consume more of their food-like substances. Sugar, colors, and salt are all evolutionary traps -- historically, these elements are not typically found in great abundance in the wild. These elements are signals to the body, telling the body to go get more of this substance. Alternatively, meat is not an evolutionary trap; "you" eat until it stops tasting good. If someone cannot stop eating, likely, s/he is in a hyperpallatable evolutionary trap designed by the processed food industry (who want to sell more food-like substances in order to make more profit).

Fundamentally, the quality of the food and resulting satiety hormones are what in large part facilitate healthy eating behavior, and not overeating. When humans are hungry, they eat; humans obey and have compulsion to eat when their body says they are not yet complete. A need to eat food can turn into a continuous compulsion to eat (non-stop eating) when the food being eaten is of low quality (in nutrient density). When people cut out the processed and low nutrient foods, people just aren't as hungry, continuously. Species appropriate high quality food to complete people’s need (of their body and mind) for food, felt as, hunger, and influencing a complex of other sensations.

> **INSIGHT:** *Food scientists working for corporations tweak tastes and creating cravings for profit.*

To distance oneself from access to the target of an addition often takes an environmental shift. There is no replacement for a healthy lifestyle. It is good not to have addictive food-like substances in one's home.

> **NOTE:** *Craving due to lack of nutrition can drive people to behave in unsane manners. It is common for people to behave irrationally prior to acquiring something they have a strong craving for; because, they become so hyper focused on the acquisition that they filter out and ignore the remainder of reality around them.*

3.14 Nutrient bioavailability

> *A.k.a., Nutrient bio-availability, nutrient utilization.*

The discussion of nutrients should also be framed in terms of [nutritional] bioavailability. Nutrient bioavailability is defined as the fraction of a nutrient in a food that is absorbed and utilized. Nutrients can be more or less bioavailable given the food form/composition it is found. In particular, plant sources of certain nutrients have a significantly lower quantity and bioavailability compared with animal derived foods. Nutrients in plants are often bound up with other compounds, significantly reducing their availability. Nutrient non-availability also refers to an individual's biophysiology state to uptake a given nutrient. The nutrition from plants comes as the cost of the plant locking up nutrients, or them being in a state that isn't accessible to human physiology.

Plants respond to herbivory through various morphological, biochemicals, and molecular mechanisms to counter/offset the effects of herbivore attack. To counter the herbivore attack, plants produce specialized morphological structures or secondary metabolites and proteins that have toxic, repellent, and/or anti-nutitional effects on the herbivores. (War et al., 2012) Plants have defense molecules as well as antinutrient molecules. Antinutrients are compounds that interfere with nutrient absorption by the human body.

Plant cell walls are significantly composed of cellulose. No mammal on earth has enzymes that can break down the cellulose from plant cells. Cellulose membranes can only be ruptured through the mechanics of repetitive grinding and the fermentation of bacteria. Human molars are not flat enough to grind plants very effectively and humans do not have the bacterial storage and physiological adaptation to ferment plant cells. The enzyme needed to digest cellulose is called cellulase. The gene for cellulase exists in a few animals, namely some insects (such as cockroaches, termites and silkworms), some earthworms, etc. Mammals that need cellulase have to make use of some additional specie(s) that does possess the gene. The most common companion species are bacteria and fungi, but also some protoctists. In these cases, parts of the mammal's digestive system are adapted to house large colonies of these companion species to ferment (and breakdown) the cellulose.

Humans have significant colonies of bacteria only within the large intestines, and there is little nutrient absorption in the human colon. Long before meat reaches the colon it has been completely broken down and absorbed. All of the enzymes for breaking down meat protein and fat (such as: pepsin, trypsin, chymotrypsin, lipase, and bile) are all manufactured by the human stomach, liver, and pancreas. Most of these enzymes are secreted into the duodenum (the first section of small bowel directly after the stomach).

Simply, humans have no need for significant additional ingested bacteria or enzymes for meat digestion, but they need significant outside help for plant cellulose digestion (e.g., fermentation and cooking).

3.15 Plant biochemical defenses

> *A.k.a., Aversive chemicals.*

Many plants have defense molecules that weaken the life system's of their predators. Plants produce Aversive chemicals to defend themselves and other organisms away. In other words, many plants have defense molecules that weaken human systems. Plants produce a diversity of defense chemicals as a cellular defense adaptation to being immobile. Plants are fighting for their existence, like every other living thing on this planet. They can't run away, bite or kick a would-be predator as most animals can so they've developed physical spikes (cacti, roses, etc.) and chemical "spikes" to dissuade such affronts. The nutrition from plants comes as the cost of the plant biochemical defense chemicals.

Plants do not actually want other organisms to eat them; and, given that they cannot runaway and are fixed to the ground, plants use chemicals as their defense. Plants have to have a defense mechanism against being eaten, and as such, they have evolved a vast array of very effective chemical toxins, most of which are immediately fatal for insects (because, it is insects that eat the most plant material, more than any other group of animals on the planet). Some plant toxins are also highly effective at immediately harming humans. Although some will be acutely illness inducing, many plant toxins don't kill people (and other higher animals) as effectively as they do insects, nevertheless, they will still severely harm humans over a lifetime of eating that sort of material.

Plant defense compounds and anti-nutrients are secondary plant compounds. Plant secondary compounds (PSCs; a.k.a., secondary metabolites) have high chemical and structural diversity and appear as non-volatile or volatile compounds. Conversely, a primary metabolite is a kind of metabolite that is directly involved in normal growth, development, and reproduction. Plants produce a variety of organic compounds over and above the primary compounds (i.e., carbohydrates, lipids, nucleotides, and peptides). These secondary plant compounds are derived from everyday components, but are not central to metabolism, hence their name, "secondary compounds". Many of these secondary plant compounds are produced for defense (because, plants can't move).

> **NOTE:** *Most vegetation (plants) in their natural state are poisons to humans. Further, there are chemicals in plants (a.k.a., vegetables/vegetation) that are harmful long before they are deadly.*

There are a variety of chemical compounds in plants that are likely to cause problems in humans when consumed:

1. Phytoalexins - are low molecular weight antimicrobial compounds that are produced by plants as a response to biotic and abiotic stresses and used for defense and communications.
    A. Phenolic phytoalexins (polyphenols):
        1. Terpenoid phytoalexins (e.g., saponins).
        2. Polyphenol phytoalexins.
        3. Flavanoid phytoalexins.
        4. Etc.
2. Plant defense proteins (i.e., amino acid chains, amino acid sequences):
    A. Lectin proteins (defense anti-nutrients).
    B. Gluten.
    C. Avenin.
    D. Histamine.
    E. Etc.
3. Plant defense acids:
    A. Phytic acid (phytates; anti-nutrient).
    B. Oxalic acid (oxalates; anti-nutrient). (Norton, 2023)
    C. Salicylic acid (salicylates; anti-nutrient).
    D. Isothiocyanates (amino acid derivative; defense against pathogen attack).
    E. Phytosterols (plant sterols and stanols).
    F. Ascorbic acid (vitamin C).
    G. Etc.
4. Other plant compounds:
    A. Non-heme iron protein.
    B. Omega 6 fatty acids (a primary life compound, but may be consumed in excess when seeds/nuts are processed into oils).

> **NOTE:** *Too much of some of these chemicals, over too long can break various aspects of the human physiology. (Norton, 2023)*

There are specific "potential" foods that most humans should not eat. For example, most humans should eat a high oxalate diet. Daily overconsumption of oxalate (more than the body can process) will cause it to be stored in body tissue. Tissue destruction, fibromyalgia and autoimmune diseases, such as rheumatoid arthritis and lupus, are all issues that can be related to oxalates; because, oxalate in tissues is not only damaging because of its crystal structure, but it also triggers the inflammasome reactions of the body's innate immune system. Calcium oxalate crystals that form in the kidney tubes can interfere with kidney function and cause urinary obstruction (e.g., kidney stones). Calcium oxalate crystals can also damage blood vessels, as well as organs including the liver and stomach.

Additionally, there is biochemical individuality, in that some people are more sensitive/reactive to these plant defense molecules than other people. Genetics, phenotype, and toxin load all play a role. People who eat too many toxins can build up a toxin load that will then make them more sensitive. Deficiencies in actual nutrition can make people more sensitive. Some people lack specific detoxification genes, or have a lesser genetic potential to detoxify. Also, generational exposure can change genetics to a specific organism is more capable of handling the toxins.

> **IMPORTANT:** *Some of these plant defense molecules, in the correct form and quantity (dose), can act as medicines for humans.*

3.16 Food sourced toxins

A.k.a., Human potential lowering substances.

Exposure to toxins can directly cause a massive drop in cognitive function and awareness. There are chemicals, such as sodium fluoride, that we know scientifically lower IQ. But, it turns out that there are also metals that do the same. We know that lead lowers IQ and gives those exposed a kind of "soft" lobotomy, it "dumbs you down". Mercury does the same kind of thing. Mercury is a potent neurotoxin. These toxic chemicals are introduced into the system through multiple vectors. Fluoride is added to municipal and bottled drinking water.

Production and pollution has introduced may sources of toxins and poisons (contaminations) into the food supply. Sources of contamination in food come from the following sources:

1. **Composition toxicity** - is a chemical found in the composition of the food itself (e.g., serine, cyanide, oxalates, ethanol, caffeine, etc.).
2. **Food matrix contamination** - mixed in with the food matrix itself (e.g., plants grown in heavy metals, etc.).
3. **Surface contamination** - carried on the surface of a food (e.g., pesticide, insecticide, diesel fumes, fungus, etc.).
4. **Processing contamination** - mixed in with food when processed, prepared, or cooked (i.e., non-stick surfaces, plastics, etc.). The manufacturing of ultra-processed foods, generally done by large industries, involves several stages of processing techniques and many ingredients, with many potential source of contamination. Even home cookware can contaminate food.
5. **Food contact material contamination** - comes from the packaging that food is placed in and has come into contact with (e.g., plastics).

Metaphorically speaking, the genes are the gun and the environment is the finger on the trigger, and whether the guns gets fired (e.g., getting cancer) or not depends upon what someone is exposed to; and, what someone is exposed to is possibly going to affect their great grandchildren.

> **APPROXIMATE PRINCIPLE:** *If you are not willing to put it in your mouth, then think most carefully about putting it on your skin.*

3.17 Food access and distribution

> **APHORISM:** *Healthy soil, healthy plant, healthy animals, healthy human being, healthy society.*

There are several ways to access food in a habitat service system:

1. Grow the food in your personal access dwelling area.
2. Access food after it has been grown for you by the cultivation service team.
   A. Access food that has been prepared for you in the form of a meal by the cultivation-cuisination service team.
   B. Access food in the form of raw ingredients and prepare the meal for oneself.

3.18 Cultivation for diet and flavor

> **APHORISM:** *If you don't like what comes out - change what goes in.*

Humans are designed to crave the foods that bring them what they need in terms of micro and macro-nutrient profiles. And, flavor is the mechanism. Since the 1950s, the flavor of whole foods has been getting progressively blander and blander. At the same time, the flavor of the foods that are not good for humans, the processed foods, have been getting more delicious and more irresistible. When flavor is changed, so is the incentive to eat. It is no surprise in the early 21st century that people are eating the wrong foods. It is a perfect storm of making the healthy whole foods taste bland, and the unhealthy foods take delicious and taste such that many people just can't stop eating it. Often, if it wasn't for the added flavoring chemicals people wouldn't eat the substrate. In the early 21st century, a lot of what is called "food" has the appearance (flavor or look) of food, but not the substance of it. (Schatzker, 2015)

> **NOTE:** *It was gas chromatography technology in the 1950s that allowed for the analysis of flavor and the creation of flavor technologies.*

It is a human requirement for optimal fulfillment to understand and experience food, which is through flavor. When humans eat, they don't experience nutrition, they experience flavor [as a signaling molecule that moves into a relational database that remembers past signals, and as input into a system that resolves a decision space into an auto-sub-conscious behavior (i.e., a behavior that requires a finitely resolving "will space" to override). Food seeking behavior is all about flavor. Flavor is the language of deliciousness and drive, and it is what makes food seem like, and is experienced as, food.

Those who experience out of control cravings have an relationship between desire and satisfaction (i.e., fulfillment) that is out of proportion. The desire/craving is spiked highly. Flavor is the cue to eat. In animal studies, you can get animals to eat a food they wouldn't normally eat by adding a flavor to it. Our behaviors are realized in a particular environment, a "cued" environment. Flavoring does cause the behavior; it is the imprinting of desire on something. It is what individuals become exposed to that ultimately determines their palate; it is the result of our experiences. Human genetics are realized in a particular environment, and flavor technology is one way in which the environment has changed in the early 21st century.

Flavor is a way of sensing for nutrients. Flavor is the language of nutrition. It is how humans identify where the nutrients are in nature. Flavors tell bodies where and how the nutrition of the physical body is. Flavors are human nutrition memory. The flavor system is a language, it is how humans identify where the nutrients are in nature. Flavor is the language of desire when it comes to food, because food is experienced on the part of consciousness as flavor. Human bodies associate flavor with nutrients. A craving for flavor is, in nature, a craving for something that will bring you the nutrient that you need. Flavor is the way the body remembers and knows where to find nutrients out there in nature. Humans evolved taste buds to find adequate nutrition in the world. The human body uses flavor as a desire/ sense to indicate the presence of nutrition and signal to start and stop consuming food. Nutrition comes in a biologocial package with its evolutionary co-factors, with one of the most significant being flavor. (Schatzker, 2015)

Individuals crave foods by taste and flavor, in order to meet their bodies "needed" nutritional requirements. It is possible here to "mess up" this natural sensing-and-drive system by cultivating food without great flavor and an accompanying "quality/rich" nutrient profile. Humans can come to understand food through the same lens by which it is experienced: how it tastes, through taste flavor chemicals. It is relevant to note here that nutrients have no flavor (on their own), with the exception of vitamin C. And yet, the way humans analyze chemicals is with flavor, and subsequent [mental-bodily] sensation.

> **NOTE:** *Sodium chloride is the only mineral with a uniquely attractive taste [to humans and other mammals].*

Modern society has begun adding signaling molecules, These signaling molecules are commonly known as "flavoring" (or, "aroma"),, to foods people would otherwise not eat. In some cases these signaling molecules isolated (e.g., terprnes) and sometimes macro-nutrient (e.g., sugar) form.

In general, individual humans who have not consciously negated (through will and bad information) the following of their flavor system can do a better job at feeding themselves. The human body tells its consciousness what is need as this or that, and therein, our body responds with a food seeking behavior. What individuals "love" about food is the projection of an image (desire of pleasure) that we know is going to bring us nutrition. Individuals know through an accurate sensing of flavor what their body needs. We follow the desire for flavor to identify foods that are nutritious, and the reading of the signaling molecules in the food tells an individuals consciousness us when to stop eating and stop searching. (Schatzker, 2015)

Humans have bodily equipment used to sense flavor, which is evolutionary and in DNA. It is how the body knows what is in its food before the body eats it. The preponderance of human DNA goes to the function of the human nose and tongue. A lot of human DNA is about the sophistication of the organism's senses of smell and taste, because it is important to the organism's daily, continued overall functioning, survival, and replication.

Humans experience taste as a combination of taste and smell. Humans are smelling when they are eating by means of retro-nasal olfaction (smell) receptors. This is a more powerful form of smelling than when someone sniffs through their nostrils. When someone eats, flavor molecules waft up the back of their throat, and move through a hole into the nasal cavity, which then connect with and stimulate olfactory receptors. Humans actually smell while they eat, and it is a process called, "retro-nasal olfaction". And, it is a more stimulating form of smelling than when they sniff through their nostrils. For consciousness, the identity of a food comes primarily from smell. Without smell, a natural food would only have some combination of the five "taste flavors" common to all foods (sweetness, sourness, saltiness, bitterness, umami). In other words, by degree, food would have a bland taste as there would be no signaling information for the sense of smell to identify the uniqueness of the food. It is the aroma (flavor) that gives a food its distinct body-sensation characteristics. And, it is someone's experience of aromatic flavors that allows them to predict the unique chemical composition of the food. It is relevant to note here that the brain, through consciousness training, can become more sensitive to the information (i.e., to detecting and analyzing chemicals and matching them with bodily needs). Which means, without good information while being exposed to bad information, individuals are more likely to make food choices that limit, or even harm, their bodily functioning.

The flavor of a tomato (or any organism) is telling the body "its delicious" come get your nutrients here. The flavor chemicals are intimately connected to the nutrients in the organism that may considered consuming. If humans take those flavors out if a tomato (or any food), and put them in a [processed food], for example, drink or chip; then, what has been done is created the sensation of nutrition, but delivered macro-calories (e.g., sugar) and/or isolated flavors (e.g., aromas) in place of the whole associable spectrum of nutrients.

> **QUESTION:** *What type of adaptation are you asking for from your body when you artificially flavor food?*

Since the 1950s flavorings have been introduced to the global society. At the macro-nutrient scale, its has been since the start of agriculture when humans began to cultivate separate food items and then mix them together to create hyperpalatable foods (e.g., wheat bread, cakes, etc.), with less nutrition. Thus, creating food that tells a lie, a nutritional lie that confuses the body's ability to sense food that is generally satisfying and leaves people feeling happy and vigorous. The consumption of "naturally" and artificially flavored foods and processed foods interferes with the way individuals naturally sense nutrition; it interferes with the way an individual would naturally sense it. Processing incentivizes people to eat food they wouldn't normally eat because the flavoring language that is sensed from the food has had "flavoring" molecules added to it to attract the body's desire (Read: food-seeking behavior). And thus, when people consume foods with flavor added, then food guidance behavior and eating can detract from optimal functioning.

Food that has "natural" or artificial flavors, or nutritionally deficient macro-nutrient sources, added together, tells a nutritional lie and disrupts the body's ability to feed itself properly, creating all sorts of seemingly irrational sorts of eating behaviors. (Schatzker, 2015)

Society in general, and habitat service systems in particular must grow food nutritionally dense and with flavor, for the local (and sometimes global) population.

In the early 21st century. agronomic performance as yield, and pest resistance, has increased significantly. But what was lost was flavor and nutrition. Selecting organismal DNA for for shell life and size, has bread out the flavor in food. Which is essentially a reverse evolutionary pressure. Food is now bread for size and flavor profitability. Companies got the market of consumers to eat more just by adding flavors. Nutritional wisdom is that what we want has some relationship to what we need. In general, we don't taste vitamin c, or minerals, for example. (Schatzker, 2015)

In general, the number one daily instinct in humans is for food, experienced as a pleasurable meal (i.e., a meal with flavor). Very few individuals have a strong enough will to overcome these cravings and desires. In community, it is understood that humans have a need to have access to real nutritions food that tastes flavorful.

Flavor is partially genetics and partially a factor of where and how something is grown. And, the flavoring added to processed foods makes them hyper-palatable, and so people overeat when they eat. Flavors added indiscriminately (Read: for profit) make people eat more food and eat food they wouldn't normally eat. People have a craving and their craving can't be met by what they are eating, and so they don't stop eating, or don't stop thinking about food. Experimentally, someone can get an animal to eat essentially whatever they want, by fooling it with flavor.

When flavor molecules are extracted or synthesized, and re-purposed, to what end and/or standards are they being re-purposed? Are they being re-purposed to manipulate consumers senses, or are they being re-purposed for our more optimized human fulfillment. When an essence (flavor) is taken and put in some other food product, then the body becomes confused and behaviors may not reflect an accurate sensory response toward fulfillment. When people fool their senses because of food choices, they change their food interface behavior.

Nature has endowed humans with their most sophisticated bodily system, because it requires daily (or, almost daily) human behavior to seek and consume nutrition for the body's, which is one of the body's most essential tasks: getting important nutrients to sustain and replicate. By manipulating this richest of senses, and most direct source of pleasure, early 21st century society has warped its relationship with the building blocks and energy source for human bodies, which require food. The market-State has taken a system designed to bring human bodies to a state of nutritional completion and turned it against humanity for profit and power. Flavor chemistry and bad information in the context of commercial profit artificially alters individuals relationship to food as that which in part individuals remake their bodies from.

When society incentivizes the wrong food, using flavoring and processing (over time), it sets up a negative cycle of eating where food loses its ability to satisfy the mental-body. The food tastes good in the moment, but over time the eating and craving experience becomes very unfulfilling. There is satisfaction in the moment, but not ultimate fulfillment in the nutrition and overall food experience and optimal bodily functioning. Food that cannot turn off someone's hunger will still make someone satisfied in the moment, but ultimately leave that individual wanting [ever more]. Industry wants the consumers' [satisfied] purchase, not their fulfillment. Its directive is not human fulfillment; its directive is profit.

Humans are moved to eat, motivated to eat, want to eat, desire to eat, and have a need to bring in nutrition; and, that eating [nutrition] need is a behavior made up of many decision, some individual and some societal. Importantly, however, what an individual desires (in the absence of sense manipulation) is needed by the body; here, the desire and the food are in alignment with optimal human functioning. (Schatzker, 2015)

What humans need is food that is being honest with them, so they can correctly interpret and respond with fulfilling behaviors. Human bodies will crave the nutrients they are deficient in, and flavor is the signaling language for that craving (Read: drive). The human flavor palate is critical in seeking out foods. At a fundamental level, humans don't make nutritional choices, they make flavor choices. That is how humans are genetically wired; they expect their food to be delicious, and they look forward to it.

Very often in the food environment of the 21st century, the foods eaten are the foods that should not be eaten. To a large extent, the cause of that behavior is the corruption of nutrition - nutrition signaling and nutrition structuring/cultivating. Society has corrupted nutrition by designing and producing foods that give people false signals, that give peoples bodies false information about the nutrients they contain. Flavorings incentivize food in an unnatural and deceptive way; they get individuals to eat food they wouldn't normally eat, and to overeat.

"Trust the child's intuition" when they are adverse to eating certain foods and favorable toward eating others (qualified, obviously, by flavoring and processing to make a food-like substance taste good). Food tastes good to an animal, because the food is good for the animal. Society ought to increase opportunities for free-choice food nutrition. The "free choice" calf experiment shows that animals make very different food choices when they have the free and natural choice. Calves did better at meeting their own needs than certified phds in animal nutrition. Eat when your hungry and listen to your cravings is a wise saying, that works when your cravings and hunger aren't being manipulated through artificially flavored food-like stuff (i.e., a different living environment) to which our body responds with behaviors that take away from our fulfillment. Eat something that tastes like it is and is both flavorful and nutritious, and you receive from your body "post-ingestive feedback" telling you to stop and that you are complete again (i.e., have all the building blocks until the next eat cycle). (Schatzker, 2015)

4 Food processing classification scale

The most well-known food processing classification scale is the NOVA Food classification system. NOVA is the food classification that categorises foods according to the extent and purpose of food processing, and not in terms of nutrients. (Monteiro et al., 2016) NOVA is considered a valid tool for nutrition and public health research, policy and action, in reports from the Food and Agriculture Organization of the United Nations and the Pan American Health Organization. (Monteiro et al., 2019)

Food processing as identified by NOVA involves physical, biological and chemical processes that occur after foods are separated from nature, and before they are consumed.

Foods may be consumed by someone in the following ways:

1. By themselves (such as fruits, nuts, milk, meat/fish, leaves, roots, saps, etc.).
2. As a main item in a culinary preparation (such as vegetables, grains, flours, meat, eggs).
3. As an accompanying items (such as a sauce that is oily, salty, sweet, and includes herbs, spices, and other similar items).
4. As food products ready to consume or heat (such as bread, cheese, ham; packaged snacks, soft drinks, pre-prepared frozen dishes).
5. As food-like products designed for entertainment of human pleasure centers.

NOVA classifies all foods and food products, including the individual items of culinary preparations obtained from recipes, into four groups. The NOVA scale takes several forms, the most common of which contains the following four slightly modified categories of processing of food and drink. (*NOVA classification reference*, 2018):

NOTE: *Most food is processed in some way.*

1. **Unprocessed or natural food** - are obtained directly from plants or animals and do not undergo any alteration following their removal from nature. These foods may be eaten raw, chilled, or lightly cooked.
    A. This category includes spring water. Unprocessed (or natural) foods are (raw or lightly cooked):
        1. Edible parts of animals (muscle, offal, eggs, milk), and
        2. Edible parts of plants (seeds, fruits, leaves, stems, roots), and
        3. Edible fungi, algae and water, after separation

from nature.

2. **Processed culinary ingredients (a.k.a., minimally processed food)** - are natural foods that have been made into something that accompanies a meal of food, or is mixed in with/as the food. These food ingredients have submitted to cleaning, removal of inedible or unwanted parts, and have had any of the following processes done to them: heating (cooking), fractioning, grinding, drying, fermentation, pasteurization, cooling, freezing, pressing, crushing, pulverizing, and refining or other processes that may heat, cool, or subtract part of the food. These processes are used by families to prepare and season food. These are food accompaniments made at home and at restaurants that use fresh ingredients. These food (as accompaniment) items may have some fats, salt, and sugar added. The fats and sugar come from natural foods (e.g., honey, maple syrup, butter, etc.). This category includes purified water. Note that there is a spectrum of what is considered a processed food:
   A. For example, these accompanying foods may or may not have added oils, fats, sugar, salt or other substances to the original food. These accompanying foods may or may not have additives used to preserve the food's original properties. Examples are vegetable oils with added anti-oxidants, cooking salt with added antihumectants, and vinegar with added preservatives that prevent microorganism proliferation. Instead, foods with added isolated anti-oxidants and antihumectants may be considered an ultra-processed food.
3. **Processed food** - are food products may be made at home and/or manufactured. Processed food is that which uses salt, sugar, fat or other substances (Group 2 *above*) added to natural or minimally processed foods (Group 1 *above*) to preserve and/or to make them more palatable (a.k.a., hyper-palatable). These products are derived directly from foods and are recognized as versions of the original foods. Most processed foods have two or three ingredients. In the market-State, these products are manufactured by competing industries. In community, some of these products can be made by families, and some require more complex machines and are manufactured, they are manufactured at all, by cooperating and contributing habitat service teams. Processed foods sometimes take the form of powders, and may take the form of liquids and gels. Note that there is a large spectrum here of what is considered a process food:
   A. For example, ultra-pasteurized and/or homogenized milk are ultra-processed foods. Examples of significantly less processed foods include: straight alcoholic beverages, salted, dried, smoked or cured meat or fish, canned fish (with or without preservatives), bacon, tomato sauces, fresh bread with flour, yeast, water and salt. Note here that bread could be considered a processed food (Group 3 *above*) if it is used as a significant part of a food meal, or it could be considered a processed culinary ingredient (group 2 *above*) if it is used as an accompaniment to a meal.
4. **Ultra processed food** - are manufactured food-like products. Ultra processed food are industrial formulations made entirely or mostly from substances extracted from foods (lipids, carbohydrates, and proteins), derived from food constituents (hydrogenated fats and modified starch), or synthesized in laboratories from food substrates or other organic sources (flavor enhancers, colors, and several food additives used to make the product hyper-palatable). This category may apply significant chemical modifications to former food substances for purposes and/or add chemical preservatives in order to preserve the product. Manufacturing techniques include: organic chemistry, extrusion, moulding, and preprocessing by frying. Liquid food (a.k.a., drinks, beverages) may be ultra-processed. Group 1 foods (*see above*) are a small proportion of, or are even absent from, ultra-processed products. Classes of additive only found in ultra-processed products include: dyes and other colours, colour stabilisers, flavours, flavour enhancers, non-sugar sweeteners, and processing aids such as carbonating, firming, bulking and anti-bulking, de-foaming, anti-caking and glazing agents, emulsifiers, sequestrants and humectants. Minerals and micronutrients may be added back to these food-like substances. Ultraprocessed foods are typically formulated by competing industries in a way that they are highly convenient (ready-to-consume), highly attractive (hyper-palatable), highly profitable (low cost ingredients).Ultra-processed products are made in factories with equipment not used by families cooking for themselves and friend (or in natural food restaurants). Ultra-processed foods reside at the height of the scale in terms of consumption after the processing of food, being very processed foods. Ultra processed foods often take the form of powders, liquids, and gels.

Given the science and the above categorization, NOVA makes recommendations about decisioning:

1. Of priority is to make unprocessed or minimally processed foods the basis of the diet.
2. Use processed culinary ingredients in a manner biochemically unique to the person eating the food. Do not use processed culinary ingredients that will weaken your body because of their biochemical interactions with you.
3. Limit the use of moderately processed foods, consuming none at all, or in small amounts.
4. Avoid all highly and ultra-processed food-like products.
5. Always prefer natural or minimally processed foods and freshly made dishes and meals to ultra-processed products.

It is relevant to note here that when pigs, and likely all humans, consume a significant ratio of their food as processed flours (powdered foods), then runaway inflammation in the digestive tract has the likely potential of occurring. Many ultra-processed foods are significantly composed of powders that have been turned into an food-like mix. The powders are either made through organic chemistry, or are the result a series of milling processes to reduce particle size, usually run through a sieve tool (for consistency) and measured in the micrometer (μm) range. Common powders include, but are not limited to: grain powders (flours), leaf powders (spice powder), sweetener powders (organic chemistry), etc.

4.1 Nutritional need calculations and qualifications

Humans have nutritional requirements for two categories of food:

1. **Micro-nutrients (a.k.a., biological micro-molecules, biologicaly active elements and molecules, micro-functional categories):** Micronutrients refer to essential nutrients required by the body in smaller quantities, such as vitamins and minerals, vital for various physiological functions and overall health, distinct from macronutrients like carbohydrates, proteins, and fats needed in larger amounts. Micronurtrients include:
   A. **Essential nutrients (a.k.a., essential exogenous co-factors)** - the body must acquire these from outside itself.
      1. Vitamins.
      2. Minerals.
      3. A microbiome.
   B. **Non-essential nutrients (a.k.a., essential endogenous co-factors)** - the body must have these and can make them itself. Co-factors include enzymes, peptides, bacteria (colonize), etc.
2. **Macro-nutrients (a.k.a., biological macro-molecules, "calorie" categories, macro-functional categories)**:
   A. **Protein** - most adults need some amount of complete protein per kilogram of body weight per day. Most people need enough protein that they no longer feel the drive to consume more.
   B. **Lipid** - most adults need enough lipids that they no longer feel the drive to consume.
   C. **Carbohydrate** - the human body can make its own carbohydrates through gluconeogenesis, and humans can consume exogenous carbohydrates. If the human body doesn't get enough carbohydrates from an exogenous source, it will makeup most of what it needs.

4.1.1 Eating animals and meeting nutritional requirements

The process of processing animals for food leads to the following meal amounts:

> **NOTE:** *The weight of an animal will vary based on breed, pasture conditions, and other factors. Some animals will have a higher/lower bone to meat ratio.*

1. Herbivore carcasses: On average, a 453.6kg (1,000lbs) herbivore will only weigh approximately 61% of its live weight once it makes it to the rail to be cut into portions (for sale in the market, or direct distribution in community). This approximate 39% loss during the slaughter and dressing procedure is a result of the animal being bled and the hide, head, hooves, and organs being removed. The remaining 61% of the carcass is referred to as the "hanging weight" (i.e., the weight of the animal when it is ready to be cut up while hanging on a rail). Note that once the carcass is on a rail it begins to leach moisture (shrink), which accounts for additional weight loss. This along with the fat and bone removed during the cutting account for an additional 18% loss. Summarily, a herbivore initially weighing 453.6kg (1,000lbs) will average around 195kg (430lbs) of non-organ meat cuts (e.g., steaks, roasts, ground beef, stew beef, ribs, etc.).
   A. With 0.453kg (1lb) meal servings, a herbivore with a meat only content of 195kg (430lbs) would feed complete protein to 88 people with one food meal each. The organs and bone marrow will add up to additional meals. Blood is edible, and can be collected and used as a human supplement, or as soil amendment.
2. Dairy animals: A dairy animal (particularly, cows) can provide meals to a lot of people over it's

lifetime. Given good pasture conditions, dairy cows gives roughly 25L (6.6 gallons) of milk a day, or about 55,000L over it's lifetime. The average lifetime of a dairy cow is 6 years, after which it usually turns into a beef cow. Hence, for a dairy cow, the total provided is 55 tons of milk and ~195kg of meat from one cow over 6 years, on average.

3. Porcine (a.k.a., pig, hog, etc.) carcasses: On average, about 57% of a hog make it from the pasture to an actual food-meal. A 114kg (250lbs) porcine will yield approximately 65kg (144lbs) of human distributable cuts. Around 28% of a porcine's live weight is inedible product removed during the slaughter and dressing procedure bringing our 114kg (250lbs) live hog to 81kg (180lbs) dressed. The organs of porcine animals are edible. The internal organs, hair, blood, and other parts account for most of the loss. Once the carcass is sanitary dressed, it is hung on a rail and placed in a cooler where it is quickly chilled. Once the carcass is thoroughly chilled it can be cut into useful end-user parts, bringing our 114kg (250lbs) carcass to 65kg (144lbs) of useful cuts (excluding organs).

   NOTE: *There is no need to trim the fat off of any cut of end-user meat. A user in community may of course ask for cuts to have the fat trimmed off, whereupon the fat would be used elsewhere (e.g., for oil production).*

5 Food (nutritional) access service

In a typical habitat, food can be accessed by users via the following methods and mediums (i.e., food access locations):

1. **A cafeteria through to restaurant (a.k.a., meal processing/creation service)** localized position-setting scenario (a typical cafe, restaurant, food court, etc.).
2. **A grocery store warehouse** browse and pickup for home heating/cooking.
3. **An restaurant combined with object transportation service**:
   A. A restaurant delivery scenario (via cyber-interface/online-interface) that delivers to:
      1. To building (e.g., dwelling) entrance pathway.
      2. To building (e.g., dwelling) hot/cold temporary storage.
      3. To a common dining specific area/zone, that is a separate location from the restaurant production unit itself (e.g., a private dining themed area, a picnic area, etc.).
   B. A grocery-store deliver scenario (via online-interface).
      1. To building (e.g., dwelling) entrance pathway.
      2. To building (e.g., dwelling) hot/cold temporary storage.
      3. To a common dining specific area/zone, that is a separate location from the restaurant production unit itself (e.g., a private dining themed area, a picnic area, etc.).
4. **A personal-access, or scheduled common-access, kitchen** where the user has the materials and tools to prepare the food as intended (to recipe) in private from the public.

6 Food (nutritional) production service

In a typical habitat, food is produced by teams of contributors via the following methods and mediums:

1. Cultivation ecological service system:
   A. Pasture cultivation [technical] units.
      1. Animal cultivation.
      2. Plant cultivation.
      3. Insect cultivation.
      4. Fungi cultivation.
      5. Bacteria cultivation.
   B. Environmentally controlled cultivation units.
      1. Animal cultivation.
      2. Plant cultivation.
      3. Insect cultivation.
      4. Fungi cultivation.
      5. Bacteria cultivation.
2. Biologics processing service system:
   A. Animal processing [technical] units.
      1. To process into usable materials, packaging, storage, and transport.
   B. Plant processing [technical] units.
      1. To process into usable materials, packaging, storage, and transport.
   C. Insect processing [technical] units.
      1. To process into usable materials, packaging, storage, and transport.
   D. Fungi processing [technical] units.
      1. To process into usable materials, packaging, storage, and transport.
   E. Bacteria processing [technical] units.
      1. To process into usable materials, packaging, storage, and transport.
3. Meal processing service system (a.k.a., restaurant, food production service):
   A. To process usable nutrients, previously packaged, stored and transported, into a food (i.e., natural foods) and/or food-like substance (i.e., ultra-processed foods). Meals of food (i.e., meals composed of food materials) are processed into needed and preferred meals.

7 Food storage

A.k.a., Food preservation.

Food preservation and techniques include, but are not limited to:

1. Open air storage.
2. Gas introduction into container storage. These are used either alone or as a mixture to extend the shelf life and prevent molecular breakdown of a wide variety of foods.
   A. Argon.
   B. Nitrogen.
   C. Carbon dioxide.
3. Salt may be added to a food to dehydrate and preserve it. Salt acts as a preservative by inhibiting microbial growth. Salt also acts by drawing water out of the cells of foods and bacteria through a process known as osmosis.
4. Vacuum storage (gas removal) of container. A vacuum pump is used to remove as much gas a possible from a container containing food.
   A. Including, sterilization of vacuum containers (e.g., cans).
5. Air depressor locks storage (simply reduce air in container). Some containers have air pressor locks that when depressed, push out gas.
6. Fermentation storage of food in a container. Bacteria and yeast can be used to ferment food in order to preserve it.
7. Dehydration (desiccation) storage.
   A. Including, freeze dehydration storage.
8. Temperature.
   A. Refrigeration (no freezing) storage.
   B. Freezer (freezing) storage.

8 Food failure modes

There are a variety of food failure modes; including, but possibly not limited to:

1. **Food safety (human-side)** - food that makes people immediately or cumulatively ill and/or diseased.
   A. Food-like substances that confuse human satiety signals immediately and/or over time.
      1. Wrong macro-nutrient mix.
      2. Insufficient nutrition per calorie.
      3. Satiety signal confuser (i.e., hyper-palatable and ultra-processed foods, drug attractants and neuro-stimulants).
   B. Food that is contaminated with a toxin/poison that harms someone immediately and/or over time.
      1. Package migration.
      2. Highly undesirable micro-organism introduction.
      3. Highly undesirable mineral introduction.
2. **Food mistreatment (food-side)** - food is to some relative degree mistreated when it does not get to live a free, healthy, and species optimal lifestyle, at any phase of life, before its life is taken to provide food to humans and fodder to other animals. Community, which requires organic life-body resources, seeks to cultivate and harvest those resources in ways that do not mistreat or harm life (besides; instantly kill "hunt" and/or "harvest" acquire in a care-taken manner, for food and fodder).
   A. Together, society may care-take a holistic habitat cycling pasture network, and a wild natural biospheric environment.

8.1 Food safety

A.k.a., Food cultivation and processing hygiene.

Hygiene can be a concern with food where harmful bacteria and other potential disease causing organisms may be on or near food. These organisms can cause acute and chronic medical incidents in humans and other animals. Improperly stored, prepared, or handled food can cause illness due to contamination by bacteria, viruses, parasites, or other pathogens. Food safety is of paramount importance in preventing foodborne illnesses that can lead to mild discomfort, severe health complications, and even fatalities. Adequate food safety practices encompass various measures, including proper storage temperatures, thorough cooking, cleanliness in food preparation areas, handwashing, and avoiding cross-contamination between raw and cooked foods. These practices are crucial as they help mitigate the risk of foodborne illnesses, ensuring that the food consumed is safe and free from harmful microorganisms that could otherwise jeopardize human health. Whether in homes, restaurants, or food production facilities, maintaining high standards of food safety is fundamental to safeguarding public health and well-being.

Preventing food contamination involves implementing proper food handling, storage, and preparation practices. This includes maintaining cleanliness in food preparation areas, cooking food to recommended temperatures, separating raw and cooked foods, ensuring food is sourced from reputable suppliers, and following good hygiene practices to reduce the risk of contamination and safeguard public health.

Typical sources of food contamination include, but are not limited to:

1. **Biological contaminants:** These include bacteria, viruses, parasites, and fungi. Common sources are:
   A. Raw food: Raw meat, poultry, seafood, and eggs can harbor pathogenic bacteria.
   B. Cross-contamination: When contaminated raw foods come into contact with ready-to-eat foods, surfaces, or utensils, pathogens can spread.
   C. Improper food handling: Poor hygiene practices, such as not washing hands thoroughly or not sanitizing food preparation areas, can introduce harmful microorganisms.
2. **Chemical contaminants:** These contaminants can include pesticides, cleaning agents, additives, and naturally occurring toxins.
   A. Plants themselves produce defense chemicals; are living (intelligent and conscious) beings and do not want to be eaten or defeated in genetic potential; they defend themselves against predation, like all categories of living being.
   B. Pesticides and chemical residues: Agricultural chemicals used on crops can remain on fruits and vegetables if not washed properly.
   C. Food additives: Incorrect use or excess amounts of food additives and preservatives can pose health risks.
   D. Environmental factors: Chemicals from contaminated air, water, or soil can find their way into the food chain.
3. **Physical contaminants:** These are foreign objects that unintentionally end up in food.
   A. Metal, plastic, glass: Bits of packaging materials or broken pieces from processing equipment.
   B. Hair, nails, dirt, blood: Foreign particles from handling or poor sanitation.

Packaging migration is the most common form of food service failure. Where there is packaging in combination with transport, there is a high potential for the migration of the packaging itself into the foodstuff itself. This material is not inert, and will often interact with human biochemistry [to some relative degree]. Migration is the transfer of chemicals from the packaging into the food. Frequently, packaging material transfers into the foodstuff being transported. In particular, plastics are polymerized monomers, which are by-products of oil refinery. Monomers are small molecules that are chemically chain-reacted (via catalysts) to make larger polymer molecules (I.e., up to 10,000 repeats of a monomer unit, as a larger molecule unit). The catalyst chemicals are not pharmaceutically pure grade, and often made-up of unaccountable constituents. The large polymeric molecules give "plastic" it's solid moldable constitution. Plastic, because of these properties, is highly lipophilic (will will migrate more easily into environmental lipids touching the plastic).

There are standards setting organizations that identity best practices for food packaging, including, but not limited to:

1. Food safety alliance for packaging standard (a.k.a., food stewardship standards, food safety standards). [iopp.org]
   A. List of chemical ought not be in packaging.
   B. List of ways food ought not be transported.
   C. List of ways food ought not be stored.
   D. Considering, list of ways food ought-not be cultivated.

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Technology Support: Information Processing Service System

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Abstract

An information-based society relies on information, including data, flows, and processes, in order to reconfigure itself optimally. Information is "stored" in repositories, which take up physical space. Information in the form of signals can be transported between physical spaces. Information can be displayed to a user, it can be monitored for changes, or it can be kept within a closed loop framework. A society can model itself informationally, the most useful representation being a complete simulation. In a real-world information system, there is information that is purely conceptual, there is information about objects, and there is information about distances between objects. And, in an adaptive information system, there is past, present, and possible future, information. All material designs are conceptual information (ideas) prior to their creation in a shapeable [spatial] environment. The configuration of objects in an environment has consequence, the results of which may be accepted as data [feedback] into an organizing information system. Early 21st century information systems are sustained through combined hardware-software packages known as computers. Computers store data in matter, and process data through patterns of electrical powered matter configurations. Calculation upon all societal-level accountable information allows for the unified socio-technical, economic planning of society at a global level without trade or coercion. In a community-type society, working groups develop an information system standard, and the InterSystem/ Habitat Information Team engineers the information systems service. Through decisioning processes, information that has been structured through some social ordering becomes integrated into solutions upon which teams take action. Actions have affects in a spatial environment; those effects are fed back as data. In a community-type society, all decisioning is transparent and must be understood prior to action. Information is a conceptual-type of access.

Graphical Abstract

Image Not Yet Associated

1 Information system overview

A.k.a., Information cycling service.

Information technology refers to information that can be input and calculated by a computer. Information service system technologies and mechanisms enable the collection, processing, storage, retrieval, and dissemination of information within habitats and among the human and machine populations of society. Humans and machines rely on the accessibility, accuracy, and reliability of information in taking intelligent and optimal decisions.

> **CLARIFICATION:** *Information systems "store concepts", which have meaning and usability to human beings. In the material habitat, objects known as data storage machines, have their internal structural configuration, their physical state, changed to record newly associated changes in concepts. In a model of the information system the interface between the transistor states in a physical computer and the 0s and 1s in conceptual software is known as the "abstraction layer" or "abstraction hierarchy". The abstraction layer in the model provides additional functioning for high-level programming language code/instructions.*

At the habitat-scale, the information service system may canvas (include):

1. A whole sector (fixed, or scheduled),
2. only a building in a sector (fixed, or scheduled), and/or
3. may cover only a room(s) in a building during a scheduled period of time.

Information-type technology spaces and activities include, but may not be limited to:

1. Computer software database server and application centers (i.e., data processing centers).
2. Computational, architectural, and power systems are required.
3. Visualization systems are required to present information to the user.
4. Control systems are required to accept inputs from the user.

Information technology development-type exploration spaces and activities include, but may not be limited to:

1. Computer engineering laboratories and workshop productions.
2. Computational, architectural, and power systems are required.

Among the many functions of the information system of community is to:

1. Organize the world's information and make it universally accessible and useful.
2. Facilitate communication and collaboration within society.
3. Facilitate the operation of the other habitat service systems.
4. Facilitate education and skill development through accessible learning resources.
5. Support decisioning processes by offering data-driven insights, analysis, and intelligence.
6. Support transparency and the timely dissemination of information.
7. Enable efficient coordination of community-related data and processes.

Societal information service support systems have the following main functions:

1. **Search [software]:**
    A. Public: An option to search for other users' public documents.
        1. Google Docs have privacy settings controlled by the document owners, and only documents shared with specific permissions might be searchable to some extent. However, Google doesn't provide a direct means for users to search all public Google Docs collectively. To search public google docs use the following search command: site:docs.google.com/document/d "search term"
    B. Personal (a.k.a., private): An option to search only your own encrypted documents.
2. **Collections [software]:**
    A. Public: Public data-service systems; repository and interface for accessing public data.
    B. Personal (a.k.a., private): An option to collect, store, and interface in the future with data that has been accessed, and then stored in a privately encrypted user-folder within data-storage.
3. **Analyses [software]:**
    A. General artificial intelligence software: Public artificial intelligence system for information access and data analytics.
        1. An option to use artificial intelligence tools to produce mathematical certainty analyses on collected data.
    B. **Analytics software:** Public analytics programs that can execute data analysis operations for their users, per requirement.
        1. An option to use statistical software tools to produce mathematical certainty analyses on collected data.
4. **Syntheses [software]:**
    A. **General artificial intelligence software:** Public

artificial intelligence system for information access and data analytics.

1. An option to use artificial intelligence tools to produce accurately (and certainty supported) modeled mechanisms and socio-technical human systems.

B. **Design software:** Public design programs that can execute the visualization of users' designs, per requirement.

1. **Computer aided design (CAD; a.k.a., computer-aided design)** tools to produce accurately modeled mechanisms and socio-technical human systems.
2. **Computer aided engineering (CAE; a.k.a., computer-aided engineering)** tools to produce accurately modeled assemblies.
3. **Building information modeling (a.k.a., object information modeling)** tools to produce complete object models where all geometry has associated information.
4. **Programming (a.k..a., computational) software** tools to produce information processing software and intelligent software agents.

The information technology coordination and control principle is:

- Information systems accept inputs (coordination) and commands (control) from authorized users, where technically possible and appropriate.

Information technology (IT) can be separated at a high-level into the following categories:

1. **Information computation technologies:** Technologies that perform computational tasks, including processing, analyzing, and managing data and algorithms.
    A. Examples: central processing units (cpus), microprocessors, and dedicated computing hardware.
2. **Information storage technologies:** Technologies that record/store data for short-term storage to long-term archival.
    A. Examples:
        1. Hard drives (hdds): magnetic storage devices for long-term data storage.
        2. Solid-state drives (ssds): flash-memory based storage offering faster data access.
        3. Optical drives: CDs, DVDs.
        4. Registers: temporary storage areas in processors for immediate, rapid data access.
3. **Information visualization technologies:** Technologies in this category are divided into analogue and digital, focusing on how data is represented visually.
    A. Analogue visualization: Traditional methods of creating visual representations of information.
        1. Examples:
            i. Pen and paper, whiteboards, physical models, and printed diagrams.
    B. Digital visualization: Uses computer hardware to create graphical displays of data.
        1. Examples:
            i. Graphical processing units (GPUs): specialized hardware designed to accelerate the creation and rendering of images, video, and animations in a computer system.
            ii. Displays: devices like monitors, projectors, and VR headsets that present digital visuals to the user.
4. **Information sensor technologies (incoming signal transduction):**
    A. Environmental sensors: Measure and record physical parameters (temperature, humidity, light).
    B. Biometric sensors: Capture biological data (fingerprint, retina scanners).
    C. Motion and position sensors: Detect and record movement (accelerometers, GPS devices).
    D. Audio and visual sensors: Capture sound and images (microphones, cameras).
5. **Information transportation technologies (outgoing signal transduction):** The "movement" of data across different locations, which can be achieved through various means.
    A. Examples:
        1. Physical (sound): older and more traditional methods, such as modems using telephone lines where data is modulated into sound waves.
        2. Electro-magnetic (light): modern, high-speed data transmission using fiber optics and wireless communication technologies, including wi-fi, cellular networks, and satellite communications.

2 Information systems

Information systems can store data, compute data, prevent errors, and overall, improve quality[-of-life]. Shannon (1949) discovered the genetic code in 1961, and in combination with computer science, the scientific discipline of information appeared (materialized within the context of a habitat as the Information Service System). There are categories of potential information:

1. There is a connection between information and consciousness.
2. There is a connection between information and materiality.
3. There is a connection between information and physics.
4. There is a connection between the information output of all individuals.

The scientific understanding of information can be used to construct efficient, optimal, and aligned procedures, documents, information, and material service systems. The fundamental foundation of the mode of production ought to be objective information about individual users and contributors, and about a habitat service system that provides resources, services and objects for human need fulfillment.

Axiomatically speaking, there would be no humans without the objective information that allows life, and humans in particular, to exist in the real world and evolve/adapt. Objective information allows accurate assessments, safe and effective constructions, and most efficient use of resources to fulfill objective human requirements. To consciousness, information exists at the conceptual level (which becomes physically encoded at the material level into functional objects). The human organism is a physical genetic [information] code evolved into a vessel to house consciousness in this world.

At the core of all information systems lies data, the fundamental unit upon which these systems are constructed. Data serves as the raw "material" that, when processed, becomes the information used to enhance decisioning, optimize operations, and ultimately improve quality-of-life. Whether stored, computed, or used to prevent errors, data is "transformed" through information systems into valuable insights and knowledge. The versatility and utility of information systems in interpreting and manipulating data have revolutionized countless aspects of modern existence, from daily conveniences to advanced scientific research. This transformation of data into actionable information (a.k.a., intelligence) is the cornerstone of service systems designed to meet human needs effectively and efficiently, reflecting the interdependence between data, information, and the advancement of society.

2.1 Data storage

One of the primary functions of an information system is to store data (i.e., it represents the data storage (hardware and software) infrastructure for the habitat service system. The utility of data is inextricably linked to the effectiveness of data storage solutions. Data storage is a critical component of information systems, ensuring the accessibility, reliability, and security of data. It is the foundation that supports the entire life-cycle of data, from initial creation to eventual archiving or disposal. Efficient data storage systems are designed not only to house vast quantities of data but also to facilitate swift retrieval and analysis. The integrity of data storage directly impacts the quality of information extracted, influencing decision-making processes and the operational agility of organizations. In an age where data is continuously generated at an unprecedented scale, robust data storage strategies are vital for maintaining the vast repositories of knowledge that drive progress and innovation.

At the foundational level, a data storage system is structured around the concept of "records," which represent discrete units of data. These records are subject to a variety of processes that enable the organization and coordination of the stored information. These processes include:

1. **Adding a new record:** This is the introduction of new data into the system, expanding the existing database with additional information.
2. **Deleting a current record:** This is the irreversible removal of a record from the storage system, effectively erasing the data it contains.
3. **Changing the status of a record:** This can involve one or both of the following adjustments:
    A. Modifying the information contained within the data record, which may involve updating, correcting, or revising the data elements.
    B. Altering its classification within the overall data structure, which could mean re-categorizing the record or changing its relational position to other records within the system.

Every stored data entry/point consumes some amount of space, measured in (sets of counts, "#"):

1. Bits (#) - single unit of memory.
    A. KiloBits (#,###); wherein, each "#" unit is a bit.
    B. MegaBites (#,###,###); wherein, each "#" unit is a bit.
2. Bytes (########) - group of eight single units of memory.
    A. MegaBytes (##,###,###); wherein, each "#" unit is a byte (8-bits).

    A. GigaBytes (

In the early 21st century, general computer storage and memory is often measured in megabytes (MB), giga-bytes (GB), and tera-bytes (TB).

Note here that the human linguistic numeral system counts in base 10 with powers of 10 (because, humans have 10 fingers):

- 10^1 = 10 count
- 10^2 = 10*10 = 100 count
- 10^3 = 10*10*10 = 1,000 count
- . . .
- 10^6 = 1,000,000 count

Computers count in base 2 with counting powers of 10 (a base 2, because computational units can only be in one of two states at a time, a "1-on" state or "0-off "state, only):

- 2^1 = 2 bytes (0-off or 1-on)
- 2^2 = 2*2 = 4 bytes
- 2^3 = 2*2*2 = 8 bytes
- . . .
- 2^{10} = 1,024 bytes (1 KB)
- . . .
- 2^{20} = 1,048,576 bytes (1 MB)
- . . .
- 2^{30} = 1,073,741,824 bytes (1 MB)
- . . .
- 2^{40} = 1,099,511,627,776 bytes (1 TB)
- . . .
- 2^{50} = 1,125,899,906,842,624 bytes (1 PB)

2.1.1 Data storage types

There are a variety of ways and mediums for storing data.

2.1.1.1 Accessibility-based data storage

In the context of accessibility-based data storage there are typically two types:

1. **Immediate access data storage (a.k.a., hot storage)** - for when the data is need right away. Designed for data that requires instant access, typically used for frequently accessed information.
   A. Systems: Includes high-performance SSDs, RAM-based storage, and networked storage solutions like SAN and NAS configured for high speed.
   B. Use cases: Real-time processing, transactional databases, and active workloads.
2. **Delayed access data storage (a.k.a., cold storage)** - for archival purposes. Designed for data that is seldom accessed and stored primarily for archival purposes.
   A. Systems: Utilizes low-cost HDDs, magnetic tapes, and cloud-based archival services.
   B. Use cases: Long-term data retention, compliance archives, and backup.

2.1.1.2 Hardware-based data storage

In the context of hardware data storage there are typically two types:

1. **Solid-State Drives (SSD):** Offers faster access times and reliability, commonly used for hot storage.
   A. No moving parts.
2. **Hard Disk Drives (HDD):** Traditional storage medium with larger capacities at a lower cost, commonly used for cold storage.
   A. Mechanical parts, slower access times compared to SSDs.
3. **Hybrid Solutions (HHD):** Combines SSD and HDD technology for a balance of speed and storage capacity.

2.1.1.3 Location-based data storage

Data can be stored in different physical locations:

1. **On-premises storage (a.k.a., local storage, habitat storage):** Data storage solutions located physically within an organization's local infrastructure. On-premises storage refers to data stored and accessed within a single habitat, or within the local region of a habitat.
2. **Cloud storage:** Remote storage provided by the whole habitat network, offering hot, cold, and scalable storage options accessed over the internet.
3. **Hybrid cloud storage:** Combines on-premises and cloud storage to leverage the benefits of both environments.

2.1.1.4 Data storage methods

A.k.a., Storage framework architectures.

There are three common methods for the storage of data:

1. **Object storage:** This method stores data as discrete units, known as 'objects', within a flat namespace, which allows for massive scalability. Each object includes the data itself, a variable amount of metadata, and a globally unique identifier. Object storage is particularly adept at handling unstructured data, making it a preferred choice for cloud storage platforms due to its flexibility and ease of access over distributed networks.
   A. Manages data as objects in a flat address space.
   B. Ideal for scalable, unstructured data.
2. **File storage:** File storage organizes and manages

data in a hierarchical structure of files and folders, similar to the directory structure on a computer's operating system. It provides a familiar system for data retrieval through named directories and subdirectories. Network-Attached Storage (NAS) systems commonly use this type of storage, offering convenient sharing and file-level data management across a network.
   A. Organizes data in a hierarchical file system of folders and files.
   B. Commonly used for NAS systems and general file sharing.
3. **Block storage:** Block storage divides data into uniformly sized volumes or 'blocks' that can be individually managed and configured. Each block acts like an individual hard drive and is controlled by an external server operating system. This fine-grained control of data blocks is optimal for environments like Storage Area Networks (SANs) where performance and complex operations, such as running databases or transactional data processes, are required.
   A. Divides data into fixed-size blocks.
   B. Suitable for SANs and performance-sensitive applications like databases.
4. **Distributed ledger storage (a.k.a., internet blockchain):** Data in a blockchain is stored in a chain of blocks, with each block containing a set of transactions or records. Unlike block storage, where 'block' refers to a fixed storage unit, a blockchain's 'block' is part of a secure, chronological chain. This method differs from file and object storage where data can typically be modified or deleted. Once data is entered into a blockchain, it cannot be altered or deleted, which ensures data integrity and trust in the system.
   A. Utilizes a decentralized and distributed ledger to store immutable records across a network.
   B. Each 'block' in the chain contains a timestamp and transaction data.

2.1.2 Database data storage requirements

Every entry in a database requires memory space. Take, for example, a pasture cultivation plant database. Pasture cultivation plant database and monitoring systems use a geospatial databases (e.g., PostGIS), which can store all 8 decimal places of each GPS coordinate and allot for quick lookups of plants in a given region. Assuming that only basic plant attributes of data are stored, then the total containing data is something like:

1. 4-8 bytes for a unique plant ID,
2. 16 bytes for positioning,
3. 2 bytes for classification,
4. 4 bytes for real or estimated planting date,
5. 4 bytes for last known size (or point cloud relational table, discussed below), and likely,
6. a number of other small columns for other plant metadata.

Given 1 through 6 above, each plant data entry could take up 50 bytes of more of memory space. This would only be about 200MB for a 4 million plant farm. Now, add in:

1. A related table of plant treatments (X plant was fertilized with Y product on Z day) and you have 4-8 bytes for that unique plants ID again,
   A. 4 bytes for an administered date,
   B. 4 bytes for a treatment ID, and probably several of these rows for each plant.
2. Assume the entire farm has been treated 25 times over a season. That's about 2.3 GB of treatment data.

Now, add in current point cloud data from current sensors (not recorded):

1. A typical point cloud format holds 15-16 bytes per point, with compression ratios of 3-5:1. So assuming 16 bytes and a 4:1 ratio, we get 4 bytes per point. These points likely also hold information about the plant at that point, like blossom type, age, etc. Even with 1000s of points per plant, and 4 more columns of metadata (24 bytes/point) there is approximately ~100GB of data. Factor in 25-30% additional space for data indexing.

2.2 Data exchange

An application programming interface (API) is a common piece of software that helps different apps exchange data. An API acts as an interface that enables communication and interaction between different software systems. An API is a set of classes, libraries, dynamic link libraries, etc., that helps someone build a software.

NOTE: *An API is not an interpreter or compiler.*

2.2.3 Data networks

A.k.a., Information networks, information technology networks, networks.

Networking, in its various forms, provides the architecture and pathways through which data is shared, facilitating the exchange of knowledge, communication, and transactions (in the market) across the globe. This fundamental process of sharing and coordinating information is underpinned by distinct types of networks. Excluding the corporate networks prevalent in the early 21st century, two primary categories emerge (Dixon, 2024):

1. **Protocol networks (a.k.a., protocols):** Such as the World Wide Web (HTTP) and email (SMTP), which form the cornerstone of internet communication. Protocol networks refer to the set of rules and standards that control the exchange of data over the internet. These protocols are open systems controlled by open standards software developers and other network stakeholders. Protocols enable digital communication by defining a common language and methodology for different digital systems to interact with each other. Protocol networks are fundamental to the functioning of the internet, enabling various services and applications that require data exchange.
2. **Blockchain networks (a.k.a., blockchains):** Are a decentralized ledger system for secure and transparent information transfer and verification across peer-to-peer networks. Blockchains are databases; hence,blockchain networks are a form of database network, unique due to their structure and function. A blockchain is a distributed ledger that maintains a continuously growing list of records, called blocks, which are linked and secured using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. This design inherently resists data modification, promoting transparency and security, making blockchain networks ideal for applications where integrity and accountability are paramount.

2.3 Computers

A.k.a., Data computation, compute data.

The development of computers has revolutionized the way information is processed, coordinated, and utilized. As tools for data computation, computers serve as the digital counterparts to material resources in the physical world. These computational resources, which rely on electrical power, mirror the efficiency and effectiveness dynamics found in the coordination of physical resources using discrete logic. Data, encompassing all meaningful information, necessitates the use of computers equipped with data storage devices to be recorded, retrieved, analyzed, and searched within an information system. Moreover, the versatility of computers is demonstrated in their ability to be programmed with a set of instructions to perform diverse tasks on data. Computers operationalize algorithms and execute ("run") programs (a.k.a., plans), thus serving as the tools for translating [raw] data into intelligence.

Whereas, at the physical-level, there are material resources, at the digital-level, there are computational resources. All computational resources involve electrical power in their calculation. Like physical resources, computation resources can be used efficiently and inefficiently, effectively and ineffectively. Data is all information that has meaning; it can be recorded, retrieved, analyzed, and searched (in an information system). All data requires computers with data storage devices. Computers can be programmed (instructed) by users to do different things. Computers execute ("run") algorithms/programs.

Computers are composed of coding in an integrated material hardware and instructional software form:

1. **Computer:** A computer is an electronic device that is capable of receiving, processing, storing, and outputting data according to a set of instructions or programs.
   A. **Computer hardware (a.k.a., electronic computing material objects):** Hardware are a set of material compositions that enable electronic computation.
   B. **Software (a.k.a., data programs, informational instructions):** Programs are a set of instructions [that record and compute data electronically].

Computers always solve for:

1. *x inquiry*,
2. given *y information* set,
3. in a prescribed # of steps,
4. wherein, the prescription is also known as: software-algorithm-code.

2.3.1 Software code

A.k.a., Software, code, algorithm.

Coding, in the information sense, is all about how data is to be computed; the instruction set for some data set. In general, coding is the process of writing instructions into some medium; it defines the logic, the instructions, and the actual execution of those instructions using computational (mitochondrial, electrical, bit) resources:

1. Biologicals, as in, DNA and RNA. Here, instructions are given to biologicals. Here, "coding" instructs the body of biologicals.
2. Objects, as in, writing instructing into the production and usage of "machines". Here, instructions are given to material resources. Here, "coding" instructs the construction and operation of physical machines.
   A. Control surface machines (actuator machines).
3. Interfaces, as in, writing instructions in a programming language to create "software" or "applications". These instructions specify how data should be processed, manipulated, and computed by a computer. Here, instructions are given to

computer resources. Here, "coding" instructs computational systems (a.k.a., computers binary / trinary).

NOTE: *Humans always monitor.*

At the highest level, coding (instructing) can occur to the material and informational (data) threads of society:

1. Manufacturing is material [en]coding [information>materials-engineering].
2. Programming is software [en]coding [information>data-engineering].

At the level of the information system, code concerns:

1. A set of instructions (or rules) that computers can understand (a metaphorical "recipe" for electrical bits, instead of food bits for a kitchen "recipe").
2. People write code and code writes code (artificial intelligence). Code instructs computers, and computers are the material base of the information system. Herein, everything powered by electricity uses code (in the computational sense), and everything that uses code is powered by electricity.
3. In the market-State, there are many names for people who create computer code: coders, programmers, developers, artificial intelligence (AI) large language model (LLM) prompters, computer scientists, software engineers, etc.
4. In community, there are people who interact with software:
   A. Software engineers:
      1. Software developers - teams who develop/ engineer software as a global and local habitat master-planned solution. Someone who develops software for inclusion in the habitat master plan.
      2. Software technicians - teams who use software in operations. Other habitat service InterSystem teams use software to complete their operational processes (required activities). Someone who knows how to use a software system in operations is a technician of that operating (software) system.
   B. Software socio-technicians - people who interact with other's physically, helping others with their use of software and also when otherwise simply mediated by software.
5. Computers run on binary (1 or 0) logical code. The binary code can be used to construct [computer programming] languages (like Python, Perl, Visual Basic, Java, Javascript, among others). Many coding languages share similar basic features. A text file (with instructions) written in a particular programming language is called a program (think of a set of instructions).
   A. There are “low-level” (binary) and “high-level” (virtual operation) coding languages. Lower-level languages more closely resemble binary code while higher-level languages get the computer to do operations directly useful for a user.

2.4 System errors

Information systems can exhibit errors that can disrupt operations and compromise data integrity. Errors occur and ought to be minimized. Errors ought to be avoided. Some errors are more dangerous than others, and hence, the resolution of a list of errors is an ordered priority list. All errors need to be actionable. It is always best to prevent errors.

All errors fall into four categories, based upon their located presence in some functional-system structure:

1. Errors that are transient, and trying again will likely work.
   A. Error reporting: State what happened, when to try again, and what to do in case the situation persists.
2. Errors that the end user can fix. Things like login name or password incorrect, syntax errors in user input, etc.
   A. Error reporting: Explain what is wrong and give the user information about how to fix it.
3. Errors that the system technician administrator (admin) can fix. Things like errors in file permissions, running out of disk space, network naming failures, etc.
   A. Error reporting: Well written and professionally complete.
4. Errors that represent bugs in the code, that the developer has to fix. Divide by zero, data structure corruption, flawed mechanism, etc. The code has to try and figure out if the problem is a hardware failure, or software failure. Errors in this category (a) shouldn’t happen, (b) should be automatically reported, and (c) the user should get a reply from the developer.
   A. Error reporting: Well written and professionally complete.

2.4.1 Error codes

All errors are reported with appropriate error number as part of the error message. Any search of the unified information system (Internet) with that code will bring the user to a complete explanation, next steps, and required links. Thus, error messages need to:

1. Explain to the user what happened,

2. What can be done.
3. Who can help.

2.4.2 Information system failure modes

There can be many kinds of problems, but security and data corruption ones are especially serious.

3 User information account coordination

A.k.a., Information identity account coordination.

Users of information systems typically have personalized accounts that serve as secure access points to enter and interact with the system. These accounts are integral to identifying and authenticating individual users, thereby ensuring that information within the system is accessed and managed responsibly. User accounts may hold varying levels of permission, determining what data or functionalities a user can access, modify, or manage. By maintaining distinct user profiles, information systems can provide useful information and experiences, maintain data privacy, and log activities for security and compliance purposes. The effective coordination of these accounts is crucial for safeguarding the integrity and appropriate transparency of the information system's data and services.

User account coordination within information systems is traditionally handled through centralized authentication services that rely on databases to store and verify user credentials, such as usernames and passwords. Cryptographically securing protocols are used here to ensure the integrity of accounts. Information technologies used to provide account services are:

1. **Cryptographic algorithms** - ensure that the data within the directory services is securely stored and transmitted. When a user logs into a system that uses LDAP or Active Directory, their password is typically encrypted using cryptographic hash functions. This means that even if the directory data were intercepted during transmission, the actual credentials would remain concealed.
2. **Software directory account services** - are the protocols that coordinate all accounts as units (objects) in the information system.
   A. **Centralized software directory account services technology**, for instance:
      1. Lightweight Directory Access Protocol (LDAP) - an open, vendor-neutral protocol for accessing and maintaining distributed directory information services over an Internet Protocol (IP) network.
      2. Active Directory (AD) - a service developed by Microsoft, is a directory service specifically for Windows domain networks.
   B. **Decentralized software directory account services technology**, for instance:
      1. Blockchain network software technology applied to user account management. A blockchain serves as an immutable ledger that records and verifies user identities and permissions without a central authority.

Blockchain-based identity coordination systems may enhance security by distributing the verification process across multiple nodes, making the system less vulnerable to attacks and unauthorized access. Additionally, these systems can give users more control and trust.

i. Herein, "smart" contracts are self-executing contracts with the terms directly written into code, can be used on a blockchain to manage access control and permissions in a transparent and immutable manner. The use of blockchain for user accounts is particularly promising in areas requiring high security, such as financial services, healthcare, and government services.

4 Software

A.k.a., The software plan, softwarization plan.

At a high-level, the following software is necessary:

1. **Project coordination software:** Coordinates projects and project information.
   A. Access control: Manage permissions and access to project resources.
   B. Locating data: Efficient search tools for finding project-related information.
   C. Versioning data: Track changes and manage different versions of project documents.
   D. Documenting: Creation and maintenance of project documentation.
   E. Commenting: Enable stakeholders to leave feedback and discussions on documents.
   F. Surveying: Collect input and feedback from project participants.
   G. Approving: Formal approval processes for project milestones and documents.
2. **Communications organization software:** Coordinates communications and communication information.
   A. Contacting: Tools for initiating contact between project participants.
   B. Chatting: Real-time text communication for quick discussions.
   C. Scheduling: Organize meetings and manage project timelines.
   D. Videoing: Video conferencing tools for remote meetings and presentations.
   E. Recording: Capture and archive video meetings and important discussions.
3. **Collaborative information design software:** Design tools.
   A. Text-based publishing software: For creating and editing written documents.
   B. Vector-graphics software: Tools for drawing and designing vector-based graphics.
   C. Technical-object CAD software: Advanced drawing tools for technical and engineering designs.
   D. Simulation software: Simulate project designs and concepts for testing and demonstration.
4. **Habitat operations software:** Habitat production operating software.
   A. Service specific: Software tailored to manage and operate specific services within the habitat.
5. **User profile software:** Coordinates individual user identities and permissions.
   A. Surveying: Tools for gathering user opinions and needs.
   B. Agreeing: Mechanisms for users to consent to

terms, agreements, and policies.

C. Habitat Residency Profile: Manage residency information and related privileges.

D. Habitat Access Profile: Control access to various habitat areas and services.

6. **Intelligence software:**
   A. Artificial intelligence agency coordination and data analytics support: Use AI and data analytics for project optimization, predictive analysis, and coordination.
7. **Financing software:**
   A. Token protocol: The underlying technology for creating and managing digital tokens.
   B. Token wallet: Secure storage and management of digital tokens for transactions and access within the habitat.

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Technology Support: Communications Service System

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Last Working Integration Point: *Project coordinator integration*

Keywords: communications, communication system, communication service, telecommunications,

Abstract

When signals are moved coherently, communication occurs and information becomes available as required. Communications refers to signal [electromagnetic object] generation and processing. For communications to occur, the entity receiving the signal must be able to interpret and/ or otherwise understand the signal. In order for entities in different locations to understand each other's signals, the subjects (entities) must have a common protocol for sharing and or otherwise generating meaningful signals (Read: object signal creation). To the entity that generates the signal and a receiver of the signal, the signal is a message (i.e., an information packet with meaningful data). Communicating systems use protocols for coherently sharing messages. At the software level, each subject-relevant meaning is encased in a technical level meaning that ensures data (meaning) is received without error (e.g., header and footer metadata). In order for sharing to occur, there must be a protocol used by all subjects and systems. That communications protocol provides pre-determined information flow responses based on provided information. A protocol defines the format of signals (messages), which is a language, though it is not commonly called that. Programming languages are those languages whose semantics describes computations. Protocols in general do not describe computations; though, some specific protocols do, such as, RPC protocols. A protocol uses well-specified signals to express well-specified meanings, but rather few of them (only two different meanings). Thinking languages (e.g., English, Mandarin, Russian, etc.) allow people to think about and to coordinate (or not) their work and service lives. Pilots and traffic controllers use protocols to communicate, some of which are highly complicated. Essentially, a protocol is a language and a language is a protocol, and subjects must share a protocol in order to think and communicate coherently. The communications service system is information oriented.

Graphical Abstract

Image Not Yet Associated

1 Communications system overview

Communications systems are utilized to convey messages or data. Communication system use signals to communicate messages between creative and receptive entities. A signal is a packet(s) of data. A signal is another word for propagating energy conveying communicative information (i.e., a communication).

A communications service is a technological service that:

1. Creates signals and messages, and
2. transmits that "information", and
3. receives related "information".

Communications-type technology spaces and activities include, but may not be limited to:

1. Sensors and actuators (transducers) placed and interconnected within an environment.
2. Network operations centers.
3. Computer-network interface technologies.
4. Pathways of signal transfer, including:
   A. Physical conduit (i.e., conductive channel such as copper or fiber-optic).
   B. Visual/unobstructed pathway (i.e., light).
5. Computational, architectural, and power systems are required.

1.1 Communications system electrical engineering design

Items to be included in the design and analysis of a communications system are:

1. Electrical engineering for a communications systems shall, at a minimum, indicate the following:
   A. Human factors engineering standards and reasoning.
   B. System riser diagram.
   C. Equipment legend.
   D. Conductor type and installation requirements.
   E. Device type and locations.
   F. Backup power sources where applicable.

1.2 Physical signals processing

Communications physical signals engineering has two modalities:

1. The analog: An "analog" signal is a constant load.
2. The digital: A "digital" signal is a pulsing load. In the case of an analog system, the load is constant in value; and in the case of the digital, the load cycles. A digital signal is a signal that varies with time (i.e., it is a signal with frequency, period, and amplitude).j

1.3 Transduction

A transducer is a device that can use any source of signal that is to be converted from one form of propagation material propagation to another, such as heat, light, sound and pressure, which are then converted, usually into an electrical form. In the case of the microphone, energy in the form of airwaves is converted into electrical [analog] signals, which are then sent into the exciter unit. Transduction is the process of using a transducer tool as a technological device to transfer ("transform") energy (flow) from one form to another (from trans- "across" + ducere "to lead"). The process of transferring flow/energy between carriers (i.e., converting one form of energy to another) is known as transduction. Of note, transducers are used in electronic communications systems to convert signals of various physical forms to electronic signals, and vice versa. Examples of transducers include a battery (energy carried by chemical composition which may be transferred to an electrically conductive circuit); a dam (energy carried by falling water transferred to an electrically conductive circuit).

There are different types of transducers in relation to their:

1. Source of power:
   A. **Active transducer** - Active sensors require an external power sources to operate, which is called an excitation signal. The signal is modulated by the sensor to produce the output signal. For example, a thermistor does not generate any electric signal, but by passing electric current through it, its resistance can be measured by detecting variations in current and/or voltage across the thermistor. Active means the intentional application of power from a source point.
   B. **Passive transducer** - Passive sensors generate electric signals in response to an external stimulus without the need of an additional energy source. Such examples are a thermocouple, photodiode, and a piezoelectric sensor. Passive means the power from the general environment.
2. System input and/or output:
   A. **Sensor (common input transducer)** - A sensor is a device that receives (and may respond) to a signal or stimulus. Sensors detect the presence of flow/energy, and changes in or the transfer of energy. Transducer is the other term that is sometimes interchangeably used instead of the term sensor, although there are subtle

differences. Human beings are equipped with at least 5 different types of input transduction sensors.

B. **Actuators (common output transducer)** - An actuator is a device that is responsible for moving or controlling a mechanism or system; it is any device that turns an input signal into a physical action. It is operated by a source of energy (e.g., mechanical force, electrical current, hydraulic fluid pressure, or pneumatic pressure), and it converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment to move a load.

C. **Bidirectional transducers -** A device that convert physicals phenomena to electrical signals and also convert electrical signals into physical phenomena. Examples of inherently bidirectional transducers are antennae, which can convert conducted electrical signals to or from propagating electromagnetic waves, and voice coils, which convert electrical signals into sound (when used in a loudspeaker) or sound into electrical signals (when used in a microphone). Likewise, electric motors may be used to generate physical torque if externally powered by electricity, or they may be used to generate electricity if externally powered by a material flow (e.g., water, wind, light, etc.). Motors are bi-directional because they can produce electricity (electromagnetic rope motion) and can produce mechanical motion (atomic motion).

NOTE: *A lens is an antenna for EM radiation in wavelength of [visible] light. A wifi antenna is a lens for EM radiation in the wavelength of gigahertz light frequency (above visible). In general terms, throughput is the rate of production or the rate at which something can be processed.*

TABLES

Table 58. *Table shows the positives and negatives of on-chain and off-chain storage types. Source: Zolfaghari, A.H., Daly, H., et al. (2008). Blockchain applications in Healthcare: A model for research. ARXIV. https://arxiv.org/ftp/arxiv/papers/2008/2008.05683.pdf*

Factors	Chain Storage Type	
	On-Chain	Off-Chain
Cost	Higher cost of data redundancy and computations.	Lower disk space and computations lead to lower costs.
Time and speed	It consumes more time to compute every transaction and synchronize all nodes.	One or a few providers keep a copy of the data. Hence, less time is consumed for synchronization.
Computations	Every transaction needs computations.	The data are queried for patient treatment; hence, computations are needed only at the time of data generation and fetching.
Replication	All full-nodes replicate the data.	Based on the solution, one or a few providers keep the data.
Privacy	Data is revealed for computations.	Data is kept by the providers until a physician request to access patient history.
Immutability	Information is in the blocks. Hence, no one can alter it without having at least 51 percent of the network power.	One or a few mediums keep the data.
Scalability	Nodes need more resources to join the system.	Easier scalability features.
Data availability	All full-nodes are available to reply to the information requested.	The data provider should be accessible.

Technology Support: Transportation Distribution Service System

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Abstract

When objects are moved coherently, transportation occurs and access [to objects] becomes available as required. Transportation refers to object translocation (i.e., the movement of an object from one location to another). For transportation to occur, the entity receiving the object must be able to available to receive and to understand the object. In order for entities in different locations to understand each other's outputs, the subjects (entities) must have a common protocol for sharing and or otherwise generating meaning from objects. An object is a structure (shape) that may or may not have meaning to subjects. Transporting systems use hardware and software for optimizing the safe and effective transportation of objects. At the software level, each object is encased in a material enclosure to some varying degree, which transports the object without loss of the object. In order for the population-scale sharing of objects to occur, there must be a hardware transportation network signaled by environmental sensors upon which a software platform calculates the optimal packaging and logistics for transportation solutions. A transportation package moves through a network of well-specified signals-object processing devices that guide it to an intended destination. Within a habitat service system, these destinations can be integrated with the infrastructural environment. For instance, think of an integrated pneumatic distribution system in an office or at a bank teller, and then imagine such a system (or, its equivalent) at the city level. Transportation can be easily scheduled or requested on demand. Some transportation is of a higher priority than other transportation, for instance, a medical evaluation, or the introduction of medical personnel into an situation. The transportation service system is materially oriented. All transportation is integrated within and between cities. Consider the reduced transportation logistics when everything needed is in a life radius and is in walking distance.

Graphical Abstract

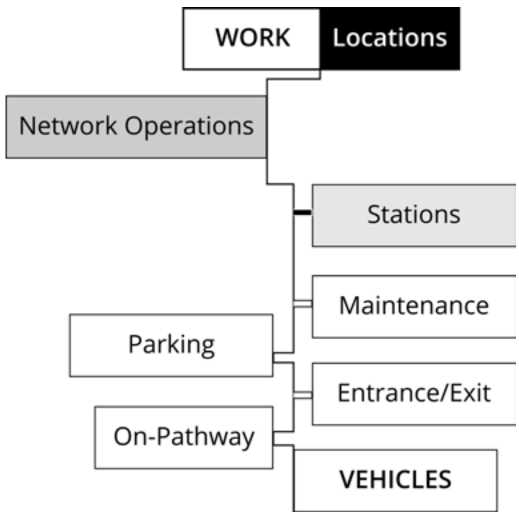

Figure 7. *Image depicts operation of a transportation service system for the transport network of a inter- and intra-habitat service system.*

1 Transportation and distribution system overview

APHORISM: *Transportation is the blood of a city.*

The transportation-distribution system is the system that transports, stores, and facilitates access to all objects around the material environment. This system includes all the resources, activities, and technologies required to transport and distribute materials. This system involves transportation/distribution processes. All access centers (where people go to browse and pickup products) are part of the transportation and distribution system. Typically, transportation has to do with the movement of objects (or, people), and distribution has to do with where and/or how the objects are delivered (e.g., are they accessed by people at a central location, or are they delivered to an architectural address). This also includes packaging and storage locations for objects. Transportation simply means the movement of objects (materials) from one place to another. Logistics is the process of planning and executing the [efficient] transportation and storage of objects/materials from a point of origin to a point of usage. Note that transportation simply means the movement of objects, whereas logistics refers to the efficient and effective coordination (a.k.a., planning) of their movement. Transportation services include the movement of goods and services, people, and animals from one location to another by rail, road, air, sea, cable, space, or pipeline.

Across the global landscape, the strategic incorporation of mass-rapid transit systems, in tandem with localized mass-object rapid transport, significantly enhances the efficiency of object delivery across and within habitats. This integrated approach ensures the optimal distribution of goods, while also providing individuals with fluid and seamless transportation options. Such connectivity facilitates easier movement between different habitats and throughout the global habitat network, that exceed walkable distances, streamlining both logistics and daily commutes for a more interconnected and accessible world.

Transportation services can be divided into two domains with the following primary sub-elements:

1. Transporting:
    A. Infrastructure (hardware and software).
        1. Appropriate infrastructure.
    B. Vehicles (or, conduits, paths).
        1. Appropriate vehicles.
    C. Operations.
        1. Standard operations.
2. Transportable:
    A. People.
        1. Safety.
        2. Efficiency.
        3. Comfort.
    B. Objects.
        1. Safety.
        2. Efficiency.
    C. Electro-magnetics (Read: signals, information).
        1. Safety.
        2. Efficiency.

2 Transportation service system design

In a master-planned habitat, the transportation system is designed in conjunction with the rest of the habitat to provide for the transportation carrying capacity needs of the habitat.

A transportation system necessitates the following transportation elements:

1. **Transportation pathways** (a.k.a., channels, streets, paths, courses, guideways, routes, lanes, lines, roads, tracks, trails, pavements, lines, links, etc.) guide, carry and/or move:
    1. People walk on footpaths (a.k.a., walkways, etc.).
        i. Intentional dirt footpath.
        ii. Intentional built footpath.
        iii. Unintentional footpaths (common where master planning was insufficient).
    A. Objects.
    1. Guided via a rail, conduit, or line.
    2. Unguided:
        i. Manual unguided (e.g., manual wheel vehicle).
        ii. Automated unguided (e.g., automated wheel vehicle).
2. **Transportation hubs** (a.k.a., transit stations, terminals, destinations, nodes, ports, hubs, centers, interchanges).
3. **Transportation vehicles** (a.k.a., shelters for transport).
    A. **Passenger vehicles** (for humans).
    B. **Freight vehicles** (for means of production).
    C. **Local object transport vehicles** (for object transport within a local/regional habitat).
    D. **Vehicular transportation access locations** (a.k.a., access points, start-points and end-points, in-points and out-points). Transportation vehicular entrance and exit locations.
    E. Medium over which vehicle transports:
    1. Lane:
        i. Raw land surface (dirt road).
        ii. Paved land surface (paved road).
        iii. Rail land surface (rails).
    2. Atmospheric medium (air).
    3. Water medium (on or in water).
4. **Operations service stations** (a.k.a., operations centers, stations, centers).
    A. **Transportation vehicular storage center** (a.k.a., parking stations, parking locations).
    B. **Transportation vehicular maintenance station** (a.k.a., maintenance locations).
    C. **Network operations station** (a.k.a., network operations centers).
    D. **Human loading stations** (a.k.a., locations where humans get on and off vehicles).
    E. **Object loading stations** (a.k.a., object loading locations).
    F. **Object packaging station** (usually, after a service-object is manufactured and assembled, it is packaged for safe transportation).

A transportation system necessitates the following life and production elements:

1. Production (manufacturing and construction) systems are required for production of all service-objects used in the transportation service system.
2. Computational systems and power systems are required for development, manufacturing-construction, and operations.

Transportation can move people and objects within and between the following areas:

1. **Local transport (a.k.a., cartage)** - transport within a single habitat itself.
2. **Regional transport** - transport between a local/regional network of habitats.
3. **Continental transport** - transport around a continental size area.
4. **Global transport** - transport around the planet.

Common transportation timing terminology includes, but may not be limited to:

1. **Actual time of arrival (ATA)** - is the actual clock time that some thing arrived (via transport).
2. **Estimated time of arrival (ETA; estimated time of delivery, ETD)** - is the estimated clock time it that some thing is expected to arrive (be delivered) at an intended destination.
3. **Actual time of departure (ATD)** - is the actual clock time that some thing started to be transported.
4. **Estimated time of departure (ETD)** - is the estimated clock time that some thing is expected to start being transported.
5. **Estimated transit time (ETT)** - is the estimated time (in seconds, minutes, hours, and/or days) it will take for some thing to arrive (be delivered) at an intended destination.
6. **Transit time** – refers to the total amount of time from the goods being picked up to the point of delivery.

There are three basic forms of transit control:

1. **Manual:** A manual users engages with the vehicle

transport network under their own self-control, and uses social and/or external automated/standard control signals for coordination (e.g., traffic lights).
2. **Hybrid:** A user monitors the automated system, and if something goes wrong, can respond with some degree certainty in some set time-frame.
3. **Automated:** Driverless vehicle control (i.e., a fully intelligent automated system/network with no significant monitoring of individual units present, and a longer human response time).

Transportation vehicles can be "driven" within and/or over the following mediums, as in:

1. Things that you fly.
2. Things that you drive on the ground.
3. Things that you drive under the ground.
4. Things that you drive in buildings.
5. Things that you drive on the surface of the ocean.
6. Things that you drive under the surface of the ocean.
7. Things you drive in space.

Transportation always occurs along pathways in the sky, on the land, in the land, where people, vehicles, and materials move. Transportation pathways that people, vehicles, and matter move along can be classified according to their positions within, on, or above a landscape. The positioning of a transportation pathway may be:

Note that "porous" means porous to rainwater.

1. Above ground, and non-porous (e.g., above ground rail). Above ground transportation fixtures are generally not made to be a porous material.
2. At ground level,
   A. Porous (e.g., porous pavement).
   B. Not porous (e.g., non-porous pavement, trench drain, etc.).
3. Bellow ground level,
   A. Porous (e.g., french drain).
   B. Not porous (e.g., basement, tunnel).

Distribution has to do with where and/or how the objects are delivered after production:

1. Are they to be fixed into the habitat.
2. Are they to be accessed at a central location (a centralized architectural address for browsing, testing, and pick-up).
3. Are they to be delivered (to an architectural address).

For any given pathway on the landscape, it is important to calculate and visualize:

1. The purpose of the path, to carry transport.
2. The width of the path (i.e., street).
3. The length of the path.
4. The depth of the path.
5. The internal zoning (if any) of the path.
6. The materials built into the path.
7. The water seepage potential and water seepage appropriateness for the path?
8. The water directed flow potentials and end-points for the path.
9. The final look of the path.

A transportation system is the root of the idea of a physically network[ed system]. Transportation systems have:

1. Nodes in a network are the intersections and destinations.
2. Linkages are the actual paths/roads and interchanges that allow cars/vehicles to be translated across the network.
3. Physicality as existing, locatable objects.

Important questions for the design of a transportation service system are:

1. Visualize the habitat's pathway grid/layout.
2. What is the target for the number of vehicles on a path?
3. What percentage of people use what type of transport?
4. What percentage of people use what type of paths?

There are two/three categories of transportation within and between habitats:

1. Transportation within a habitat.
   A. Transportation over landscape within a habitat.
      1. Human.
      2. Non-human.
      3. Mixed.
   B. Transportation within and between buildings in a habitat.
      1. Human.
      2. Non-human.
      3. Mixed.
   C. Transportation by access type:
      1. Personal and common access object transportation:
         i. To residency.
         ii. To current location.
         iii. To common location.
      2. Contribution access:
         i. To common team access work places.
         ii. To current work location.
2. Transportation between habitats.
   A. Human transportation between habitats.

B. Non-human (object) transportation (a.k.a., freight).
3. Transportation within and between heavy production centers and habitats.
   A. Human transportation.
   B. Non-human (object) transportation (a.k.a., freight).

Most cities in community are walking-oriented cities. Where walking oriented cities become large enough, they will incorporate a network of trains, trams, partially grid connected buses, overhead monorails, or underground metros. Mass rapid transportation (i.e., a train system) is used to transport objects between habitats and between habitats and heavy production centers.

Using techniques on the ground, there are several ways to mass rapid-transit people within and between cities.

1. **Manual transit** - the vehicle requires a manual driver. Here, manual transit does not mean powering the vehicle oneself (e.g., bicycling); instead, it means simply, driving (as in, controlling the location and speed of) the vehicle.
   A. Self as driver.
   B. Transportation team member as driver.
2. **Autonomous transit** - the vehicle does not require a human driver, or even, local monitor. Autonomous vehicles are driven by intelligent computational drivers.
   A. Smart/intelligent vehicle (e.g., autonomous driving car, smart bus, or smart rail transit).
3. **Flat path transit (a.k.a., road vehicles)** - the vehicles is placed on a path/road with traffic markings.
   A. A smart bus is an autonomous bus-linkage vehicle that follows flat path traffic markings.
4. **Rail transit (a.k.a., train track vehicles)** - the vehicles is placed on a railed track.

2.1 Transportation prime movers

Transportation prime movers move people and object over a path-grid (path-layout) design. All prime movers are machines that cause motion (unlike machines that compute data).

Prime Movers serve to drive other components and cause motion. Examples of prime movers include, but may not be limited to:

1. Organic:
   A. Animals used as horsepower.
2. Minerals:
   A. Internal combustion engine (i.e., sparked; e.g., gasoline, diesel, natural gas or propane, biofuel, hybrid, hydrogen, amonia, etc.)
   B. External combustion (e.g., steam engine or gas turbine).
   C. Electric motors or drives constant torque, speed control, small size.
   D. Pneumatic motors or drives or piston actuators (i.e., sparkless).
   E. Hydraulic systems (e.g., actuators) limited motions, low weight.
   F. Clockwork or wind-up motors provide limited power, but high reliability.

2.2 Habitat pathway layout design

A.k.a., Habitat pathway grid design, street layout, street network, street pattern, path network, path layout, road layout, road network, transport path network, transport network, site configuration, grid-path, layout-path, grid-layout path network.

In many ways, the transportation pathway of a city forms the who grid/layout of the city. The transportation pathway of a city (a.k.a., path network, road network), forms the fundamental movement surface/floor formed into a grid-layout upon which the entire urban fabric is built. This grid-like structure serves as the circulatory system of the city, determining how people and objects move, how people connect, and how essential services are distributed and accessed. The design and planning of this transportation network play a pivotal role in shaping the life experience, the functionality, sustainability, and quality of life within the city. In many ways, a path network fixes a habitat's site configuration.

The design of the internal transportation pathway of a habitat is a crucial semi-permanent fixture in the layout/ configuration and life-experience of a habitat:

1. Accessibility, connectivity, and stress: Path networks determine how different areas within a habitat are connected and accessible, and the amount of stress anyone experiences when moving along the path itself (because, transportation system itself). The location and layout of paths dictate where people and vehicles can travel, which, in turn, influences sector inter- and intra-positioning.
2. Sector divisioning and land use: Paths often act as boundaries or divisions between sectors of land. The path network can define the size, shape, and orientation of these sectors (including all zones and sub-sectors), affecting land use.
3. Zoning and land use: Local zoning regulations and land use plans are closely tied to the path network. The types of roads, their widths can influence which type of habitat service sub-system a sector/ area is zoned for.
4. Building placement: The placement of paths can dictate where buildings can be constructed.

5. Traffic flow and safety: The design and configuration of the path network are crucial for traffic flow and safety. Path layouts, intersections, and traffic signals affect the movement of vehicles and walkers, shaping the overall urban environment.
6. Aesthetic and environmental considerations: The path network can impact the aesthetic and environmental aspects of a habitat. Walkable paths with landscaping and pedestrian-friendly features may create a more appealing and sustainable environment.
7. Infrastructure integration: Infrastructure elements such as utilities, drainage systems, and public/common transportation often follow the path network. The location of paths determines how these services are distributed and integrated into the habitat.
8. Traffic calming measure: Mechanisms that cause cause manual drivers of vehicles to slow down their vehicle's speed and pay more attention when they are driving at intersections with high pedestrian traffic.

The design and configuration of pathways within the built perimeter environment of a habitat exerts a significant influence on both the experiences of individuals utilizing the pathway network and the overall efficiency of transportation. The layout of these pathways can either facilitate or hinder movement and transport efficiency. The physical arrangement of artifacts and infrastructure along the pathway network plays a crucial role in shaping not only the movement patterns of individuals but also the effectiveness of the transportation system.

The importance of smart and well-thought-out path layout design is essential for:

1. Efficient mobility: A well-designed path network ensures efficient mobility. It allows for smooth traffic flow, reduces congestion, and minimizes travel times, improving overall accessibility within the city.
2. Habitat operations (in the market, "economic vitality"): The layout of transportation pathways can impact the ease of contributors completing their work (i.e., "economic vitality") by influencing the ease of object/goods movement and access to services/businesses. Efficient transport networks in community facilitate logistics optimization, and in the market-State, they facilitate trade, support local industries, and attract investments (leading to two very different material city configurations).
3. Common heritage sustainability: Sustainable urban planning integrates all habitat services into a socio-technical InterSystem team service that optimizes human need and human preference fulfillment (for personal-, common-, and contribution-access).
4. Social connectivity: The path layout can either connect or divide individuals, families, and people. A well-connected network promotes social interactions, inclusivity, and a sense of belonging among residents.
5. Life-interactivity: The path layout can either facilitate human engagement with different habitat services as they move through the sectored landscape, or disengage them from participation in all that humanity has to offer.
6. Safety and security: Careful design can enhance path safety by minimizing traffic conflicts, improving visibility at intersections, and providing adequate crossings. It contributes to reduced accidents and improved security.
7. Resource efficiency: A smartly designed and integrated layout optimizes land use and minimizes wasted space. It can support higher population densities, reduce urban sprawl, and conserve valuable natural resources.
8. Resilience and adaptability: Planning for resilience in the face of unforeseen, but predictable, negative climactic events is essential. The layout should accommodate alternative transportation modes, emergency evacuation routes, and adaptable infrastructure.
9. Quality of life: Ultimately, a thoughtfully designed transportation network contributes to a higher quality of life for residents. It enables convenient access to all urban habitat services with beauty and efficiency.

The path through which anyone can travel around the built environment constricts the potential of the built environment. For instance, the presence of cul-de-sac formations (i.e., dead-end nodes) within a transit network system tends to impede the smooth flow of transportation. A French term, cul de sac literally means "bottom of the sack." It commonly refers to a dead-end street.

> **CLARIFICATION:** *The difference between the terms cul-de-sac and dead-end is that the cul-de-sac terminates in a circular space ("sac") and a dead-end terminates the path abruptly, with no geometric change to the path at the location of termination.*

Dead-end (cul-de-sac) types of structures in pathway networks limit the potential of users in the following ways:

1. Limited connectivity: Cul-de-sacs are dead-end streets or loops that do not provide through access

to other pathways. Limited connectivity may be preferred if an objective of the location is privacy. However, if privacy is not the objective, then limited connectivity makes it challenging to create efficient routes for transportation (as a service that values efficiency). Vehicles and walkers often need to backtrack or take longer detours to reach their destinations, which can increase travel times.
2. Inefficient routing: Vehicles using cul-de-sacs may be forced to follow circuitous routes to reach their destinations, leading to wasted time and fuel consumption.
3. Inefficient space usage: Cul-de-sacs with or without a central island consume more landscape area (as part of the pathway network) than otherwise necessary.
4. Emergency response challenges: For emergency services, such as fire-medical, cul-de-sacs can pose significant challenges (because they are dead-ends). Limited access can delay response times, potentially compromising safety and well-being during emergencies.
5. Traffic disruption: Cul-de-sacs can disrupt the flow of traffic in a sector. Vehicles must slow down, turn around, or navigate tight spaces, leading to excessive time spent to transport. Where there are personal cars, cul-de-sacs can become a parking lot, thus reducing the road space for normal transit.
6. Inconvenience for walkers: Walkers and cyclists may encounter difficulties when navigating cul-de-sac-heavy areas.
7. Inefficient use of land: Cul-de-sacs consume land that could otherwise be used for housing, green spaces, or other habitat services.
8. Reduced accessibility: For public/comon transportation systems, cul-de-sacs can reduce accessibility. Bus routes, for example, may need to be altered to accommodate these dead-end streets, which can result in longer travel times for passengers.
9. Dependency on vehicles: The layout of cul-de-sacs often discourages walking, cycling, or the use of public transit. This can contribute to a car-dependent culture, increasing traffic congestion and pollution.
10. Environmental impact: Longer travel distances and increased vehicle usage associated with cul-de-sacs can have negative environmental consequences, including higher greenhouse gas emissions and air pollution.

NOTE: *Dead-end paths may be of benefit where privacy (or, less transit in general) is the objective. Less vehicle transit will equate to a safer environment.*

When considering shapes or configurations within transport networks, there are specific layout designs that can resemble cul-de-sacs in terms of their negative impacts. Here are some examples:

1. Tight loop roads (loop streets): Similar to cul-de-sacs, tight loop roads or circular road layouts that lack connectivity to other routes can lead to inefficient navigation and increased travel distances.
2. Dead-end streets: Streets that terminate abruptly without providing access to other roads or through routes can result in unnecessary detours and traffic congestion.
3. Irregularly shaped intersections: Complex and irregularly shaped intersections can confuse drivers and create traffic bottlenecks, similar to the challenges posed by cul-de-sacs.
4. Excessive interchanges: Overly complex highway interchanges with multiple ramps and lanes can be difficult to navigate, leading to congestion and safety concerns.
5. Isolated residential developments: Housing developments that are designed as isolated clusters with limited road connections can force residents to rely heavily on vehicles for transportation.
6. Island medians: In some cases, raised or landscaped island medians within roadways can restrict access and make it challenging for drivers to change lanes, turn around, or navigate safely.
7. Cul-de-sac-like road obstructions: Some road designs include features that resemble cul-de-sacs, such as dead-end chicanes or curb extensions, which disrupt the flow of traffic and may not serve a clear purpose.
8. Roadway expansion bypasses: Roadway expansions that bypass existing sections of a road network can lead to the neglect of older road segments, reducing their utility and creating traffic bottlenecks.
9. One-way streets without alternatives: One-way streets that lack nearby alternatives for drivers heading in the opposite direction can force motorists into longer routes and congestion.
10. Disconnected pathways: Pedestrian and cycling pathways that are disconnected or lead to dead-ends can discourage non-motorized transportation and create safety hazards.

Other examples of shapes placed on the pathway by which people walk (or, could walk around the habitat) that interferes with the life-radius of the residents include, but are not limited to:

1. Poorly designed intersections: Complex or poorly designed intersections can lead to accidents, congestion, and inefficiencies in traffic flow.
2. Roadway speed bumps: Indicate a poorly thought ought design that limits efficiency, can slow down traffic, increase wear and tear on vehicles, and create discomfort for drivers and passengers.

2.3 Transportation acoustic accounting

A.k.a., Acoustics accountability.

Transport, which involves the moving of objects, is likely to create acoustic emanations that ought to be accounted for in the design of the transportation system for habitat.

Factors that affect transportation acoustics include:

1. Pathway makeup.
2. Vehicle makeup.
3. Connectors (e.g., tires, rails) makeup.
4. Speed of vehicles.

2.4 Pathway width and material accounting

A.k.a., Pathway accountability.

The width of pathways is designed to accommodate the type and quantity of transport riding along it:

1. 1-2 meter path - not large enough to ride personal transport on.
2. 3-4 meter path - large enough to ride personal transport up to full size vehicles on.

2.5 Occupancy accounting

A.k.a., Occupancy accountability.

What is the possible occupancy of the area:

1. Volume
2. Rate at a single point or area passage.
3. Ratio.

Transportation systems must account for both:

1. Object(s) to be transported, and
2. Object(s) doing the transport.
   A. The static objects (e.g., rails and roads) doing the transport.
   B. The dynamic (e.g., vehicles, cars, bikes, etc.) doing the transport.

Cars are actual material being transmitted, even though their function is to transit their occupants. Rails and roads are the actual material doing support of the transport.

In the transportation system, an area that is occupied is either the transport technical unit resource itself, or the traffic along the transport pathway and the pathway itself.

1. Transportation systems have an occupancy rate/ ratio as the rate (of number-quantity) of unit objects moving past some observable-spatial point or area. A six-lane car-vehicle highway may have an occupancy rate of 112,000 vehicles that can travel pas a specific bridge per day -- carrying an estimated 168,000 people past some spatial point or area over 24 hours (86,400 consciously counted "seconds").
2. An occupancy rate can be given for transport vehicles themselves, how full are they; and if they are less full than possible/expected, is their unnecessary material? Here, occupancy concerns the amount of mass and power required to transport and object(s) some distance, divided into the actual number unoccupied, but available units.
3. In concern to static object/service volume, occupancy rate is calculated by dividing the total number of occupied rooms by the total number of rooms available.

Occupation along any path can be represented as a ratio of its available volume, divided by the actual volume occupied by passengers:

1. A line of people/vehicles touching person/bumper to bumper would represent 100% occupancy.
2. People/vehicles separated equally by a single vehicle space would represent 50% occupancy.
3. No people/vehicles at all would represent 0% occupancy.

Congestion is unwanted occupation along a transport path. Typically, the following occupancy ranges can be used to help predict highway congestions level:

1. 0 to 20 percent occupation = uncongested.
2. 20 to 30 percent occupation = unstable (impending congestion).
3. 30 to 100 percent occupation = congested.

2.6 Traffic accounting

A.k.a., Traffic accountability.

The following are the set of factors associated with traffic on vehicle roadway:

1. Transport service options.
   A. Asphalt concrete surface (gravity surface craft).
   B. Railed surface (rail surface craft).
   C. Air-surface craft.
   D. Water-surface craft.
2. Traffic control devices.
   A. Traffic barriers.
   B. Traffic markings.
   C. Traffic lighting.
   D. Signage.
   E. Noise barriers.
3. Safety control systems.
   A. Lighting.
   B. Protection deployment systems.
   C. Accident and emergency response.
4. Traffic re-positioning.
   A. Ramps.
   B. Overpasses.
   C. Underpasses.
   D. Wildlife bridges.
5. Policing (market-State only).
6. Advertising (market-State only).
7. Habitat transportation service system.
   A. Road works.
   B. Quality checks.
   C. Cleaning.

2.7 Damage accounting

A.k.a., Damage accountability.

The design must account for damage as performance loss of structure/capacity over time. Due to friction, occupancy damages material surfaces and structures over time. a given area (e.g., bridge or tunnel) unit and per unit of occupancy per day. Asphalt roles become damaged quickly for two reasons:

1. Improper construction.
2. Improper usage.
3. Occupancy traffic (vehicle and/or human traffic of transporting objects) - increasing the weight or number of objects/vehicles increases road ware (damage) significantly.

2.8 User accounting

A.k.a., User accountability.

Users are expected to be accountable for their usage of all systems, transportation systems included. Some transportation systems may have control sensors to maintain accountable compliance. For example, it is possible to image a urine detector on a lift that stops the lift when it detects urine and signals for a responsible habitat service team personnel. Airplane may similarly be equipped with smoke and vapor detectors that would signal a contributing team member to respond.

2.9 Performance accounting

A.k.a., Performance accountability.

Key vehicle transportation measurement factors include, but are not limited to (in design and operation):

1. Gross vehicle weight rating: The maximum operating weight of the vehicle as stated (by the manufacturer). It includes all the aspects like driver, engine, fuels, entire body, chassis, cargo but excludes the weight of the container.
2. Vehicle emissions: Measuring the gas emissions of for powering the vehicle.
3. Fuel efficiency: Calculating the kilometers per liter (KPL) of fuel ("energy") consumed.
4. Vehicle safety ratings: Accident statistics and crash test results.
5. Maintenance costs: Assessing the cost of maintenance and repairs over time provides insights into the reliability and longevity of vehicles.
6. Vehicle age: The age of a vehicle can impact its performance, emissions, and safety.
7. Usage patterns: Analyzing how often and under what conditions vehicles are used can help optimize routes, schedules, and vehicle allocation.
8. Transportation mode shift: Tracking the shift from private vehicles to public transportation, cycling, or walking can indicate progress toward sustainable transportation goals.
9. Infrastructure condition: Evaluating the condition of roads, bridges, and transportation infrastructure is critical for safety and efficiency.
10. Congestion metrics: Measuring traffic congestion levels, average commute times, and delay statistics helps identify areas with transportation challenges.
11. Accessibility: Assessing how easily individuals can access all services in the habitat via the transportation systems is crucial for urban planning.
12. Noise pollution: Monitoring and quantifying noise levels generated by transportation systems can help mitigate noise pollution impacts on communities.
13. Modal split: Tracking the percentage of trips made by different transportation modes (e.g., car, public transit, walking) helps inform transportation planning.

Systems can lose performance and capacity rapidly due to environmental extremes.

For example,

1. Lithium batteries and temperature. Electric car batteries are at their peak performance when the all-weather is 21c. Anything above or below that will result in performance loss.
2. Asphalt roles become damaged due to vehicle traffic, wherein increasing the weight or number of vehicles increases road ware exponentially.
3. In the context of a car fire, comparing lithium batteries to "normal" diesel or gasoline engines. The following number of liters of water is typically required to put out car fires of the following types (electric or normal gas/petrol):
   A. 2649L on average to put a natural gas car fire.
   B. 1100L on average to put out a petrol/diesel car fire.
   C. 11000-30000L to put out an electric car fire.
   D. It requires 10 to 26 times more water to put out an electric car fire.

2.9.1 Performance accounting by vehicle category

There are three general categories of vehicle, and each has additional and related performance factors; including, but not limited to:

1. **Land-based residential vehicles** (i.e., personal and common access vehicles):
   A. Passenger capacity: The number of passengers a vehicle can safely and comfortably accommodate.
   B. Cargo capacity: The amount of cargo space available for transporting personal- and common-access belongings in vehicles.
   C. Wheel size: The size of the wheels and how wheel size impacts fuel efficiency and other forms of performance.
   D. Fuel tank capacity: The volume of fuel/battery a vehicle can hold, impacting its range and the frequency of refueling.
   E. Towing capacity: The maximum weight a vehicle can tow, relevant for those who need to tow trailers or other vehicles.
   F. Vehicle length: The physical length of a vehicle, which affects maneuverability and parking.
2. **Land-based team and freight vehicles** (i.e., InterSystem team vehicles):
   A. Payload capacity: The maximum weight of cargo that a vehicle can transport.
   B. Axle load distribution: The distribution of weight across the axles of heavy trucks, which impacts road wear and safety.
   C. Freight volume: The volume of transported cargo by weight or cubic measurement.
   D. Load efficiency: The utilization rate of a vehicle's cargo capacity, which can affect shipping costs and efficiency.
   E. Idle time: The time a vehicle spends idling rather than in productive transport, which can impact fuel consumption and emissions.
   F. Freight emissions: Measurement of emissions generated by freight vehicles,.
   G. Delivery performance: Metrics related to on-time delivery, accuracy, and efficiency for freight transport.
3. **Water vehicles** (any water going vehicle):
   A. Displacement: The weight of a ship when fully loaded, including cargo, fuel, and passengers, which affects buoyancy and stability.
   B. Draught: The depth of a ship's keel below the waterline, impacting navigation in shallow waters and ports.
   C. Deadweight tonnage (dwt): The maximum weight a ship can carry, including cargo, fuel, and supplies, often used to assess a vessel's capacity.
   D. Container capacity: The number and size of shipping containers a cargo ship can carry.
   E. Fuel efficiency at sea: Measurement of a ship's fuel consumption per unit of distance travelled.
   F. Cargo turnaround time: The time it takes to load and unload cargo from a ship, which affects port efficiency and supply chain logistics.
4. **Air vehicles** (any air going vehicle):
   A. Aircraft gross weight: The total weight of an aircraft when fully loaded, including passengers, cargo, fuel, and equipment. It affects performance, fuel consumption, and safety.
   B. Maximum takeoff weight (mtow): The maximum weight at which an aircraft is certified to take off, ensuring safe operation during departure.
   C. Payload capacity: The maximum weight of passengers and cargo that an aircraft can transport, often used for calculating load factors.
   D. Fuel capacity: The volume of fuel that an aircraft can carry, impacting its range and endurance.
   E. Fuel efficiency: Measurement of an aircraft's fuel consumption per kilometer flown.
   F. Range: The maximum distance an aircraft can travel on a single tank of fuel or charge, crucial for long-haul flights.
   G. Passenger capacity: The number of passengers an aircraft can carry, varying by seating configuration (e.G., Economy, business, first class).
   H. Cargo volume: The available cargo space in an aircraft for transporting goods and freight, measured in cubic feet or meters.

I. Cruising speed: The average speed at which an aircraft travels during its cruise phase, affecting flight duration.
J. Altitude capability: The maximum altitude an aircraft can reach safely, influencing route planning and fuel efficiency.
K. Aircraft range diagram: A graphical representation of an aircraft's range based on fuel capacity and payload, useful for route optimization.
L. Aircraft emissions: Measurement of greenhouse gas emissions, such as co2 and nox, produced during flight, crucial for environmental assessments.
M. Takeoff and landing performance: Metrics related to an aircraft's takeoff and landing distances, important for airport planning and safety.
N. Aircraft noise levels: Measurement of noise produced during takeoff, landing, and in-flight, impacting community noise pollution.
O. Aircraft efficiency improvements: Evaluating modifications and technologies to enhance fuel efficiency, reduce emissions, and improve aircraft performance.

2.10 Transportation system failure modes

Common failure modes for transit include, but are not limited to:

1. **Derailment**: When a train or tram leaves its tracks or rails, resulting in a loss of control and potential damage to the vehicle, infrastructure, and, in some cases, injuries to passengers.
2. **Accidents**: Accidents are collisions and breakages.
3. **Operational errors:** Human errors, such as operator mistakes, scheduling issues, or failure to follow procedures, can lead to accidents or service disruptions.
4. **Resource limitation**: When there is insufficient path space, routes, or bandwidth to handle demand.
5. **Congestion (a.k.a., decrease throughput)**: When slower transfer or travel due to congestion.
6. **Overcrowding:** Overcrowded vehicles are uncomfortable and pose safety risks, create delays, and make life difficult for people.
7. **Increased latency**: Latency refers to situations where transit time is longer, delays in delivery or transfer.
8. **Queuing**: Undesirable waiting and queueing.
9. **Signal failures:** Malfunctioning or misaligned signals can lead to confusion among operators and increase the risk of collisions or near-miss incidents.
10. **Bottlenecking:** Bottlenecking refers to expanding a single point (like a gate or a street) without considering the entire system (the network of streets or pathways leading from and to the gate) can lead to inefficiencies and congestion. It's akin to trying to pour a large amount of water through a funnel; no matter how wide the top of the funnel is, the water's flow rate is limited by the size of the funnel's neck. In urban design, making a city street wider to accommodate more people, only to have everyone try to go through one gate, highlights the inefficiency of focusing on a single aspect of the traffic flow without addressing the capacity of the entire network. This situation can cause several issues:
    A. **Increased congestion:** Even with a wider street, the congestion might simply move to the next choke point in the network, which in this case is the gate. This can lead to traffic jams, increased travel times, and frustration among commuters.
    B. **Underutilized resources:** Other routes or gates that might alleviate traffic are underused because the focus has been placed on widening a single street or gate, thus not optimizing the overall network's capacity.
    C. **Diminishing returns:** There's a principle in urban planning and traffic engineering known as "induced demand." Essentially, widening roads can lead to more traffic rather than less, as the increased capacity encourages more people to use that route, quickly negating any initial improvements in traffic flow.
11. **Induced demand:** Induced demand means that adding more lanes, thus making traffic flow faster, will motivate more people to drive, leading to more traffic. More traffic will lead to longer commute times. Thus, paying to create more lanes is often paying to make commute worse. Building more roads to prevent congestion is like a fat man loosening his belt to prevent obesity. Lewis Mumford. Self-driving cars are likely not going to make this situation any better. Because, imagine someone owning three cars with a self-driving function. The owner gets in the first to go shopping, they send the second to pick b up their kid from school, and the third to go the mechanic. In this case, one person just generated three cars worth of traffic. The more a road is widened, the more people will choose the car as transport, and the traffic jams become a problem. If cities are planned for cars and traffic, the city will have cars and traffic. Alternatively, if cities are planned fora set number of people and optimized places, they

city will have an appropriate number of people and amazing places for them. Induced demand could appear anywhere there is transportation. For example, a city street becomes congested with pedestrian traffic, and the city is growing yearly in population size. Equipment breakdowns - mechanical failures in transit systems can disrupt service and require maintenance or replacement of components.

Common mitigation strategies for the failure modes are:

1. First and foremost, comprehensive systems-level planning and design.
2. Alternative routes (a.k.a detours) being able to reroute traffic to alleviate network congestion.
3. Appropriate and correct signage.
4. Appropriate and correct headway.

3 Habitat transportation circulation

A.k.a., Transportation access.

Habitat circulation planning involves the planning of access by means of some form of transportation. The planning of a transportation system within a habitat service system requires the identification and analysis of access, and its various sub-types:

1. Walking access.
2. Cyclist (or like) access.
3. Land vehicle access.
4. Air vehicle access
5. Water vehicle access.
6. High, medium, and low speed vehicular access.
7. Service access (InterSystem Team access).
8. Parking/garage access.
9. Vehicle repair center access.
10. Piping access.

"Transportation infrastructure" encompasses all the physical and organizational structures and systems that support and facilitate the movement of people, goods, and vehicles within a region or across regions. This broader concept includes not only the actual pathways or routes (such as roads, railways, cableways, etc.) but also the supporting facilities, services, regulations, and planning that make transportation possible.

3.1 Transportation pathways

A.k.a., Transportation tracks.

All transportation occurs along pathways. Different types of transportation require different mediums, areas, and lengths of pathway. In a general sense, a "transportation path" refers to a route, trail, or course along which one can travel, move, or progress from one place to another. Paths can be physical[ized] or virtual.

1. **Physical path:** A physical path is a tangible route that people and objects can traverse.
   A. On foot (i.e., on a floor/landscape surface).
   B. In enclosures (i.e., in vehicles, cages, etc.).
2. **Virtual path (a.k.a., instrument path):** A virtual path is a digitally constructed and projected path that people can traverse over/through any medium (i.e., is a medium agnostic concept). Pilots, for instance, use instrument flight rules/systems to navigate without external visual cues.
   A. Through water and over water.
   B. Through land and over land.
   C. Through air and outer-space.

Physical transportation pathways can be classified according to what is moving on them (the following types of pathways are the most common):

1. **Walkway** (a.k.a., sidewalk, walk path, walk track, foot path) - pathway for humans to walk on. A walkway is a dedicated pathway designed for people (a.k.a., pedestrians) to walk on.
2. **Road** (a.k.a., motorway, vehicle path, vehicle track, street) - pathway for wheeled vehicles larger than micro-mobility. A road is a pathway or route designed for the movement of larger wheeled vehicles, including cars, trucks, buses, and motorcycles.
3. **Bridge** - a pathway over and/or around something.
4. **Elevator** (a.k.a., vertical moving cage via cable) - moves people vertically between floors in buildings. An elevator is a vertical transportation device that moves people or products between different floors or levels within a building. It is an essential component of multi-story structures, providing efficient access to various floors.
5. **Micro-mobility pathway** (a.k.a., bikeway, bike path, bike track) - pathway for micro-mobility wheeled vehicles. A micro-mobility pathway is designed for the use of small, wheeled vehicles such as bicycles, electric scooters, skateboards, etc.
6. **Railway** (a.k.a., rail path, railway track, monorail, etc.) - rail transport is a means of transport that transfers passengers and goods on wheeled vehicles running on rails, which are incorporated into tracks. A railway is a specialized transportation system that uses rails or tracks to transport passengers and goods on wheeled vehicles, such as trains or monorails. Railways provide efficient and long-distance travel options, often connecting cities and regions.
7. **Cableway** (ak.a., cablecar, ropeway, aerial tram) - uses cables or ropes to transport passengers or cargo from one point to another. It typically involves cabins or gondolas that are suspended and moved along a cable or rope system. Cableways are often employed in areas with challenging terrain, such as mountains, valleys, or urban environments, where traditional road or rail transportation is impractical. They provide a scenic and efficient mode of transportation, offering aerial views of the surroundings.
8. **Pressurized tube network** (a.k.a., pneumatic tube system) - uses a pressurized tube to vacuum a capsule containing people or small objects from one point to another in a capsule within a pressurized suctioning tube.

Pathways upon which vehicles and people move can be porous or not:

1. **Impermeable pathway** - does not allow water to seep into the landscape rapidly.
2. **Permeable pathway (a.k.a., permeable pavement, porous concrete)** - does allow water to seep into the landscape rapidly.

3.1 Transportation signaling

Transportation works in conjunction with communications and illumination to ensure the safe operation of a transportation system. In order to communicate effectively, there are transportation signals and signage that must be appropriately illuminated to be observed and followed:

1. Illumination of:
   A. Signaling.
   B. Signage.
2. Communications of transportation related messages.

3.2 Transportation system vehicles

A habitat transportation system is likely to involve all of the following elements (Note: all vehicles have some source of power):

1. Humans walking. No engine/motor to power the drive train. All other categories use engines/motors to power transportation.
2. Vehicle transport (a.k.a., auto transport, automobile transportation, car carrier services, vehicular conveyance, vehicle hauling, and auto relocation):
   A. Wheeled vehicles (a.k.a., tire guided vehicles, tire vehicles).
      1. Human powered wheel vehicles.
         i. E.g., bicycle, long-board.
      2. Human + electric powered wheel vehicles (e.g., electric bicycle, electric bike or e-bike).
      3. Small car vehicles (a.k.a., small automobiles).
         i. Electric powered (electrical conduction engine).
            1. Passenger car.
               a. Moped or scooter.
               b. Motorcycle.
               c. Golf cart car.
               d. Small car.
            2. Service car.
         ii. Petrol powered (internal combustion engine).
            1. Passenger car.
               a. Moped or scooter.
               b. Motorcycle.
               c. Golf cart car.
               d. Small car.
            2. Service car.

4. Medium car vehicles (a.k.a., medium car automobiles).
    i. Electric powered.
        1. Passenger car.
        2. Service car.
    ii. Petrol powered.
        1. Passenger car.
        2. Service car.
5. Bus vehicles (a.k.a., bus automobiles).
    i. Electric powered.
        1. Light van.
        2. Heavy van.
    ii. Petrol powered.
        1. Light van.
        2. Heavy van.
6. Truck vehicles (a.k.a., lorry vehicles).
    i. Electric powered.
        1. Light truck.
        2. Heavy truck.
        3. Support vehicles. *(Note: some support vehicles, such as cranes, may be on chained wheels)*
    ii. Petrol powered.
        1. Light truck.
        2. Heavy truck.
        3. Support vehicles. *(Note: some support vehicles, such as cranes, may be on chained wheels)*

B. Rail vehicles (a.k.a., rail guided, trains, trams, monorails, metros).
    1. Light rail.
        i. Human passenger train.
        ii. Service-object carrying train.
    2. Heavy rail.
        i. Service-object carrying train.

C. Cable vehicles (a.k.a., cable guided, cablecar, cableway, ropeway).
    1. Light cable (horizontal).
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.
    2. Heavy cable (horizontal).
        i. Service-object carrying vehicle.
    3. Vertical moving cable caged vehicles.
        i. Cable elevator.

D. Atmospheric pressured vehicles.
    1. Succession pressure people vehicles.
        i. Suction elevators.
        ii. Suction capsule networks.

E. Aerial vehicles.
    1. Light aerial.
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.
    2. Heavy aerial.
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.

F. Water vehicles.
    1. Light water craft (surface and sub-surface).
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.
    2. Heavy water craft (surface and sub-surface).
        i. Human passenger vehicle (e.g., cruise ship, ferries, water taxis).
        ii. Service-object carrying vehicle (e.g., freight transport ship).

G. Space vehicles:
    1. Light space craft.
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.
    2. Heavy space craft.
        i. Human passenger vehicle.
        ii. Service-object carrying vehicle.

3. Pipeline transport (uses a motor to pressurize a conduit to push and/or pull, or carry, objects). Different pipeline systems are available for the transport of different types of matter:
    A. Liquids.
    B. Gases.
    C. Solids.

CLARIFICATIONS: *The terms "engine" and "motor" are often used interchangeably, particular in the case of petrol fuel, but the difference is that motors run on electricity and engines run on combustion. Anything that has a motor in its system and/or is automated in some way is an automobile.*

3.2.1 Vehicle parameters

Vehicles have at least the following parameters:

1. Vehicle capacity (max).
2. Speed (average, max).
3. Weight of vehicle.
4. Category of transport (e.g., people, objects, containers).
5. Power system.
6. Resource maintenance requirements.
7. Guided and/or unguided.
8. Automated and/or manual.

3.3 Type of transportation path system design

A transportation path system design involves various layers of transport, including but not limited to:

1. Walking radius.
2. Life-radius vehicular transport.
3. Personal power transport (e.g., bicycle).
4. Headway in network (i.e., time between vehicles).

5. Personal local electric power transport (e.g., electric bicycle or electric family cart).
6. Rapid local [electric] transport (e.g., electric passenger/freight vehicle).
7. Rapid inter-habitat [electric/hydrocarbon] transport (e.g., passenger/freight train).
8. Support and constructor vehicles (e.g., cranes).
9. Buffer zone area between transport and other service systems, or between two different types of transport (e.g., high velocity and human walking).
10. Package/object transport.

3.4 Mass-rapid mobility

A.k.a., Mass rapid transit, mass rapid transport.

The following types of integrated networks of electric trains, tracks, buses, and stations can move many people rapidly around an urban landscape (or, between spaced urban landscapes; e.g., between habitats). Common types of mass-rapid human transport systems:

1. **Mass rapid transport (MRT; a.k.a., subway, metro, tram, light rail transit or LRT)** - a high-capacity (public) transportation system that uses electric trains running on dedicated tracks, typically underground, elevated, or at-grade. MRT systems require specialized train stations. MRT systems are designed to move large numbers of passengers quickly and efficiently within urban areas, making them a crucial component of public transit networks in many cities worldwide. This type of transportation is typically has a pre-set schedule and is not on demand. An MRT system is optimal for transport between habitats, or within an extremely large habitat (a "mega-city").
2. **Personal rapid transport (PRT; a.k.a., pod transport, pod taxi, driverless cars)** - an automated, on-demand, and small-scale urban transportation system designed for individual or small group use. PRT systems consist of small, self-driving vehicles or pods that passengers can summon as needed to travel within a defined network of guideways or tracks. A PRT system is a mass-rapid transport system within a smaller area. PRT is often used for short-distance, point-to-point trips, offering personalized and convenient mobility options. PRT vehicles are smaller than MRT vehicles, and typically, are more on-demand. A PRT network is usually a small driverless vehicle network that transports people on rail or on a floor wheeled-vehicle pathway. Often the system operates on pathways dedicated only to its usage (i.e., dedicated guideways). A PRT system typically has stations, and may or may not be designed to pick and drop-off anyone or anything anywhere in along the transit path network of the habitat. A driverless wheeled-path vehicle system may have more flexibility in this way than a rail-based system. PRT systems are a very successful and power/resource efficient transportation system when constructed and operated appropriately. A PRT system is optimal for transport within a habitat. PRT systems have varying degrees of the following characteristics:
   A. On-location: Do the vehicles only operate out of stations, or can someone/something be picked up and dropped off along any wheeled transit pathway?
   B. On-demand: Can a vehicle be called to a location or station, and/or are they waiting without congestion for use at a station?
   C. Personal (directeness): Can the system transition between a longer distance PRT system and a shorter distance PRT system, thus making the system more personal? Are the vehicles personal or common?
   D. Transport technology: On wheels or on rails (guided)?
   E. Flexible: PRT vehicles are lightweight and have the ability to navigate tight corners; they can be stylized and decorated commonly.
3. **Bus rapid transit (BRT; a.k.a., van rapid transit, VRP) -** relies on buses, dedicated bus lanes, specialized bus stations, and high-frequency service to provide efficient and rapid public van/bus transportation within urban areas.
   A. It is possible to have different types of BRT system:
      1. Small vans to large buses.
      2. Scheduled versus on-demand.
   B. For example,
      1. A mass rapid bussing system with larger scheduled buses.
      2. A personal rapid van system, where the buses (vans) are smaller and available on-demand.

3.5 Micro-mobility

A.k.a., Micromobility.

Micro-mobility generally involves the following vehicles types:

1. Long-boards (board on wheels):
   A. Human leg powered.
   B. Electrical DC motor powered.
2. Electric unicycle - electric unicycles with a wheel that self-balances underneath and the user's feet on either side of the wheel.

3. Bicycle (bike):
    A. Human peddle powered bicycle.
    B. Electrical DC motor powered (electric bike, ebike or e-bike), and is measured in watts of power.
4. Scooter (moped, small motorcycle):
    A. Electric scooter.
    B. Motor scooter.

NOTE: *There are fold-down micro-mobility transport vehicles that users can fold down and take with them on transit.*

The technical class of micro-mobility vary by State, but generally encompass the following micro-mobility (e-bike) classes:

1. Class 1 e-bike:
    A. Pedal assist.
        1. Max Watt limit often set to 500watts equivalent to a top speed of 32kph.
2. Class 2 e-bike:
    A. Pedal assist.
    B. Can have a throttle assist.
3. Class 3 ebike.
    A. Moped is controlled by a throttle.

Problems with micro-mobility in the market-State often include:

1. Vehicles parked in the wrong places and/or all over the sidewalk.
2. Users riding them too fast on the sidewalk where people are walking.
3. Speed limiters on devices are additive material and can be removed.

Most electrical micro-mobility technologies consist of a few simple subsystems:

1. Wheel(s).
2. Battery.
3. Controller.
4. Motor.
5. Chassis.

4 Distribution of objects

A.k.a., Transport of objects.

Typical city distribution of objects occurs in the following manners (in a habitat):

1. Human contribution.
    A. Automated robotic.
    B. Human assisted robotic.
2. Object delivery service.
    A. Vehicle.
3. Access center ("retail warehouse") *in habitat*.
4. Habitat service zone sectors
    A. Personal dwelling sector locations.
    B. Other habitat service sector locations.

4.1 Habitat access centers

A.k.a., Access locations, libraries, repositories, warehouses, etc.

A habitat access centers is a central building that people go to access warehoused items. It is effectively a library of accessible items are available at that location, and may even be deliverable using some sort of vehicular object deliver service (integrated into the habitat's design).

4.2 Automated storage and retrieval system

An automated storage and retrieval system is a mechanized system with software that automates the storage and retrieval of objects in a warehouse (or, in the case of information, a database).

4.3 Track and trace

A track and trace system is a software-based solution to track vehicles, loading units, shipments or products throughout the entire habitat network (note: in the market-State, a track and trace system tracks/traces products throughout the supply chain, from supplier to consumer). In concern to the tracking of vehicles, a track and trace system is also called a, vehicle tracking system. In that case, it is a system that is in contact with all vehicles via GPS communications. A track and trace systems allows the global information system to know the geographical position of all its vehicles in real time, for which there are many benefits to efficiency.

4.4 Access location designations

There are three types of material access designation in community:

1. Personal access designations.
2. Common access designations.

3. Systems access designations (a.k.a., team access designations).

Location specific [visitation] attributes include, but are not limited to:

1. Residency or visitor?
2. Frequency [of visit to location]?
3. Duration [of visit to location]?
4. Recency [of visit to location]?
5. Transfer at visitation [of location]?

4.4.1 Warehouses (product storage)

A warehouse is a location for the storage of objects in a specific space for a particular amount of time. All types of materials and products are generally stored at a warehouses up to the point where they are ready to be shipped or accessed.

5 Transportation systems within a habitat

NOTE: *Most habitats in community are designed to a master plan where residents can meet their daily needs by walking, bicycling, and taking transit.*

There are multiple ways of transporting services, resources and products within a habitat and between a habitats. These include, but may not be limited to:

1. **Package/object transportation** (a.k.a., box transportation) - where packaged objects move through.
   A. Transports items in a box. May also transport waste in special boxes.
   B. Transmission tube technology (a.k.a., transmitting tube technology, pneumatic tube, rail tube, etc.)
2. **Water transport** - where objects move over or safely protected within water.
3. **Liquid transportation** - where liquids move through conduits/pipes.
4. **Atmospheric transportation** (a.k.a., air/gas transportation) - where atmosphere moves through conduits/pipes.
5. **Electrical power transportation** (a.k.a., power transportation) - where electrical power moves through (e.g., atmosphere in the case of WiFi, and cables in the case of electricity).
6. **Road/path transportation** - where persons and road/path specialized vehicles locomote.
7. **Rail transportation** - where specialized rail vehicles locomote.
8. **Cable transportation** - where specialized cable vehicles locomote.
9. **Conduit transportation** - where gases, fluids, and electricity travel through pipes and channels.
   A. Pipes are standard objects for moving fluids and gasses from one place to another. Electrical and signaling lines may be run through pipes for protection.
   B. Channels are for moving fluids and may be open (to the air) at the top.

5.1 Transportation in the market-State and community

In a community-type society, the population lives within integrated habitat service systems within an integrated habitat service system network. Transportation occurs within the habitats themselves, and between habitats. In the early 21st century, the population lives in market-State urban, sub-urban, and rural environments, with road, and some rail, connecting them.

5.1.1 Trucking

In the early 21st century market-State, trucking is the heart of the transportation architecture. Trucks transport goods over near and far distances. Despite their significance, trucks are often viewed as resource-intensive and relatively inefficient in certain aspects:

1. Fuel consumption: Trucks tend to have lower fuel efficiency compared to other modes of transportation, especially when carrying heavy loads over long distances.
2. Limited capacity: Although trucks can transport substantial cargo, their individual capacity is limited compared to other freight transportation methods, such as trains or cargo ships. This limitation leads to the necessity for numerous trucks on the road, impacting traffic congestion and increasing fuel consumption.
3. Infrastructure wear and tear: Trucks exert a significant toll on road infrastructure due to their weight and volume. This leads to increased maintenance costs for roads and highways upon which trucks travel.
4. Traffic congestion: The reliance on trucks for goods transportation contributes to traffic congestion in urban areas and along major highways. This congestion not only slows down the transportation process but also increases fuel consumption and greenhouse gas emissions.

5.1.2 Rail

Rail transportation offers several advantages over trucks for certain types of freight movement, especially over long distances or for bulk cargo. Advantages to rail include, but may not be limited to:

1. Efficiency in moving bulk cargo: Rail is particularly efficient in transporting large quantities of goods over long distances. Trains can carry substantially more freight than individual trucks, making them more efficient for bulk shipments.
2. Lower environmental impact: Trains tend to be more fuel-efficient per weighted-distance (e.g., kilogram-kilometer) compared to trucks. They consume less fuel per unit of freight transported
3. Reduced traffic congestion: Railroads operate on dedicated tracks, reducing the congestion and wear and tear on public roads caused by trucks. This separation of freight from road traffic helps alleviate traffic congestion and decreases road maintenance costs.
4. Energy efficiency: Trains are generally more energy-efficient than trucks, especially when moving heavy or large-volume freight. This efficiency contributes to reduced fuel consumption and lower operating costs per unit of freight moved.
5. Reliability and safety: Railways are known for their reliability and safety record. They are less prone to weather-related delays and accidents compared to road transportation.

While rail transport offers numerous advantages for certain types of cargo and routes, it might not be as flexible or suitable for short-distance shipments where trucks might have an edge due to their ability to reach more remote locations and provide door-to-door delivery (if there is no integrated local object-package delivery system).

5.1.3 The family car

In the market-State where family cars are a fundamental part of industrial profit, governments create regulatory codes that maintain and prescribe cars. Most urban planning in the market-State is car centric. Therein, laws prescribe car based cities and force developers to build car transportation and parking sufficiency. In general, governments do this by enacting parking minimum requirements. Cars need to be stored when not in use. Parking lots are car storage (i.e., are places where cars are stores). Surface parking lots create heat islands. Being dependent ones own car(s) means more isolation, more resource expenditure, more stress, longer travel times, etc. In the market-State, the car industry played a significant role in making cars universally necessary by lobbying States to change laws in favor of automobiles, and by propaganda. By implementing a variety of strategies and initiatives, the formerly mentioned two, the car industry effectively created an environment where cars are the primary mode of transportation.

In the market-State, free parking induces demand and incentivizes car centric planning. The more cars there are, the mare planners will plan around cars, until the material environment is one where everyone needs a car to get around.

In community cities, the "family car" often ceases to be the primary mode of transportation, and in some cases, it may not be used for transportation at all. The reasons for this shift are multifaceted. Firstly, these cities tend to have been designed for walkability and bikability. Between, and sometimes within these cities, there are well-developed common access (a.k.a., public) transportation systems, including efficient personal and rapid transport systems. Residents can rely on walking, biking, or optimized rapid transport to move between and within a habitat. Importantly, these cities often prioritize pedestrian and cycling infrastructure (a.k.a., walkable neighborhoods, bikable neighborhoods). Community is an alternative to the market-State that allows individuals to access to transportation when needed without the burden of ownership or rental. The combination of robust public transportation, pedestrian- and bicycle-friendly environments, and shared/common free-access mobility options creates a cityscape where the "family car" becomes obsolete for local transportation. Of course, in community, the automobile will still exist for people to use as transport into the wild and/or between cities.

In community-based integrated city systems, the solution to local transport is to create an environment where it is easy to get around by foot and bike. Notably, a person walking or biking takes up vastly less path space than one driving a car, or even, bussing. Which, isn't to say that no vehicles will not be used in integrated community cities. There will always be the requirement for emergency and maintenance vehicles, and in some cities, there may even be smaller-sized (because they are only for local use) personal transport vehicles and common personal transport vehicles (i.e., shared/public use transport vehicles).

One big step towards improving the ability to get around by walking or biking is to specifically design cities with an appropriate walking and biking path length between destinations. A 20 to 40 minute walking length integrated city would likely optimize path lengths for walking and biking. Then transportation between cities would include an automated common service vehicle of some kind.

6 Local habitat object transportation system

NOTE: *Through intelligent master planning objects can be transported throughout the local and global habitat [service system] network without the need for excess packaging, which is what creates the majority of the waste/trash in the early 21st century.*

Integrated master planned habitats in community typically have a local [habitat] object transportation system. A habitat object transportation system is a mechanical packaging, transportation, and distribution system technology that is used in some integrated city systems. This automated packaging and transportation distribution technology allows almost any object to be appropriately packaged and transported anywhere in the local habitat network. Using this technology, objects can be sent and received safely and with the greatest efficiency almost anywhere in the habitat. Every dwelling, for example, can receive packages from elsewhere in the habitat. This service is like an extremely advanced version of the packaging and delivery services of the early 21st century. There are two main ways to seriously increase efficiency in the world. One of them is computation and mechanization, and the other is linking all the phases of life (education, contribution, liberation) to free access to that which is required to meet human need (i.e., without any form of exchange, except for contribution). It is foreseen that there will always be necessary human work, which can be reduced and also made more liberating (in terms of human choice) through automation. This socio-technical life optimization transport technology multiplies efficiency. This transfer (a.k.a., transport, transmission) technology is seen as the next huge development in freeing user access to all material services. This integrated object transfer network includes a variety of different interoperated sub-transportation technologies, including pneumatics, conveyors, rails, vehicles, access ports, and packaging systems. Most dwellings, and all common and systems access locations have access ports to this habitat transport system. Those dwellings that do not have access to the network do not have access because that is the personal preference of the user. Of note, this system may also interoperate with the human vehicular transport system, and may even transport objects automatically between local habitats in a network of habitats. This type of system is sometimes known as a habitat object storage and transportation system (a.k.a., integrated city resource transportation network technology). It is an integrated and highly automated habitat-wide (sometimes inter-habitat) object locating, storing, and transporting technology. Objects can be sent (or, simulated with high certainty to be sent) from the warehouses to people, from people to people, and from any relative location in the habitat to another, efficiently. Object transport occurs, in part, for continued usage, re-allocation [of resources], and sharing. The storage of objects is done in one or more location centralized and appropriately automated (cold and ambient temperature) storage warehouses located in the habitat. These systems are still monitored by people, and where there is no danger, but still demand for that type of contributed job, then human labor is included. It is automated to the desire of individuals in a habitat to perform absolutely necessary work and/or find the work intrinsically desirable to do. Possibly the first form of this system, earlier in history, was the pneumatic tube transport system for large buildings. Robotics and vehicular technology advanced over time, as well as logistic software technology. There was a synthesis of this technology over time into the engineering of an automated packaging, storing, retrieving, and delivering (transport) that could cover whole cities, as well as transport between cities; like the years earlier postal service did. Access ports for the service are placed within architectural structures. Because of this system, people in community do not need so much storage space in their home and other habitat access spaces; storage can be centrally distributed, as can the mechanization of services. People no longer need to feel trapped to their homes and properties therein, because it is easily distributable around the habitat. This habitat service transportation and locationing sub-system creates greater freedom for our population, reducing the feeling and sense of needing to possess objects. The application of this technology reduced the sense of needing to own objects to sustain happiness. In an integrated city system, this transportation technology is seen as just another conduit for transport into (and out of) architecture, like electricity, water, and gas. Water was once seen as a basic input for any family or household, now too are other needed products, and that principle is conveyed by this service (transportation and delivery of objects, without trade). An automated object delivery service, like the pre-existing water and electricity services, is seen as a basic right. One of the biggest events that amplified the recycling of resources was the global, habitat-centered, object packaging, storage, and transportation network. In other words, one of the biggest advances in the habitat, in concern to the recycling of resources, was this technology, which allowed for such efficient tracking, relocating, and packaging of resources that recycling became an integrated habitat process and an almost intuitive process for all inhabitants. This technology amplifies the recycling of resources.

7 Packaging for transport and storage

It is possible to optimally pack and store objects given what is known and available. Packaging is the task of packing something for transportation or storage. Product packing may include, but is not necessarily limited to:

1. Product information.
   - A. Assembly diagrams.
     1. Lists parts.
     2. Lists required tools.
     3. Describes assembly procedure.
   - B. Technical Specifications.
     1. Lists relevant parts, materials, or compositions.
     2. Describes relevant specifications of the parts. What is relevant?
        - i. Energy requirements.
        - ii. Care / Maintenance Requirements.
        - iii. Disposal / Upcycling guidelines.
        - iv. Operating Guidelines
2. Product protection.
   - A. From environment.
     1. Abrasion.
     2. Corrosion.
     3. Infection.
     4. Deterioration.
3. Product storage.
   - A. Each piece has a place.
     1. Place is determined by how it is accessed (How it is accessed means by whom and in what order).
4. Product Transportation.
   - A. Moving the product from point of manufacture to place of access / use.
   - B. Moving product from one point of access to another.
   - C. Moving product from a state of access to a state of suspended access (a.k.a. "storage") Why?
     1. Seasonality of suitable access environment.
     2. Reaction to demand for access.

8 Transportation network drainage

Transportation networks require drainage, mostly from rainwater.

8.1 Roadway drainage

The construction of roads affects the natural surface and subsurface drainage patters of an environment. The provision of adequate drainage is important to prevent the accumulation of excess water or moisture on or within road constructions that can adversely affect their material properties, compromise overall stability and user safety.

Drainage must account for water from:

1. Carriageways.
2. Hard shoulders.
3. Foot/cycle paths.
4. Verges.
5. Adjacent catchment areas.

The design of roadway drainage will depend on several factors, including:

1. The intensity of rainfall expected.
2. The size of catchment area.
3. The permeability of the surfaces.

The road camber or cross-fall should be designed to cope with heavy water run-off. Insufficient cross-fall can increase the risk of vehicles skidding or aquaplaning on the surface water. The standard cross-fall for roads is usually taken as 1:40, although the camber will vary depending on the individual requirements of the road.

Drainage on urban and rural roads may be handled differently:

1. Urban roads - Surface water is generally collected in channels at the road-side and discharged through gullies (drainage gratings at the edges of the road) into storm water sewers or storm water channels. Gullies are typically positioned at intervals of 25-30m, depending on the road width and nature of the cross-fall. Gully covers can be either top opening or side opening. To reduce the number of required drainage points, pavings and verges should be graded towards the channel. Culverts may also be used. A culvert is a closed conduit or tunnel used to convey water from one area to another, normally from one side of a road to the other side.
2. Rural roads - Minor roads usually use simple openings or channels which feed into roadside ditches. Most main roads use a system of gullies and piped sewers. However, soakaways may also be used to discharge water, these are large underground chambers into which water flows from a gully. Water collects and gradually soaks through holes into the surrounding ground or to streams and roadside ditches.

8.2 Paved area drainage

Paved areas are provided with some method of surface water drainage, including but not limited to:

1. **Permeable pavement** - allows the water to percolate downward into the ground.
2. **Yard gully collection** - wherein, a paved area near a building is laid to falls of 1:60 towards a gully. The type of area being drained and the shape of the paved area will determine the size and number of gullies. The maximum paved area per gully should be 400sq.m. If it is connected to a combined sewer, the yard gully should be trapped with a minimum 50mm water seal.
3. **Channel collection** - The paving, laid to the same falls, drains away from a building to a channel laid to falls of 1:120. The channel is connected to the drainage system. The channel is typically:
   A. Half-round glazed clayware channel: Either open or with a grating cover.
   B. Precast concrete channel blocks: With a continuous slot down the centre of the top.
   C. Precast or in situ concrete box channel: With a cast iron square mesh grating.

Table 59. *Table showing categories of vehicle and path types.*

Categories of vehicle / **Categories of path**	1 Person Walking	*n* Number of people walking	1 Person on bicycle	*n* Number of bicycles	Electric cart	Passenger car
Depth of path expected (in meters)						
Separate path and/ or multiple vehicle types available on path	Separate or Slow path	Separate or Slow path	Separate or Slow path	Separate or Slow path	Separate or Slow path	Fast wheeled vehicle path

Technology Support: Production Service System

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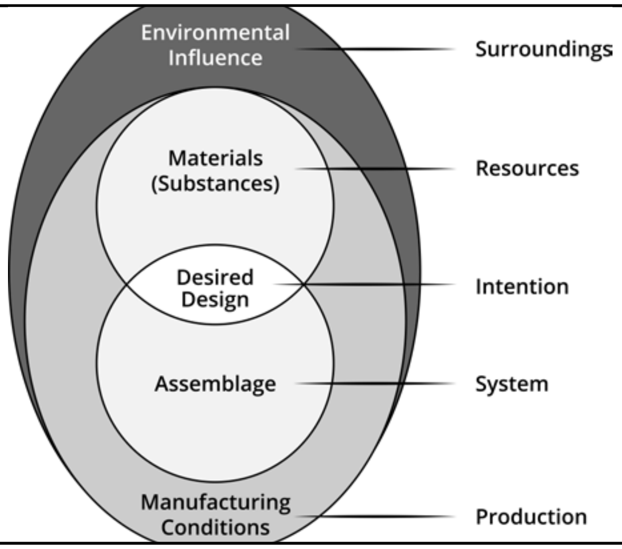
Abstract

There are objects that could exist, and there are objects do exist. There are intangible objects, such as the software model of a chair (i.e., the chair displayed on a monitor is an intangible object). When/if the chair is assembled to be a chair, then it will have been materialized [as an event, a new object-resource] in the system. A materialized chair is a tangible object. There is a distinction between objects recognizable on a monitor screen and made up of software, and a physicalized (materialized) chair that a subject can sit in. Any material environment must be composed of any one or combination of: life (subject), land, object, structure (architecture), and energetics (power). The prime objective of the materialization (materials cycling) system is to materialize and de-materialize objects, as compositions of resources. The decision system determines the solution for the next iteration of the societal configuration upon which teams may put effort. The human animal [subject] has evolved to send moral signals about their well-being and the state of its habitat, in three primary way: life, technology, and exploratory. Different types of societies could be looked at as different types of signaling configurations. A decision system allows for coherency in the fulfillment of societal configuration solutions to meet the demands of life, technology, and exploration opportunity. Different signal configurations may have significantly different effects on peoples actions, behaviors, and lives. The moral visions (values) people have for one another really matter from an evolutionary perspective. Humans are an evolved living individuated organism, and hence, have needs for life-support services at that habitat level. Humans explore life together through an exploratory service support system. Humans use technology to support their informational and spatial needs. This service system combines decisioning data with executionable data for InterSystem team tasking, which may combine in a variety of different ways depending upon a given society's configuration.

Graphical Abstract

Figure 8. *Image depicts the layers of a matter-based existence, wherein matter may be reconfigured through intentional effort into fulfillment-oriented socio-technical habitat services to optimize human socio-technical need fulfillment. Herein, socio-technical systems may be designed and intentionally materialized with available resources to produce useful functions, given environmental influences and total conditions.*



1 Production system overview

CLARIFICATION: *Every produced object is a technology, and every system that produces an object is also a technology, and all are assemblies [of objects].*

There are many ways to bring new visualizations into real materialization. Humans have a need to cycle materials through their habitat(s). Some of the realized objects these materials take remain static and/or stationary for a long duration of time, relative to others. Materials cycle in and through habitats and human life systems. Materials become objects. Some objects and their relationships are of a sufficiently coherent nature to be called the materializations of life support, or technology support, or exploratory support. There are materializations that are appearing. There are materializations in memory of that which existed, and that which could exist (or, could be shown to potentially exist). When there is recognition that which comes after can be different than that which came before allows for real-time materialization, then there is potential for adaptation. Engineering InterSysem teams work in the materialization of habitat service sub-systems which are constructed primarily as integrated city systems (a.k.a., total city system). Material flows can be traced to remain accountable for finite resources. To materialize is to be materially realized. In a community-type society, realization is executed (i.e., "is done") through team contribution. Teams contribute to the decided reconfiguration and operation of the habitat environment. Many objects become larger and more functional technological objects, which become useful services of function with object, for which there is a habitat of them. Afer production, objects are transported and distributed for their intended storage and usage.

INSIGHT: *Matter, which is the expression of nature that humans receive signals from and interact, is architected and engineered into different configurations for human need fulfillment.*

Production can be sub-composed into axiomatic categories:

1. [Static] Objects (materials, forming assemblies).
2. [Functional] Concepts (techniques applied to materials, processes).

The basic materialization cycle is the resource [production] cycle, which is:

1. Extraction or cultivation.
2. Transformation/production (intermediary and final-product).
3. Utilization (habitat support services).
4. Cycling (catchment, recycling).

Materialization-type zones inclusive of materialization-type technologies and activities include, but may not be limited to:

1. Physical work production centers (a.k.a., manufacturing centers, construction centers, FAIT centers: fabrication-assembly-integration-testing centers).
   A. Center for the production of 'the means of production' (e.g., habitat intermediary, InterSystem team tools).
   B. Center where 'the means of production' produce usable and needed products for individuals in the habitat network (e.g., goods, consumables).
   C. Maintenance work centers.
   D. Recycling work centers.
2. Center for monitoring materialization and controlling based on standard operating procedures.
3. Storage centers.
4. User access/distribution centers.
5. Computational, architectural, and power systems are required.

Effectively, production is where changes are made to physical objects to conform them to extended functioning as "assemblies", which are operated as service systems that deliver service-objects, and then, disassembled when no longer needed.

Production involves four phases and four pathways therein, all of which must be accounted for by any solution/production:

1. Phase: Design.
   A. Design-decision pathway.
2. Phase: Construction.
   A. Assembly pathway (a.k.a., construction, building).
3. Phase: Operation.
   A. Operating manual and tactical procedures pathway.
4. Phase: De-construction
   A. Breakdown pathway (a.k.a., de-construction, taking down, disassembling, etc.).

Production is where the following mix of elements is actually executed and actualized:

1. **Materials.**
   A. Cultivation.
   B. Mineralization.
   C. Synthesization.
2. **Techniques.**
   A. Biological.
   B. Mechanical.

   C. Electromagnetic (electrical).
   D. Intellectual.
3. **Power.**
   A. Physical pressure (force).
   B. Electromagnetic torque (electricity-light).
   C. Electromagnetic tension (gravity).
   D. Atomic decay (atomic radiation).
4. **Time.**
   A. Labor-time.
   B. Compute-time.

Production using standards to inform specifications and produce desired assemblies of objects. To "produce" means to combine the materials (i.e., elements) and forces within an environment in coherent manner to change the expression (configuration) of existence. The production of objects in society can be done in a standard (formal) or non-standard[-ized] (informal) way. In simple words, it is possible to reconfigure the material environment by formal and informal means to produce different objects and different functions for society. Here, "materialization" means to cause or become real as an object in the physical world (Read: to exist as an object with location, exist : object + location). Materialization also means to be realized or carried out. The materialization of the specifications for community, as a type of society, are partly experienced as a habitat service system and partly experienced as an information environment. Matter can be reconfigured. The intentional reconfiguring of matter can produce greater function (ability) within an environment. City systems allow for the localized coordination of materialized service systems. The idea of materialization carries with it the idea that embodied consciousness exists within an environment that is responsive to thought by some degree, for it is conscious thought that moves capable effectors in the system. Simply, a physical environment can respond more quickly or less quickly to though by embodied consciousness. A lower order dynamic of though responsiveness may be an environment where someone must think of vase (type of object) and then use their body to use a tool to produce the vase. A middle order dynamic may be an environment where someone must think of a vase and then use modeling software and 3d manufacturing hardware to produce a vase-like object. A higher order dynamic may be an environment that can communicated with via thought, such that the user simply thinks of a vase and the environment procedurally develops it and then 3D manufactures it in real-time.

Other words for the term "materialization" include, but are not limited to: production; manufacturing; construction; fabrication & prefabrication; and assembly. All of these terms include in their definitions the meaning that something occurs that changes or reconfigures the materially sensed expression or appearance of existence. For example, when you whittle wood you are materializing a different structure. When you construct a building you are doing similarly. When you assemble a toy you are modifying the position and location, and maybe even composition, of material for a new function. When you code a program you are assembling a new set of functions into the world.

Information takes material form and becomes active in terms of doing things. Nature doesn't separate information and matter. When we understand this we can make objects that integrate with natural cycles. All production comes from an information system. Digital materialization is the term used to describe this, and it means a two way conversion between matter (material information) and information, or at least matter in different forms. One is more information friendly, electrons and photons, the other is static, matter. In order for this to exist we need: symbols; volumetric (3d or 4D space); constructive (modular); continuous (infinite surface, you can scale to any resolution you want); exact.

Fabrication is part of the production process in which an item is made ("fabricated") from raw or semi-finished materials, instead of being "assembled" from already-made (i.e., pre-fabricated) components or parts.

Another less common definition which does not apply here is: "materialization" is the appearance of something out of nowhere, or from an unknown source.

> **INSIGHT:** *For anything which is to be of service its formation must be accounted for.*

Every life-assembled material thing in the universe has a four phase cycle:

1. An imagination phase.
2. A birthing or construction period.
3. An optimal running life cycle.
4. A period where it gets broken down and re-purposed.

Materialization has several related meanings:

1. Materialization as an organized physical structure for implementing a technology.
2. Materialization as an organized structure for reifying a concept.
3. Materialization as the science of designing physical objects and structures.

The generalized steps of the production process include:

1. Identification of a demand (a.k.a., need, issue) from society for a physical object (assembly), always set within a habitat service.
2. A standards development working group prepares the draft specification for construction and operation of the object (assembly).
3. A standards development working group prepares the final specification (assembly).
4. A decision working group selects the final

specification for the object (assembly).
5. A habitat team as part of a habitat production service system produces the final object(s) with common heritage resources, and delivers it to where it is needed and may be operated.
6. A habitat service team dissembles the object when it is no longer needed or operated, and cycles the materials.

There are two general types of service productions,

1. **Continuous homogeneous outputs** – all users/customers receive the same product; although, not in the same quantities. The supply of fresh water and electricity are examples.
2. **Limited heterogeneous range outputs** - most services produce a wide variety of products of different sizes, styles, and qualities (e.g., dishes, computers, etc.).

1.1 Materialization

A.k.a., Production.

Materialization is the process of acquiring, producing, and using materials. The processing of materials has three principal purposes/aims (Messler, 2014):

1. To change the geometry (i.e., shape and dimensions).
   A. Different methods are used to achieve the aims of the material. Shape and dimensions (as these create geometry) can be achieved by three basic methods (Messler, 2014:463):
      1. Flow (or rheological) processes.
      2. Machining.
      3. Assembly of premade parts by joining.
      4. Vision and aesthetic.
2. To change the electro-chemical (includes optical) properties. Materials are selected for their properties. Property changes occur to materials when the materials are brought to the right condition (e.g., heating, a chemical bath, etc.).
3. To change the finish of the material. Finishing includes, but is not limited to: engineering tolerances, surface quality finishing, and surface protection and appearance, which are achieved either by machining or a variety of other mechanical, chemical, or thermal methods/treatments.

All materialization values/uses time, power, and objects (some volume of matter). The material assembly variables are:

1. Power (energy).
2. Time.
3. Object (volume).
   A. Mass quantity.
   B. Mass composition.
4. Tools, techniques, and knowledge.
   A. A tool used in a specific way, in conjunction with the material used, is called a technique.
   B. Knowledge of how to create the tools.
   C. Knowledge of how to use the tools.
   D. Knowledge of what substances to use the tools on/with.

1.1.1 Waste

Waste, fundamentally, can be understood as an unwanted output stream, a by-product of consumption and production processes that occur both in nature and within human activities. In the natural world, waste is an integral part of ecological cycles, where the by-products of one organism become the resources for another, showcasing an inherent balance. However, human-generated waste, especially from bodily functions, household consumption, production, and service operations, often disrupts this natural balance due to its volume, composition, and the manner in which it is discarded.

The challenge with human-generated waste lies not only in its quantity, but also in its materials cycling and potential for resource reuse or integration back into the environment without causing harm. As societies have evolved, so too have the complexities of waste coordination, pushing the boundaries of what can be recycled, repurposed, or safely reintegrated into ecosystems. The outputs of waste in community are handled as a service by the InterSystem team; the outputs of waste are then elemental inputs back into production, or ecological re-integration.

Waste streams (for material lifecycles) can follow the following paths:

1. **Waste to production** (e.g., refurbishing and repurposing).
2. **Waste to materials refining** (macro-material and technology disassembly).
   A. Here, refined materials are re-acquired.
3. **Waste to raw materials** (molecular and atomic disassembly).
   A. Here, raw material constituents are re-acquried.
4. **Waste flows into the Power Service as raw resources for combustion** (Read: combusting).
   A. Waste to energy (WTE; waste to combustion power) - is a process that converts waste into energy by burning it. Waste combustion facilities can generate electricity, heat, or steam from waste. Combustion waste to energy facilities also have a number of drawbacks. They produce terrible emissions, including dioxins, furans,

and heavy metals. These emissions can have a negative impact on human health and the environment.

5. **Waste due to market-State conditions ("wasting")**.
   A. Waste to landfill (WTL; waste to millenia compost).

Waste flow sources and streams in society include, but may not be limited to:

1. User personal- and common-access waste:
   A. Unsorted (not preferred).
   B. Sorted (preferred).
2. Habitat team service construction and operation waste.
   A. Sorted.
3. Production of technologies waste.
   A. Sorted.

Particularly in the context of waste it is important to identify commonly contaminated waste sources, which include, but may not be limited to:

1. Landfill leachate.
2. Contaminated recycling.
3. Sewage, sewage plant sludge.
4. Settling pond sludge .
5. Hazardous waste.
6. Hazardous chemicals.
7. Toxic chemicals and radioactive chemical waste..
8. Munitions and explosives.

Wasted object resource re-acquisition examples include,

1. Outputs 1 (from a depolymerization process):
   A. Multiple liquids.
   B. Monomers
   C. Molecules.
   D. Oligomers
   E. Waxes.
2. Outputs 1 go into (production):
   A. Chemical production (i.e., amine, styrene, glycols, PMMA, toluene, limonene, isoprene, etc.).
   B. To plastic production (i.e., polymerize PP, PU, PAG).
   C. Back-end distillation, then to chemical production.
   D. Non-thermal plasma (e.g., ethylene, proplyene, butelene), then to plastic production.
3. Outputs 2 (from another chemical process):
   A. Syngas.
   B. Gaseous molecules.
4. Outputs 2 go into (production):
   A. Use as internal combustion gas.
   B. Non-thermal plasma
   C. Micro-filtration/freezing.
   D. Thermal plasma.
5. Outputs 3 (from a combustion process):
   A. Char.
   B. CB.
   C. Activated carbon.
6. Outputs 3 go into (production):
   A. Thermal plasma
   B. Oxidize out to CO2.
7. Outputs 4 (from the disassembly process):
   A. Metals.
8. Outputs 3 go into (production):
   A. Recycling.
9. Outputs 5:
   A. Inorganics (minerals from refined disassemblies).
10. Outputs 5 go into (production):
    A. To plastic production or composites.
11. Outputs 6:
    A. CO2.
12. Outputs 6 go into:
    A. Non-thermal plasma (solid carbon).
    B. Thermal plasma (graphene, graphite, CB, nanotubes).

1.1.1.1 Habitat waste life-cycling

Habitats materialize, typically, around a source of water, and thereafter, due to human presence and the presence of human habitat services, there are waste streams (within the life-cycle). Technically, there is no "waste" is a system that naturally cycles all resources. In this way there are two types of waste cycling systems:

1. **Waste cycling systems that cycle resources within the human habitat service system.**
   A. **Re-cycling and up-cycling processes:** Systems designed to recover materials for reuse, either in their original form (recycling) or by transforming them into products of higher value (upcycling).
   B. **De-cycling processes:** Composting systems designed to de-compose organic matter into useful substrate (e.g., top-soil, gas, etc.).
2. **Waste cycling systems that lose, degenerate, and/or decay resources** (e.g., most combustion systems).

The typical life-cycle of a habitat waste cycling system includes waste moving from some source (production itself, or final usage), back into the production system:

1. **Waste from [a source]:**
   A. Users of final products: Waste generated from residential dwellings and common access

locations, encompassing human waste, food waste, and technology waste. This category includes the collection and sorting hubs for final-use waste. Here, there is final-use waste collections and sorting hub. This includes human waste, food waste, and technology waste.

B. Waste from production of final user services and products (i.e., waste from production of each local set of habitat services). This includes raw resource wastes and technology wastes.

2. **Waste to up-cycle - An upcycling production facility/complex:** Complex focused on re-use and re-purposing of wasted, disassembled objects.
   A. **An assembly production (up-cycling) facility/complex:** An "up-cycling" facility/complex re-purposes disassembled technologies, and puts those sub-objects into service elsewhere.
   B. **Re-use as feed for other animals:** Conversion of organic waste into feedstock for animals, contributing to the circular food system.
   C. **Re-use for another material purpose in the habitat:** Redirecting waste materials for alternative uses within the same habitat, minimizing the need for new raw materials.
3. **Waste to re-cycle - A recycling production facility/complex:** Centers focused on the recovery and processing of materials for reintroduction into the production cycle.
   A. A **re-cycling** production facility/complex (a refining, smelting, and mineral processing complex):
      1. A **pyrometallurgical recycling system** is a facility that utilizes high temperatures to separate and recover minerals.Pyrometallurgy is a heat-based extraction and purification process. Pyro-metal material recycling complex use heat to re-cycle metals):
         i. Feedstock piles.
         ii. Pyrometallurgy service operations.
         iii. Recycled residues streams warehouse.
      2. A **hydrometallurgical (hydromet) recycling system** is a facility that utilizes hydrometallurgical processes to recover "valuable" metals from various types of waste materials, including electronic waste (e-waste), batteries, and metal scraps. Unlike pyrometallurgical methods, which involve high-temperature processes to extract metals, hydrometallurgical techniques use aqueous solutions to dissolve and separate metals in a more environmentally friendly manner. Hydrometallurgy involves using water for the extraction of metals. A hydro-metal material recycling complex includes:
         i. Feedstock piles.
         ii. Hydrometallurgy service operations.
         iii. Recycled residues streams warehouse.
      3. **Cutting and chemical processing center** (chemical refining facilities). Breaks down complex materials into simpler substances for re-use and/or re-purposing as: cuttings, powders, and simple chemical substances/elements.
         i. **Hydrolysis:** A chemical process that involves the splitting of molecules through the reaction with water. It's often used in the breakdown of organic material and certain types of plastics.
         ii. **Gasification:** A process that converts organic or fossil-based carbonaceous materials into carbon monoxide, hydrogen, and carbon dioxide. This is achieved by reacting the material at high temperatures, with a controlled amount of oxygen and/or steam. The gas produced, known as syngas, can be used for energy production.
4. **Waste to de-cycle - A decycling production facility/complex:**
   A. **Compost-cycling facility/complex:** Sites dedicated to the transformation of organic waste into compost, supporting biomass production and enhancing soil fertility.
      1. **Anaerobic and aerobic digestion:** A series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. It's widely used for treating wastewater and organic waste, producing biogas and digestate as outputs, which can be used for energy production and as a fertilizer, respectively.
   B. **Combustion-cycling facility/complex (a.k.a., incineration and pyrolysis):** Utilizes the combustion of waste materials for energy generation through processes like pyrolysis, contributing to the habitat’s energy needs.
      1. **Incineration:** The combustion of organic material and waste with oxygen to produce $CO2$, water, and ash. While primarily a method of waste disposal, it can be used to generate energy.
      2. **Pyrolysis:** A thermal decomposition of materials at elevated temperatures in an inert atmosphere. It's an essential process for converting waste into biochar, syngas, and bio-oil, contributing to the production of renewable energy and chemicals. **Pyrolysis**

(heating the feedstock without oxygen until catalytic cracking occurs) of rubber can be used to make a fuel oil, which can be used in diesel engines after some further fractional distillation steps. This process also produces carbon black, which could be ued to produce graphene.

1.1.1.2 Waste phases and services

The common waste phases and services are:

1. Education phase:
   A. Education on waste, as a service.
2. Collection phase:
   A. Waste sorting and deposition (into a collection point) by user.
   B. Post-collection waste sorting by InterSystem team (reduced through pre-collection user-waste sorting).
3. Post-collection processing phase (a.k.a., waste production processing, waste processing, production waste services):
   A. Waste refurbishing and re-distribution to an accessible access-category status.
   B. Waste re-purposing. Where, the technology is disassembled and items are used elsewhere, or re-used in a similar system.
   C. Waste shredding. Where, the object is cut into pieces.
   D. Waste chemical operations (e.g., melting, molecular disassembly, etc.).

Waste service sub-systems (a.k.a., waste-service production clusters) include the sorting and collection of waste from residential and production services:

1. Residential and production waste sorting.
2. Collecting:
   A. Electrical (Waste Electrical and Electronic Equipment, WEEE).
   B. Ceramics.
   C. Glass.
   D. Plastics.
   E. Organics.
   F. Magnetic steel scrap.
   G. Non-ferrous heavy metal scraps.
   H. Non-ferris light metal scraps.
   I. Central mineral processing facility connected to three endpoints:
      1. Feedstock.
      2. Tailings dam.
      3. Waste dump.

1.2 Taxonomy of production-localization

A.k.a., Production zoning, manufacturing zoning, materialization zoning, etc.

All production, like all physical service interfaces, is physically localized to some address on the landscape. The following taxonomy provides a structured overview of production localization in a community habitat network, from urban habitats to remote and wild locations:

1. **Production within a local habitat** (which, exists within a regional habitat network, within a global Commons habitat service network):
   A. **Urban production facilities:** Factories or workshops located within the perimeter of a single, local habitat. Typically, this type of production is production for the local population's needs (and typically, also supporting the needs of the regional population, within the global network) and utilizing habitat infrastructure.
      1. Note: In the market-State, there are a separate class of production centers, suburban ("sprawled") production units -- smaller production units and artisan workshops located in suburban areas.
   B. **Rural agricultural sites:** Holistic pastoral-type agricultural production sites situated in rural parts of the habitat, focusing on the production of food, fiber, fuel, and other agricultural products.
2. **Single production point in the wild, for example:**
   A. **Remote extractive and electromagnetic harvesting sites:** Isolated locations for the extraction of natural resources, such as mining sites, oil rigs, or timber camps, often situated far from established habitats due to their dependence on natural resource locations, and their emissions. Renewable energy farms are concentrated installations of technologies designed to harvest "renewable energy" sources of electrical power, such as solar panel fields or wind turbine farms, which are situated in areas optimal for energy generation rather than urban proximity.
   B. **Research and development stations:** Specialized facilities for scientific research or development projects that require isolation from urban influences, such as astronomical observatories or ecological research stations.
3. **Production clusters outside habitat, for example:**
   A. **Production complexes (a.k.a., industrial complexes, heavy industry production, heavy industrial cluster production):** Aggregations of multiple heavy production

facilities in proximity to each other, but located outside [urban] habitats. Production clusters are typically localized to/around:

1. An easy to access location outside of any local habitat; and optimally, "near" enough to a regional habitat transportation network to take advantage of shared infrastructure and logistics efficiencies.
2. A specific location where there is the extraction of natural resources (i.e., where there is a remote extractive site). Here, the production (and assembly) facilities are centered around a specific location of extracting/harvesting (e.g., mine, geothermal point, solar/wind array, etc.). Centering production proximal to the location of extraction/harvest can potentially optimize and economizes transportation and power requirements for production purposes (by localizing materials processing and assembly to the landscape location of extraction). Localizing production clusters to points proximal the point of extraction (in the wild) reduces the likelihood of hazardous waste plumes entering the world's watersheds and ecosystems.

B. **Wild hunting and gathering:** Cultivation producers (i.e., InterSystem team members) who pool their resources for mutual benefit, caretake and cultivate the wilds, within which, they hunt animals and gather an array of other organisms.

1.2.1 Production clusters

Production clusters are clusters of production facilities with a rail transport line that can move both people and cargo between; and then, between production clusters themselves, and a regional habitat network. Effectively, industrial systems a placed close together with a rail network between them, and connected to a regional habitat network. Each production cluster network would be designed as one single entity (whereas, in the market under conventional standard practice, each process plant would be required to be economically viable and sell their products to the market to stay operating. There is no price within the production of the means of production, in community. Production clusters localize production inputs and inter-production cycles.

1.3 Taxonomy of visualization-specification

Every production in the material world is based upon some prior specification (Read: visualization). Specifications are composed of:

1. **Lists** - because, every specification is a feasible project proposal, ready for execution; all projects are executed via a series of lists).
2. **2D conceptual system model(s)** - show concept models, conceptual figures.
3. **3D object system model** - shows object in a static frame, including geometry associated data (i.e., show object models, object/assembly figures).
4. **4D (3D + motion/time) process system model, including simulation associated data** - shows objects in motion with geometry-associated data; show simulation.
   A. Mechanical visualizations (including, definitional associations and understandable explanations).
5. **Manual instructions** - shows user how to operate a tool/system.
   A. **Production of service technologies manuals** (a.k.a., production technology manuals; construction, manufacturing, installation, distribution, disassembly manuals).
   B. **Service operating manuals** (i.e., final socio-technical habitat service operating manuals for using produced technologies within habitats).
   C. **User-side manuals:** Manuals about how to use final personal- and common-access technologies (and services).
   D. **Analytics manuals:** Manuals about the easurement and data analysis visualizations, formuli and definitional associations.

A production [of some object/system] information data sheet should include at least the following:

1. Names or other identifications of object components.
2. Names or other identifications of supra-system, system, and sub-systems (sub-assemblies).
3. Shape (i.e., geometry) and dimensions of object components (including dimensions to allow proper orientation and arrangement of components in major subsystems (sub-assemblies), and within the overall product)
4. Tolerances (i.e., durability force parameters).
5. Weights of components (i.e., atomic/elemental mass and acceleration, weight).
6. Material(s) used to create each component.
7. Manufacturing (i.e., fabrication, processing, and assembly) processes/techniques.
8. Finishes on components.
9. Function(s) of each and every component and any and all sub-systems (sub-assemblies).
10. Estimated amount of human effort.
11. Estimated costs (in the market for materials, processing, and assembly).

1.4 Production machines

A.k.a., Prime movers, tools of production, technical means of production, tools.

Object-assembly "means of production" are the production machines themselves, which produce the products (and services), and include the operation of those products as services themselves.

Here, there are two primary categories of production machine:

1. Machines that produce physical motion of objects.
2. Machines that produce computation of data.
3. Machines that produce electrical power.

These machines can be operated along a spectrum from highly manual to highly automated.

Habitats are a continuous production, composed of service sectors produced, maintained, and updated through two types of [motion] machines:

1. **Mechanization machines:** Machines that produce (acquire and assemble) and transport (distribute) material objects (and people), "movers".
   A. These systems need to carry and sustain physical forces, loads, and pressures.
      1. Engines (a.k.a., actuators, spatial movement generators): Actuators cause an action by transferred energy or, more often, motion from one object to another. The motions transferred may be translational, rotational, or both.
         i. Motion converters: These devices or mechanisms change directed movement from one direction or speed or torque to another.
2. **Structural machines** (enclosures, not true machines): Structures are intended to carry, resist, sustain, and/or transfer forces or loads.
   A. **Joints (joining)** - the process of joining, and being joined. Joining processes (a.k.a., joining techniques) include, but are not limited to: mechanical joining, adhesive bonding, welding, slotting, etc.). There are two general categories of joint (joining):
      1. **Rigid joining (as in, fixed structures):** Joints are complex assembly systems consist of multiple fixed, unmoving parts.
      2. **Elastic joining (as in moving by stretching structures):** Joints are complex assembly systems consist of multiple moving parts. These parts need to be held together to create an functional moving assembly.
      3. **Combination** of rigidly and elastic, as in an elastic tendon rigidly locked with a screw into a bone.
3. **Computation machines:** Machines that store, analyze, and allow us to interface with and use data, information.
   A. These systems need to carry and sustain computational loads and instruction pressures.
      1. Computers (a.k.a., computational generators).
4. **Electrification machines:** Machines that produce electrical power by "pumping" atoms (with electromagnets), thus producing atoms spinning in place along a conductive atomic surface (Read: electricity).
   A. These systems need to carry and sustain electrical loads and electrical pressures.
      1. Electricity generators (a.k.a., electrical generators). Examples include, coal generators, wind turbines, solar arrays, etc.
         i. Electrical converters: These devices or mechanisms change power or energy from one form to another. Examples cited include heaters, coolers or chillers, heat exchangers, transmissions, and differentials. Also in this category is insulation.
5. **Hybrids:** Involve a combination of the above machines.

Machines common to all types include:

1. **Sensors** - that detect change [in the environment].
2. **Movers** - that create change [in the environment].
3. **Recorders** - that record change [in the material environment].
4. **Controllers** - that select from a set a parameters and execute the decided selection to move, to sense, and/or to record.

1.5 Material production data

Material production system [material] data structure:

1. Class: Materials to which the process is amenable based on some useful factor(s). For example, hardness and, in some cases, T_{MP} or T_g.
2. Size: Minimum and maximum size suitability, based cn either volume or weight
3. Shape: Symmetry; aspect ratio; thickness to depth; surface-to-volume ratio.
4. Complexity: Number of steps to produce as an assembly.
5. Tolerance: Accuracy or precision attainable in dimension.
6. Surface roughness: Surface finish as measured by roughness.

7. Surface detail: Smallest radius of curvature; intricacy of details.
8. Minimum batch size: Minimum number of units that can be produced.
9. Production rate: Cycle time; time to produce one unit.
10. Cost (market-only): Cost per unit, Including capital cost and labor.

1.6 Material production processes

Production processes can be modeled in the following way:

1. Raw materials acquisition (i.e., acquiring raw material parts):
   A. Mineral - mining.
   B. Organic - cultivating.
2. Shaping (shape intermediary part):
   A. Casting methods; e.g., sand, die.
   B. Molding methods: e.g., injection, compression, blow.
   C. Deformation methods; e.g., rolling, forging, drawing.
   D. Powder methods; e.g., sintering, HIPing, slip casting, laser 3D printing.
   E. Other methods.
3. Machining (make part):
   A. Motion machine.
   B. Heat machine (i.e., heat treat).
   C. Electrical power machine.
   D. Construction"machine".
   E. Computation "machine".
4. Joining (join):
   A. Adhesives.
   B. Welding.
   C. Fasteners.
   D. Perfect slotting.
5. Finishing (finish):
   A. Polish; e.g., electropolish, burnish, lap.
   B. Coating; e.g., electroplate anodize.
   C. Paint; e.g., enamal, paint, print, silk screen.
   D. Texture; e.g., roll, brush, laser, electrotexture, natural rust.

1.6.1 Shaping techniques

A.k.a., Shaping methods, shaping processes.

Shaping techniques include, but are in no way limited to:

1. **Casting (is a primary shaping, flow process)** - producing a crystalline metallic or, occasionally, ceramic material is melted and poured into a sacrificial mold or permanent, reusable die. Casting allows repeated production of complex shapes and is capable of intricate details.
2. **Pressure molding (is a primary shaping, flow process)** - an amorphous glass, amorphous or semicrystalline polymer is made soft by heating sufficiently above its glass transition temperature (Tg) to allow flow into all areas of a mold or die cavity under an applied pressure. The system is then allowed to cool until the part becomes suitably rigid below the material's Tg that it will retain shape upon ejection. Pressure molding allows complex shapes, intricate details, and precise dimensional control.
3. **Deformation (is a primary shaping, flow process)** - is the process whereby a metal or alloy is forced to change shape by using sufficient pressure or stress to cause plastic-like deformation. There are hot (heated) and cold deformation types.
4. **Powder metallurgy (is a primary shaping, flow process)** - is a manufacturing method that uses powdered materials like metals, ceramics, or plastics. These powders are pressed together under high pressure in molds, and then heated to make them stick together.
5. **Machining (is a cutting process; considered a secondary shaping process)** - is the sub-classification that involves cutting (e.g., sawing, planing, milling, threading), turning (e.g., using lathes), drilling (including boring and reaming), and grinding (i.e., removing either hard material or very undesired material). Machining is often required following a primary shaping process, in order add required geometric features not achievable via the primary shaping process.

2 Production service organizations

Production is a service, but not all services are of the production (materialization) type. Production and services can be seen as two different categories of habitat support:

1. **Habitation [material productions] service organization** - produce physical objects and services, as well as intangible products (e.g., music) that cannot be produced ahead of time. Production organizations produce physical, tangible goods that can be stored in inventory before they are needed. Productive operational services refer to the physical production of material objects and social life, technological, and exploratory services. The technological (technical) service organizations that produce and distribute social services and technological objects throughout the habitat are:
    1. Services to acquire objects (cultivation and mining).
    2. A service to produce objects via assemblies (materialization).
    3. A service to transport objects via assemblies, vehicles and paths.
    4. A service to perform computation via assemblies, computers.
    5. A service to enable human communication via assemblies.
    6. A service to enable human design collaboration and intelligence analysis via assemblies (e.g., artificial intelligence).
2. **Mining [mineral extraction] service** - the acquisition of elemental minerals from the earth's landscape and water bodies.
    A. A service system to extract and appropriately process minerals into habitat service productions (to be used by contributor-users and end-users).
3. **Cultivation [biological extraction] service** - the acquisition of organic materials from the earth's landscapes and water bodies.
    A. A service system to extract and appropriately process food, fuel, and fiber into habitat service productions (to be used by contributor-users and end-users).

2.1 Mining

Mining is the acquisition of natural and artificial minerals and elements from the landscape (including, oceanscape):

1. Stone: Mining starts with stone in large, uniform, aesthetically-perfect pieces suitable for a large function.
2. Gas and liquids: typically of hydrocarbon or liquid metal form.

2.1.1 The mining processes

The mining process involves:

1. Exploration:
    A. Identification of potential mineral deposits through geological surveys, satellite imagery, or drilling.
    B. Exploration involves locating mineral-rich areas and assessing their economic viability for mining.
2. Site preparation.
    A. Conducting assessments and mining site actualization decisioning.
    B. Clearing land, building access roads, and establishing infrastructure like power lines, water sources, and accommodation facilities.
3. Extraction and mining operation.
    A. Excavation of the mineral deposit using various mining methods such as open-pit mining, underground mining, or surface mining.
    B. Extraction of the solid, liquid or gas material using tools, machinery, conduits, explosives, or drilling equipment.
4. Transport.
    A. Transporting the extracted ore to storage and/or processing via trucks, conveyor belts, or railcars for further refinement.
5. Storage.
    A. Packaging or bulk loading of materials into containers or rooms for protection from the elements.
6. Processing (grinding, cutting, beneficiation, refinement).
    A. Crushing and grinding of the mined ore into smaller particles using crushers and mills to liberate valuable minerals from the surrounding rock.
    B. Chemical and physical processing techniques are applied to concentrate the minerals, separating them from impurities.
    C. Various techniques like flotation, gravity separation, magnetic separation, or leaching are used to separate and refine the desired minerals from the ore.
7. Mineral product classification and packaging.
    A. After processing, minerals are graded and classified based on their quality and size specifications.
    B. Packaging or bulk loading of the refined materials into containers, bags, or bulk carriers

for transportation.

8. Assembly end-use manufacturing, for products, for example, production into:
   A. Metal machines.
   B. Countertops.
   C. Etc.

2.1.2 Mining outputs

There are several primary forms of mining outputs (mineral extraction deliverables):

1. **Waste dump (a.k.a., waste rock dump or spoil pile):** An area where non-valuable or uneconomical materials, often referred to as waste rock or overburden, are deposited. These materials are excavated during mining operations but do not contain economically viable minerals or metals. Waste dumps are typically located near the mining site and serve as a designated area to store and manage this excess material.
2. **Feedstock:** In mining, "feedstock" generally refers to the raw materials or ore that is extracted from the earth and subsequently processed to extract valuable minerals or metals. It represents the starting point of the mining and metallurgical processes. Feedstock can vary widely in composition, and its characteristics influence the selection of processing methods.
3. **Tailings dam:** A tailings dam, also known as a tailings pond or tailings storage facility, is a constructed reservoir where the waste materials or tailings from ore processing are stored. These tailings typically consist of finely ground rock, water, and chemicals used in the extraction and beneficiation processes. The tailings dam is designed to contain and manage these materials to prevent environmental contamination and provide long-term storage.

2.1.3 Mining extraction processes

Extraction methods used in metallurgy and mining include, but may not be limited to:
Hydrometallurgy: The use of water-based solutions for the extraction and purification of metals from ores.

1. Pyrometallurgy: A heat-based extraction and purification process that involves high-temperature treatments.
2. Electrometallurgy: Utilizing electrical energy to extract and refine metals, often through processes like electrolysis.
3. Bioleaching: Employing microorganisms, typically bacteria, to aid in the breakdown of minerals and extraction of metals from ores.
4. Solvent extraction: Separating and purifying metals from complex mixtures using selective solvents, often in hydrometallurgical processes.
5. Flotation: A method for the separation of minerals from ores based on differences in surface properties, involving the use of air bubbles.
6. Leaching: The process of extracting metals from ores or other materials using chemical solutions.
7. Magnetic separation: Utilizing magnetic properties to separate magnetic materials (including some metals) from non-magnetic materials.
8. Gravity separation: Separating minerals or metals based on differences in density using gravitational forces.
9. Smelting: Melting ores to extract metals, often followed by further purification.
10. Electrorefining: Refining metals through an electrolytic process, which involves passing an electric current through a molten or dissolved metal to remove impurities.
11. Cyanide leaching: A specific form of leaching using cyanide solutions to extract gold and silver from ores.
12. Heap leaching: A method of extracting metals from low-grade ores by piling them into heaps and using chemical solutions to leach the metals.
13. Pressure oxidation: A hydrometallurgical process used to extract metals from refractory ores by subjecting them to high-pressure, high-temperature conditions.
14. Carbon-in-Leach (CIL) and Carbon-in-Pulp (CIP): Techniques for extracting gold from ore by adsorbing the metal onto activated carbon particles.

2.1.4 Basic mining-production cluster processes

The basic mining cluster production processes are:

1. **Physical processing plant:** A processing plant is where the extracted feedstock is subjected to various physical and chemical processes to separate and extract valuable minerals or metals. This often involves crushing, grinding, milling, and concentration processes to produce a concentrate for further refining.
2. **Smelting and refining:** After processing, some metals may undergo smelting and refining processes to further purify and shape them into marketable products. Smelting involves melting the metal, while refining involves removing impurities to achieve desired purity levels.
3. **Heap leaching:** A method used for certain types of ores, where ore is stacked into heaps and

subjected to chemical leaching processes to extract valuable metals.

4. **Electrowinning and electrorefining:** These processes involve the use of electricity to extract and refine metals, such as copper and aluminum, from solutions or concentrates.
5. **Environmental controls:** Environmental considerations are crucial in mining and often involve the implementation of control measures to mitigate the impact of mining activities on surrounding ecosystems, air, and water quality.

2.2 Economic production categorization[-ing]

There are several main types of production relations in concern to human presence in the base production equation and the type of object output as the result of production:

1. Human-hand only production.
2. Human and machine production.
3. Human and computer to machine production.
4. Computer only to machine production.

Production can be categorized in relation to automation and human involvement:

1. **Manual product** - the work is done by human hand and mind, to some relatively high-degree (given context).
2. **Automated production** - a fully automated system geared to manufacturing only one type of object in a fully automated manner with humans monitoring the functioning of the operating equipment.
   A. Robotics.
   B. Artificial intelligence.
3. **Hybrid production** - a production type that combines automation with human effort.
   A. Hybrid machine and human production.
   B. Hybrid machine and computer and human production.

For any complex socio-technical society, machines and computers must be produced, including the power to "energize" machines. Machines (machine labor) improve human life in two ways:

1. They amplify the human ability to produce goods and services (e.g., a crane allows one human to lift very heavy loads).
2. They extend/expands human ability to. It allows us to do thins that no human being could do (e.g., virtual reality or simulation).

If a population wants a world that is more liveable, they might need a world where machines are doing more work for humanity than in the early 21st century (and in the market-State, that requires energy being low cost). All human beings desire the time and freedom to peruse intrinsic interests and life purposes. This pursuit at a global scale is only possible if machines are doing most of the banal, and often laboriously and dangerous physical work. In the market-State, low cost reliable energy allows machines to do a lot of the work for humanity and free up time to facilitate transition to community.

The two primary methods for producing needed object assemblies using of machines (and computers) any are:

1. **On-demand production:** Produce individually on-demand.
   A. On-demand production (e.g., 3D printing and custom work).
2. **Continuous production:** Produced continuously into the strategic future (e.g., life, technology, and exploratory support). For instance, drinking water is produced continuously. Continuous production uses production line tools (a.k.a., assembly lines).
3. **Batch production (a.k.a., fixed production):** Produced in fixed quantity (batch), rather than continuous or completely on-demand. For instance, a specific wine is produced in batch.

Note that this manufacturing type categorization ought not to be confused with the configured resource fixability categorization as:

1. **Resources fixed [continuously]** onto the landscape. For instance, a building and pond become fixed architecture (as needed).
2. **Resources flexible [ad-hoc]** personal and common access (as preferred).
3. **Resources cyclical re-applied** to the landscape as a regularly repeating operation). A cyclical event is a cyclical (Read: regular) configuration of resource on an area of land; for instance, as preferred, a yearly fiesta).

The classic manufacturing processes in commercial practice (in order of decreasing volume):

1. Continuous flow - large and continuously required production volume (e.g., oil and utilities, infrastructure).
2. Production line - high-volume production of standard products or “design window”.
3. Batch (high volume) production.
4. Batch (low volume) production.
5. Job shop - low volume, one-of-a-kind products, on demand customization.
6. On-demand automation - produced as specified on-demand without customization.

The production of products can be categorized in the following temporal manner:

1. **On-demand customized (a.k.a., engineer to order, ETO)** - the items are produced only after receiving a customer order with one key difference—the product specifications are custom for each item. In other words, a type of manufacturing where a product is engineered and produced after an order has been received. Items are produced with low frequency or sporadically in ETO. Since the specifications are custom, every item will also have a different materials list (bill of materials, BOM).
2. **On-demand automated (a.k.a., make to order MTO, single product orders)** - a pull approach where production begins only after receiving a customer/user order, and there is no further necessary customization of the product. The materials list (bill of materials, BOM) and specifications remain the same for goods produced in MTO. Since items are made only after receiving a customer order, it is called "make to order".
   A. **Assemble to order (ATO), configure to order (CTO), build to order, BTO):** Assembly occurs after the producer receives a user's (customer's) order. CTO is a variant of make-to-order production approach in which configuration starts only after a customer's order is received.
   B. **Intelligent production ordering (IPO):** Assembly continues according to demand as visible by stock surveys and informed user surveys.
3. **Make to stock (MTS)** - inventory is produced and stocked in warehouses. MTS is the most common manufacturing method prevalent in fast moving "consumer" goods. In MTS, the materials list (bill of materials, BOM) remains the same for one type of product. These are the important factors to consider when manufacturing items to stock:
   A. Forecasting.
   B. Seasonality.
   C. User demand.
   D. Product expiry dates.
   E. Available warehouse space.

2.2.1 Product complexity index (PCI)

A.k.a., Object complexity index (OCI).

In community, the product complexity index refers to how complex a product is in therms of its resource composition and the processes that are required to produce the final composition.

CLARIFICATION: *The concept of product complexity index (PCI) means something different in the market-State, where it refers to how diversified a country's exports are currently. It is calculated as the mathematical limit of a measure based on how many products a country exports and how many exporters each product has.*

2.3 Product specification[-ing]

INSIGHT: *There are constraints imposed on what we can make by the universe, by our knowledge of the universe, and by our intelligence in the universe. There is a general constraint determined by the physics of the universe, and within that "cone" of constraint there is our knowledge, our intelligence, and our will/intentionality.*

Product specificationing refers to the [sub-]production of a set of standards to produce the product. Specifications are documentation that describe the materials, products, work and techniques, and tolerances (and other aspects) that must be adhered to and are required for a specific materialization. Documentation refers to symbols, text, imagery, and simulation. Effectively, every product is a "documented" design. Therefore, all specifications together may be referred to as a "documented design" specification (a.k.a., engineering specification). A complete product specification is the knowledge ("facts") of a product, what it is, how to produce it, and how to use it. It includes data sufficient to completely produce the product, operate the product, and de-cycle the product.

The most common types of specifications used in production service projects are:

1. **[Issue] Outline specifications (a.k.a., product project charter specifications)** - A first and continuous stage in the development of a specification is the preparation and continued active coordination of an outline/overview [specification].
   A. **Purpose of system (a.k.a., needs):**
      1. What is needed?
      2. Why is it needed?
      3. What does it do?
      4. Who is it made by?
      5. How is it made?
      6. How can it be made at a specific location?
      7. How to apply and/or operate the system?
      8. What does it cost to research, construct, maintain in operation, and de-construct?
   B. **Objectives (a.k.a., operational values):** Detailed checklist on evaluating the product:
      1. Structural serviceability - resistance to natural forces such as wind and earthquake; structural adequacy and physical properties

such as strength, compression, tension, shear, and behavior against impact and indentation.

2. Fire safety - resistance against the effects of fire such as flame propagation, burn through, smoke, toxic gases, etc..
3. Habitability - livability relative to thermal efficiency, acoustic properties, water permeability, optical properties, hygiene, comfort, light, and ventilation, etc.
4. Durability - ability to withstand wear, weather resistance such as ozone and ultraviolet, dimensional stability, etc.
5. Practicability - ability to surmount field conditions such as transportation, storage, handling, tolerances, connections, site hazards, etc.)
6. Compatibility - ability to withstand reaction with adjacent materials in terms of chemical interaction, galvanic action, ability to be coated, etc.)
7. Maintainability - ease of cleaning; repairability of punctures, gouges, and tears; recoating, etc.
8. Code acceptability - review of code and manufacturer's claims as to code compliance.
9. Market economics - financial, currency costs associated with acquisition, installation and maintenance of everything from the market.
10. Governmental (jurisdictional) legality - reviewing and paying the government to meet codes and permit requirements as set by different governmental jurisdictions.

C. **Titling and numbering requirements:** Title and number checklist of every nameable object and definable process (concept).

D. **An outline/overview specification:** A brief textual and imagery based description of the main components to be used in materialization.

2. **[Requirements] Functional specifications (a.k.a., text-specific description of product, services level specification):** Describing the specific functions and operations a product must perform or deliver. The focus is on the project outcome, indicating how the final project must be able to function.
   A. **Requirements specification (a.k.a., needs and objectives specification, feature specification)** - list the needs that must be met to complete a function.
   B. **Performance specifications (a.k.a., performance criteria, performance parameters and metrics, indicators, capability specifications, quality specifications)** - describe the result that is required from particular items. Capability specifications identify what capabilities and performance levels a product needs to achieve under defined conditions or criteria. Quality specifications define the quality standards, benchmarks, or metrics that the product must adhere to in terms of performance and functionality.
3. **[Visualization] Technical specifications (a.k.a., visual-specific description of product, prescriptive specifications, engineering specifications)** - specification that contain detailed visual and geometric metadata (e.g., BIM and GIS). The documentation to be used to produce, transport, install, operate, and de-cycling assembled objects.
   A. **Required standards (a.k.a., general requirements, general provisions):** requirements surrounding what standards to follow in the product's design, including regulations (codes), in order to complete production. Uses specific standards in the product's design.
   B. **Required materials and tools for production**: the type of materials and products required based on performance and structural specifications.
   C. **Required procedures and tools for production:** how to produce, transport, install and measure its effectiveness.
4. **[Solution] Simulation specification (a.k.a., clash detection visualization):** Simulate the objective environment to analyze and understand the flow of resources through different material service configuration:
   A. Locate resources (objects) into service assemblies in the habitat.
   B. Move resources through processes (concepts) that complete needs and requirements for human survival and fulfillment, given current conditions.
5. **Operation[al] specifications (a.k.a., manuals, help interfaces, AI assistants)** - are the manuals produced to describe how to correctly use the produced product as part of some larger habitat system.
6. **Proprietary specifications (market only) -** specification that demand that only one specific product be used for a given installation. It is commonly utilized if the portion of a project requires a certain performance that only one product can achieve.

Specifications can also be classified according their allowance of one or more suppliers:

1. **Open specifications** - an open specification when a producer does not name a specific supplier or product and allows for substitutions to be made by the contractor. Open specifications do not limit competition, but rather is dictated by a set of standards that more than one manufacturer can meet, allowing for many alternatives to be submitted for approval. Performance specifications are often considered to be open.
2. **Closed specifications** - a closed specification lists specific products, systems and manufacturers, with no alternatives or mechanisms to apply a substitution. Closed specifications are most often seen when matching a specification to an existing building, or when an exact duplication is important. By default, closed specifications are proprietary. However, they can be made “open” by not referring to a singular brand or providing requirements applicable only to a specific product. This is commonly done by adding “or equal” after the listed brand.

2.4 Production location[-ing]

A.k.a., A.k.a., Production centers, manufacturing locations, manufacturing facility placement, manufacturing centers, construction locations, fabrication locations, etc.

There are locations ("centers") within and between habitats where resources are processed and assemblies of objects are produced. Production includes every form of production, from mining, to processing, to assembling, storage before use, to disassembling and re-cycling.

There are two qualitative locations wherein designs get built, they are:

1. **Manufactured**, if the work is done or could have been done indoors (in a factory). It is important to note here that "manufacturing" is sometimes defined from a commercial perspective: Manufacturing is the production of merchandise for use or sale using labour and ...” Considering that there is no commerce in community, this definition does not apply.
   A. For example, cars, airplanes, boats, food, user objects, and even hydrocarbon oil, etc., are all manufactured inside architecture (i.e., inside some form of shelter).
2. **Constructed**, if the work, of necessity, is done outdoors.
   A. For example, a house, bridge, dam, fixed solar power array, etc., are constructed outside.

Production (manufacturing and construction) are essential to consider because they affix objects into the environment and produce assemblies with real-world emergent effects. So many of the remaining choices are fixed by the productions of the past.

Placement of possible production locations include:

1. Land.
2. Water.
3. Space.

There are three categories of production operations in concern to proximity to a city, and scale of complexity and waste (in concern to the locating of production technical units there are three categorizations):

1. **Light production** - is production that which can be done within a habitat. During light production, it is easy to collect waste streams and cycle the material for further use. Light production within a habitat typically occurs indoors. Light production does not significantly disturb the surrounding population living in a local habitat. “Light” production is production that is done within a habitat.
   A. Light production of architecture (land-fixed objects).
   B. Light production of socio-technical products (typically non-fixed objects).
2. **Medium production (optional category)** - is production that is done just beyond the edges or just within the edge of the perimeter of an integrated city habitat. Heavy production uses medium machinery best environmentally isolated within the perimeter of the habitat, or concealed just outside the perimeter of a local habitat.
3. **Heavy production** - is production that is done away from human population densities. With heavy production, it is significantly more difficult to collect waste streams, and some waste must be disseminated into the environment. Heavy production outside of the perimeter of a habitat may occur outdoor and/or indoor. Heavy production is likely to disturb the population living in a local habitat if it was to be conducted within the perimeter of the habitat. “Heavy” production is production that is done away from human population densities. Heavy production uses heavy machinery best not operated near human habitation.

Society requires both light and heavy production of materials in order to construct and maintain habitat operations and the objects used by people therein.

In concern to the locating of centers of production, different functional production (industrial) facilities ought to be positioned close together and have a rail network between them, then internal combustion engine vehicle transportation would not be required. These production centers, if classified as heavy production and/or require more space, may be located outside of the integrated city systems.

2.5 Production method selection[-ing]

A.k.a., Production methodology, manufacturing method selection, manufacturing methodology.

Production methods are considered in relation to their:

1. Completeness of life-cycle analysis.
2. Completeness of characteristic analysis.
3. Completeness of reliability analysis.
4. Completeness of location analysis:
   A. Viability of on-site production.
   B. Viability of factory production (where repetition, predictability, quality control, and economies of scale can more readily be realized).
5. Cost analysis (market only).

The selection of a different production method will affect the following production factors:

1. Delivery time.
2. Change impact.
3. Development time and requirements.
4. Engineering time and requirements.
5. Risk of design error.

2.5.1 Production workflow, production phases

A.k.a., Manufacturing phases, production workflow.

The phases of the production/materialization (i.e., manufacturing and integration) process are:

- Materials conversion > FAIT (Fabrication > Assembly > Integration > Testing)

Example with a simple window frame module:

1. Conversion = raw lumber; molten glass
2. Fabrication = frame wood; window panes
3. Assembly = assembled windows
4. Integration = window placed in building
5. Testing may be a separate phase, but may also be a process associated with each of the other phases.

2.6 Production materialize[-ing]

A.k.a., Production processes, fabrication processes, construction processes, materialization processes, re-materialization processes, production processes.

The production of objects can be separated into the following basic technological categories, each with their own specific (discipline) processes:

1. **Chemicals production** (i.e., chemical objects, non-solid objects).
   A. Chemicals (with product identifiers) are the result of chemical production. Chemical objects (chemicals), such as water, soap, lubricant, minerals, molecules, biologics, etc.
      1. Manual operated tools and machines.
      2. Automation operated tools and machines.
2. **Mechanical production** (i.e., machine objects, solid objects).
   A. Machines (with product identifiers) are the result of chemical production. Machine objects (machines), such as cars, compactors, fans, stoves, etc.
      1. Manual operated tools and machines.
      2. Automation operated tools and machines.
3. **Computer production** (i.e., computing objects, hardware-language objects, hardware-logic objects).
   A. Computers (with product identifiers) are the result of chemical and mechanical production (and, logic-language, software production). Computer objects (computers), such as desktop computers, smartphone computers, server computers.
      1. Manual operated tools and machines.
      2. Automation operated tools and machines.

Note: A finale assembly may be composed of products from one or more of the three object categories.

2.6.1 Methods of mechanical production

The basic mechanical production (a.k.a., manufacturing) methods are:

1. **Cutting and joining** - a process of subtracting and then joining.
2. **3D printing** - an additive process whereby layers of material are built up to create a 3D part, and then maybe, joining.
3. **Solid extrusion** - a process used to create objects of a fixed cross-sectional profile by pushing material through a die of the desired cross-section.

Manufacturing processes and/or methods can be divided into the following categories (Messler, 2014):

1. **Flow types:** Move material around without removing or adding any material (a.k.a., flow

processes). Note, in the case of heat treatment processes, which neither add nor subtract material, the “flow” involves the movement of atoms around, generally by diffusion mechanisms but, possibly, by a massive shear mechanism.

2. **Additive processes (additive manufacturing) -** Adding material (additive). 3D printing (3-D printing) - consecutively layering a material or materials, on top of one another, building the structure from the based up (in gravity) or from anywhere (without gravity). 3D printers extrude, deposit, and fuse material one layer at a time. 3D printers rely on software control and multi-axis automated tooling. Their crucial advantage over CNC machines is their ability to create hollow shapes, such as curved tubes and globes, in one single piece.
3. **Subtractive machining processes (subtractive machining manufacturing) -** cuts away material (i.e., cuts away the contrast to the intended object; cuts away the excess material surrounding the intended object). Removing material (subtractive). Various controlled machining and material removal processes that start with solid blocks, bars, rods of plastic, metal, or other materials that are shaped by removing material through cutting, boring, drilling, and grinding. Computer numerical control (CNC) machines carve objects out of solid blocks of material (e.g., wood, metal, etc.) with computer-driven lathes and mills. 3D printers extrude, deposit, and fuse material one layer at a time. CNC machines rely on software control and multi-axis automated tooling. Newer types of CNC machines can create simple hollow spaces.
   A. Working piece rotation processes (**turning production**) - This type of tool rotates a workpiece, while the cutting tool moves in a linear motion. Turning forces a workpiece to rotate and stationary or linearly moving cutting tool removes material from a workpiece.
   B. Cutting tool rotation process (**milling production**) - milling forces the cutting tool to rotate. Milling operations involve using multi-point rotary cutters to remove material from a workpiece. Milling systems can use different numbers of axis, anywhere from 1 axis to 5.
   C. Cutting tool rotation process (**drilling production**) - Drilling creates a round hole in a workpiece by the use of a rotating cutting tool.
   D. **Milling and turning system** - an advanced system that is capable of milling and turning with the same machine (not at the exact same time).
   E. Benefits: Precision is easy.
   F. Disadvantages:
4. **Subtractive light processes**: using light to etch away material.
5. **Subtractive + additive (hybrid manufacturing)** - One after the other.

To produce a final product, raw material resources are first shaped, then shaped again, then joined (assembled), then finished (Read: a manufacturing process taxonomy) (Ashby, 1992:169):

1. Shaped.
   A. First shaping processes include, but are not limited to:
      1. Casting methods:
         i. Sand, die, investment.
      2. Molding methods.
         i. Compression, injection, blow modling.
      3. Deformation methods.
         i. Rolling.
         ii. Forging.
         iii. Drawing.
      4. Powder methods
         i. Sintering.
         ii. HPing.
         iii. Slip casting.
      5. Special methods.
         i. Rapid prototyping.
         ii. Lay-up.
         iii. Electroform.
2. Then shaped again.
   A. Secondary shaping processes include, but are not limited to:
      1. Machining.
         i. Cut.
         ii. Turn.
         iii. Plane.
         iv. Drill.
         v. Grind.
      2. Heat treatment.
         i. Quench.
         ii. Temper.
         iii. Age-harden
      3. Chemical bath.
3. Then joined.
   A. Joining processes include, but are not limited to:
      1. Adhesives.
         i. Flexible.
         ii. Rigid.
      2. Welding.
         i. Metal inert gas (MIG).
         ii. Tungsten inert gas (TIG) .
         iii. Solder.
         iv. Hot gas and bar.
      3. Fasteners.
         i. Rivet.

ii. Bolt.
iii. Stable.
iv. Sew.
v. Zip-tie.
vi. Clips and clamps.

4. Then finished.
   A. Finishing processes include, but are not limited to:
      1. Polish.
         i. Electro-polish.
         ii. Lap.
         iii. Burnish.
      2. Coating.
         i. Electroplate anodize.
         ii. Spray.
      3. Paint/print.
         i. Enamel.
         ii. Pad print.
         iii. Silk screen.
      4. Texture.
         i. Roll.
         ii. Laser electro-texture and laser etching.
         iii. Mechanical etching.

2.6.1.1 3D printing an object

The following are the possible material types for the 3D printing of non-building objects:

1. Ceramic and clay mixtures.
   A. Objects can be printed by extruding layers of a ceramic / clay paste from a nozzle or by glue-bonding powder particles layer-by-layer.
2. Polymers and plastics.

2.6.1.2 Connecting objects into an assembly

Materials are connected in various ways, including but not limited to the type and degree of [being fully] integrated:

1. Clips (e.g., metal clips).
2. Corks (e.g., wood stopper).
3. Velcro (e.g., hook and loop fastening).
4. Zips (e.g.,, crimped fastening).
5. Laces (e.g. cordage fastening).
6. Screws and nails (e.g., twist or stretch insert fasting)
7. Adhesion.
8. Solder.

2.6.2 Methods of chemical production

The production of isolated chemicals in society encompasses a broad range of processes involved in obtaining, refining, and utilizing individual chemical compounds. The process typically involves:

1. Extraction or synthesis: Isolated chemicals can be obtained through various methods. They might be extracted from natural sources like plants, minerals, or animals. Alternatively, chemicals can be synthesized in laboratories or industrial settings through chemical reactions, often using raw materials derived from petroleum, natural gas, or other sources. Hydrocarbons are a significantly used for chemical production.
2. Purification and refinement: Once obtained or synthesized, the chemicals often undergo purification processes to remove impurities and isolate the desired compound. Techniques like distillation, filtration, chromatography, or crystallization are employed to achieve high purity levels.
3. Manufacturing and scale-up: industrial-scale production involves manufacturing these isolated chemicals in larger quantities. This requires optimizing production processes for efficiency, scalability, and cost-effectiveness. Specialized equipment and controlled conditions are often necessary for large-scale chemical production.
4. Quality control and testing: Stringent quality control measures are implemented throughout the production process to ensure the chemical's purity, consistency, and safety. Rigorous testing, analysis, and adherence to regulatory standards are essential before the chemicals are deemed suitable for use.
5. Application and utilization: Isolated chemicals serve diverse purposes across industries. They're utilized in pharmaceuticals, agriculture (such as pesticides or fertilizers), manufacturing (including plastics, textiles, and electronics), energy production, food additives, cosmetics, and various other sectors.
6. Environmental and safety considerations: Chemical production processes must comply with environmental regulations to minimize ecological impact and ensure worker and public safety. Sustainable practices, waste management, and the reduction of harmful byproducts are crucial aspects of responsible chemical production.
7. Continuous research and innovation: Ongoing research and development in chemistry drive innovation in chemical production. Advancements in technologies, methodologies, and sustainable practices continually shape and improve the production of isolated chemicals, aiming for increased efficiency and reduced environmental impact.

2.7 Production optimization[-ing]

Parallelization is the fundamental material automation processes. Examples of parallelization are: 3D printing, silicon processors, and the printing press. Parallelization in product production massively increases productivity.

Types of parallelism in manufacturing include:

1. **Printing done in parallel** through many printing press.
2. **Spinning mill parallelization** (spindles can run in parallel meaning one worker could monitor many, versus one worker to one spindle).
3. **Liquid molding metal into objects done in parallel**. Parallelization of liquid metal molding. Mass production of cast iron (complex iron objects can be made in a single action by pouring molten iron, wherein a mold transmogrifies the iron (or iron complex) into a specify defined object).
4. **Metalwork operations such as folding, pressing and rolling are done in parallel**. Parallelization of metal dipress molding. Dipresses allowed the forming of complex metallic framework, which allowed for the mass production of cars by forming the bottom framework part (chassis) or upper framework part of the car with a single impression of the dipress.
5. **Injection molding plastic done in parallel**.
6. **Silicon processor production run in parallel**. Integrated circuitry manufacturing done by a single photolithographic process (multiple of them).
7. **3D printing done in parallel**. Multiple write heads that go back and forth, operating serially.
8. **Dexterous robotics done in parallel**. Multiple dexterous robots working together.

2.7.1 Product standards

Product standards are established by research and consensus. Product standards define what products are made of, as well as how they perform. For most products, product standards standardize ("govern") the characteristics, materials, performance and operability, as well as how products need to interact with other system elements. Alternatively, **prescriptive product standards** differ from performance-based product standards in that they attempt to achieve a desired outcome by specifying the characteristics, materials, performance and operability of products. For example, a prescriptive product standard for fittings would specify the maximum amount of alloy material, such as lead, that can come in direct contact with the drinking water.

2.7.2 Product codes

> **ASSOCIATION:** *This section is associated with an equivalent section in the Decision System > Classification of the Economic Decision System for a Community-Type Society > ... > Product coding.*

Product codes allow for the appropriate categorization, tracking, and coordination of all products (including services) and their used materials.

3 Product safety and user assurance

NSF International [nsf.org] is a not-for-profit, non-governmental organization that develops standards and product certifications in the area of public health and safety.

3.1 Production safety

The InterSystem Productions/Materializations Team is responsible for containing, sustaining, and restoring technological disasters (e.g., Chernobyl, Four Mile Island, etc.). This team would operate in conjunction with other InterSystem teams to provide a comprehensive incident response and service support continuity function. Here, monitoring and controlling for safety/disaster situations could be considered a "security" function.

3.2 Technology labeling and signage

Proper labeling and signage are essential aspects of technology production and deployment, serving both users and producers alike. Adequate labeling ensures that users have access to crucial information about the technology's specifications, usage guidelines, and safety instructions. This ensures users can informed decisions about the technology's appropriateness for their needs and enables them to operate it safely and effectively. Clear signage during installation or use of the technology helps users navigate its functions and potential risks, minimizing the chances of accidents or misuse. For producers, comprehensive labeling and signage not only fulfill legal and regulatory requirements but also contribute to building trust with users. It demonstrates a commitment to safety, transparency, and user satisfaction, which can enhance the reputation of the company and its products in the marketplace. Adequate labeling and signage are indispensable elements of responsible technology production and deployment, benefiting both users and producers by fostering safer and more informed interactions with the technology.

4 Relevant external materialization standards

Material standards ensure the safe, efficient, and effective construction of objects and architecture in society.

4.1 Cradle-to-cradle product standard

> **NOTE:** *In the market all constructions are products.*

The Cradle-to-Cradle Certified Product Standard guides designers and manufacturers through a continual improvement process that looks at a product through five quality categories — material health, material re-utilization, renewable energy and carbon management, water stewardship, and social fairness. A product receives an achievement level in each category — Basic, Bronze, Silver, Gold, or Platinum — with the lowest achievement level representing the product’s overall mark. Necessarily, Cradle to Cradle involves a labeling system and the declaration of ingredients.

Product assessments lead to the earning of a “certificate” indicating that the business standards body known as “Cradle to Cradle” has assessed and qualified the product to meet one of multiple achievements. Assessments are performed by a qualified independent organization trained by the Institute. The training and accompanying accreditation provided by Cradle to Cradle Products Innovation Institute comes at a financial cost (i.e., it is sold). The assessment provided by the “independent organizations” that purchased training from Cradle to Cradle comes at a financial cost to the product producer.

The idea that waste is actually food [as input for some other life process]. The essence of Cradle to Cradle is the importance of a closed loop, that only materials and processes that can be reused endlessly should be included in product design. And that if these guidelines are followed, humans can live in a world of abundance.

The cradle-to-cradle process accounts for the following:

1. **Material health** - Knowing the chemical ingredients of every material in a product, and optimizing towards safer materials.
   A. Identify materials as either biological or technical nutrients
   B. Understand how chemical hazards combine with likely exposures to determine potential threats to human health and the environment certified
2. **Material re-utilization** - Designing products made with materials that come from and can safely return to nature or industry.
   A. Maximize the percentage of rapidly renewable materials or recycled content used in a product

   B. Maximize the percentage of materials that can be safely reused, recycled, or composted at the product's end of use
   C. Designate your product as technical (can safely return to industry) and/or biological (can safely return to nature)
3. **Renewable energy & carbon management** - Envisioning a future in which all manufacturing is powered by 100% clean renewable energy.
   A. Source renewable electricity and offset carbon emissions for the product's final manufacturing stage
4. **Water stewardship** - Manage clean water as a precious resource and an essential human right.
   A. Address local geographic and industry water impacts at each manufacturing facility
   B. Identify, assess, and optimize any industrial chemicals in a facility's effluent
5. **Social fairness** - Design operations to honor all people and natural systems affected by the creation, use, disposal or reuse of a product.
   A. Use globally recognized resources to conduct self-assessments to identify local and supply chain issues and third party audits to assure optimal conditions
   B. Make a positive difference in the lives of employees, and the local community

Cradle to Cradle certification launched in 2005 and rates products using five criteria:

1. Their use of environmentally safe and healthy materials
2. Materials are designed for recycling or composting at end of life
3. Manufacturing must make use of renewable energy and carbon management
4. Water stewardship
5. Social fairness

4.1.1 The cradle-to-cradle red list

In the cradle-to-cradle decisioning process, the "Red List" contains ingredients that inhibit all further forward movement. Or, it can move forward, but the company producing the Red Listed ingredient must be notified that the ingredient will be changed as soon as a suitable alternative becomes available. If a construction list has any of these ingredients, and production can't move forward without 1 of them, then the producer must send a letter to the provider of the Red Listed product stating that as soon as there is another option available "we wont use your product".

5 Product packaging

Products need that need to be transported need to be properly prepared, labeled, and packaged. This is so they can be received accurately and in functioning order (i.e., in the best possible condition).

5.1 Instructions and warning labels

Packaging should have appropriate instructions and warning labels. Depending on the products, some additional labeling may be required.

> **NOTE:** *In community, there is greater monitoring of products, and coding has real relevance.*

5.1.1 Address labels

There is naming system for locating every possible deliverable location in the habitat.

The most optimized addressing is:

- Global position addressing (GPS).

Common language addressing has an optimized form also:

1. Receiver name (identifier)
2. Receiver address:
   A. Region | City-Identifier | Sector | Building (or Addressable Landscape) | Room

5.1.2 Readiness labels

There are also labels for phase of preparation prior to shipping:

1. Not ready to ship.
2. Ready to ship.

5.1.3 Warning labels

Common warning labels include, but are not limited to:

1. Suffocation.
2. Heavy objects.
3. Dangerous materials (e.g., lithium batteries).
4. Handle with care (Read: Fragile).
5. Loose products.
6. Expiration dates.

6 Product life-spans

A.k.a., Asset lifespans.

Different productions are designed to last different lengths of time. Designing, understanding, and estimating lifespans is a crucial considerations for production, for making informed choices and optimizing resource utilization.

For instance, in the early 21st century, the typical lifespans of the most common products are:

1. Shipping assets, such as cargo vessels, are characterized by long-lived assets with asset lives typically ranging from 20 to 50 years. These extended lifespans account for the considerable investment involved in their construction and operation, with minimal retrofitting during their operational lifespan.
2. Building assets:
   A. Commercial and industrial buildings are typically constructed to last more than 100 years.
   B. Dwellings are highly variable in concern to their life-span, but the structures are typically designed to last 50-100 years or more. Dwellings are acquired and operated based on having a full life with significant potential for internal (and external) retrofit.
3. Automobiles, such as cars, are typically characterized by lifespans ranging between 15 to 30 years, depending on factors such as maintenance and usage. Ships are acquired and operated based on having a full life with minimal retrofit.
4. Smartphones are designed to last, on average, 2 to 10 years before significant technological advancements encourage replacement.
5. Personal computers generally have a lifespan of about 3 to 5 years, after which hardware and software upgrades may be necessary for optimal performance.
6. Commercial aircraft are engineered with an operational lifespan of 20 to 30 years, during which they undergo regular maintenance and periodic refurbishments to ensure safety and performance

7 End of produced product lifecycle

Each produced (existent) product undergoes a life-cycle, progressing through stages of design, usage, usage growth, consumption and eventual de-cycling. All productions come to an end and are cycled through the habitat.

7.1 Waste materials cycling

A.k.a., Materials re-cycling, reprocessing, reclamation.

There are three types of waste streams related to the three categories of matter:

1. Solid waste results from the following:
   A. Metabolic output of humans and other organisms.
   B. Food preparation.
   C. Material primary system operation (e.g., production, packaging, etc.)
   D. Material subsystem operation (e.g., residual substances from water processing).
2. Liquid waste results from the following:
   A. Metabolic output of humans and other organisms.
   B. Food preparation.
   C. Material primary system operation (e.g., production, packaging, etc.)
   D. Material subsystem operation (e.g., residual substances from water processing).
3. Gaseous waste results from the following:
   A. Metabolic output of humans and other organisms.
   B. Food preparation.
   C. Material primary system operation (e.g., production, packaging, etc.)
   D. Material subsystem operation (e.g., residual substances from water processing).

During the process of waste coordination, firstly, the waste is disposed of by a user and collected as part of the habitat service. If necessary, during disposal and/or collection, the waste is separated according to its composition and other applied materials cycling concepts (e.g., color).

The primary waste materials cycling processes are:

1. **Up-cycle the material** - give food to other animals or use device for another technical system.
2. **Re-cycle the material**- process resource so that it can be re-used again.
3. **De-cycle the material** - compost (natural or trash

landfill) or combust the material. This includes waste material to be buried or burnt. Note that a landfill is technically a compost site with hazardous materials.

Habitats have the following potential methods of processing waste materials:

1. Recyclables (no trash bag required for collection).
    A. Plastic.
    B. Glass.
    C. Paper.
    D. Metal.
    E. Fibers.
2. Not recyclable (no trash bag required for collection).
    A. Waste to be de-cycled:
        1. Compost safe biologics (biodegradable). Waste to be buried (a.k.a., composted).
            i. Carbohydrates - biodegradable (may use compostable trash bag).
            ii. Protein - biodegradable (may use compostable trash bag).
            iii. Lipids - biodegradable (may use compostable trash bag).
        2. Waste to be combusted (a.k.a., burnt, including plasma).
        3. Waste to be released with dilution (a.k.a., pollution).
        4. Waste to be disassembled and have its materials stored.
    B. Waste to be up-cycled (i.e., used for other useful productions).

7.1.1 Trash

Trash refers to things that are considered no longer useful, valuable, or needed by an individual or organization. Trash commonly includes waste, discarded objects, or materials that are intended for disposal because they are deemed as having no further use or purpose. In a truly sustainable society, the concept of "trash" is minimized or ideally eliminated. Community practices prioritize reduction, reuse, re-cycling, and responsible disposal of materials. Instead of discarding items as trash, efforts are made to re-purpose, re-cycle, compost, or properly coordinate materials to avoid their unnecessary wasting.

In community, within buildings and along transportation networks it is optimal to place (position and orientation) appropriate disposal tanks (i.e., trash receptacles, trash cans, recycling bins, garbage bins, waste collectors, etc.). A habitat service system that maintains a local automated object transportation network will be able to automate the transportation of trash receptacles from filling location to centralized areas for processing.

7.2 Product expiration dates

A.k.a., Expiration date (EXP or ED), best if used by dates, use by dates, expiry date.

Product expiration information ("use by" dates) tells the user that the producer cannot guarantee that the product will function as it is intended after the date (often, an estimation). Naturally, material compounds degrade with environmental exposure to conditions such as light, heat, and temperature. Some products have no expiration. Honey, for example, has would have no expiration date. In the market-State, some States, for all [food] products distributed and/or sold, a set "soon" expiration date must be set by the manufacturer. Some corporations are honest about their expiration dates, most are not, or more importantly, cannot be honest. In the early 21st century, expiration dates are not and have never been about when food actually expires in the real world. Instead, the expiration date on the package is often some workers best guess as to when the optimal taste experience will pass for a product. Such conditions would obviously lead to many people throwing away perfectly fine food and supplements, only because an arbitrary "expiration date" said so. Some user of magnesium pills may see a specific set of expired magnesium pills and throw the product in the waste. And yet, likely, the magnesium pill product is likely not expire for useful intended beneficial usage in any way; because, magnesium (in mineral and dry form) doesn't have an expiration date. Misleading expiration dates are a major contributing factor to the unnecessary wasting of large amounts of food and products (and planned obsolescence, even more).

Expiration dates on community products involve a complexity of cases:

1. In some cases, dates can be an indication of a products safety, or how long the product will last (given stated usage conditions).
2. In other cases, dates are not a good indicator of product safety (e.g., having an expiry date on a powdered mineral supplement).

An expiration date (a.k.a., expiry date) is a previously determined date (determined by some technical or taste engineer) after which something should no longer be used, or is not expected to function as expected. What happens henceforth with the product is up to the user and/or service provider. Maybe the product is an unopened milk dairy product; whereupon it will be called-back (re-turned) and likely pasteurized more than a dairy product with a shorter shelf-life. One option is to powder it to add it to dairy powder stock. The dairy powder stock then has its own material storage conditions under which degradation will start to occur to the constituent dairy materials. Note here that if conditions of the materials change, then the real-world expiration [future] date of the product will change, and any prior set expiry date (if it does not change) will be wrong. In the real-world, there is complexity to expiration, which includes, but is not limited to the following processes:

1. Discovering data about products and their life-spans.
2. Stating a expiration data (or, expiry date-range), if there is one, after which:
   A. To not use the product ever again.
   B. To be cautious using the product.
   C. To have something about the product (whole or part) replaced.
3. Identifying the risks taken if using the product beyond the expiry date.
4. Identifying the certainty that the product is actually expired at some stated date (or, date range).
5. Identifying a way to potentially self and/or technologically determine whether the product is expired.

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TABLES

Table 60. Technology Support > Materialization*: Material cycling solutions.*

Material Cycling Solutions						
Repair & Maintenance	Reuse & Distribution	Refurbishment & Re-manufacturing	Recycling	Cascading & Re-purposing	Organic Feedstock	Market
Repair	Reuse, refurbish, maintain, redistribute	Re-manufacturing	Closed-loop production	Co-product generation from waste	Co-product generation from waste	Sell waste and/or product
Product life extension	Reuse	Upgrading	Re-materialization		Circular supplies	Waste exchange
Classic long-term model	Product life extension	Product life extension	Recycling and waste management		Resource recovery	Product lease

Exploratory Support: Scientific Discovery System

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Keywords: scientific discovery, scientific experimentation, laboratories

Abstract

Humans are, at least, adaptive and self-integrating systems who express evolved exploratory signaling ability. Young humans express exploratory behaviors oriented at learning (understanding) and controlling (testing). Every society is, in many ways, an experiment. Science involves environments appropriate for thinking and testing, for learning and demonstrating, for practicing and experimenting. It is favorable for humans to have the opportunity to select a scientific discovery system as one of its exploratory subsystems, because allows for safe navigation and technical validation. Some scientific discoveries may be operated at the community access scale and others may be operated through intersystem teams and working groups. Science enables reproducibility, and it is reproducibility that enables technology. Technology, then, enables societal-level services, and highly automated and coordinated fulfillment therefrom. New scientific discoveries may advance understanding and/or technological development. Safely coordinated discovery is possible at the societal level, when local individuals may choose to participate in scientific endeavours, particular as a life-learning experience. Some of these endeavours may be objectives at the societal level (e.g., the launching of a spaceship), and others may be localized, such as a youth running a common experiment in a lab in a city somewhere. The scientific discovery system is primarily run as a working group, but some cities and regions do have InterSystem habitat scientific discovery teams; those on other planets, for example. Some scientific discoveries are new and others are simply required for self-verification, since a community-type society is composed of self-directing individuals with life experience to be explored.

Graphical Abstract

Image Not Yet
Associated

1 Scientific discovery system overview

Here, research may be more accurately known as scientific research. In the early 21st century, research is primarily an academician's category and development is an industrial category. Community organization, however, is not concerned with labor roles, but with where the actual information being worked on fits into a unified information model, and therein, a habitat service model. Scientific research and engineering development representing two distinct states of knowledge. Science is used to explore what happens and why in the natural world, while engineering uses the discoveries of science to create (and operate) technical constructions. Essentially, technical information about the operation of nature can be discovered [through science] and applied toward technical fulfillment [through engineering]. Science discovers what already is, and engineering creates that which isn't. Together, research and engineering/ technology development (R&D) is composed of those activities which rely on science and engineering, and which are devoted to developing and operating socio-technical systems and services. Science informs, technology bridges. Technology is applied science. Scientists work with things that are testable, falsifiable, and reproducible. Then, systems engineers work through scientific discoveries to develop technologies.

> **CLARIFICATION:** *The scientific discovery service system consists of architectural and infrastructural services necessary to shelter and support scientific discovery.*

The outputs of research feed into engineering development, and the output of engineering development are technical service modules (i.e., technologies) which are in use and operational as part of the habitat service system. Science is about explaining and technology is about developing technical systems through trial and error.

Scientific discovery-type exploration spaces and activities include, but may not be limited to:

1. Scientific laboratories and instrument measurements.
2. Computational, architectural, and power systems are required.

Exploratory Support: Technology Development System

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Keywords: technological development, technological engineering, workshops

Abstract

Technology is the engineered interface of a commonly interrelated world. Technology enables function, as well as destruction of all function. Technological advancement continues over time to look like a more thought responsive environment. Humans can build and understand technical systems together. When humans are building technical systems together, they may rely on a pre-developed standard for building the new system. Working groups develop technological systems and their standards. Teams construct and operate the standards of a habitat service system. Technological development is an exploratory behavior, naturally enjoyable to humankind. Engineered technology is synonymous with high certainty deliverables, given the data and what is known. Technologies are operated. Some technologies are enjoyable for humans to operate. Technologies, or the use of technologies, that detract from human life or harm human operation should be reduced and monitored where necessary.

In many ways, a technology is a control package influential at the information and/or spatial level. Technologies can be shared, communicated, transported, and materialized together, or not. Technologies enable the extension of function throughout an environment. Technologies and their applications can improve and degrade the quality of a life if their users as well as the social environment of users. Technology makes things possible that couldn't be done without the technology. Community uses technology in service of humanity, in the early 21st century technology is in service of the free enterprise system.

Graphical Abstract

Image Not Yet Associated

1 Technology system overview

The technology development system consists of architectural and infrastructural services necessary to shelter and support technology development.

Technology development-type exploration spaces and activities include, but may not be limited to:

1. Technology engineering laboratories and workshop productions.
2. Computational, architectural, and power systems are required.

2 Technology certification

Technologies under development have to go through a process of getting some technology and/or some technology unit certified for usage.

Exploratory Support: Education System

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Keywords: Learning system, learning service, education service, certification service

Abstract

This article provides a comprehensive examination of the material infrastructural services within the educational service of a habitat service system. Here, there is an interconnection between physical facilities, human and AI facilitators, technological resources, and logistical services supporting the educational framework within the urban environment. There is an indispensable integration of learners, technology, digital resources, facilitation, and connectivity solutions, that produces a conducive learning environment for an urban educational setting. Material infrastructural service-objects include: school buildings, classrooms, laboratories, libraries, work group labs, and all learning tools and equipment.

Graphical Abstract

Image Not Yet Associated

1 Education system overview

The education/learning system consists of architectural and infrastructural services necessary to shelter and support learning and education. A learning system is an arrangement of services, people and tools, some of which are informational and others of which are material, that facilitate individual in learning about themselves and becoming educated on society, reality, and contribution. Learning is a lifelong process that originates from within the individual. In a community-type society, learning about the society progresses best through participation in the society. Technologies and the flow state enable learning. More formalized learning (Read: education) is that which involves mentorship, tutorship, and certification (e.g., like being certified to fly an airplane or conduct a surgical procedure). The application of resources to learning systems (informal and formal) facilitates societal adaptation and safety overall.

Education-type exploration spaces and activities include, but may not be limited to:

1. Education facilitation technology centers (e.g., rooms with education facilitators and various learning technologies). This area represents the traditional classroom, only with facilitators instead of teachers, and populated with useful learning technologies.
2. Education facilitation open outdoor meeting areas (e.g., an open covered pagoda area for a pleasant class atmospheric meeting environment). This area represents the traditional outdoor fresh-air meeting area. Any open contextually-appropriate meeting area could suffice for the purpose of a learning environment.
3. Computational, architectural, and power systems are required.

NOTE: *Virtual reality is the newest and most effective learning technology, since visualization is key to integration and memory.*

Exploratory Support: Recreation System

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Keywords: leisure, rest and recreation, playful and restorative activities

Abstract

A recreation system is composed of many different components, the combination of which provide facilities and landscapes for indoor and outdoor recreation. Many entities are involved in the development and coordination of recreational areas and facilities within a habitat service system and its local network. There may be a recreational belt in any given city, and there may be recreational centers out in nature. In many market-State societies, a recreation system is a governmental function and a necessary State expense. In the market-State, recreation is largely considered to be unpaid/unpayable actions.

In community, habitats have recreational areas (zones) for recreational activities, which are highly customized to the local habitat population, and may change over time. All habitats have recreational activities that everyone in the habitat can enjoy. Recreation refers to all those activities that people choose to do to refresh their bodies and minds and make their leisure time most interesting, restorative, playful, and/or enjoyable. It is important to note here that 'leisure' is a life phase in community, and 'recreation' is a habitat service sub-system. In common parlance, the two words are often used synonymously.

Graphical Abstract

Image Not Yet Associated

1 Recreation system overview

The recreation system consists of architectural and infrastructural services necessary to shelter and support recreation.

Recreation-type exploration areas and activities include, but may not be limited to:

1. Land-based recreational activities (a.k.a., parks):
    A. Nature-based parks (a.k.a., parks and pastures, botanical gardens, look-out areas, etc.):
        1. Physical activities in nature-base and/or pasture-based settings (e.g., hiking, swimming, climbing, picnicking, etc.).
    B. Amusement parks (a.k.a., entertainment parks):
        1. Involve various rides and attractions, including roller coasters, thrill rides, water rides, games, and sometimes shows or entertainment events.
    C. Sports parks (a.k.a., sports fields, recreational centers, fitness center, playgrounds):
        1. Involve centers, arenas and sports-specific architecture (e.g., tennis, pools, golf, basketball, playground, gym, etc.). Sports fields include but are in no way limited to: stadiums, soccer fields, baseball diamonds, climbing, football fields, and basketball courts, golf course, tennis court, skate park, etc.
    D. Historical parks (a.k.a., museums):
        1. Focus on preserving historical sites, landmarks, or structures. They often provide educational opportunities about the area's history through exhibits, tours, or re-enactments.
    E. Recreational paths:
        1. Designated lanes or paths for recreational movement, separate from regular traffic, such as bicycling, skating, relaxed walking.
2. Water-body recreational activities:
    A. Boating on, under, and above water.
    B. Fishing on, under, and above water.
    C. Water-sports on and in the water (e.g., swimming, water-skiing, scuba diving, etc.).
3. Air-base recreational activities:
    A. Floating above the landscape.
    B. Flying above the landscape.

Exploratory Support: Art and Music System

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Last Working Integration Point: *Project coordinator integration*

Keywords: art, music, creative expression,

Abstract

An art and music system (a.k.a., creative expression system) is composed of many different components, the combination of which provide facilities and tools for art and sound production. Many entities are involved in the development and coordination of art and music components within a habitat service system and local network. In general, locations with music require sound protection barriers to reduce disturbances in the surrounding environment. Art and music are forms of human expression. This sub-system could be considered the human expression service, allowing.

Graphical Abstract

Image Not Yet Associated

1 Art and music system overview

The art and music system consists of architectural and infrastructural services necessary to shelter and support art and music.

Art- and music-type exploration spaces and activities include, but may not be limited to:

1. Creative common rooms for practicing and developing artwork.
2. Quiet and secluded, private places for socially isolated performance.
3. Display (of art) areas. There are areas in the habitat where artwork is on display.
4. Event (performance) areas. There are areas in the habitat that performance events take place (e.g., concert hall, stage, etc.).
5. Computational, architectural, and power systems are required.

Exploratory Support: Consciousness System

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Keywords: consciousness exploration system, spiritual service system, spiritual exploration system

Abstract

A consciousness exploration system is composed of many different components, the combination of which provide facilities and tools for consciousness exploration, healing, and spiritual connection/growth. Many entities are involved in the development and coordination of a consciousness service system for a habitat's population.

Graphical Abstract

Image Not Yet Associated

1 Consciousness system overview

The consciousness system consists of architectural and infrastructural services necessary to shelter and support consciousness exploration.

Consciousness-type exploration spaces and activities include, but may not be limited to:

1. Labs for studying consciousness.
2. Quiet and secluded, private places for human contemplation.
3. Religious centers.
4. Ceremonial centers.
5. Computational, architectural, and power systems are required.

The Auravana Project exists to co-create the emergence of a community-type society through the openly shared development and operation of a information standard, from which is expressed a network of integrated city systems, within which purposefully driven individuals are fulfilled in their development toward a higher potential life experience for themselves and all others. Significant project deliverables include: a societal specification standard and a highly automated, tradeless habitat service operation, which together orient humanity toward fulfillment, wellbeing, and sustainability. The Auravana Project societal standard provides the full specification and explanation for a community-type of society.

This publication is the Habitat System for a community-type society. A habitat (a.k.a., city, town) is a material-operational service environment where humans live and have their needs fulfilled. It is a service composed of interacting material objects. This habitat system standard identifies the services, technologies, components, and processes that compose a habitat service system. A habitat service system encodes and expresses humanity's decided material fulfillment services. When a decision resolves into a service, that service is specified to exist in the habitat system. Different configurations of a habitat lead to different levels and qualities of fulfillment. The coherent integration and open visualization of the habitat system is important for human requirements to be met at the local and global level through scientific planning. This standard represents the encoding of decisions into a global habitat service system with many local configurations of habitat that act together as a fulfillment platform for the whole community population. The visualization and simulation of humanity's interconnected habitat systems is essential for maintaining a set of complex, fulfillment-oriented constructions and operations that meet human fulfillment requirements. This publication details what has been, what is, and what could be constructed in the material environment. It depicts through language and symbols, visualization, and simulation, a habitat service environment consisting of life, technology, and exploratory support services. For anything that is to be constructed in the material system, there is a written part, a drawing part, and a simulation part, which is also how the material system is sub-divided. Further, all habitats are designed and operated by means of master planning; they all have a master plan.

Fundamentally, this standard facilitates individual humans in becoming more aware of who they really are.

All volumes in the societal standard:

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