JUDGE_____ FINAL ADJUSTED SCORE_____

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CAROL G. SALLMAN STWALLEY - PURDUE UNIVERSITY

00712

AEROSPACE Booklet Number _____

The land mass on earth cannot be enlarged, yet the population is continually growing. To begin to ease the population growth problems of today, mankind will explore and eventually expand out into the solar system. As a preliminary step in this expansion, lunar manufacturing and supply colonies will be built on the lighted side of the moon. These colonies will have advantages over earth-bound industry, namely cheap energy, abundant raw materials, and a relatively low gravitational potential. The moon will become the industrial heart of man's outward progression through space. While interstellar space-ships won't be leaving lunar ship yards soon, within 25 years completed blueprints for the first lunar settlements will exist and newly designed specialized equipment for the colonies will be in the testing stages. The individuals that will start building the colonies are living today.

The first colonists will have to be very rugged individuals. The first jobs will involve construction. All beginning materials for the lunar city will have to be shipped from earth. Eventually the materials and personnel will all be transported by shuttle-crafts. These new crafts will be large supply carriers that transport needed equipment to the moon from pre-existing earth orbiting space stations. A landing strip will be prepared on the moon's surface. The shuttle will land using thrusters for control and deceleration. A large catapult will be used to return the shuttle to earth orbit to dock at a space station. These stations will be stocked with supplies from earth by Columbia-type shuttles. Beginning construction work on the moon will be slow. All cargo space will be at a premium, but as equipment and people on the moon continue to increase, so will the rate of progress.

The initial builders will have to endure cramped living quarters within the first one-way transport ships. Later, after shuttle-craft servicing facilities are completed, the ground work for the city can be started. There will be two sections of a lunar city, a subterranean development and an above ground portion with an atmospheric dome. The surface sections of the city will be constructed first, using a heavy, yet transparent dome to keep in the internal atmosphere and protect the inhabitants from solar radiation. Extension of the dome will be possible for expansion of the city. Trees and other plants will be grown under the dome to help stabilize the atmosphere. Heartier cold weather plants will be selected, so that the dome does not have to be extensively heated. The later below ground portions of the city will have less of a heat loss and insulation problem. Temperature and other climatic conditions will be easily monitored and controlled. Consequently living quarters and administrative facilities will eventually move below the surface. Plant horticulture and industry will remain on the surface under the domes.

The beginning of farming on the moon will have been carefully planned. Only the most efficient plants will be among the initial choices for lunar cultivation. Lunar soil samples

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AEROSPACE (continued)

will have been brought back to earth prior to the start of the settlements. Horticulturalists will have bred lines of corn, wheat beans, tomatoes, and squash which will grow in lunar soils with a minimum of water and fertilizer. Air in the farming domes will be heated by solar collectors. Future generations of the crops will grow better than the first, utilizing composts of the unused plant parts. Aquacultures of fish in controlled tanks will give the citizens of the moon one of the more efficient protein sources. Chickens and turkeys will have been chosen for their ease of production. Produce growing sections of the domes will expand as the population grows. Agricultural self-sufficiency will reduce the need for the shipping of all basic supplies and will allow the industrialization of the moon to proceed more rapidly.

The first industries to develop on the moon will be mining and metallurgy. The sites for the cities will be chosen so that they are within a mineral rich area. Ore processing plants, foundaries, and other factories will be under separate above ground domes. Surface transportation will be needed to reach mining and factory sites. Air locks will be provided so that electrically powered ground shuttles can dock and unload passengers. The mining will also take place using specially designed electrical machinery. The lack of oxygen in the moon's environment will not allow the use of combustion-type engines. Oxygen will be saved for human consumption by utilizing centrally produced and stored electrical energy.

The energy for these cities and industries will come from abundant solar radiation. Giant collectors will be placed on the surface to receive solar power for generating electrical energy and heating water and air. The electricity produced by the thermal power plant will run the foundaries and factories, charge the mining and transport vehicles, and light the subterranean tunnels. Because electricity will be so crucial to lunar life, a backup heat source for the power plant, probably a nuclear reactor, will be needed to assure power is always available. Unlike earth, on the moon energy will be cheap and items that we take for granted on earth will be expensive. Water, air, and food will need to be shipped from earth, until an environmental equilibrium can be established. Extreme measures of conservation and continual recycling will be employed to reduce the need for high priced transported goods from earth.

If we on earth ever hope to leave some land for farming areas or just as natural beauty, we must reach out to new places to replenish our diminishing resources. The solar system will provide us with new space for homes, abundant energy, and fresh mineral reserves. These lunar colonies will be the beginning step toward fulfilling these goals.

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MARINE SYSTEMS Booklet Number 00712

In the time span of 25 years, the people of this earth will realize that the oceans can not continue to be used as a dump site. Even now some species of fish are becoming extinct, and Kelp plants are not growing with the vigor of past years. The loss of fish causes the reduction of a valuable protein source; the loss of Kelp creates an even larger problem. The plants of the ocean produce a large proportion of the oxygen that we on land consume. As our experiences and knowledge of the ocean and its problems broadens, so will our understanding and ability to utilize its tremendous resources.

Food, minerals, and energy are three contributions that the ocean will give us in the year 2008. Underwater city/stations will have been built to act as collecting and processing stations for these products. These complexes will have production facilities and living areas. Mineral separation and storage, fish processing, and Kelp processing and ethanol production areas will exist along with crew living quarters and recreational facilities. The cities will be built to withstand the water pressure between 100 to 200 meters depth, approximately 11 to 21 atmospheres. This setup has several advantages over a surface or bottom city. This underwater station design avoids the tremendous pressures at great depths and the surface effects of violent storms and continual rocking with the waves. Therefore, with proper ballast control, the tethering cables will only need to be designed to hold the station in place. The outer wall of the city will be made from advanced products of the plastics and alloy industries. Ribs of a strong, light weight alloy will be covered by a sturdy "bubble" of an insulating plastic. The plastic will be designed so that oxygen can diffuse in, yet water will be held out.

Electric energy to supply the station's processing areas will be provided by the world's largest solar collector, the ocean. The thermal gradient between the surface and the deep isothermal layer will be used to run a large thermal power plant. Since the surface of the subtropical Atlantic is about 24°C, and the Pacific is a bit warmer, a Rankine vapor cycle plant would be used with an ammonia working fluid. Surface water would be run through heat exchangers to vaporize the ammonia. After power is extracted using a turbine, the working fluid is condensed using 3°C water from the deep isothermal layer in a heat exchanger. The ammonia is then compressed and returned to the evaporator. This power plant will form the heart of the complex. Energy usages will be integrated with the other processes where possible. For example, space heat to keep the complex air temperature above the 15°C water ambient temperature, will be supplied by the surface water to run the power plant. The processing areas will all be using electricity generated by the turbine. Any non-peak excess power can be utilized by a seawater hydrolysis facility. The hydrogen can then be utilized as a fuel or made into ammonia. The oxygen can also be stored. Energy integration

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MARINE SYSTEMS (continued)

and non-peak power utilization will be two techniques used to achieve maximum production from these stations.

The mining of metallic nodules of magnesium, iron, nickel, and traces of cobalt and copper will be a profitable venture. Some sources quote an estimate of 7300 metric tons of raw ore per square kilometer of Pacific Ocean floor. The collection of these nodules will require the design of a new type of specialized submarine. It will have robotic arms in front that can pick up the metallic nodules. Each arm will have a detector which can sense the metals being collected in the area. The submarine will return to the city to unload the ore, when its storage is full. The transfer of ore and supplies to and from the submarine takes place through a boarding tunnel similar to those in use today at airports. Electric forklifts will be used for most materials handling. The metallic ore will be sorted and held in storage aboard the station, awaiting transporation back to land and processing via surface ship.

Surface ships will also be used to transport processed fish back to land. One major problem in our fishing industry today is the high cost of hauling fish from the area where it is caught, back to land aboard the fishing vessel, before it spoils. Fishermen can have at-sea deposit sites above the cities, where they can dump their catch. The crated fish will be conveyed down into the city. The fish are eviscerated, cleaned, and packaged by the processing crew. This ready for the consumer product is then put in frozen storage. The packaged fish will be periodically shipped back to land using a single large refrigerated boat, rather than several small specialized fishing vessels.

Kelp will be grown as a product on a floating support matrix. The matrix will be made of a knotted rope which will allow the kelp plants to anchor themselves firmly. The matrix will sit approximately 12 meters below the surface and will be attached to the station, to keep from drifting. Certain kelp plants can grow up to a foot a day; therefore, there will be a steady supply of feedstock for the ethanol distillery. The harvested kelp is transported using the same conveyor as the fish catch. The kelp is fermented, and then the ethanol produced is distilled to remove the water. The ethanol will be stored, until it can be pumped into a tanker for transport to shore.

In 2008 the ocean city/stations will be processing many resources that have become increasingly limited and needed on land. The majority of the people will continue to live and work on land, yet they in part owe this fact to the men and women that work in the ocean. People can learn and profit from their past mistakes, and the ocean communities will prove this. The careful planning of these cities will allow mankind to have the continued use of the ocean as a natural resource.

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SOCIETAL IMPACT Booklet Number 10712

The impact of these two new ways of life will be felt in many ways, both by the citizens of the oceanic and lunar communities and by the people who choose to remain in a traditional culture. The building and manning of the cities will create many new jobs and produce needed items for the world economy. New lifestyles will be evolved to deal with the problems the citizens of these new colonies will face.

The underwater cities will have been built and administered jointly by the food, metal, and energy industries. The people who live and work in the sea will be employed by a specific company division. Extensive personnel testing will be performed on applicants for these jobs. They must be able to become accustomed to living in an area where they cannot see the sun or open sky. "Cabin fever" could become a problem with limited area cities. Experience with naval submariner's will help psychologists spot potential trouble. Jogging tracks, swimming pools, and tennis, basketball, and raquetball courts will be provided for outlets of physical energy. The good mental health of employees will be essential to the successful operation of the facilities.

The working atmosphere will have been carefully studied to provide for happy and motivated workers. To relieve some of the monotony on the job, individuals will have two assignments. Shifts will be divided so that a black team can remain at the station, while a gold team goes out to perform duties in the submarines. The teams can then trade tasks on alternate trips. The total working cycle will consist of five weeks of duty below the surface at the station, followed by a week's leave somewhere on shore. The compensation provided workers for this demanding and unusual work will be good.

Corporations that sponsor oceanic city/stations will find them a good investment. Energy will be cheaply and steadily supplied from the water's thermal gradient. Transportation costs of finished products to market will be reduced by using central collection points. Less spoilage of perishable items will occur, allowing their sale at a lower price. The profitability of the underwater statiens for the founding corporations will insure their success and continued growth.

The social problem of refuse from the cities should not be difficult to solve. The generation and use of electrical energy will be a totally clean process, as will be the retrieval and storage of metallic nodules. Organic wastes can be returned to the sea to be utilized by living organisms after some initial processing. Other items of refuse can be shipped back to land for recycling or treatment, so the station will not be overly burdened by having to support excessive waste processing equipment.

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**SOCIETAL IMPACT (continued)**

The underwater work stations of 25 years in the future will be used as an industrial park. Social scientists will be conducting studies on how people adapt to this new environment. Artificial gills that will allow an uptake of oxygen from the water will be in the testing stages, so that people can move about more easily in their environment. If humans adapt favorably to this new way of life, plans will be started to build more cities for people who wish to make the ocean their permanent habitat.

The social situations surrounding a lunar colony are different from those of an aquatic city on earth. The corporations interested in industrializing the moon will bear far greater initial expenses than those involved in a sea station. The employees manning an oceanic complex in most cases have a home to return to. The construction workers who build the lunar colonies will, of course, have the option to return to earth at the end of their contract periods. Unlike many other jobs, though, they will also be able to stay. The major social impact of the lunar colonies will be the reemergence of the pioneering spirit in mankind.

The workers who go to the moon will be paid very well for their time with the corporations. Those who elect to return to earth, will undoubtably do so with large bankrolls, but those who elect to stay and colonize will receive more than simply a cash compensation. Colonization will begin slowly, with only the most adventurous people deciding to stay on the moon. As work progresses and the moon colonies begin to develop, more and more people will be drawn for various reasons. Condominium-type living quarters will have to be rented or bought from the corporation that constructed them. Permanent residents will eventually begin to out number temporary laborers.

Once a majority of the city's inhabitants are permanent residents, then a local government will be established. The uniqueness of lunar problems assures that there will be a local branch of government formed, not tied to any earth government. The free citizens of the moon will require public decisions to be made locally, not in abstentia. The importance of this will grow as the residents become more settled, have some spare moments, and mere survival no longer occupies all of their time. The local economy will undoubtably remain tied to the large founding corporations for a long time. But as colonization proceeds, merchantilism and a service economy will develop. Eventually the moon will become a completely self-sufficient community.

Just as America was founded relying on supplies from the Old World and eventually sold goods back to Europe, so will it be with the lunar colonies and earth. As the people of the moon live their lives and meet the unique problems of their existence, they will slowly become natives of the moon rather than just visitors from earth. Similar to the people of the 1600's looking at the New World pioneers, in 2008, people will look with great fascination at those preparing to embark for the moon, a new world.