors, and most females wore only a narrow band

around genitals. When it was necessary to sleep in an unheated temporary shelter such as an igloo, an efficient way to keep bodies warm was to sleep naked, many people together, in one wide bed made by sheets of animal skin. It was important to have more layers of animal skin between the floor and the bodies than over the bodies. The outdoor clothing of Eskimos was made of animal skin. Seal hunting required a great deal of body immobility for a prolonged period on frozen ice, but animal skin clothing was sufficient for Eskimos. It is interesting to note that the Eskimo principle of sleeping warm was widely practiced among the ordinary people in medieval France, where the entire family slept naked in one large bed.

Other examples of human adaptation to cold weather can be found in the southern end of South America, where some humans lived entirely naked in cold rains at freezing temperatures, and in Australia where today many tribes live completely naked even in winter.

On the other hand, many populations who live in hot but dry areas cover their entire body to keep radiation heat out. But most of the tribes in the Amazon area, which is very humid and warm, live completely naked.

Interesting examples can be taken also from those who live in temperate zones: the traditional Navajo women in Arizona could live with exactly the same clothing throughout the year, where the summer temperature reaches above 100°F (311 K) and the winter temperature sinks far below freezing.

Food. The Eskimo food consisted almost entirely of animal meat and internal organs, with some berries harvested in summer. Large variations are found in the amount of liquid intake and outlet in different cultures. The Japanese have a higher amount of urine output than the world average, probably due to two reasons: eating rice instead of bread, and use of dried, salted or sauce-treated fish, which must be accompanied by liquid intake.

Proxemics. The spatial patterns between individuals or for an individual's activities vary from culture to culture. For example, physical crowding is more tolerated in other cultures than in the American culture. In the American culture, a close distance between two individuals, of the same or opposite sex, is interpreted to have sexual intention.

In many non-hierarchical cultures, people sit in a circle even in offical meetings, and the American pattern of seating in rows before a podium is unthinkable.

Americans tend to define space in terms of walls and enclosures. In other cultures, for example in Bali, space is defined around something rather than inside something. The traditional Japanese considered the indoor as a continuation of the outdoor, and houses had removable walls (sliding partitions).

The American concept of privacy requires one enclosed, lockable room for each individual, while in other cultures privacy is achieved by a thin paper screen, or privacy is found "in the bush" rather than in the house. In some cultures privacy is achieved by simply turning off the lamp, or by looking in another direction. In the Navajo culture, a man was not supposed to look at his mother-in-law, and had to look in another direction. In some cultures there were no secrets or visual taboo, and the concept of "privacy" did not exist.

Americans require sound-proofing for individual space, while Japanese do not "hear" the conversation taking place behind a paper screen. Americans also require olfactory insulation.

The American idea of putting a toilet in the bathroom is shocking in many cultures, while Americans are shocked by mixed public bath.

If a large Japanese family traveling in the United States is assigned several rooms at a hotel, they may nevertheless sleep together in one room, getting rid of the bed if necessary.

Time Structure. Christians have a seven-day week. On the other hand, the Balinese have several types of weeks running concurrently: 2-day week, 3-day week, 5-day week, 7-day week, etc. These different cycles "heterodyne" at regular intervals (though not at different frequencies, but at common multiple intervals), and you have a 105-day anniversary, 210-day anniversary, 420-day anniversary, etc.

Most Americans eat three times a day. There are cultures in which the number of meals per day is 1, 2, or 5. In France and in Italy, the largest meal of the day is the noon meal, and the "lunch break" lasts 2 to 3 hours.

Most American have weekends. Traditional American Indians work without a weekend, but take time off whenever a relative or a friend comes to visit. Many Japanese companies give paid

menstruation leaves to women workers, recognizing the physiological cycle.

American workers are put to work on the assumption of homogeneity of time, and are expected to work in the same way summer or winter, morning or afternoon, pregnant or menstruating.

Principles of architecture and landscaping. Esthetic principles vary from culture to culture. Some of the Islamic designs are characterized by intricate repetitions of minute details. The European Vitruvius principle also achieves its design unity by repetitions of similar elements. There is also frequent use of "subdominant" patterns which, in a miniature form, repeat the "dominant" pattern. Many of the French and Italian gardens as well as ancient Chinese city designs are geometric and symmetrical. All these are based on *homogenistic principles.*

On the other hand, the Japanese gardens and flow arrangements, and English gardens to a great extent, avoid repetitions and redundancies, and create harmony of dissimilar elements. These are based on *heterogenistic principles.*

Another contrast can be found between the two concepts "sappari" and "kudoi". In Japan repetitiousness, whether in design, in poetry or in human behavior, is considered "kudoi" (heavy, overdone, obnoxious) and is avoided. The contrary of "kudoi" is "sappari" (fresh, clear), and is a very important consideration in Japanese esthetics. The architectural designs by Walter Gropius and Frank Lloyd Wright as well as the Swedish glassware are sappari, while the "art nouveau", the Gothic design, and psychedelic paintings are kudoi.

There are also different basic numbers in different cultures. In Navajo, the basic number is 4. In Sioux, the basic numbers are 4 and 6, corresponding to the four directions of west, north, east and south, with sky and earth sometimes included as two additional dimensions. The Japanese flower arrangement is based on various principles of making a composition out of 3, 5, 7, or 9 different elements. Many Japanese designs use a triangle of unequal sides as a basic layout, often with secondary triangles added which should be dissimilar from the main triangle.

Also important is the contrast between the contextual principle and the individualistic principle. For example, in the Japanese architecture there has been, and there still is, a great deal of concern in harmonizing the building with its surrounding environment. On the other hand, many of the American architects tend to regard the building mainly as an expression of its or his individuality unrelated to other surrounding buildings. Le Corbusier had another philosophy. He thought that man-made buildings should not imitate nature; to do so would mean lack of respect for nature.

Another consideration is that, as mentioned earlier, the Japanese regard the indoor as a continuation of the outdoor, and minimize the barriers between the outdoor and the indoor. This principle was adopted by Frank Lloyd Wright. The traditional Japanese house is like an astronomical "black hole", designed to suck the outside into the inside instead of proclaiming its presence against the outside. Where the outdoor is not readily available, as in urban areas, the Japanese employ techniques to create a perspective of the outdoor. One evening while traveling in Japan, I came upon an inexpensive inn, and decided to spend a night there. It was cramped between other inns. Next morning I inadvertently walked into a wrong direction from my room, and was surprised to see a corner of a large, beautiful garden opening up around the next room. My steps were naturally drawn to the garden. But as I approached the corner, what looked like an entrance to a large garden turned out to be a small recess in a wall, no deeper than ten inches. There was no garden at all. A multi-floor restaurant in Tokyo has a foot-wide shelf outside very other floor, on which two-floor-high trees are planted. Viewed from the inside, these trees give an illusion of a forest. Viewed from outside, the building looks like a tree-covered mountain. A large building in another Japanese city has an exterior surface which looks like a Yosemite cliff, complete with a waterfall. There is also a ring-shaped kindergarten building, whose sloped exterior sides are covered with grass, giving an appearance of a hill when viewed from outside. In Portland, Oregon, there is a tall building which looks like a gigantic redwood trunk by virtue of its strong vertical lines along the entire length of the building and slanted windows at the top and at the bottom. The Russians have perfected a technique to reproduce immense outdoor scenes in a small wall recess, with changing lighting to create sunrise, sunset, and various weather and seasonal effects. It is also conceivable to make such recesses on the exterior walls of a building for the enjoyment of pedestrians.

Another cultural comparison can be made

regarding the principles of the use of rooms. In the American house, most of the space is taken up by furniture such as beds and tables, and different rooms are required for different furniture. In Japan, on the other hand, the furniture is removable and the entire space can be used by people, not by furniture. Furthermore, since the furniture is removable, the same one room can be used as a living room, a dining room, and a bedroom, resulting in enormous economy of space. This consideration may be important in extraterrestrial communities.

Different Logics. Many Americans know only one type of logic: the Aristotelian deductive logic, and believe this to be "the" logic. However, there are many other types of logics. I do not mean multivalued logic or fuzzy logic, which are nothing more than variations of the Aristotelian logic.

One of the drawbacks of the deductive logic is that it prohibits "circular reasoning". Until recently the deductive logical order was often confused with the causal order in physical, biological and social processes. As a result of this confusion, the concept of mutual causality (A and B cause each other: many things cause one another) was tabooed in spite of the fact that mutual causal relations are abundant in biological, social and some physical processes. As I have already mentioned, mutual causal processes can increase differentiation, heterogeneity and complexity, and make evolution and growth possible. Without mutual causal relations, such processes are impossible. Philosopher Hans Reichenback, who did not recognize mutual causality, had to introduce a teleology (the future determining the present) in order to explain growth and evolution (Ref. 146).

Another drawback is that the deductive logic leads to hierarchical social structure, dictatorship, aristocracy, elitocracy, technocracy, bureaucracy, etc. The deductive logic cannot see any alternative order of society. The only alternative conceivable within its logical limitation is anarchy or numerocracy (majority rule, domination by quantity). However, once we recognize other types of logics, other alternatives become possible. For example, the mutual causal logic enables us to conceptualize a network system of mutual interaction.

One of the most serious drawbacks of the deductive logic is that it fosters homogenistic thinking, belief that differences create conflicts, belief in the existence of one truth, one ultimate God, etc. As these are very basic problems, let me comment on them one by one.

The logic of the Mandenka tribe (Ref. 143), who live in West Africa, is heterogenistic. According to this logic, it is homogeneity, not heterogeneity, which creates conflicts. They say: "If you force individuals to be similar, the only way left to them to be different is to get on top of one another. This creates conflicts." There is a great deal of wisdom in this. Furthermore, the individual in this tribe goes through different phases of tasks and functions in the society: adolescents are assigned certain specific tasks; those between 30 and 35 are assigned administrative and caretaker functions of the tribe; those older are given less demanding tasks, etc. By going through these different phases, the individual learns to see the same situation from different points of view, and to understand individuals in different situations. The individual becomes heterogeneous in himself, and becomes capable of poly-ocular vision. They are skeptical of westernization mainly because the system of specialization brought by the Westerners will lock each individual in one task, and he will become incapable of seeing other persons' points of view.

Likewise, the Japanese think in poly-ocular vision. Americans, who believe in the existence of one truth, will inevitably ask: if you have different views, which one is right? But consider the following: in the binocular vision it is irrelevant to raise the question as to which eye is correct and which is wrong. Binocular vision works, *not* because two eyes see different sides of the same object, but because the *differential* between the two images enables the brain to compute the *invisible* dimension. The binocular vision sees more than twice the monocular vision: it sees the invisible dimension. When there are different points of view, Americans tend to say: "Let's ignore the parts on which we differ, and work on the parts on which we agree." Well, if you cut down the binocular vision to parts on which two eyes agree, what is left is much less than the monocular vision. For the same reason, insistence on the "objective" parts on which everybody agrees is a tremendous impoverishment of our vision, even though many people would consider this as the "scientific" thinking. We can say that the "objective" parts are the most insignificant parts of our thinking. The Japanese do not even bother to find out "objectivity", because they can go much further with cross-subjectivity.

Throughout the planning of our extraterrestrial communities, I can predict that many hours will be wasted on the arguments as to who is right and who is wrong. Let us keep in mind that these hours can be used constructively if we know how to make use of the differentials.

The belief in the existence of one truth, one universal formula for happiness, etc., is very common among engineers. On the other hand, theoretical physicists who appreciate the hypothetical nature of physical theories, and mathematicians who understand the axiomatic basis of mathematical theories, are less prone to blind belief in one formulation. I may add that the belief in one truth is an aspect of what is called 'monopolarization" (Ref. 147). Monopolarization is a psychological need to seek and hang onto one authority, one way of doing things, one explanation, one god, etc. Tendency for monopolarization is particularly strong among those who have been brought up in the family system with one father figure. In other family systems such as extended family, communal rearing of children, or periodical exchange of children between families, there is less tendency for monopolarization. It is not an exaggeration to say that the belief in one truth is a psychological hang-up from having been brought up in the nuclear family system.

Further discussions on different logics can be found in Ref. 142, for example.

Different paradigms of life. The word "culture" is used in social sciences in the sense of philosophy and pattern of life shared by a number of interacting individuals. It does not mean fine arts, music, and literature as is the case in many European countries, nor entertainment facilities and restaurants, as is the case among urban planners in America. "Culture" includes life style, but it goes much deeper. It also goes further than what is commonly called "social value system," which consists of the preferential order in which the community members rank various physical, psychological, ethical, and esthetic qualities. More basically, "culture" means cognitive and behavioral structure with which a person interacts with others and interprets the universe. It is more like "philosophy of life" or "paradigm of life." Some examples may be helpful.

- Example A: Life is cut-throat competition. The stronger takes advantage of the weaker. Success depends on effects. If someone is unsuccessful, it is his fault because he is not making the necessary effort. Outdo others or you will be a loser. People who are equal to you are your competitors. People who are different are your enemies. Life is a zero-sum game: what someone gains is what someone else loses. Life is a constant competition.

- Example B: Life is a harmony of mutual relations. Life is a non-zero-sum game. People can help one another and gain from one another without anybody necessarily losing. Different people can contribute different talents to one another. Some people are born and live under disadvantaged conditions, and they should be helped.

Note that "culture" is not a geographic concept. Within the same community, within the same office or even within the same family, you can find people belonging to different cultures. This is obvious in the case of generation gap. Example A stems from the hierarchical, competitive logic, while Example B is based on the mutualistic logic. There are many other paradigms of life stemming from other different logics:

- Example C: Everybody should earn his living. He can work as much as he wants or as little as he wants. But he must be self-sufficient. He must save for his rainy days. He does not need to help others. Do your own thing. Everybody minds his own business.

This is an individualistic, isolationistic paradigm. This paradigm is closely related to the logic of probabilistic independent events (Ref. 142). It is different both from hierarchism and from mutualism. There may be also several different paradigms based on one logic. An example is Example D, which stems from the hierarchical logic but is different from Example A:

- Example D: Life is exploitation. I have been exploited. I am a victim. It is not my fault. Rich people should give me what they owe me. I will go begging for a dime on the street, not because I am starving, but because I am entitled to the dime.

An example of a paradigm which is based on the mutualistic logic but is slightly different from Example B is:

- Example E: I tend to have surplus. There is no

need to save for rainy days because when I am in need, someone will help me. So I keep giving away my surplus.

It is interesting to note that seemingly similar or identical behavior may be governed by different paradigms stemming from different logics. Compare the following with the preceding example:

- Example F: I keep giving things to others because I want to have power over others. Others, who want to receive things from me, would have to obey me. I keep showing off my ability to give, because those who have not yet received anything from me would obey me in the hope of getting something from me.

- Example G: I give things to others because I want to be famous for being generous. I do not expect anything in return. I just want to be a generous man. I am a good guy and a do-gooder. I am superior to others.

Both examples are based on the hierarchical logic, even though the behavior may look identical to Example E, which is based on the mutualistic logic. As these examples show, culture cannot be identified from or defined by behavior and other observable manifestations only. The paradigm underlying the behavior, and the logic underlying the paradigm, must be understood.

The design of extraterrestrial communities does not have to be based on the paradigm and the logic which we are familiar with. We need to examine a wide range of paradigms and logics for their possible use in extraterrestrial communities.

Principles of community structure. There are, and can be, many different principles of community structure. We give here three principles as examples: *hierarchical, individualistic* and *mutualistic*. Theoretically, it is possible for each of the three to be either homogenistic or heterogenistic. In fact, a hierarchical community is heterogeneous in the sense of vertical stratification. But philosophically it tends to be homogenistic for the reason that hierarchism is related to deductive logic. A mutualistic community has no vertical stratification, and allows for horizontal heterogeneity. As discussed before, mutual causal processes are more capable of producing heterogeneity than the process of random independent events (individualistic systems). It is also useful to discuss the distinction between *Gesellschaft* structure and *Gemeinschaft* structure in terms of horizontal mobility as they are relevant to heterogenization and homogenization. Related are also two different textures of heterogeneity called *localization* and *interweaving*. Let us discuss them one by one.

First, about the notion of hierarchy. The word is used with different meanings in different fields of specialization. In physical sciences, the word is often used in the sense of unit organization: for example, atoms make a molecule; molecules make a biological cell; cells make a tissue; tissues make an organ; organs make a body, etc. This type of ordering is called "hierarchy."

On the other hand, in social sciences the word "hierarchy" is used in the sense of power structure: who has power over whom. A hierarchical society has a vertical power structure: somebody is at the top, and some people are at the bottom; in between, there are chains of command.

If the physical science definition of "hierarchy" is used, then all communities are hierarchical. However, when the social science definition of hierarchy is used, there are communities which are not hierarchical. Let me first give an example:

The Navajo universe consists of mutual relations between several types of beings as well as between beings within the same type: humans, animals, supernaturals, ghosts and natural forces (Refs. 152 and 153). Humans can manipulate supernatural and natural forces by using appropriate formulas, and these forces can influence humans; animals can influence people, and people can influence animals; etc. There is no hierarchy in terms of the direction of influences. Among humans, there were no hierarchical organizations before the white government made Navajos organize the tribal council and other organizational structures. There were no chiefs in the sense of political authority. Old men and women as well as people with experiences were sought out as advisers when occasions arose, but those who sought their advice did not have to obey them: they could ignore the advice or change the advisers. White people often mistook these advisers as chiefs or leaders.

No one, either human or supernatural, is perfect, omnipotent or omniscient. In fact, such concepts do not exist in the Navajo epistemology. There are not even the concepts "good" and "evil". The Navajo concept closest to our "good" is "nice". Each of the supernaturals can be both beneficial and dangerous to humans, depending on the cir-

cumstances and the way humans behave toward them. Each medicine man has his limits of ability, and even the respected medicine men "go dry" unless they know some harmful witchcraft. Talented speakers are pleasant to hear, but too much talking spoils its own beauty. Drinking is enjoyable. But too much drinking results in loss of reasoning power and in dangerous mistakes. There is no concept of punishment. The man who causes damage or kills someone is not punished but is made to repair the damage or to take care of the family of the dead man. If someone behaves against the usual custom, no one prohibits him, but people feel sorry for him because some misfortune will certainly result from the misdeed due to the disturbed harmony in the universe.

The purpose of life is to maintain harmony and to enjoy beauty and pleasure. The Navajos live scattered over a wide area. But when a family shears wool, plants vegetables, harvest crops, or builds a house, relatives and friends come great distances to help, even though the concept of "paid labor" is gradually changing this traditional pattern.

The cooperativeness of the Navajos is not based on a belief in the unity of society, on obedience to a supreme order, or on a centralized coordination. On the contrary, their cooperation stems from their respect for the individual. Their universe consists of informal interrelations between individuals and between clans. Even a child possesses his own livestock and is free to dispose of his own property in any way he wishes. Men and women are equal, and each person chooses his own way of doing things. For example a husband may choose to own a horse and his wife may choose to own turquoise necklaces, or vice versa. When they travel together, one may ride his horse and the other may walk.

An inevitable skepticism which most white Americans raise regarding non-hierarchical social systems is that hierarchy is necessary in a large society, and that non-hierarchical systems work only in small societies. (Here the word "hierarchy" is used in the sense of power stratification, not in the sense of organization units.) But the Navajo society has a population size of 150,000 on the reservation alone. This is about one-half of the size of Dayton, Ohio, or Portland, Oregon. It is fifteen times the size of all Model 1 communities combined together. The geographic size of the Navajo reservation is 24,000 square miles, equivalent to four or five New England states put together. But even if future extraterrestrial communities become much larger and more complex, the size and the complexity is not an obstacle in extending non-hierarchical principles because we can mobilize computer and communication technology.

The Navajo society is at the same time individualist and mutualistic: individualistic in the sense of allowing maximum individual freedom; and mutualistic in their cooperation. Let me illustrate:

In order to maintain harmony with other beings in the universe, one must know the complex workings of these beings and their forces. Ignorance causes mistakes, and mistakes bring misfortune and illness. Therefore knowledge is virtue. Since the purpose of Navajo religion is to maintain harmony, knowledge is religious. There is no separation between science, religion, ethics and esthetics in the Navajo culture.

The ceremony called "sing" exemplifies this inseparability of science, religion, ethics, esthetics and even economics, fun, social activity and psychological outlet. A "sing" is called for when someone becomes ill. A usual sing takes three days to perform, but some may last nine days. A sing is an occasion for a large, enjoyable social gathering. People who hear that there will be a sing will come from a considerable distance. They contribute whatever food they can; those whose crops were plenty bring more, and others less. But everybody can eat as much as he wants. There are games, dances, and other activities, though recently these extra activities are increasingly omitted.

For the patient, the feeling that so many people care for him is as much a part of the cure as the curing ceremony itself. The medicine man traces the sources of illness to some mistakes in the maintenance of harmony, and performs corrective measures which require highly complex and precise knowledge and formulae, as well as artistic skills in singing, sand-painting, etc.

An atmosphere of intense concentration dominates the ritual – not a concentration which can be called solemnity, supplication or humility, but rather like a concentration of an engineer operating a complicated machine. Minutely prescribed details have to be followed. But just as engineers take a break during their work, moments of relaxation, even joking, often punctuate the Navajo rituals. If a medicineman-apprentice is present, he may make many mistakes in singing. This often causes good-natured laughter both on the part of the apprentice himself and the audience.

The sings are frequent. During the summer there are one or two sings every week within one's reach. Therefore a Navajo can find frequent sources of food, social contact, and psychological outlet.

In addition to the contrast between the hierarchical, individualistic and mutualistic principles, it is useful to discuss the distinction between the homogenistic and heterogenistic principles. We must also distinguish between homogeneous and homogenistic, and between heterogeneous and heterogenistic. For example, the American society has been heterogeneous in its population, but ideologically it has been homogenistic with its concepts of melting pot, assimilation and standardization. Canada has been much more heterogenistic than the USA, with its official recognition of at least two cultural groups and two languages. Recently heterogenism began to emergy in USA, especially in the forms of ethnic movements and counter-culture movements, but some aspects of the ethnic movements and much of the women's liberation movement are aiming toward homogenization of the entire society.

Here it is important to distinguish two opposite concepts of social integration: one is homogenistic, and the other is heterogenistic. A non-white person who wants to move into a white neighborhood in order to behave like a white person is aiming at homogenistic integration. On the other hand, a Japanese who wants to move into a white neighborhood and build a Japanese house is aiming at heterogenistic integration. This distinction is relevant to the design of extraterrestrial communities: do the planners consider it sufficient to let all ethnic groups settle in the same sort of housing, or do they plan for different types of housing for different ethnic groups?

It is also important to consider two different principles of heterogenization: *localization* and *interweaving*. In localization, each of the heterogeneous elements separates itself and settles in one locality. Chinatown in San Francisco is an example. In localization, heterogenization increases between different localities, but each locality becomes homogeneous. On the other hand, in interweaving, each of the heterogeneous elements is not localized, but is interwoven with others. In this system the accessibility to different elements increases. This system creates no great differences between localities, but within each locality there is a great diversity. In an interwoven system, it becomes easier for the individual to heterogenize himself or to become something else than what he was. For example, a white person may eat Chinese food on Sunday, Italian food on Friday, learn Judo on Wednesday, etc. He may also become a full-time Tibetan monk. All these involve the concept of *Gesellschaft*, as will be discussed presently.

The German sociologist Tönnies made an important distinction between two types of social systems: *Gesellschaft* and *Gemeinschaft* (Ref. 148). There are many differences between the two, but what concerns us here is the difference that it is easy to move in and out of a *Gesellschaft*, but it is difficult to do so with a *Gemeinschaft*. *Gesellschaften* allow for horizontal mobility of people between them. For example, one can relatively easily change jobs between companies or agencies in USA, while it is more difficult to do so in Germany or in Japan. In this respect American companies and agencies are more of *Gesellschaften*, and German and Japanese companies are more like *Gemeinschaften*. One of the characteristics of a *Gesellschaft* is that it can amplify its eccentricity: those who do not like it will leave, and those who like it will join and stay. It can also easily eliminate non-conformists. Thus, homogeneity tends to increase within a *Gesellschaft*, though heterogeneity may increase between *Gesellschaften*. At the same time, a *Gesellschaft* may become very intolerant toward non-conformists.

There is an interesting relationship between the fact that the USA began as a colony of *voluntary* immigrants and the fact that its past philosophy and ideology has been homogenistic. USA simply began as a *Gesellschaft* with a slogan: "If you like our ideology, you are welcome. But if you do not like our ideology, go back to where you came from." Thus began the policy of assimilation, and immigrants were eager to become "standard Americans."

A *Gemeinschaft*, on the other hand, must deal with non-conformists differently. It must either suppress non-conformists or accept them. Thus, it may become either homogenistically totalitarian or heterogenistic, depending on its policy and philosophy. These are very important considerations in the design of extraterrestrial communities. The degree to which you make the extraterrestrial communities *Gesellschaft*-like or *Gemeinschaft*-like makes a great difference in the degree of homogeneity or heterogeneity they attain. As discussed earlier, there must be heterogeneity between communities as well as within each community.

However, heterogenization is only the first step.

The fact that heterogenization took place does not determine what the interrelations are between the heterogeneous elements. There are many possible types of interrelations:

Type	Gain	Loss	Remarks
Hierarchism	some persons	some persons	-
Separatism	-	-	No interaction
Symbiosis	all persons	no person	positive-sum
Parasitism	some persons	some persons	zero-sum
Antibiosis	no person	some persons	negative-sum
Mutual Antibiosis	no person	all persons	negative-sum

What we must avoid are the last three types. What we can experiment with are the first three types. Since Model 1 will have four different communities, a possible suggestion is that three of these communities can try the three first types respectively, and the fourth community can try the interweaving of the three types.

Family Structure. A usual American family consists of a father, a mother and their children. This type of family system is called the nuclear family system. In many cultures a family may include grandparents or other blood-related relatives. This is called the extended family system. In some cultures, such as West Alaska Eskimos, children move between different families from time to time. Though there is no established name for this system, let us call it the children-exchange system. In some cultures children may be disciplined by specific relations such as uncles, but not by their biological father or mother. Israel and Russia have a system of raising children collectively by child specialists away from the homes of the children's parents during the working hours of the parents. This is commonly called communal rearing of children. In USA, many young people are experimenting with alternative family systems. Some examples are commune and multi-marriage, in which several adults of both sexes live together with their children; lesbian colonies, in which there are no adult males and women live with their children (women go out for a date to get pregnant); male homosexual households with adopted or borrowed children; etc.

There are also various ways to produce blood-relations or non-blood relations which are called family. For example, in a tribe in Kenya, if a man is impotent, he asks one of his relatives to fertilize his wife, and if a woman is sterile, she may bring another woman into the household to obtain a child. An Eskimo may sleep with another man's wife in order that his children and her children become "cousins" who help one another as such. Americans practice adoption to obtain children. Artificial insemination is practiced in some countries.

Since we are already familiar with the nuclear family system, let us discuss applicability of other family systems to extraterrestrial communities. Undoubtedly many people would want to maintain the nuclear family system, but many would also want to explore other alternatives.

We have already mentioned one disadvantage of the nuclear family system: people who are reared in the nuclear family system have a tendency for mono-polarization. They tend to have a psychological need to seek and hang onto *one* authority, *one* truth, *one* theory, *one* god, *one* way of doing things, etc., and if they face many theories or many ways, they feel insecure until they make up their answer as to which one is right and which one is wrong, or which one is better and which one is inferior. They also have psychological monocular vision. And they tend to assume that their logic or their belief is the universal logic or universal belief, and try to advertise it or impose it upon others. They also tend to misinterpret and reduce others into their own logic. A typical misinterpretation is: "Different religions worship the same god by different names." They cannot see the difference between polytheistic harmonism and monotheistic homogenism. (A Christian missionary came to an African tribe whose universe consisted of harmony of 360 gods. Their religion was this harmony. They welcomed the missionary's god expecting that the new god would be a part of the harmony. But the missionary told them that their gods were wrong and there was supposed to be only one right god. Can you see how unharmonious *his* god was?)

Sex and Love. Contraceptives have separated sex from pregnancy. As more women choose to remain unmarried, sex and marriage become separated. And as professional and geographical mobility of people increases, love and marriage become more and more separated.

In the traditional American society, love,