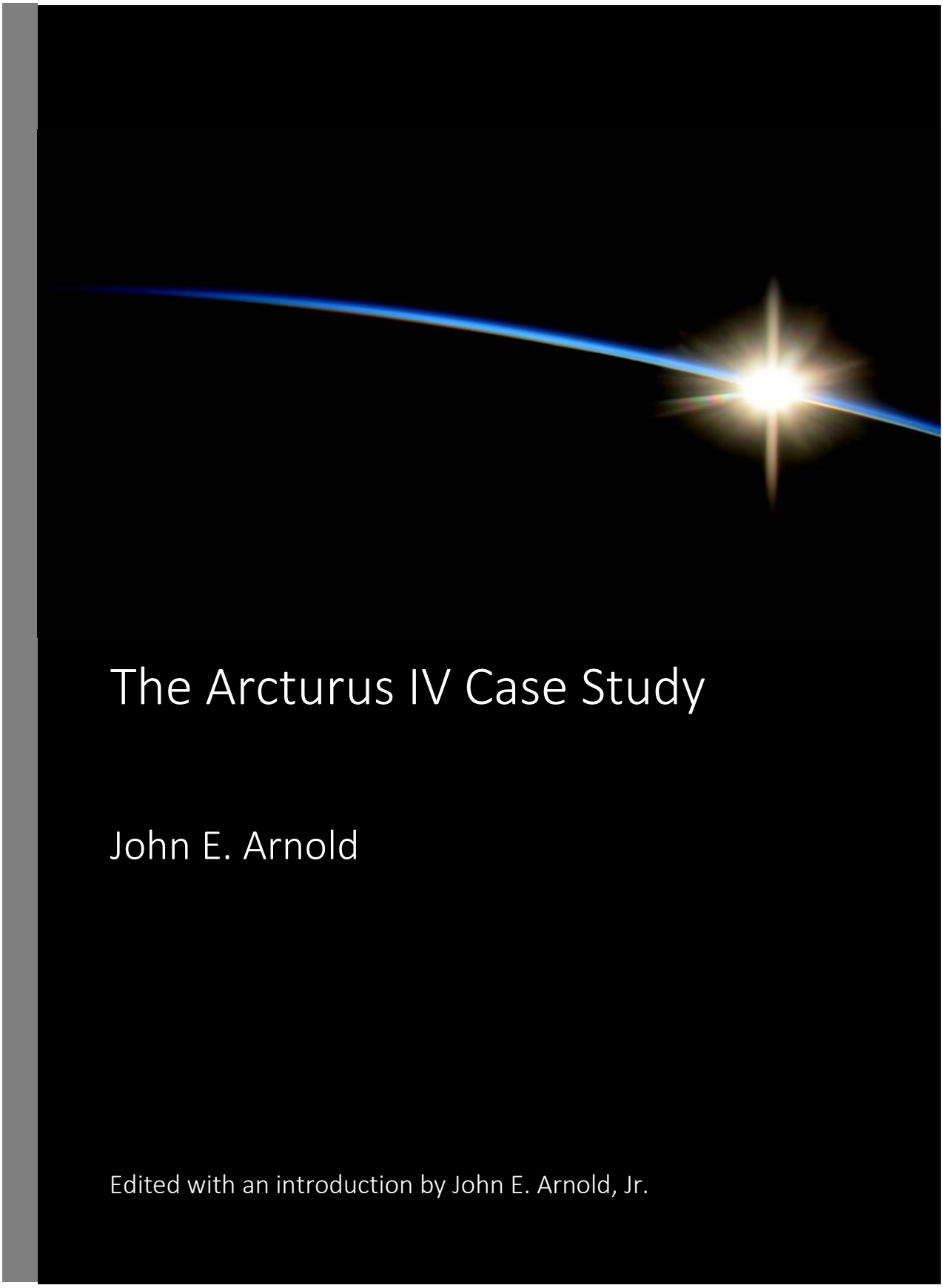


The Arcturus IV Case Study

John E. Arnold

Edited with an introduction by John E. Arnold, Jr.

Arcturus IV Case Study

John E. Arnold

Edited with an introduction by John E. Arnold, Jr.

Cover photography by NASA under a General Use permission

Permission to reprint the May, 1953, *Astounding Science Fiction* article, Space, Time and Education, by John E. Arnold was granted by Penny Publications LLC / Dell Magazines, 6 Prowitt Street, Norwalk CT 06855. Originally published in *Astounding Science Fiction*, May 1953. The cover image is copyright © 2016 Penny Publications LLC/Dell magazines.

Reproduction of the routing slip in Appendix 2 courtesy of the MIT Museum.

Table of Contents

Table of Figures

***Case Study* Page**

Acknowledgements

The idea of preserving *Case Study: Arcturus IV* (Arnold 1953b) through its digitization arose in talks with William J. Clancey, Ph.D. who had become interested in my father's philosophy of design and his work at the Massachusetts Institute of Technology (1942-1957) and Stanford University (1957-1963). Two volumes have followed (Arnold [1953] 2016) and (Arnold [1959] 2016) and Bill deserves much credit for both. His guidance and help eased my way and in the process I acquired a deeper appreciation of my father's contributions to teaching and creative design. It has been a rewarding collaboration.

Brenda Arnold, wife and enthusiast, not only lent her raptor-like proofreading eyes to my efforts but also exposed some wonderful humor in the case study such as the transmogrification of the real life Eames's lounge into Lame's lounge.

Tim Bigelow of the Internet Archive was both gracious and generous with his time and expertise, and the end result was the addition of five more of John Arnold's case studies to the online ASEE Engineering Case Library, available at https://archive.org/details/engineeringcaselibraryasee.

Daniel Hartwig, Archivist at the Stanford University Library was instrumental in securing primary source materials and helping me through the labyrinth of copyright inscrutables, as well as posting this digitized version of the original *Arcturus IV* case study to Stanford Library's Digital Repository.

Introduction: Designing the Future

Preliminaries

Arcturus IV is a novel record of a creative experiment in teaching product design to engineering students. Its focus was not so much on imparting engineering knowledge and methodology as it was on innovative problem solving strategies and analysis of design issues. It stands apart as well because of its early place in the history of efforts to ensure a human-centered conception of design — products which adapt to man and serve a human need.

This engineering case study deviates from the more typical ones which attempt a thorough review and summary of an engineering problem in preparation for an improved solution to it (e.g., Arnold 1952a). *Arcturus IV*, being a record of an experimental design project, was largely created as it was being taught. The work of students and teachers is represented in the case study but not obviously, as one might expect[1]. Rather, they become participants (often under assumed names; e.g., J.E. Arnold becomes J. R. Nold or Arnold Edward, depending on the role being played) in a science fiction story, 1000 years in the future, of intergalactic trade with the inhabitants of the fourth planet of a star in the constellation, Arcturus, some 33 light years from Earth. Life there, as you will see, differs greatly from our experience here. The story develops through correspondence between Earth organizations and their representatives on Arcturus IV and elsewhere, and principally concerns itself with the studied needs of the Arcturian inhabitants and the products the Earth groups (the students) can design and successfully market to them in non-exploitative fashion in exchange for high grade uranium and platinum. Subtracting 1000 from the date on a correspondence will quite accurately tell the reader when the classroom event occurred.

For all the publicity that the teaching experiment and its case study reaped 60 or more years ago, *Arcturus IV* is not found currently in many archives. In March, 2015, the only public copy I found was in the Stanford Library. It is now publicly available online at the American Society of Engineering Education's (ASEE) Engineering Case Library (ECL; Arnold 1953b), part of the vast Internet Archive project (archive.org). This annotated edition (Arnold [1953] 2016) supplementally adds to the case study the larger context of Arnold's Product Design course wherein the Arcturus project[2] began. The digitization of the case study itself attempts to faithfully reproduce the look and feel of the 1953 original, minus some (but not all) misspelling. The interested reader can easily compare the two versions as both are available at the Internet Archive (Arnold 1953b; Arnold [1953] 2016).

Hindsight

Sixty-three years makes stark how our world has changed since *Arcturus IV* was copywrited in 1953. Words like "creativity," "innovation," and "design" are buzzwords today, but not so then. The

[1] Disguised as case study communications, student/instructor or instructor/students entries concerning course assignments or deadlines are evident in *Arcturus IV*.

[2] When "Arcturus IV" is italicized it refers to the case study that arose gradually from instructor and student contributions. When un-italicized, it refers to the in-classroom activity that dealt with the presentation of the science fiction of Arcturus IV.

same holds for words or phrases like “artificial intelligence,” “robotics,” “self-driving car,” “smart phones,” “Mars rovers,” “gene editing,” and "nanotechnology.” There has been an explosion of scientific and technical innovation and concomitant business formation and wealth generation. The rate of technological change has an exponential feel to it. In less than a lifetime the music industry discarded analog vinyl and tape recordings for compact digital disks and subscription streaming services from the “cloud” straight to computers, home networks, smart TVs, and smart phones. In the world of semiconductors Moore’s Law may shortly come to an end as the limits of miniaturization are reached. Yet along the way we pocketed computing power that once needed a room to house itself. Our present day digital world has become so engulfing, if not smothering, that some find the need to escape it and re-ground themselves periodically to the non-virtual, tangible world.

So the question may be raised, why republish a 62-year-old case study? What is there to merit our attention today? The answer starts with another question: How did all this change come about? And to begin to answer that question we need to revisit the pedagogic experiment that began in 1951 when John E. Arnold incorporated the Arcturus Project into his senior elective Product Design course at MIT (Arnold 1952b, 1953a).

The Experiment

A core tenet of Arnold’s design philosophy was that in order for an engineer to become a skilled designer, he must master more than mechanical engineering knowledge. While necessary, facts and formulae were not sufficient for design excellence. What was missing, and what was not being addressed in engineering education, was instruction in creative problem-solving (Howe 1952). The traditional analytical engineering approach was good at solving problems that had one correct answer. Was a new bridge design going to produce a structure strong enough to carry the anticipated loads? Yes or no? The traditional approach was not good in solving a large class of design challenges characterized by many workable solutions but no obvious best answer: Can any single design capture all the qualities of the superior automobile?

How then does the designer find the best answer? What strategy should be followed when our conventional kitchen appliances fail to meet the needs of someone whose anatomy differs radically from our own? Arnold believed specific creative techniques to solving such problems existed, that they could be taught and learned, and that they would lead to better design outcomes.

Unfortunately for Arnold, creativity in the mid-20th century America was not academically well-understood. Was creativity an inherited trait, little given to modification, or could it be enhanced with training and study? Did essentially everyone possess creative talent or only the few? Could Arnold's students who exhibited both imaginative and analytic skills generate better solutions than those exhibiting only one of the two skill types? Arnold felt the time was ripe to seek some answers (Arnold 1955).

However, Arnold had another problem. The insertion of creative problem solving strategies into design instruction implicitly suggested that existing methods of teaching design were inadequate. MIT needed to do better; at least so said a junior faculty member with no Ph.D. named Arnold. The more

established members of the faculty might wonder if creativity instruction had any place in a technical institute. Isn't that a topic for psychologists? MIT trains engineers.

Arcturus IV

Perhaps Arnold wondered whether producing innovative designers necessitated the use of inventive instructional methods. His novel and unorthodox use of in-classroom science fiction is consistent with the belief that he did. Design a planet radically unlike the Earth and your students essentially are forced to engage their imaginations in completing their design assignments. At the least, the students were being led by an innovative instructor.

In the classroom and labs where slide rules, drafting tables, science textbooks and technical manuals traditionally dominated, it could be debated as to whether there room was some purposeful science fiction. What was not, was whether it was welcomed. Science fiction was immensely popular on campus (Arnold 1953a; Kizilos-Clift 2009, 187-219). In fact in 1950, MIT students organized their own Science Fiction Society (MITSFS) and had it sanctioned as an approved student organization the following year (*MIT Science Fiction Society* 2016). MITSFS has continued ever since. With eager students willing to space travel and a totally original world awaiting them, with an extroverted and unconventional professor raising controversial questions, perhaps it will not be a shock to learn that the general public would soon begin to take an interest in how undergraduate engineering students were being taught product design at a prestigious technical institute.[1]

Arcturus IV gives us a ringside seat from which we can witness the experiment's progression, and what may be most surprising is that from very early on, it was apparent that for all concerned—teacher and student (and reader)—the Arcturus project was more like play than work. That is not to say that the students were not busy or challenged, just that what confronted them was not perceived as onerous. There were demands. Each student had just three weeks to learn and then apply new mental skills to design a product that would, by definition and the constraints of the course, be alien to the designer student. With the completion of the Arcturus phase, the students "returned" to Earth and tackled two more conventional cases in the remaining 8-9 weeks of the course (e. g., modernizing railroad boxcars or hospital beds (Arnold 1952a; Arnold & Wood 1956, Strong 1954)).

How different was the fictitious planet, Arcturus IV? It was very distant, some 33 light years from us, being the fourth planet circling the star, alpha Boötes, in the Arcturus constellation.[2].The planet was much colder than Earth. Summer temperatures averaged -50°C, while winter's were -110°C. The atmosphere of Arcturus IV was largely methane. Gravity on Arcturus IV was 11 times that of Earth. Plants grew upsidedown, the roots extending into the atmosphere, their fruit into the soil. The people inhabiting it had evolved from large birds, and while they were social and intelligent, their anatomy included exceedingly long arms and legs, three fingers per hand, hooves for feet, an x-ray eye between

[1] The general public seemed primed for interest in the Arcturus segment of the Product Design course. UFOs, a U.S. Air Force term, were well established in the public mind of the early 1950s. The Roswell, NM, incident occurred in 1947; frequent sightings of UFOs had prompted three different official U.S.A.F. inquiries by 1952.

[2] It was not until 1991 that the existence of an exoplanet outside our solar system was confirmed. At the time Arcturus IV was "discovered," a sister planet, Arcturus III, was "found" which possessed earth-like conditions. Unfortunately it was devoid of life as a high level of radioactivity covered the entire planet.

two more normal ones, and other features which easily distinguished them from humans, including a two-second behavioral stimulus-response time. Imagine trying to dance with one of them or what the music tempo must have been like with such a lag between the auditory stimulus and the bodily dance response.

The Arcturus classroom project was not fully formed at birth, at least as far as the information the students needed to carry out their assignments. It was known that technologically the people of Arcturus IV lagged the level familiar to MIT students by about 50 years in many areas like electronics (but not in atomic energy), and hence there was every reason to believe a strong intergalactic level of trade might develop once a better understanding of the Methanians and their culture developed. For instance, without knowing the Methanian[1] numeric system how can you design a time piece's dial? How did Methanians keep track of time on a planet whose day was equivalent to 159 of our hours? What were their units of time (Arnold 1953a)?

These "blanks" and more had to be filled in by the students, consistent with what was already known of the planet and its inhabitants, before Earth-originated products could be introduced.[2] So, for example, students, realizing Methanians possessed only three digits per hand, decided to give them a base-6 number system with its own unique set of symbolic numerals. In such ways the students were thereby forced to assume some creative powers over their fictitious world in order to complete assignments. Methanians were unfamiliar with mechanized vehicles, other than a very slow electro-scooter, used by relatively few. So what would be the upper speed limit that a Methanian could safely approach in undertaking to drive a "car" Terran[3] engineers might design for them, given their 2-second S-R lag? Clearly the student designers would have to take account of Methanian limitations and differences and ensure that the vehicle matched the end users' abilities and needs —what on Earth today would be called "human-centered" design but which seemed avant-garde then. Any profit would be a derivative of the product's value to the Methanians. If no apparent value was manifest, T. E. C. H.[4] would not approve the design, as happened with the carriage-incubator that was proposed by M.I.T.[5] for export to Arcturus IV. A strong ethical basis underlay Terran–Arcturan dealings which was often reflected in the communiqués of Terran engineers.

National popular-press publications like Astounding Science Fiction*, Popular Science, Readers Digest, Pageant,* and *Life Magazine* all, at different times, ran articles about Arnold and his design course. However, without exception, each article focused almost exclusively on the course's first segment when Arcturus IV was front and center in the classroom and lab. The *Arcturus IV* case study that was produced over the course's first three years became increasingly famous as more articles appeared. The compiled case study became the reference book that documented, for all to see, the

[1] The name for the inhabitants of Snafu, the capital city of Arcturus IV, and its surrounding countryside.

[2] The newly generated information was then added to the case study for succeeding students to learn and built upon.

[3] The name for Earth in the 30th century.

[4] Terran Exporting Counsel Headquarters, a Terran government supervisory agency of interstellar trade. (Also a nickname for MIT used by students and faculty).

[5] Massachusetts Intergalactic Traders, Inc., a for-profit, private corporation skilled in the design, manufacture, and sale of goods throughout the known galaxies.

results of the experiment as more student work was added to it in successive iterations of the course. Student Austin Baer's Eggomobile became the "poster child" in many of the articles with its clever and novel design, seemingly proof positive that the course was generating unconventional products that solved important problems in novel ways unseen on Earth.[1] Of course, nobody claimed that one innovative product, or several, answered any or all questions raised by the experiment. But it was an encouraging start.

Success can come in different forms and it did with Arcturus IV. Student enthusiasm and demand prompted a rapid expansion of the MIT design curriculum into a sophomore to senior sequential series of courses within three years of Arcturus IV being included in the curriculum (Arnold 1953a; Hunt 1955).

Corporations that were experiencing their own product design issues contacted Arnold and sought the potentially new and fresh approaches his students might generate in response to the corporate case studies specifically written for class consideration. Corporate grants even paid the classroom expenses incurred in the process (Strong, 1954). In fact, corporate interest provoked Arnold to offer a two-week summer seminar on creative problem solving. Large corporations such as General Electric, Eastman Kodak, DuPont, Hewlett-Packard, Hoover, American Can, RCA, and American Machine and Foundry sent their executives and engineers (Strong 1954; Katz 2015). These same or similar businesses hired former MIT design graduates. (Hunt, 1955). Professor Arnold began consulting for General Motors, and A. C. Spark Plug established its own creative engineering program under his guidance (Hunt 1955).

The Legacy

The *Arcturus IV* case study is a rough-cut diamond. It is so, in part, because the 1953 case study lacked a Table of Contents, figure captions, Indices, and pagination. Its internal structure was not immediately evident even though it was largely, but not entirely, chronological.

Even so, it is a seminal document in the history of creative design that sparkles with its innovative approach to teaching and its creative results. Indeed, as we read it we are witnessing the beginning of the transformation of design in America from its machine based drafting foundations into the vastly expanded and more inclusive concept of design that we have today (Arnold [1959] 2016, Katz 2015). Yet in spite of all the changes that have occurred since his death, much of Arnold's philosophy of design is recognizable in today's iteration. A fuller treatment of the legacy of John E. Arnold, can be found in *Make It New: The History of Silicon Valley Design* (Katz 2015, pp 1-5, 118-124) and *Creative Engineering: Promoting innovtion by thinking differently*, William J. Clancey's illuminating examination of Arnold's philosophy of design (Arnold [1959] 2016).

Arcturus IV appears to have been used for at least two or three more years at MIT but when Arnold accepted full professorships in the School of Engineering and the Graduate School of Business at

[1] Arnold hired Baer post-1952 to assist in the instruction of creative problem solving seminars and Arcturus IV and prior to Baer's departure from MIT in 1955 (Baer, 2015).

Stanford University in 1957, it is believed that *Arcturus IV* ceased to be used[1], replaced by newer cases. Of the eleven case studies associated with Arnold that we know about (see Appendix 1) only two used the science fiction genre in the post-*Arcturus IV* period—*Ceres* and *Zylerium Blindness*—and both were in some senses smaller in scope than *Arcturus IV*. *Ceres* (Arnold, Babcock, & Davis Undated) dealt with the low-gravity challenges of mining on an asteroid. *Zylerium Blindness* (Arnold Undated) focused on the world-wide aftereffects of a limited nuclear exchange between the United States and the Soviet Union across the Bering Straits. But regardless of where the case study was staged, imaginative and resourceful problem solving was required.[2]

The waves John E. Arnold put in motion so long ago in the intellectual waters of teaching, design, creativity, and innovation still ripple today. His vision of the value of creativity in our lives was meant for not just engineers, but for politician and government workers, entrepreneurs, educators, husbands and wives, parents, and anyone else who confronts the complex issues of our modern culture and way of life (Arnold 1955).

What Now?

It is your turn to judge how the experiment fared. It holds much more than what I have touched upon. It was and is a surprising voyage of discovery for teacher, student, and reader. Its playfulness seems so atypical in the usually high-pressured atmosphere of an elite technical institute.

Effort was made in the digitization of the original paper version to preserve its look and feel. That meant the look of the various letterheads, and much of the formatting and spellings were largely preserved (obvious misspellings were corrected). While the original had no pagination, its collection of correspondence, sketches, calculations, and drawings were largely but not entirely in chronological order. That same order has been maintained in the digital version where pagination was added to facilitate navigation and permit indexation. Thus, there remains a very close 1:1 relationship between the pages of each version. In the cases where correspondence exceeded a page in length, slight variations in where a page ended are evident between the two versions, due to varying margins in the original, without affecting the overall synchronization of digital and original pages.

You may notice that a number of the engineering drawings have faded lines and some discoloration. Digital enhancement helped but could not completely eliminate signs of aging.

The original version contains abundant evidence that proofreading was not a high priority. While many spelling oversights were corrected in creating this digitized version, not all were, so as to leave a diluted sense of the original. A scan of the original as found in the ASEE Engineering Case Library of the Internet Archive (Arnold 1953b) will reveal the difference. The magnitude of what was taught, learned, and produced in such a brief period of time (three to four weeks out of the design course's twelve-week period), under a non-judgmental creativity umbrella inside the classroom, may explain the rest.

[1] There is evidence a *Part Two* to *Arcturus IV* was produced but I have been unable to find a copy of it, just an Internet screenshot of its cover.

[2] A literature search still turns up recent engineering cases that employed fictitious aliens for instructional purposes (Mendoza-Garcia & Cardella, 2014); (Jordan, Lande, Cardella, & Ali, 2013).

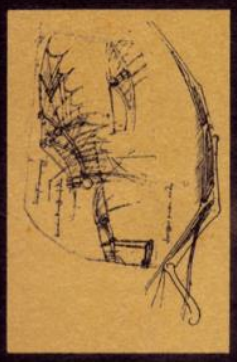
Appendices 2 and 3 contain informative writings by Arnold discussing the Arcturus IV project. Appendix 2 is a short report detailing Arnold's reasons for undertaking the project. Appendix 3 reproduces Arnold's 1953 *Astounding Science Fiction* article on the project and the rationale behind it. Reading both before tackling the case study itself may prove helpful to the reader.

CREATIVE ENGINEERING LABORATORY, MECHANICAL ENGINEERING DEPARTMENT

CASE STUDY ARCTURUS IV

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE 39, MASSACHUSETTS



Printed in U. S. A.

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: General Manager To: All Employees

Subject: Confidential Reports File No. 3463

A great deal of the material in our office files is of an extremely confidential nature and not to be disclosed to unauthorized persons. The penalties for such disclosure are very severe both from the company and government.

This sheet should, therefore, appear as the first sheet of any file confidential material and serve as a warning to persons not cleared to receive such. Any person not cleared who reads further in this file does so at their own risk and is subject to the extreme penalty of the law.

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From : General Mgr. To : All Employees

Subject : Time for Records File No. 3453

Please note that all time used in letters and reports is referred back to Terran time at Cambridge. All M.I.T.$_3$ ships and Branch offices must keep at least one calendar chronometer measuring Terran time.

Minute of 60 seconds
Hour of 60 minutes
Day of 24 hours - 1 o'clock is first hour after midnight
Week of seven days
Month of four weeks
Year of thirteen months
Year Day between 28 December and 1 January
Every fourth year - Leap year day between 28 June and 1 Jul.

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

3 May 2951

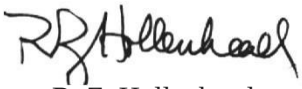
OFFICE OF THE
BOARD CHAIRMAN

K Wad Lee, Director General
T. E. C. H.
Hexagon Bldg., 187 Level
Washington 99, Terran

Dear K W:

I noticed on last nite's Newscope the announcement of the discovery of intelligent life on Arcturus IV. As you know, our company has been actively engaged for some time now in galactic trading and are well equipped for the design, manufacture and distribution of machines and products for human and sub-human use. Our recent expansion program qualifies us to handle new virgin territory and I would appreciate it very much if you could send us a copy of your file on the α Bootis system and, as in the past, keep us informed as to changes and additions to this file.

Cordially,



R. Z. Hollenhead
Chairman of the Board

T E R R A N
E X P O R T I N G
C O U N S E L
H E A D Q U A R T E R S

INTERGALACTIC CODE NO. 19
ADDRESS TECH

Hexagon Building - 187 Level - Washington 99 - Terran

14 May 2951

R. Z. Hollenhead
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts

Dear Zepp:

Enclosed you will find copies of the file you requested on α Bootis. I think you are dammed smart to get in on the ground floor on this new planet. Information about Arcturus IV is very sketchy at this date, but what we have looks promising. We, of course, will keep you informed on new information as it comes in and you do the same with us.

I hope you are planning to attend the Galactic Exporters Convention this fall so that I can have the pleasure of seeing you and your charming wife again. Maybe, we can ditch the girls again like we did three years ago on another "Technological Toot".

Cordially,

K Wad Lee
Director General

CONFIDENTIAL

Received
Mass. Intergalactic Traders
17 May 2951

T E R R A N
E X P O R T I N G
C O U N S E L
H E A D Q U A R T E R S

INTERGALACTIC CODE NO. 19
ADDRESS TECH

H e x a g o n B u i l d i n g - 1 8 7 L e v e l - W a s h i n g t o n 9 9 - T e r r a n

26 Sol 2949

Solar and Galactic Explorers Union
Local 257
East Atom 82,
Saturn

Gentlemen:

In a recent director's meeting we were discussing and reviewing the progress of exploration in our Galaxy. We noted that little work has been done in the α Bootis region. We feel that this territory might well be explored with good chance of profitable return. It is close enough to Terran and not too far off established routes into deep space.

Please keep this suggestion in mind and when time permits look into it. Any expense involved will be covered in our usual manner but will double the bonus paid for the discovery of intelligent life.

Yours very truly,

K Wad Lee
Director General

Solar and Galactic Explorers Union

Local 257

SATURN BRANCH
EAST ATOM 82

14 March 2951

Mr. K. Wad Lee
Director T.E.C.H.
Hexagon Bldg., 187 Level
Washington 99, Terran

CONFIDENTIAL

Dear Sir:

The suggestion in your letter of 26 Sol 2949 that investigation of the Arcturus Region might prove fruitful was a good one. I have just returned from that region having made contact with at least one planet containing sub-human intelligent life. It is a rather amazing planet as you can see from the attached form. The natives were friendly and welcomed Terran contact, but the conditions there make it very rugged for human existence.

Trade possibilities seem unlimited, the state of culture reminding one very much of the descriptions of early 20th century America that I used to read about in our history books. Large deposits of pure uranium and platinum could provide more than adequate repayment for any goods and services that we exchange with them.

My contact with them was relatively short because of the extreme living conditions and other urgent matters. I landed near the largest city observed in quick flight around the planet. This city is called Snafu and the inhabitants are of a race called Methanians, a queer lot apparently evolved from birds (see photo in report). This planet is the fourth out from Arcturus. Six planets are known to the Methanians, but there are undoubtedly more. I only had time to visit briefly one other planet (report attached) but no life of any kind was found. I wish I had though as you'll see from the report, conditions in Arcturus III are very similar to Terran conditions except for high radioactivity.

I recommend highly that you advance the contact with Arcturus IV as it will be very profitable. Those detailed investigations should be carried out by your staffs and I suggest that the first group consist of a goodly number of construction engineers to establish permanent headquarters. There is no wood on the planet but ample supplies of stone, brick, and most metals are available.

Kindly deposit bonus check (double you recall) and expense check for 43,000 credits to my account in Third Bank of Terran, Saturn Branch. If I can be of service in any other way, please do not hesitate to call on me.

Yours in space,

Care E. Toff

Care E. Toff
Licensed Explorer
License No. 3470

Received
Mass. Intergalactic Traders
17 May 2951

COPY

EXTRA-SOLAR PLANET REPORT

Terran Exporting Counsel Headquarters

SUN α Bootis **SPECTRAL CLASS** Ko **LUMINOSITY** 83X **MASS** $6x10^{33}$ grams

DIAMETER $19x10^{6}$ miles **SURFCE TEMP.** 4000^{o} Abs **DISTANCE** 33 L.Y.

PLANET NAME **NUMBER** III **FILE NO.** 3463

FIRST CONTACT 10 January 2951 **BY** Gare E Toff

DISTANCE (from sun) 880×10^{6} miles **MASS** 12×10^{27} grams **DIAMETER** 17.6×10^{6} meters

ACC.OF GRAVITY (cgs) 1038 **SIDERIAL PERIOD** (Terran time) 16.82 years

LENGTH OF DAY (Terran time) 24 hours **DAYS IN YEAR** (Local time) 6140

MEAN TEMP. (Winter) ? **MEAN TEMP.** (Summer) ?

LIFE None **TRADE POSSIBILITIES** None

REMARKS & FOLLOW-UP

1.) Atmosphere - similar to Terran but radioactivity high.

2.) Temperature when I was there was mild +20°C but do not know if this is winter or summer.

3.) Data above obtained from astronomers on Arcturus IV.

4.) Conditions on this planet ideal for human life except for high radioactivity.

5.) Looks as if some atomic disruption destroyed all life forms at some time or another on this planet.

6.) Suggest archeological investigations be carried out here when time permits.

EXTRA-SOLAR PLANET REPORT

Terran Exporting Counsel Headquarters

SUN α Bootis **SPECTRAL CLASS** Ko **LUMINOSITY** 83X **MASS** 6×10^{33} grams

DIAMETER 19×10^{6} miles **SURFCE TEMP.** 4000^{o} Abs **DISTANCE** 33 L.Y.

PLANET NAME Arcturus IV **NUMBER** IV **FILE NO.** 3463

FIRST CONTACT 22 January 2951 **BY** Gare E Toff

DISTANCE (from sun) 1800×10^{6} miles **MASS** 60×10^{27} grams **DIAMETER** 12×10^{6} meters

ACC.OF GRAVITY (cgs) 11,000 **SIDERIAL PERIOD** (Terran time) 49.4 years

LENGTH OF DAY (Terran time) 159 hours **DAYS IN YEAR** (Local time) 2720

MEAN TEMP. (Winter) -110° C **MEAN TEMP.** (Summer) -50° C

LIFE Intelligent sub-human **TRADE POSSIBILITIES** Excellent

REMARKS & FOLLOW-UP

1.) Atmosphere is largely methane and strangely enough the name of the local races translates to Methanian.

2.) State of Culture - early 20th century, say around 1905, America.

3.) Intelligent life extremely friendly. Quite short (height of male in picture 4'6") - apparently evolved from birds - covered with feathery type fur. - third eye seems to extend visual perception over much greater range than we are capable of. Hearing is much more acute in both high and low frequencies.

4.) Many different types of domestic animal life in evidence.

5.) Plant life is all low growing (similar to our mosses)and is apparently part of the root system of the plant. The edible portions of the plant are under ground at considerable depth. The blossoming and fruiting takes place underground, pollination being accomplished by worms similar to our earth worms.

6.) Due to high pressures, gravity and extreme cold the inhabitants move very sluggishly. This extreme slow pace is hard to adjust to.

T E R R A N

E X P O R T I N G

INTERGALACTIC CODE NO. 19
ADDRESS TECH

C O U N S E L

H E A D Q U A R T E R S

H e x a g o n B u i l d i n g – 1 8 7 L e v e l – W a s h i n g t o n 9 9 - T e r r a n

20 March 2951

Memo To: J. H. Rones, Director of Engineering
J. R. Nold, Director of Design and Production
J. S. Wick, Director of Psychology & Physiology

Gentlemen:

Enclosed you will please find a copy of the letter from Gare E. Toff announcing first contact with the Planet Arcturus IV and his reports on the same. In accordance with established policy you will prepare plans for an immediate thorough investigation of this planet so that it can be announced to the public as soon as possible. Remember, of course, until public announcement is made, all plans must be kept perfectly secret.

Read the reports very carefully noting the extreme conditions existing on planet IV and make your plans accordingly. I would like to have a permanent Headquarters established and built as quickly as possible so sufficient men and supplies should be taken along for this purpose. At the same time a careful study of the physical aspects of the country and culture should be carried out by the General Engineering Group.

The Psychological and Physiological group should make a complete survey of the animal and intelligent life so that we can advise all interested Terran trading companies. Do not, of course, overlook the spiritual, moral and psychological aspects of their culture and try to evaluate the effect of Terran contact on same. The Design and Production group should concern themselves with the material side of their culture so that we can lay out a program for a future trading program.

Expense under "Project Arcturus" should be charged to order No. XK0-4139-A. Flight zero hour should not be later than 6:30, 25 March.

K Wad Lee
Director General

CONFIDENTIAL

Received
Mass. Intergalactic Traders
17 May 2951

T E R R A N

E X P O R T I N G

INTERGALACTIC CODE NO. 19
ADDRESS TECH

C O U N S E L

H E A D Q U A R T E R S

H e x a g o n B u i l d i n g – 1 8 7 L e v e l – W a s h i n g t o n 9 9 – T e r r a n

GENERAL ENGINEERING DIVISION
J. H. RONES, DIRECTOR

20 April 2951

CONFIDENTIAL

K. Wad Lee
Director General

Dear Sir:

Since the space ship must be sent back to Terran for more supplies, men and equipment, I am taking this opportunity to tell you of our progress on Arcturus IV to date.

As you know we left the Space port at Washington at 6:00, 24 March, one day ahead of schedule and after an uneventful 12 day flight we safely reached Arcturus IV. We circled the planet once and had little difficulty locating the city of Snafu reported by Toff. It is in the northern hemisphere of the planet on a large plain ranged with very rugged mountains.

On landing we were greeted by Z. Yutaka, the Governor of Snafu, and some of the other city dignitaries. They had been expecting and waiting for another visit from Terran men ever since Gare E. Toff departed last February. They were even more friendly than we had expected or hoped for and did everything in their power to make us comfortable. We experienced little difficulty in conversing with them through our space suit phones and found we could keep up with their extremely slow pace even under the high pressures and G, thanks to the new Hi-G space suit design. We had some difficulty in regulating temperature at first. It was only -100°C the day we landed.

Yutaka appointed J. Burgweiss his liaison officer and with his cooperation a site for the new headquarters was chosen and procurement of materials for construction ordered. Native workers were provided and work on the building progressed rather rapidly considering the pace of the workers. Our men worked in shifts, all taking part in the construction work. We Terrainians worked eight hours and slept eight hours. The Methanians worked throughout their day, now 80 hours long, and then took the remaining 79 hours off, they would not work nights.

The building follows the attached plan and the walls are three ply stone and brick with a vermiculite type of insulation and a thin aluminum gas seal. The floors, partitions and roof are aluminum sheet on prefabricated joists and studs. The entrances are triple sealed locks and the windows are quadruple thermopane with heated methane circulating in the spaces to cut down bodily radiation loss to these areas.

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

H e x a g o n B u i l d i n g – 1 8 7 L e v e l – W a s h i n g t o n 9 9 – T e r r a n

INTERGALACTIC CODE NO. 19
ADDRESS TECH

GENERAL ENGINEERING DIVISION
J. H. RONES, DIRECTOR

Office space, storage space, recreation space, and living space for 200 humans is being provided in a heated, partially degravitized, oxygen atmosphere. We are also providing for two large conference rooms or show rooms heated to only -50°C and having a methane atmosphere to accommodate our Methanian friends.

We hope that it will not be too long before the work is at such a point that we can release some of our men to start the research programs originally planned. Please see that the list of materials and supplies that the space ship captain has is quickly obtained and shipped back to us. Jack Nold and Jim Wick join me in sending you our best regards.

Yours in space,

John H. Rones
Director, Project Arcturus

CONFIDENTIAL

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

17 May 2951

From: RZH To: J. Sapmill

Subject: Arcturus IV File No. 3463

I have just received the enclosed file from T.E.C.H. and suggest you look it over very carefully. This looks like a wonderful opportunity for our company to get in on the ground floor. Here is a large planet, inhabited by an intelligent people of a relatively backward culture. Without too much trouble on our part we should be able to design and build a wide range of machines and products that they can use. There will be, of course, some technical difficulties but I am sure that our engineering and design staff can solve them.

Before we have a company conference on programing our entrance into this market, I would like to have a first-hand report on the general conditions there. With your past experience, Joe, you're the man to do this job. Your long interest in 20th century Terranian history should make you sympathetic to the culture on Arcturus IV.

Check with Peggy on the best route and accommodations. I feel that probably for a slight extra charge the Spica flight might be diverted off its course a little and let you off at Arcturus IV. I have checked with T.E.C.H. and they say that their headquarters is now ready for guests. Charge all expenses to order No. OK 2734, and good luck to you in space.

CONFIDENTIAL

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

INTERGALACTIC CODE NO. 19
ADDRESS TECH

H e x a g o n B u i l d i n g – 1 8 7 L e v e l – W a s h i n g t o n 9 9 – T e r r a n

PSYCHOLOGY & PHYSIOLOGY DIV.
J. S. WICK, DIRECTOR

27 July 2951

CONFIDENTIAL

R. Z. Hollenhead
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue Cambridge, Mass.

Dear Sir:

At the request of our Director K Wad Lee, I am sending you a copy of our report on Arcturus IV. This, of course, is just a brief survey of Sub-Human type SH-1406-A and it will be followed with more detailed information as our group progresses in our analysis of intelligent life on this planet.

The work is progressing as rapidly as can be expected, considering the extreme conditions under which we have to work. The natives seem to be extremely cooperative and their government welcomes the opportunity of Galactic contact. Any specific information that you desire not covered in this or subsequent reports will be obtained, if at all possible, on receipt of your request.

Respectfully,

J. S. Wick

J. S. Wick, Director

Received
Mass. Intergalactic Traders
2 August 2951

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 25 July 2951

FROM J. S. Wick **TO** K. Wad Lee

SUBJECT SH-1046-A **FILE NO.** 3463

This is the first report of the Psychological and Physiological Division attached to Project "Arcturus" and operating under order No. XK0-4139-A issued by the Director General. Up to 1 June 2951 the majority of our Division was engaged in helping the General Engineering Division with the planning and construction of the permanent Headquarters on the outskirts of Snafu. Shortly before that work was finished, the writer and two others started laying out a research program in the Psychological and Physiological fields. Our work has now been going on for almost two months and we are ready with this interim report.

As has been stated before, the Methanians are a friendly cooperative people in spite of the somewhat backward culture. Unfortunately they are not the only race inhabiting Arcturus IV and from what we have been able to learn there are other less friendly people to deal with. A good share of the information and data in this report has been obtained from Methanian libraries. It is supplemented and checked by our own anthropometric measurements and psychological tests.

Figure I shows the average skeletal dimensions of the Methanian male of two Arcturian years (98.8 Terran years). The average female height is 4'-0". Physical maturity is reached in one Arcturian year and senility sets in in about l0 Arcturian years. There are very few old people, however. The severity of their physical surroundings combined with their own physical limitations prevents the great majority from reaching old age.

Strangely enough the Methanian metabolic process is similar to Terran plant life. Carbon is obtained from the Methane atmosphere and oxygen from the plant and animal life eaten as food. There is no liquid water anywhere on the planet and due to the very cold temperature, little in the atmosphere. That which is present is in the solid state resulting in a foggy condition both winter and summer. Ammonia is the Arcturian substitute for water.

The Methanians weigh very little compared to us. One of the largest we met was weighed on a Terranian spring scale at 187 pounds. Their bones are hollow and apparently filled with hydrogen and helium. There is no question but these people have evolved from a race of bird-men, their appearance seems to indicate it, their history seems to prove it. Their long arms and claw like hands are vestiges of once great wings. The only anomaly is their single-toed feet like that of a horse. This adaption to ground living evolved very rapidly once the power of flight was lost.

The young are born in eggs and the eggs are carried around in skin pockets or pouches similar to those of the now extinct Terranian Penguin until the egg hatches. Both male and female take turns in the hatching process. The young grow rapidly, at first, and are ready to take care of

themselves in about 20 Terranian years. They, however, seldom leave home before physical maturity is reached (49.4 years).

The Arcturian normal body temperature is -40°C and their pulse rate is 5 times per minute. As a result they are very slow moving and they frequently walk using one or both arms as a cane or pair of crutches. Their normal walking pace is about 1/4 mile / hour, but if pressed they can go almost eight times this fast for very short periods. Even with Hi-G units we don't travel much faster than they do. This slow pace does not seem to bother them since their whole system is similar, their stimulus-response time is about 2 seconds.

Their auditory, vocal and visual range is extremely large. They can hear sounds with frequencies as low as l/l00 cycle/second up to 50,000 cycles/second. Their vocal range goes from 1/50 to 25,000 cycles/second and their visual range extends from the infra red up thru the ultra-violet.

As you might expect they are very stable emotionally, very slow to anger and with tremendous patience measured by our standards. They have a limited amount of telepathic ability, but seem to use this form of communication only under duress. In the ESP-tests we thought we had discovered a race with exceptional talent but later found out that their high (almost perfect) scoring was due to the X-ray like vision of the third eye.

They are monogamous and divorce is not known. They are extremely gregarious and even the farmers live in little centralized communities. Their religion is monotheistic (and without a devil) and their music, literature and art is well advanced.

All in all they are a very interesting people and well worth a great deal more study. Subsequent reports will attempt to go into a great deal more detail.

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 14 MAR 2951

FROM GARE E. TOFF **TO** K. WAD LEE – T.E.C.H.

SUBJECT METHANIAN MALE **FILE NO.** 3463

s

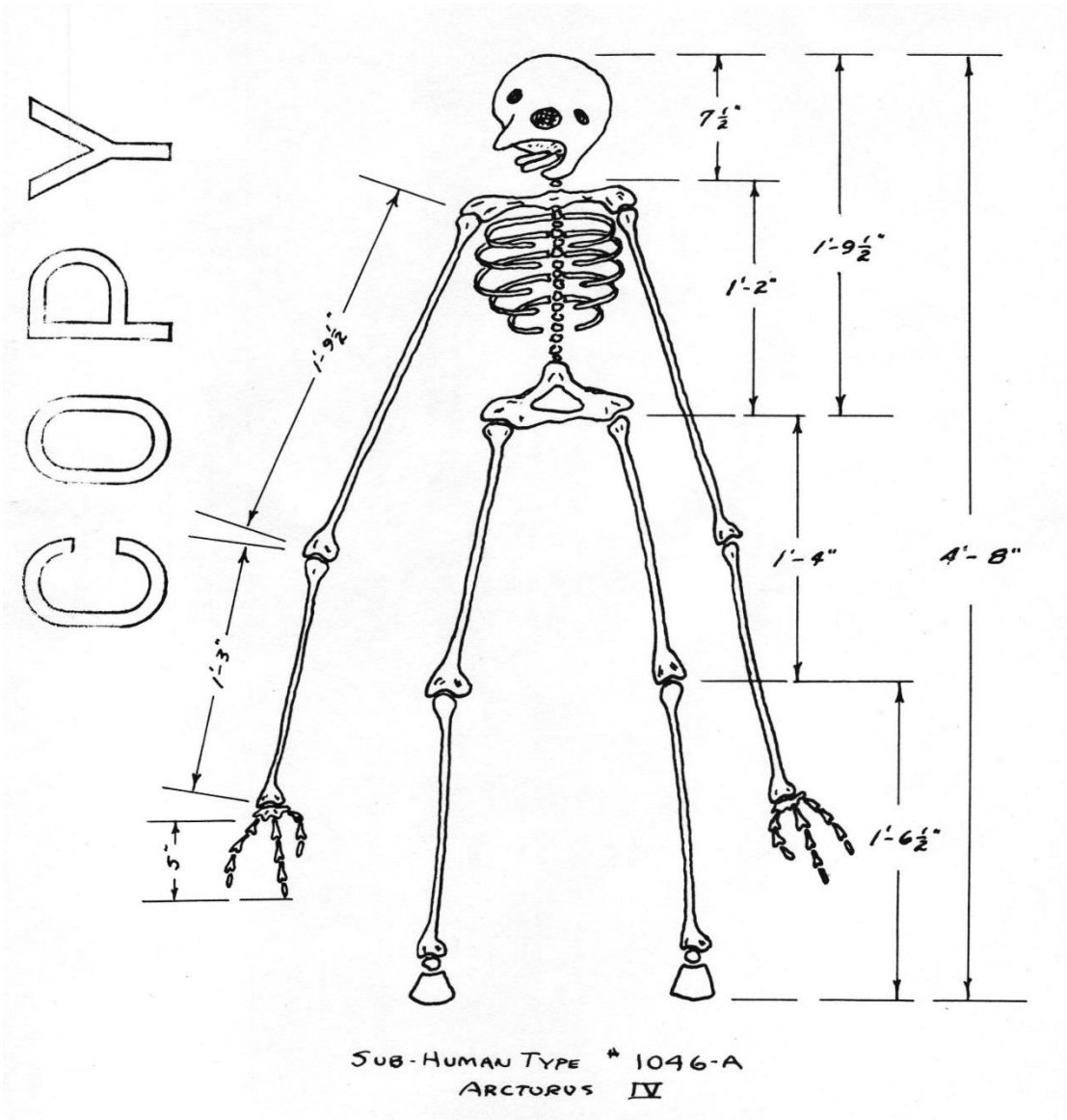


FIG. 1: SUB-HUMAN TYPE 1046-A

TERRAN
EXPORTING
COUNSEL
HEADQUARTERS

Hexagon Building - 187 Level - Washington 99 - Terran

INTERGALACTIC CODE NO. 19
ADDRESS TECH

GENERAL ENGINEERING DIVISION
J. H. RONES, DIRECTOR

5 August 2951

CONFIDENTIAL

R. Z. Hollenhead
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Mass.

Dear Sir:

I have just returned from a rather extended sojourn on Arcturus IV, completing the construction of the permanent headquarters there and carrying out a preliminary survey of the physical aspects of the planet. Enclosed is a copy of our Division's first report which, I understand, you have requested.

It is difficult to describe in such a brief report all the wonders of this strange world. You must experience the thrill first hand in order to appreciate it. The trip thru space is not a difficult one and our headquarters provide extremely comfortable accommodations.

Very truly yours,

J. H. Rones
Director, General
Engineering Division

Received
Mass. Intergalactic Traders
8 Aug 2951

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 4 August 2951

FROM J.H.R. TO K. Wad Lee

SUBJECT Arcturus IV FILE NO. 3463

General Engineering Report

The construction of the permanent headquarters has now been completed according to plans and specifications on file in this office. All mechanical equipment is adjusted and running smoothly providing all the comforts of Terran. This report will deal primarily with the physical aspects of Arcturus IV.

The dimensions of this world have been given (See Extra-Solar Planet Report) but a more detailed report is necessary for future traders and travelers. The world is an extremely large one and only a small part has been investigated by this Division. The libraries of the Methanians, however, contain a wealth of reference material and this has been helpful in preparing this report.

The surface of the planet is about equally divided between land and sea. The liquid in this case being ammonia, the large oceans do not freeze in the winter time but all the small lakes and rivers do. The rainfall in all but the torrid zones is very slight so that irrigation has to be practiced by the farmers for their crops. In addition to the ammonia large pools or lakes of Tetrasilicance (Six H_{10}) are scattered over the surface. This fluid in conjunction with the ammonia is used to irrigate the crops.

The Methanians live on a very large continent in the northern half of the western hemisphere. It is about 4 times the size of North America and inhabited by over 500 million people. The topography, for the most part, consists of large flat plains ringed by high rugged mountains. These plains range in size from a few hundred square miles to about 100,000 square miles. The city of Snafu is located centrally in one 95,000 square miles. The population of Snafu is 15,500,000 and the only city as such in this plain. The farmers live in small groups (ten to twenty families) scattered all over the rest of the plain. They have no local government, all paying taxes and receiving protection from the city of Snafu (City and Plain have the same name).

Most all of the rivers and lakes are spring fed and many of them run from one plain to the next thru large underground passageways. These rivers provide cheap and easy transportation.

The metabolic processes of both plant and animal life are very interesting. The plant life in effect grows upsidedown. The root structure extending into the atmosphere where it obtains some oxygen from the CO_2 present, nitrogen and hydrogen from the NH_3 and gives off methane (CH_4) in rather large quantities. The lower fruiting portion of the plants extend in some cases to considerable depth (making the harvesting very difficult) tho usually to a depth of only two or three feet. Additional oxygen is taken in by the plants from the oxides in the soil along with the necessary

carbon and silicon. The soil must be kept moist all of the time of their growing season with the tetrasilicance in order to prevent freezing. The plants and their fruit are very rich in oxygen which when eaten by the animal life and in combination with the methane they breathe provides the exothermic process necessary for the maintenance of life. The combustion products are mainly CO_2 and NH_3 and H_2O.

Most of the wild animal life that is herbivorous is of the burrowing rodent type and the ground is honeycombed with their tunnels. Control of these animals is a serious problem to the farmers. Herbivorous domestic animals have been evolved that graze on the root portions of the plants, but this grazing must be carefully controlled or the plant life will be destroyed.

There is no wood of any type on the planet so cellulose products are unknown. All textiles are mineral or silicon derivatives or synthetics. Building materials are stone, brick, metal or synthetics.

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

H e x a g o n B u i l d i n g - 1 8 7 L e v e l - W a s h i n g t o n 9 9 - T e r r a n

INTERGALACTIC CODE NO. 19
ADDRESS TECH

DESIGN & PRODUCTION DIVISION
J. R. NOLD, DIRECTOR

7 August 2951

CONFIDENTIAL

Mr. R. Z. Hollenhead
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts

Dear Dr. Hollenhead:

Enclosed you will find a copy of my first report on the marketing and production opportunities on Arcturus IV. The report, of necessity, is brief but, I hope, to the point. As further investigations are carried out we will be glad to send you additional information.

Your man J. Sapmill was very helpful to us in our work and his report will probably be more specific than our general observations.

Sincerely yours,

J. R. Nold
Director of Design
and Production Division

Received
Mass. Intergalactic Traders
10 Aug 2951

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 5 August 2951

FROM J. R. Nold **TO** K. Wad Lee

SUBJECT Arcturus IV **FILE NO.** 3463

MARKETING AND PRODUCTION REPORT

The scope of our investigation is so large that it is almost impossible to go into any detail in the description of the Methanian culture from the standpoint of products and machine development. This report, then, will be extremely general in nature. Requests received for any specific information are welcomed and this information will be promptly supplied from our files or from our representatives in Snafu.

The material culture is a rather strange mixture, being quite advanced in some fields and slow, if not completely non-existent in other fields. For example, the use of atomic power for the generation of electricity for heating, lighting and conversion to mechanical work is widely known and used, but the field of electronics is completely missing. Considerable use of electricity for heating occurs in the farming and outlying districts of the large cities. In the cities themselves, ammonia vapor from the cooling coils of the large atomic piles, is piped from house to house as the heating media. It also has the advantage that it can be used as drinking fluid as well. In the summer time it serves as a cooling medium.

The previous reports that the culture is similar to early 20th century America is somewhat misleading due to the anomaly above and others like it. What previous reporters referred to was probably the fact that the Industrial Revolution of the Methanians is just getting under way in full swing. There is still a great deal of craftwork being carried out, but large factories are beginning to take over more and more. Steel and iron has nowhere near the importance here that it has on Terran because of its extreme density and weight. Aluminum, magnesium and titanium are widely used as are the various plastics. Lithium is very scarce on Arcturus IV but highly prized because of its light weight. Light weight with adequate strength will be one of the big problems for Terran designers. Another is the question of impact strength and hydrogen embittlement.

The possibilities of design for industry are tremendous but a great deal of study and investigation will have to be carried out before laying out a design program. Any plans that Terran firms may lay out for work in this field will have to be carefully studied by our Division and receive our approval before they can be carried out. This Division's approval should be obtained, of course, before any product or machine is sold on Arcturus IV. The industrial problem is so complex that it will be sometime before we will even consider requests for production in this field.

The product field, however, is quite different and the possibilities are limitless. The Division is prepared to review applications for design approval in this field immediately. A brief outline of some of the areas in which these products might be used are described below:

1.) Household Equipment.

Furniture of all types, designed to fit the dimensions of the Methanians could be readily sold. The use of wood in their construction would prove to be quite a novelty, but care must be exercised to keep the product light. Dust is not a problem on Arcturus IV but the removal of frozen water vapor, which keeps settling out of the atmosphere is a nuisance to the Methanian housewife. Vacuum cleaners are unknown, the old fashioned broom does the job now.

Electricity is used for lighting and cooking (and heating in the country) and all equipment in this field can be greatly improved upon, both from a functional and an aesthetic standpoint. The people have a well-developed sense of beauty as evidenced by their high attainments in art and music. This love of beauty, however, has not yet been translated into the products they use.

2.) Equipment for Personal Use and Recreation.

Equipment in this area is very limited at this time, consisting primarily of balls of various types for simple group games and various types of cards for indoor games and for gambling purposes. Photography, radio, television (even the telephone) are unknown, but they can undoubtedly be gradually introduced to the profit of Terran companies. The people do attend a great many musical concerts and they frequent the legitimate theatre and gambling houses. One of the strangest sights we observed in our stay was a dance recital. What the Terranians consider to be a fast intricate dance step appears to us as the slowest of slow motions. On the other hand, one of our movies projected at 20 frames per second would be just a blur of light to them with their very slow stimulus-response time.

3.) Industrial and Commercial Products.

Equipment that we would normally include in this category does not exist on Arcturus IV (typewriters, business machines, telephones, recording equipment, power tools, etc.) Their commercial equipment consists largely of hand tools. These can be redesigned, of course, but the blank spaces in the field should provide a greater challenge.

4.) Transportation.

This area is somewhat more advanced than we would at first suspect primarily because it is so vital that the Methanians conserve as much of their energy as possible. The power source for the scooter type vehicles used is battery supplied electricity. They operate at a very slow speed to prevent the operator or pedestrian from being hurt. Even the large transportation units operate at slow speed. It is suggested that some thought be given to the design of automatically controlled "busses" or "trains" for them so that the transportation system could be speeded up.

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: J. Sapmill To: R. Z. Hollenhead

Subject: Arcturus IV File No. 3463

CONFIDENTIAL

10 August 2951

Under order No. 0K2734 issued by the Chairman of the Board R. Z. Hollenhead on 17 May 2951 the writer proceeded to lay plans for a first-hand investigation of the conditions on Arcturus IV and to evaluate the trade possibilities with the intelligent life discovered there. Provision was made with the Commanding Officer of the Spica transport to make a side excursion on their regularly scheduled flight of 22 May 2951, arriving on Arcturus IV on 6 June 2951.

Comfortable accommodations were obtained in the new permanent Headquarters of the T.E.C.H. and the investigation started. A number of field trips were made but due to the high gravity and the extremely slow moving electro-scooters available for hire very little can be accomplished in any one trip. About six hours outside the degravitized headquarters building is about all the average human being can stand in any 24 hour period even with a Hi-G suit. This means that at present we were limited to an area within a six or seven mile radius of headquarters. The T.E.C.H., however, has on order some small two and four place space ships and when they arrive human travel will be greatly facilitated.

The writer offered his services to the Design and Production Division of T.E.C.H. and this was accepted by Jack Nold, Director of the Division. The writer feels that this cooperation was very beneficial to our company and speeded up the process of accumulating and recording data. The report of Mr. Nold (5 August 2951) although general gives a true picture of the state of Methanian culture.

One field of design that Mr. Nold did not touch upon and which strikes the writer as one of the more urgent problems of Arcturus IV is the equipping of the Methanian farmer so as to increase his productive capacity. His soil preparation methods are antiquated even for this "early 20th century" culture and his methods and equipment for harvesting are completely inadequate for the big job they have to do. It is the fierce opinion of this investigator that the small size and relative weakness of the Methanians is partly the result of the near starvation rations of many many generations.

Even if the farmer's methods of planting and harvesting were "modernized" with newly designed machines and tools, he is still faced with the terrible rodent problem and the losses they inflict in eating his crops. Design can ease this situation, too.

It is probably not wise to delay trade with these people until farming equipment can be designed and built, but a project under this classification should be started as soon as possible. Nothing else will do more towards cementing the friendship of the Methanians to the Terranians and especially our company than products of this type.

In the meantime, short range projects in the household and personal use fields should be carried out at a very handsome profit to our company.

In the name of the company, the writer has provisionally reserved office space and living quarters for 20 members of our staff in the Headquarters Building of T.E.C.H.

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenhead **To:** Heads of all Departments

Subject: Arcturus IV **File No** 3463

13 August 2951

Gentlemen:

You are requested to read carefully the enclosed reports of J. R. Nold (T.E.C.H. - 5 August 2951) and of J. Sapmill (M.I.T.3 - 10 August 2951) on design and production opportunities on Arcturus IV. The complete file on this planet is available in my office for further study.

Kindly meet in the large conference room off my office at 10:00 on 16 August 2951 to plan a design production and sales program for this new territory. This is a very important meeting and may lead to the break that we have been looking for.

CC: A. Edward – Chief Designer
Shelton Maw – Production Manager
Showen Leare – Chief Engineer
Lean Dent – Sales Manager
J. Sapmill – Assoc. Designer

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenhead To: Department Heads

Subject: Conference of 16 August File No. 3463

18 August 2951

The meeting of Department Heads was called to order by the Chairman of the Board, Mr. R. Z. Hollenhead, at 10:05, 16 August 2951. R. Z. reviewed the Arcturus File from the time first contact was made on 22 January 2951 to the present. He then called on Dr. J. H. Rones, Director of "Project Arcturus" for the Terran Exporting Counsel Headquarters. Dr. Rones gave a lengthy account of this government agency's work to date. He emphasized the need of the Methanians for design and production help and showed how that help can be extremely profitable to any Terranian Company. He also mentioned (but would not divulge names) that a number of other Terran Trading companies were planning projects for Arcturus IV.

R. Z. then spoke of the urgency of the situation if our company was to maintain its leadership in the Intergalactic Trading business. It was decided by unanimous vote that all divisions work overtime until the first design was built and in the hands of the Sales Department. All Department Heads pledge their utmost cooperation to this end.

It was decided that the Design Department prepare a number of different designs in the household and personal use field to submit to this gathering at our next meeting.

J. Sapmill then reported on his trip to Arcturus IV and spoke eloquently of the dire need of the Methanian farmers. It was decided that a number of specific long range programs be instigated at this time. Sapmill was put in charge of "Project Hayseed" with instructions to form a study group and then a design group to see what can be done to increase the Arcturian production of food.

Other study and design groups were authorized and set up in the general field of electronics and communication, photography and general entertainment and in the field of high speed automatic transportation (30 to 40 miles per hour). Special meetings of the Department Heads will be called as soon as anyone of these long range groups has anything to report.

The group was reminded that the annual company picnic will be held on Labor Day, 2 Sept. as in the past. The location is not definite as yet but the committee thinks that it will be at Blue Hills.

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT3

78 massachusetts avenue - cambridge, massachusetts - terran

OFFICE OF THE BOARD CHAIRMAN

20 August 2951

Mr. Arnold Edward
Chief Designer

Dear Arnold:

This letter is your formal authorization to proceed at once on design work for Arcturus IV. This will be known as "Project Dishpan" and expense should be charged to order No OK 2735. As you recall from our Department Heads Meeting your group is to prepare a number of Designs in the general fields of Household Products or Personal Use Products. All engineering details should be carefully worked out. S. Leare, Chief Engineer, assures me that his group will cooperate with you in every way to expedite the work.

Yours very truly,

R. Z. Hollenhead
Chairman of the Board

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenhead To: Heads of All Departments

Subject: Arcturus IV File No. 3463

24 August 2951

Gentlemen:

The following step has been taken to facilitate the flow of necessary information between Earth and Arcturus IV for the development of project "Dishpan".

A special information division has been set up on Arcturus IV by T.E.C.H. All inquiries may be made directly to:

Mr. Will Tehlum
Assistant Director of Information
T.E.C.H. Spaceport 17321
Snafu, Arcturus IV

All department heads are hereby authorized to use this new communication channel as they see fit. The project will be further expedited if one copy of all incoming data is placed in a master file to be located in the M.I.T. engineering library.

CC: A. Edward – Chief Designer
Shelton Maw – Production Manager
Showen Leare – Chief Engineer
Lean Dent – Sales Manager
J. Sapmill – Assoc. Designer

CONFIDENTIAL

M a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
C H I E F D E S I G N E R

3 October 2951

CONFIDENTIAL

Mr. Will Tellum
Assistant Director of Information
T.E.C.H. Spaceport 17321
Snafus, Arcturus IV

Dear Mr. Tellum:

It was a pleasure to hear that T.E.C.H. had set up a special department to expedite communications between Terra and Arcturus IV. I am afraid I'll be bothering you quite a bit in the near future, since our job will require extensive detail information. Incidentally, if I can ever help you in any way, just let me know. I'll be glad to do it.

As you probably know, we are embarking on a program to develop household and personal use products for the Methanians. Therefore, the nature of our first request shouldn't surprise you. One of my designers is investigating the possibility of producing electric clocks for the Methanians. He has prepared a list of questions which are on the attached sheet. I would greatly appreciate it, if you could supply answers to any or all of them.

Thank you for your consideration, and I hope to hear from you soon.

Yours very truly,

/s/

Arnold Edward
Chief Designer

Enc.

QUESTION SHEET

1.) What is the exact length of the day in Terran hours?

* 2.) Is the day subdivided in time units?

* 3.) Is there any system or device in use to tell the time of day?

* 4.) What number system is used?

5.) What is the method of reading the written language? Is it read from right to left, up, or down, etc.? What are the symbols for the time units, if any?

6.) Is alternating current generated? If so, what frequency? What is the standard house voltage? What type of connection is used to connect appliances, if any? (Analogous to our wall plugs and sockets.)

7.) What kind of faces, dials, scales, etc. appear on any instruments in use? If circular dials are used, are they read clockwise, or counter clockwise?

* Please describe, if possible.

Terran Exporting Counsel Headquarters

Spaceport 17321 **Snafu** **Arcturus IV**

Office of General Information

25 October 2951

Mr. Arnold Edward, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts

Dear Mr. Arnold:

You will find enclosed, a report which contains the answers to the questions you sent with your letter of October 3. I am happy to state that we have been able to collect data on all the questions. I hope that you will find the report complete and satisfactory.

It is our intention to supply all needed information as quickly and as accurately as possible, so do not hesitate to make further requests. We will be glad to serve you.

Very truly yours,

/s/

Will Tellum
Assistant Director of Information

Received
Mass. Intergalactic Traders
18 Nov. 2951

CONFIDENTIAL

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE _____

FROM Arcturus IV **TO** Terra

SUBJECT T.E.C.H. Information Report #1 **FILE NO.** Spaceport 17321

1) Length of Methanian Day:

The day is 159.16 ± .01 Terran hours long. (This was determined by the Condenserchron method.)

2) Subdivision of Methanian Day:

The day is divided into 6 GAHLOS. Each GAHLO is divided into 6 BAHLOS. Each BAHLO is divided into 36 NAHLOS. Therefore, 1 day = 6 GAHLOS = 36 BAHLOS = 1296 NAHLOS. The NAHLO is equal to 159.16/1296 hour, or 0.1228 hour, = 7.37 minutes. The NAHLO corresponds roughly to our minute. The average Methanian does not seem to be troubled by the lack of a precise time unit. However, for scientific work, the NAHLO has been further subdivided into 36 SAHLOS.

3) Methanian Time Recording Systems:

The manner in which the Methanians designate the time of day, is to recite three numbers in sequence. Thus 2-3-25 would mean that it is the 25th NAHLO of the 3rd BAHLO of the 2nd GAHLO. For reasons mentioned below, it is generally understood that the NAHLO figure is approximate. Their method is equivalent to our custom of saying 2:15 to designate 15 minutes after 2:O'clock. Their system is used throughout the planet. The most important method of time keeping in operation at present consists of audio signals, (bells or whistles), which are sounded at the beginning of each BAHLO. For instance, two blasts followed by three, indicates the 3rd BAHLO of the 2nd GAHLO. The signals are regulated by accurate time keeping devices in local observatories, and are transmitted electrically. Prior to the introduction of electricity, time was recorded by the Arcturan sun dial. Thus, it was a commodity possessed only by the few. However, time signal devices are as common on Arcturus IV, as street lights are in North America.

From our point of view, the Methanian ability to do without a more precise measure of time of day is amazing, considering the level of their culture. As nearly as can be determined, they seem to possess a "feeling" for the approximate time in NAHLOS, during any one BAHLO. This is probably due to the fact that they are subjected periodically to the time signals. The signals are inoperative in large areas during most of the night. There has been no attempt to produce time keeping devices for individual Methanians. Devices, (which we would call machines), have been built, which use the pendulum principle and are installed in observatories, laboratories, and factories or other large buildings having a direct need for more accurate time keeping methods. The concept of small, neat, light, timekeeping devices is unheard of here, at present.

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE _____

FROM _____ **TO** _____

SUBJECT T.E.C.H. Information Report #1 **FILE NO.** _____

4) Methanian Number System:

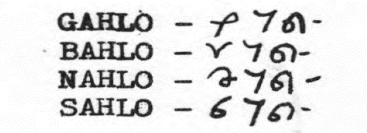
The number system is based upon six (6),as would be suspected upon considering Methanian three digit hands. The number system definitely evolved from finger counting. Thus, 1, 2, and 3 are ı, ∨, and ₩. An alternate symbol for three was the closed fist, which gradually deteriorated into a small circle, (as a symbol). Thus, four would be one finger and one fist, or o ı. This gradually became o ı. Similarly, five is o ∨ Six would be two fists. This ultimately became two circles, one on top of the other, or 8. This is, of course, our figure "eight", exactly. The idea of building up larger numbers by arranging symbols in sequence, and allowing the position of the symbol to indicate its value, (as we do in Arabic notation), was introduced about 85 Methanian years ago. The complete history of the development of the number system is interesting, but only the final result is given here:

0=8	1	ı	7	ıı	13	∨ı	19	₩ı	25	o ı	31	o∨ı
	2	∨	8	ı∨	14	∨∨	20	₩∨	26	o ∨	32	o∨∨
	3	₩	9	ı₩	15	∨₩	21	₩₩	27	o ₩	33	o∨₩
	4	o	10	ıo	16	∨o	22	₩o	28	oo	34	o∨o
	5	o∨	11	ıo∨	17	∨o∨	23	₩o∨	29	oo∨	35	o∨o∨
	6	ı8	12	∨8	18	₩8	24	o8	30	o∨8	36	ı88

etc.

5) Methanian Written Language:

The language is based on symbolic notation and consists of 19 symbols representing consonant and vowel sounds. It resembles early 20th century Terran shorthand. The writing is read from left to right. Sentences are written horizontally starting at the top of the page with subsequent sentences proceeding downward. A Methanian book is almost identical to a Terran book as far as the mechanics of reading are concerned. The symbols for the Methan time units are:--



6) Generation of Electric Current:

Alternating current is generated. The frequency of the current is 1296 cycles per NAHLO. (Note that $1296 = 6^4 = 18888$ in Methanian notation. This is analogous to 10000 in Terran notation).

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE _____

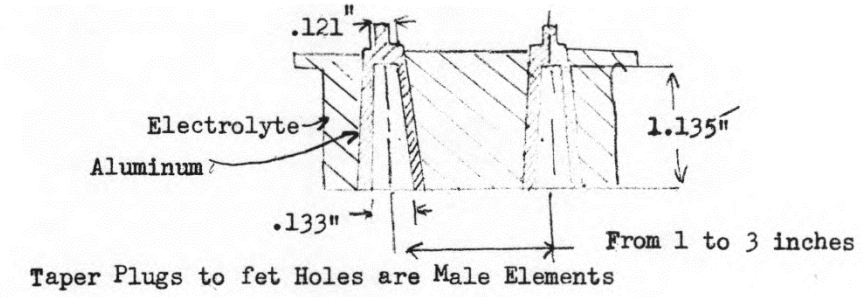
FROM _____ **TO** _____

SUBJECT T.E.C.H. Information Report #1 **FILE NO.** _____

Since 1 NAHLO = 7.37 min = 442.5 sec, then 1296/N = 1296/442.5 sec = 2.926 cps (This is about 1/20 of standard Terran frequency of 60 cps).

The Methanian electrical science is, of course based upon the concepts of emf, current, and resistance. Their unit of emf is called the GINT which is equivalent to 2.378 ± .001 volts. Electrical transmission over great distances is accomplished with an emf of 1296 GINTS=3080 volts. Individual house voltage is stepped down to 1.36 of this = 85.6 volts. This standard emf of 36 GINTS seems to be available in almost every Methanian structure which uses electricity.

The typical electrical connector for portable appliances consists of a female element which has two cylindrical tapered holes. This is placed on the walls of a room, generally projecting out of the wall about 1½ inches. The male elements are two separate tapered plugs fastened to the wire ends. The accompanying sketch gives the necessary dimensions.



Taper Plugs to fet Holes are Male Elements

7) Methanian Instrument Scales:

Many standard Terran type instrument scales are known. The circular dial is commonly used, and numbers increase in magnitude in a clockwise direction. Numbers are placed to mark the space between graduations, rather than the graduation. This is always true when the divisions are large. The production of instruments is increasing with the advancing Methanian technology.

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenbach To: Arnold Edwards
Subject: Methanian Clock File No. Z

The first step in the design of a Methanian clock was to obtain added special information. The correspondence undertaken to secure the extra data appears in the appendix of this report. A study of the new information revealed:

1.) A Methanian clock could be electrically driven
2.) The Methanians are used to thinking of time in terms of three separate numbers.
3.) A small timepiece with an instrument face would be completely new to their culture.

Item 1.) The generated alternating current of the Methanians is sufficiently accurate in frequency to rotate a small synchronous motor unit at the constant speed required. The work of converting between Methan and Terran units was sidestepped by using the Methan frequency unit exclusively. This was possible, since the shaft speed of a synchronous unit is directly proportional to the applied frequency. The given Methan frequency is 1296 cycles per NAHLO, and there are 1296 NAHLOS per day. This indicated that a large gear reduction would be necessary somewhere in the clock. The possibility of reducing the shaft speed electrically was investigated. Consultation with Gerald Fitz, M.I.T's famous electrical designer, brought out the point that electrical reduction of speed is attendant with increase of unit size. It was decided to have a synchronome designed which would give a shaft speed of 1/6 the impressed frequency. This would still be small and light enough to serve the purpose, and also have sufficient torque to drive the clock mechanism. A sketch of the "Fitz" synchronome with necessary additions is given on page 3.

Item 2.) The Methan manner of telling time immediately suggested a clock face with three numbers which would change periodically. The mechanism would be of a counter type. The idea was investigated, but the resulting mechanism proved to be too heavy, and complicated to be practical.

The idea of a dial face clock was then considered. It was decided to have three separate dials, each showing a separate time unity. Two of the dials, are identical. It was felt that the idea of a single dial with two hands to take their place would not do for an initial mode. (This could be introduced later as a "new" improvement.

Since the drive shaft of the synchronome is 216 rev./NAHLO, and the day is broken into units of 6 and powers of 6, a compact gear reduction unit was designed using eight identical 6-1 reducer gears. The clock hand shafts and drive shafts are conveniently geared into the reduction unit. (The complete gear box is shown on Drawing No.M-31, and a schematic of the clock drive is shown on Drawing No. S-82.)

The position of the dial faces was next considered. The obvious choice would be to place them in line, to be read off as the Methanians recite their time numbers. However, the NAHLO dial was necessarily the largest. Therefore, considerations of symmetry indicated that it should be the

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenbach To: Arnold Edwards
Subject: Methanian Clock (Cont'd) File No.

central dial. After some experiment, the arrangement used was decided upon. This also had the advantage of simplifying the connections to the gear reduction unit.

Item 3.)

The newness of a small dial clock in Methanian culture sets up the requirement that its function must be visually evident. Therefore, each dial face is clearly marked with the symbol for its time unit. All dials are adequately numbered. The clock is made in bright contrasting colors, with the definite purpose of attracting immediate attention. This policy may be modified when the Methanians become used to the idea of a dial clock.

Note: For more complete engineering data, see Drawing No. A-30 (This is the assembly of the unit).

BY RZ.H. DATE SUBJECT SYNCHRONOME ASSEMBLY SHEET NO. 1 OF 1
CHKD. BY DATE DRAWING NO. E-48 JOB NO.

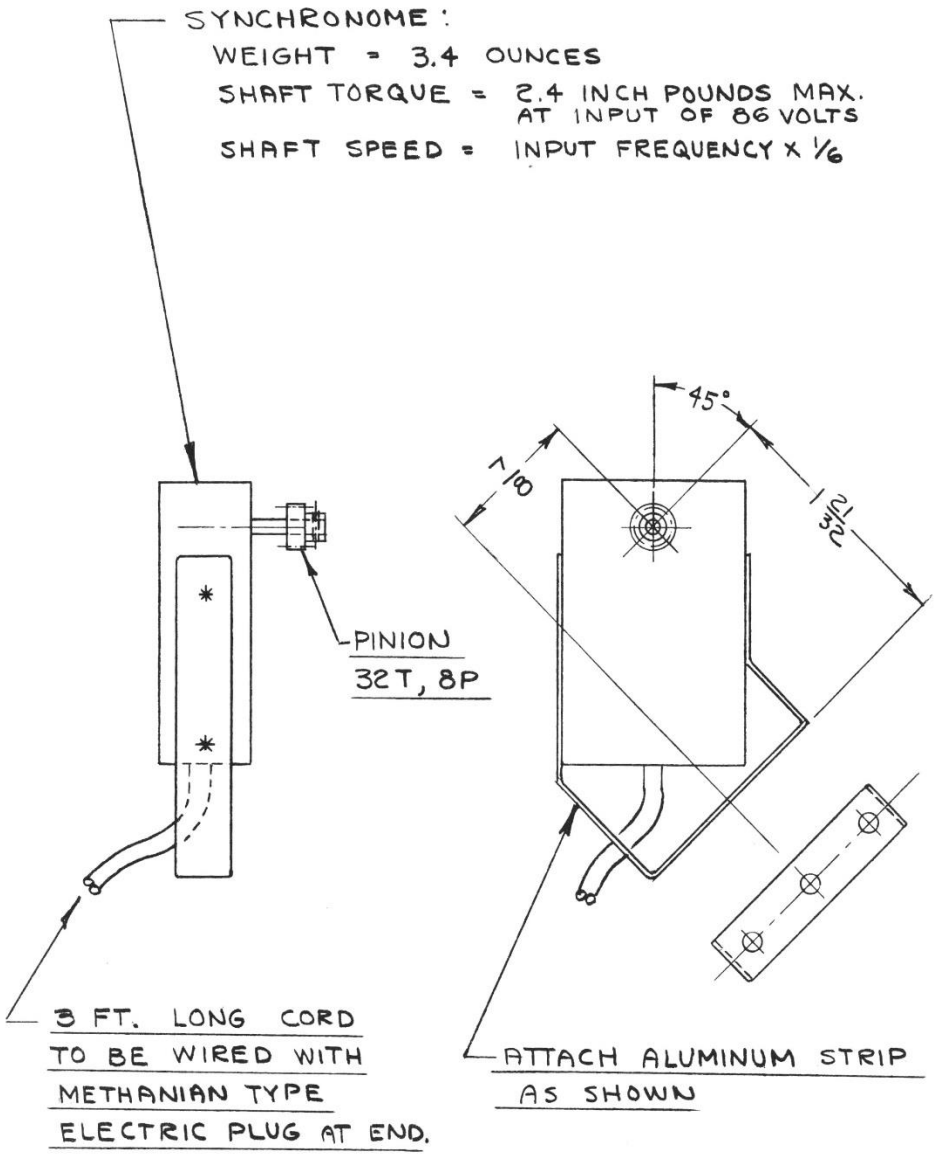


FIG. 2: SYNCHRONOME ASSEMBLY, E-48

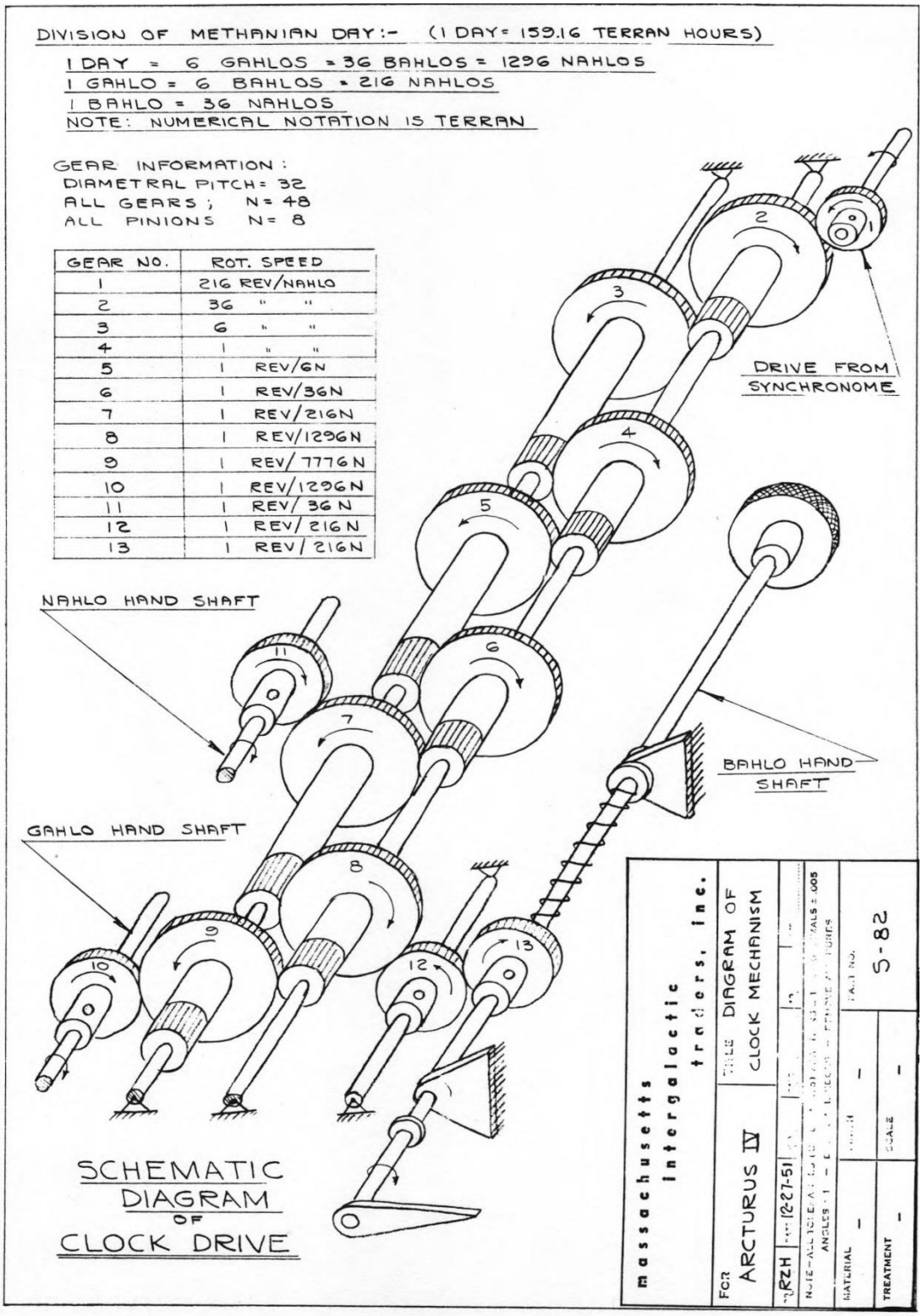


FIG. 3: DIAGRAM OF CLOCK MECHANISM, S-82

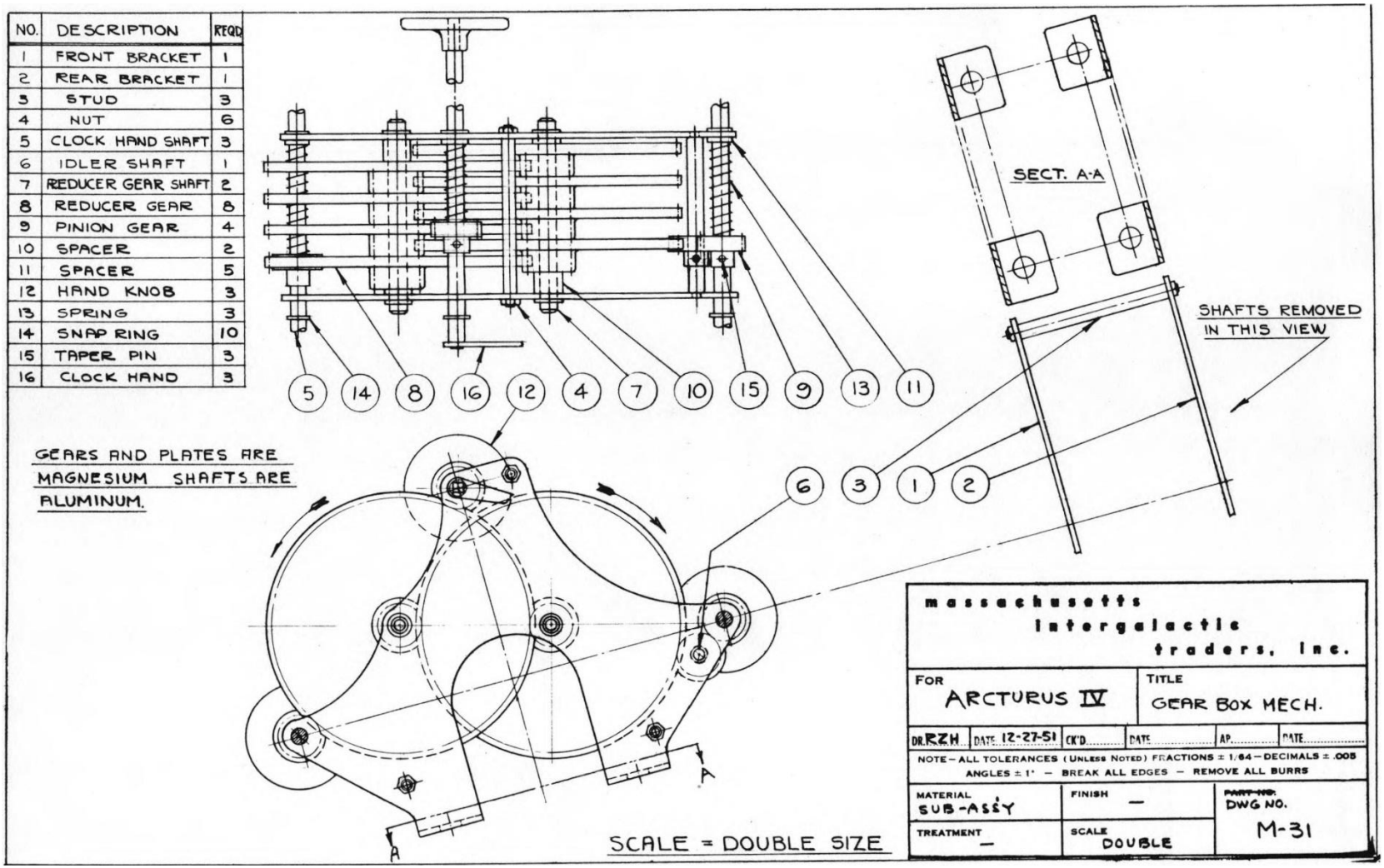
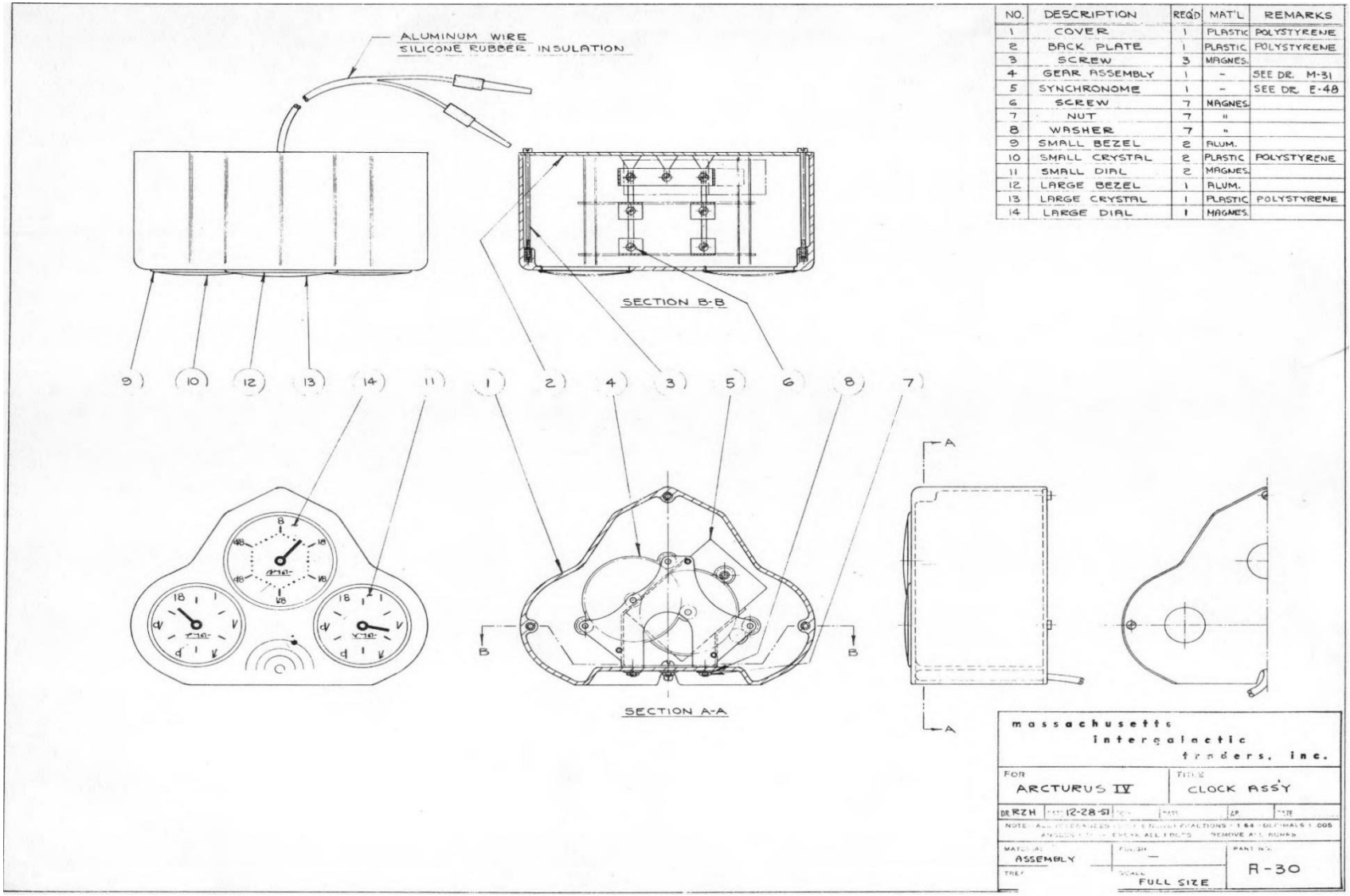


FIG. 4: GEAR BOX MECHANISM, M-31



NO.	DESCRIPTION	REQ'D	MAT'L	REMARKS
1	COVER	1	PLASTIC	POLYSTYRENE
2	BACK PLATE	1	PLASTIC	POLYSTYRENE
3	SCREW	3	MAGNES.	
4	GEAR ASSEMBLY	1	-	SEE DR. M-31
5	SYNCHRONOME	1	-	SEE DR. E-48
6	SCREW	7	MAGNES.	
7	NUT	7	"	
8	WASHER	7	"	
9	SMALL BEZEL	2	ALUM.	
10	SMALL CRYSTAL	2	PLASTIC	POLYSTYRENE
11	SMALL DIAL	2	MAGNES.	
12	LARGE BEZEL	1	ALUM.	
13	LARGE CRYSTAL	1	PLASTIC	POLYSTYRENE
14	LARGE DIAL	1	MAGNES.	

massachusetts intergalactic traders, inc.

FOR	TITLE
ARCTURUS IV	CLOCK ASSY

DR RZH 12-28-51

MATERIAL: ASSEMBLY

FINISH: —

PART NO.: R-30

SCALE: FULL SIZE

FIG. 5: CLOCK ASSEMBLY, R-30

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue. - cambridge, massachusetts - terran

O F F I C E O F T H E
C H I E F D E S I G N E R

26 December 2951

Mr. J. S. Wick
Terran Exporting Counsel Headquarters
Arcturus Division
Methane 90, Arcturus IV

Dear Sir:

We have been confronted with a few problems dealing with Methane psychology in our design project here.

One of our top designers, Mr. Reenidrag, has come up with the idea which I think has merit, but I feel I should have more confirmation on its acceptability before I authorize additional work.

He has prepared rough sketches of a baby stroller or cart, with a provision for using it as a portable incubator before the youngster is hatched from the egg. He suggests a very lightweight construction that could easily be shipped in package form and assembled there.

Do you have information at present on the possibility of the mechanical hatching of the egg being acceptable in Methanian culture.

Any help or suggestions would be greatly appreciated. Thanks again for making my first visit to Arcturus so enjoyable. Give my best regards to all the fellows and Happy New Year!

Very truly yours,

/s/

J. Sapmill

JS:am

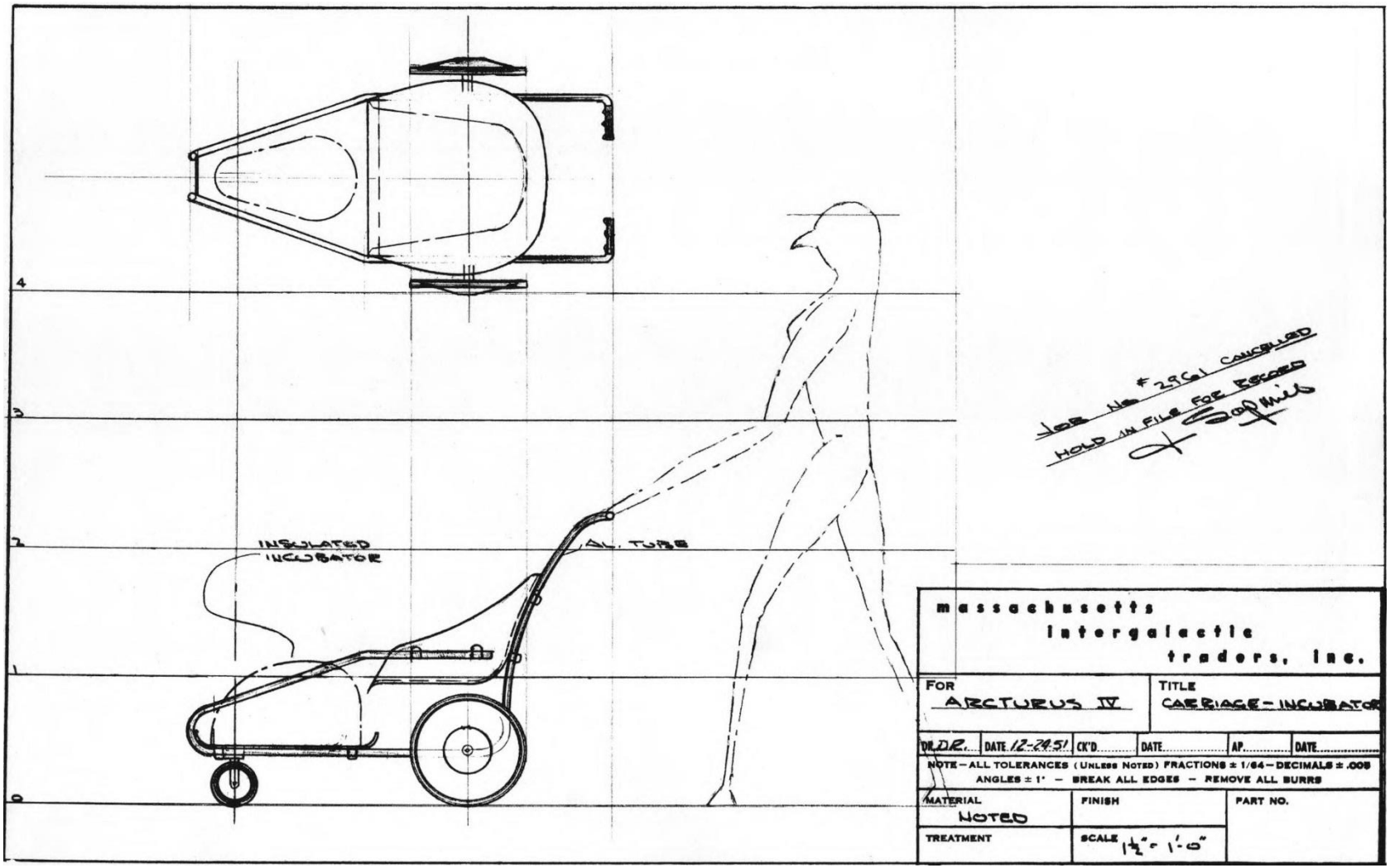


FIG. 6: CARRIAGE - INCUBATOR

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

INTERGALACTIC CODE NO. 19
ADDRESS TECH

H e x a g o n B u i l d i n g – 1 8 7 L e v e l – W a s h i n g t o n 9 9 – T e r r a n

PSYCHOLOGY & PHYSIOLOGY DIV.
J. S. WICK, DIRECTOR

13 January 2952

Mr. J. Sapmill
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge 29, Massachusetts, Terran

Dear Mr. Sapmill:

In reference to your letter of December 26, I am afraid I have bad news for you.

Our committee compiling data on Methanian psychology consulted one of our Methanian consultants, a Professor Bsptflik, who seems to be quite an authority on history of Methanian culture and well informed on current trends and opinions.

His decision was favorable on a baby stroller but was very much against a mechanical incubator. He believes this might come in several generations, but it would be a slow evolutionary process.

Another factor against such a design is the fact that the young learn to walk or move about in a very short time.

I am sorry I can't give you more favorable reports. Maybe we will have better luck next time.

Very truly yours,

/s/

J. S. Wick

CONFIDENTIAL

JSW:pm

Received
Mass. Intergalactic Traders
18 Jan. 2052

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

OFFICE OF THE
CHIEF DESIGNER

14 February 2952

Mr. J. S. Wick
Terran Exporting Counsel Headquarters
Arcturus Division
Methane 90, Arcturus IV

CONFIDENTIAL

Dear Mr. Wick:

We are in need of further physiological data on the Methanians. We have a design project underway on a small stereoscope.

Some of the questions which have arisen are:

1. What are the general dimensions of the head? (Especially the eye, nose, forehead region).

2. What is the average lateral spacing of the eyes?
   How much does the spacing vary?

3. What sort of line of vision do the general purpose eyes have?

4. Is focus adjustable as in the human eye?

5. Does the X-Ray eye function constantly?

6. What is general bone structure shape around the eye? (In reference to design of an eye piece).

We think pictures of various scene and people on Terran would be a good seller. I believe this product would help promote good will between the planets.

I would appreciate any data which you may have that would help in the development of this design project.

Very truly yours,

/s/

J. Sapmill

JS:am

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

H e x a g o n B u i l d i n g - 1 8 7 L e v e l - W a s h i n g t o n 9 9 - T e r r a n

PSYCHOLOGY & PHYSIOLOGY DIV.
J. S. WICK, DIRECTOR

1 March 2952

Mr. J. Sapmill
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge 39, Massachusetts, Terran

CONFIDENTIAL

Dear Sap:

Our physiological committee has rounded up the information you need. The consensus of opinion is that you hit the jackpot on this project. I believe it would have a terrific sales appeal due to the fact that we are constantly quizzed as to what earth looks like, what do our homes look like, etc. There is no present viewing apparatus like this in Methane to the best of my knowledge.

I am enclosing a grid sketch which was taken from Methanian government statistics bureau files.

I will outline answers to your questions.

(1) Dimensions of head. (See grid sketch)

(2) Eye spacing (Transposed to our scales) 3.00 Ins.
Varies very little (extreme cases ± .1 Ins.)

(3) & (4) Line of vision and angle of vision and ability to focus is practically same as that of human.

(5) X-Ray Eye is an amazing feature. They have the ability to use it at will. It is controlled from conscious portions of brain and may be "turned off or on as they desire". It has a protective lid to prevent injury from dust and particles, etc.

(6) As for bone structure surrounding the eye, refer to my free hand sketch. The eyes are deeply inset in a small opening. The area around this opening is represented by contour line in the drawing.

I hope this information is satisfactory. We will delve into it deeper if necessary.

Very truly yours,

/s/

J. S. Wick

JSW:pm

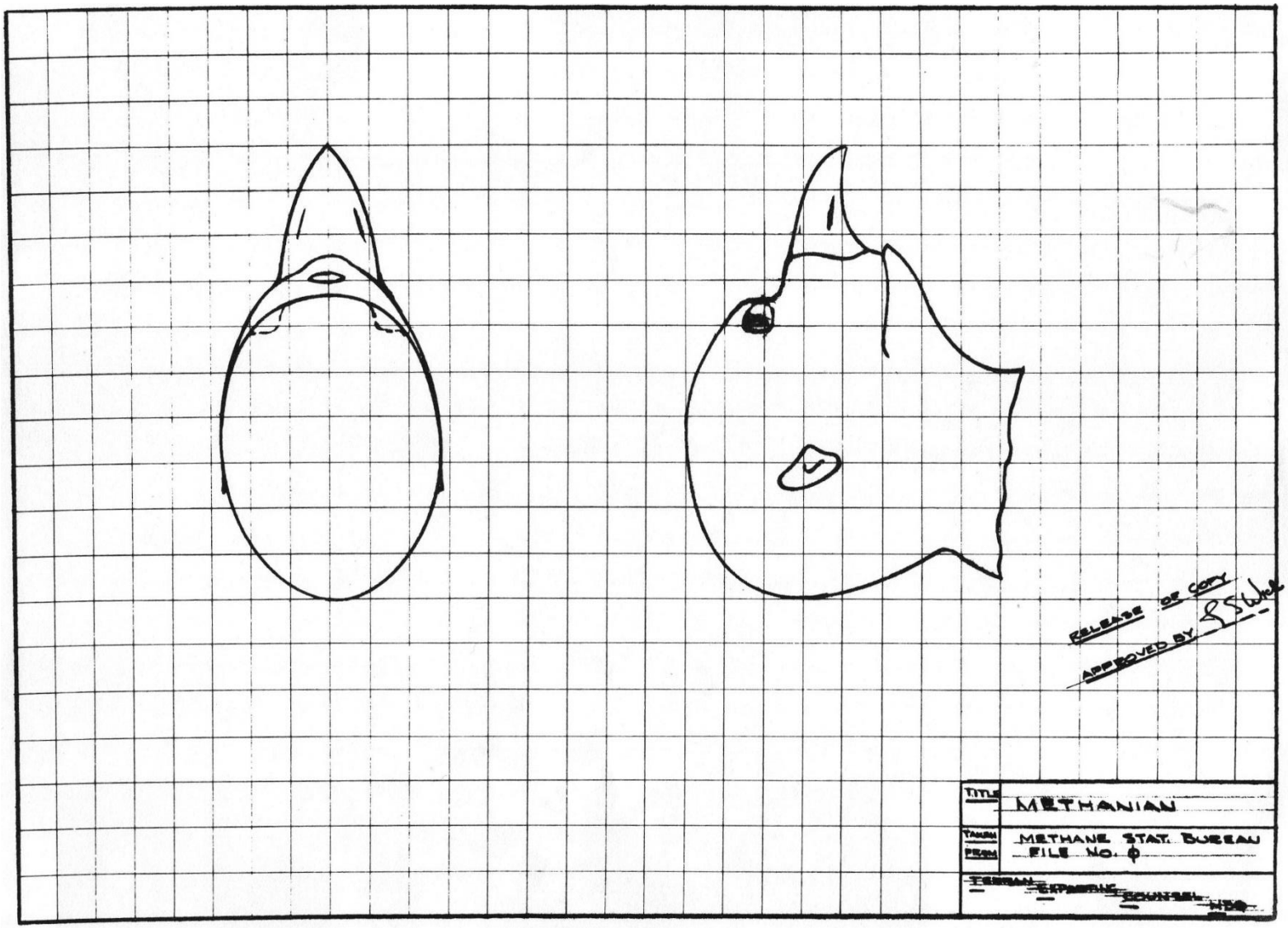


FIG. 7: METHANIAN HEAD, METHANIAN STATE BUREAU

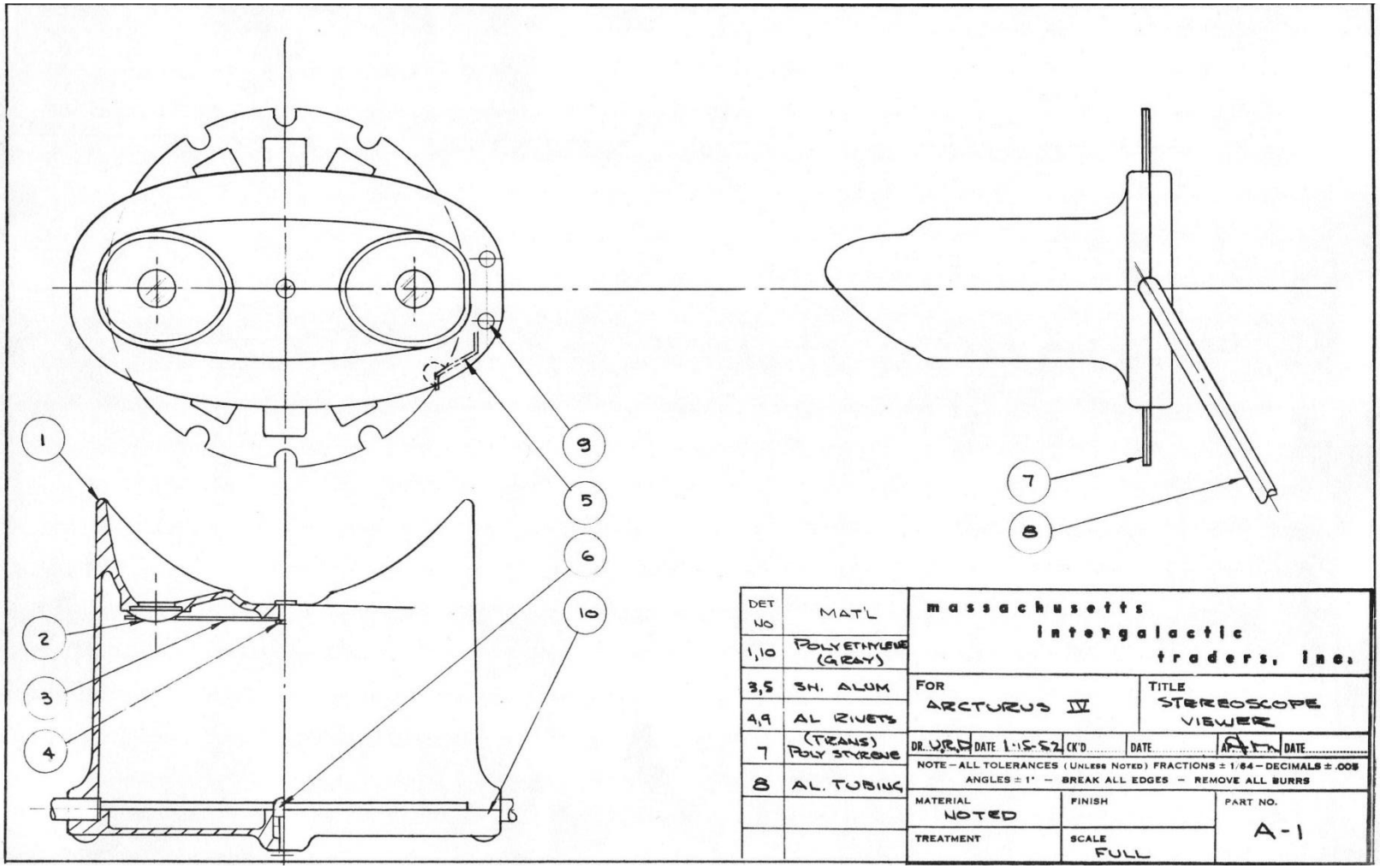


FIG. 8: STEREOSCOPE VIEWER, DRAWING A-1

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT3

78 massachusetts avenue - cambridge, massachusetts - terran

22 August 2951

OFFICE OF THE
CHIEF DESIGNER

Bayard Gardineer
b-g Design Associates
500 Park Avenue
New York, New York

Dear Bayard:

After persuading the company to retain your organization on a consulting basis I[1]ve finally found some use for you. We've been paying your damn fat fee for two months while you sat back and laughed. Well boy, here's your chance. You'll find the file on Arcturus 4 enclosed. Project "dishpan" is well under way within our own organization but as I said we decided to get something for our money.

Your job is to design a unit that combines a food mixer, a knife sharpener, a coffee grinder and a fruit juicer. How you do it is your worry. I decided to give this phase to you after seeing your new "Square Spray Sprinkler" design. Much as I hate to admit it, I thought it was the finest job of its kind I've seen. Good luck, son, I think you'll need it.

Best regards,

/s/

Arnold Edward
Chief Designer

bg DESIGN ASSOCIATES

24 August 2951

Arnold Edward, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts

Dear Arnold,

You Sucker!

Why the hell didn't you ask me to make it a rocket ship as well? Okay, "big wheel" I'll show you. Believe it or not I can do just what you want, and it'll sell too. (I hope)

Nothing else to report, just wanted to acknowledge your assignment and inform you that you have placed your trust in the best possible hands.

Give my love to Lana and the kids. You know sometimes I miss the old days in your design department; that is, I miss the old cronies, (notice the…[1]) you and Daffy and the rest of the boys. However, I don't miss the shiny pants and the cheese sandwich lunches...I eat three times a day now, Imagine ! A real old-fashioned capitalist.

Cordially,

Bayard Gardineer
President

[1] Unreadable due to the CONFIDENTIAL stamp smudge in the original. The preceding sentence suggests it may have been "old"

b g DESIGN ASSOCIATES

10 September 2951

Arnold Edward, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue Cambridge, Massachusetts

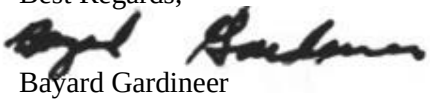
Dear Arnold,

I am sending you, under separate cover, my design for the mixer you asked for. Also included are thumbnail sketches of the juicer and sharpener attachments that are in the process of design. I must apologize for not having completed them also but complications have arisen.

As you. probably know I am under contract to Cum, Lative and Co**.** and have done a great deal of work for them. To make a long story short, Fi (you remember him, Fi Nalexam, president of the company) called me up on urgent business for immediate delivery. Consequently I have had to suspend work on "dishpan" temporarily but have no fear, I'll make it in a month or so. I trust this is satisfactory since you can begin manufacture of the base and mixer immediately. That ought to keep you busy for a while.

Once again, my love to Lana, the kids and all the boys in the "perspiration pen".

Best Regards,



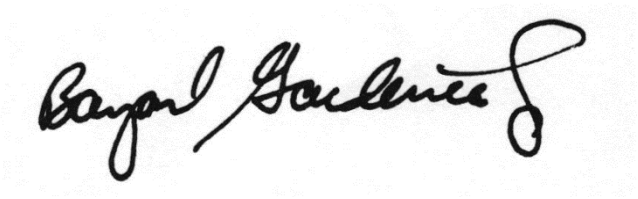
Bayard Gardineer
President

Re. Food Mixer
for Massachusetts Intergalactic Traders

The basic reason behind the design of the mixer and proposed attachments is the weight consideration. Since articles weigh approximately eleven times as much on Arcturus 4 as they do on Terran, this is an important phase of the problem. If the mixer were designed as Terran mixers are, with the motor in the overhead beam, I don't believe the average Arcturian housewife would be able to tip the beam backward. However, the beam must be tipped in order to free the beater blades from the mix. Therefore, I found myself confronted with the task of lightening the overhead beam in weight. This was accomplished by placing the motor in the base and using a flexible shaft to carry the torque to the blades. This design feature cuts down the moment necessary to tip the beam since only the weight of the hollow shell, the beater blades and a few gears act. There is also the moment due to the spring constant of the flexible shaft but the combination of the two is nevertheless much easier to tip back than the conventional mixer.

Once this feature had been worked out I had to decide how to make the other attachments fit the basic mechanism. I decided against the idea of attaching the other devices to the power source by way of the mixer head and separated the motor unit from the mixer unit. This means that the Arcturians can set the base unit (which is relatively heavy) on a low kitchen cabinet and leave it there permanently. The attachments (food mixer, fruit juicer, coffee grinder, knife sharpener) can then be stored in the kitchen and placed upon the base as their various services are required. There is no handle on the beam because of the design shape of the beam, its form is such that the fingers can easily reach around it and tip it back.

The major parts of the mechanism are magnesium, die cast in most cases. The gears are of steel and the flexible shaft is of steel with a flexible magnesium cover. The bushings are of nylon which is resistant to the common organic solvents and is resistant to weak acids and bases. These bushings can be injection molded. One feature that is not immediately apparent is the safety feature incorporated in the hookup between the base unit and the mixer attachment. If a slow moving Arcturian should chance to catch a finger in the beater blades this hook-up coupling will separate and the finger will get twisted but not chopped off. After the finger is extracted the couple will come together again and mixer will operate, this also saves strain on the motor. The rheostat may be thought to be a crude one as compared with the usual circular one. However, I decided this would be easier for the Arcturian to operate with his slow reaction time.



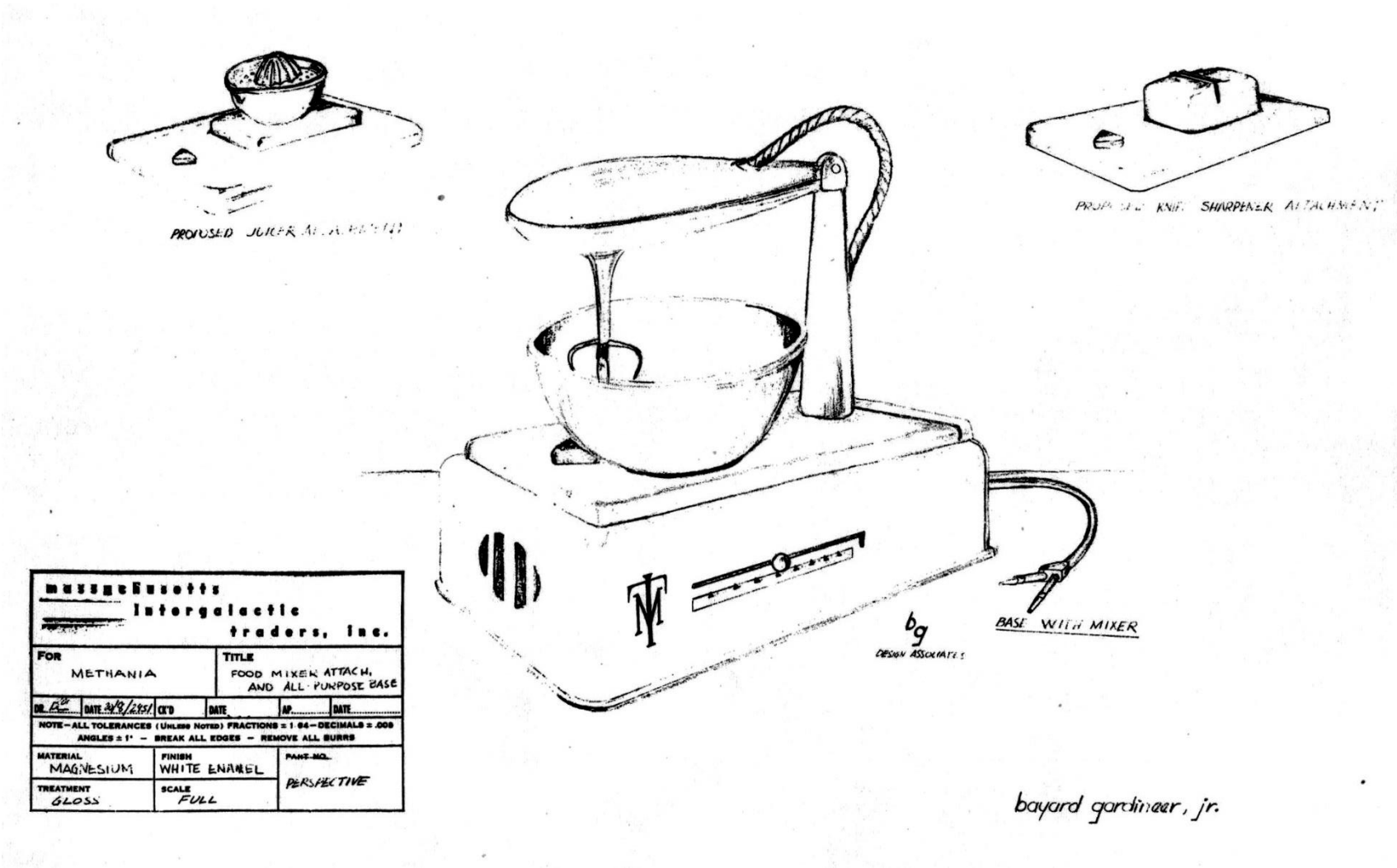


FIG. 9: FOOD MIXER ATTACHMENT AND ALL PURPOSE BASE

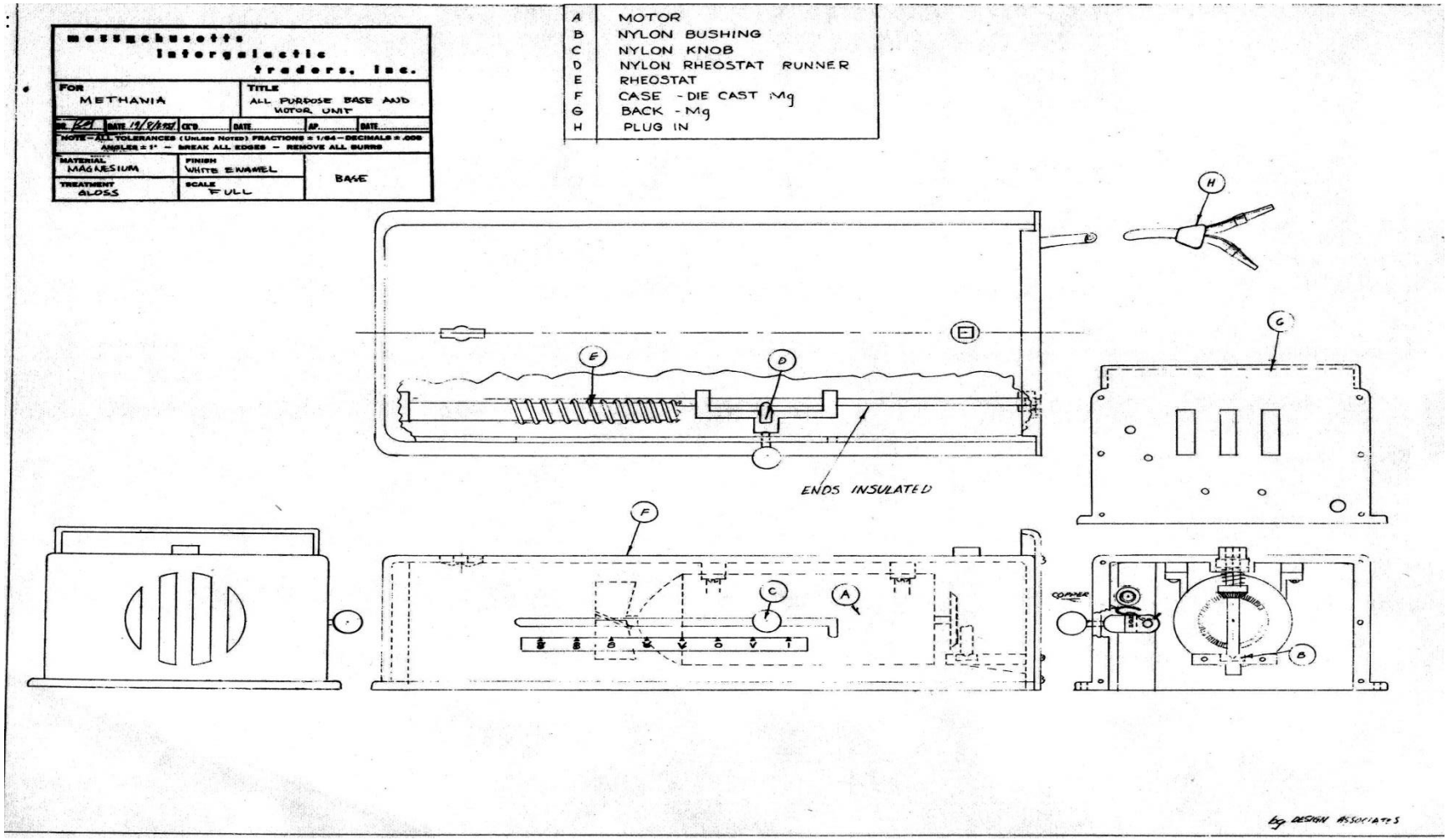


FIG. 10: ALL PURPOSE BASE AND MOTOR UNIT

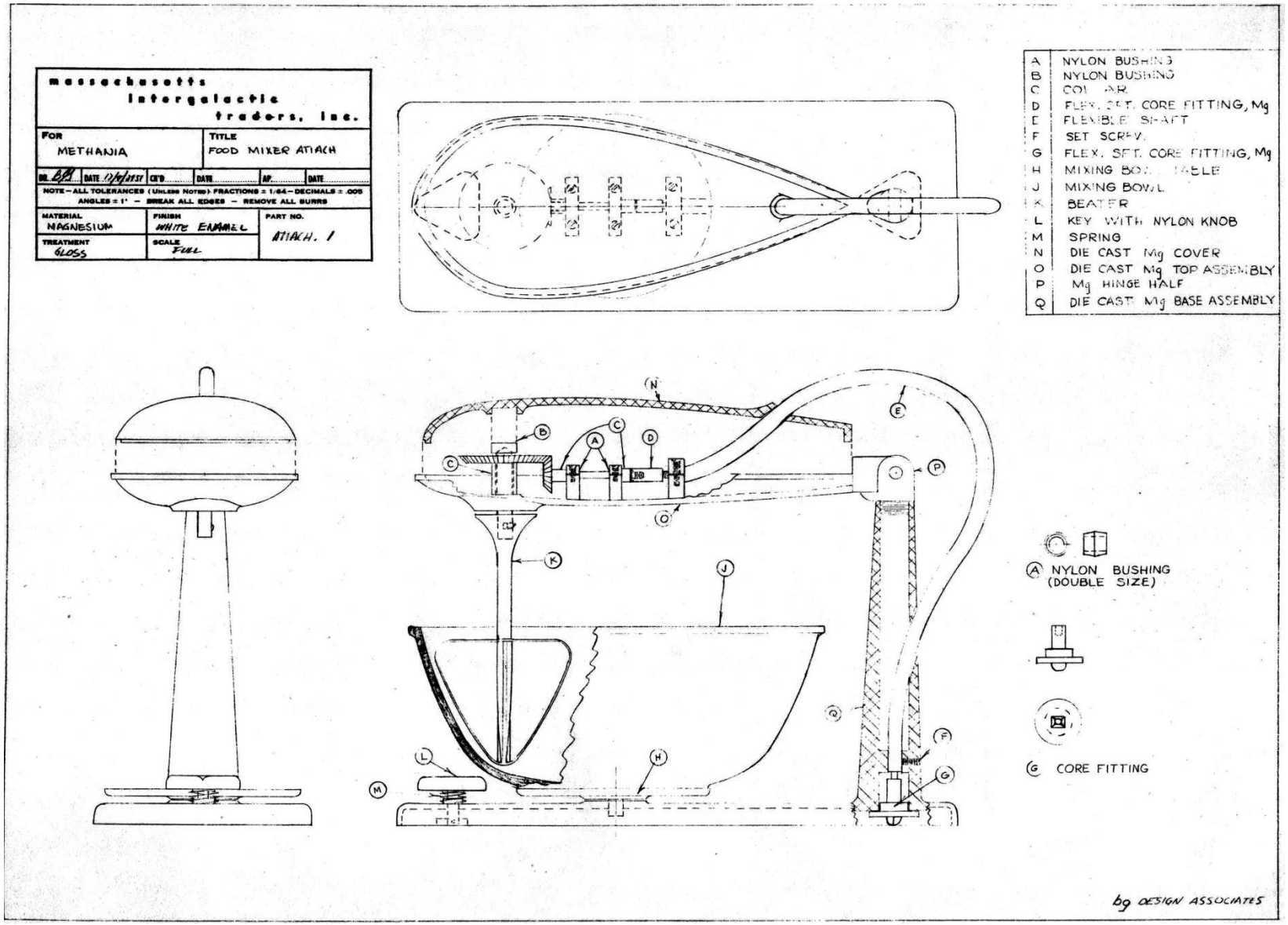


FIG. 11: FOOD MIXER ATTACHMENT

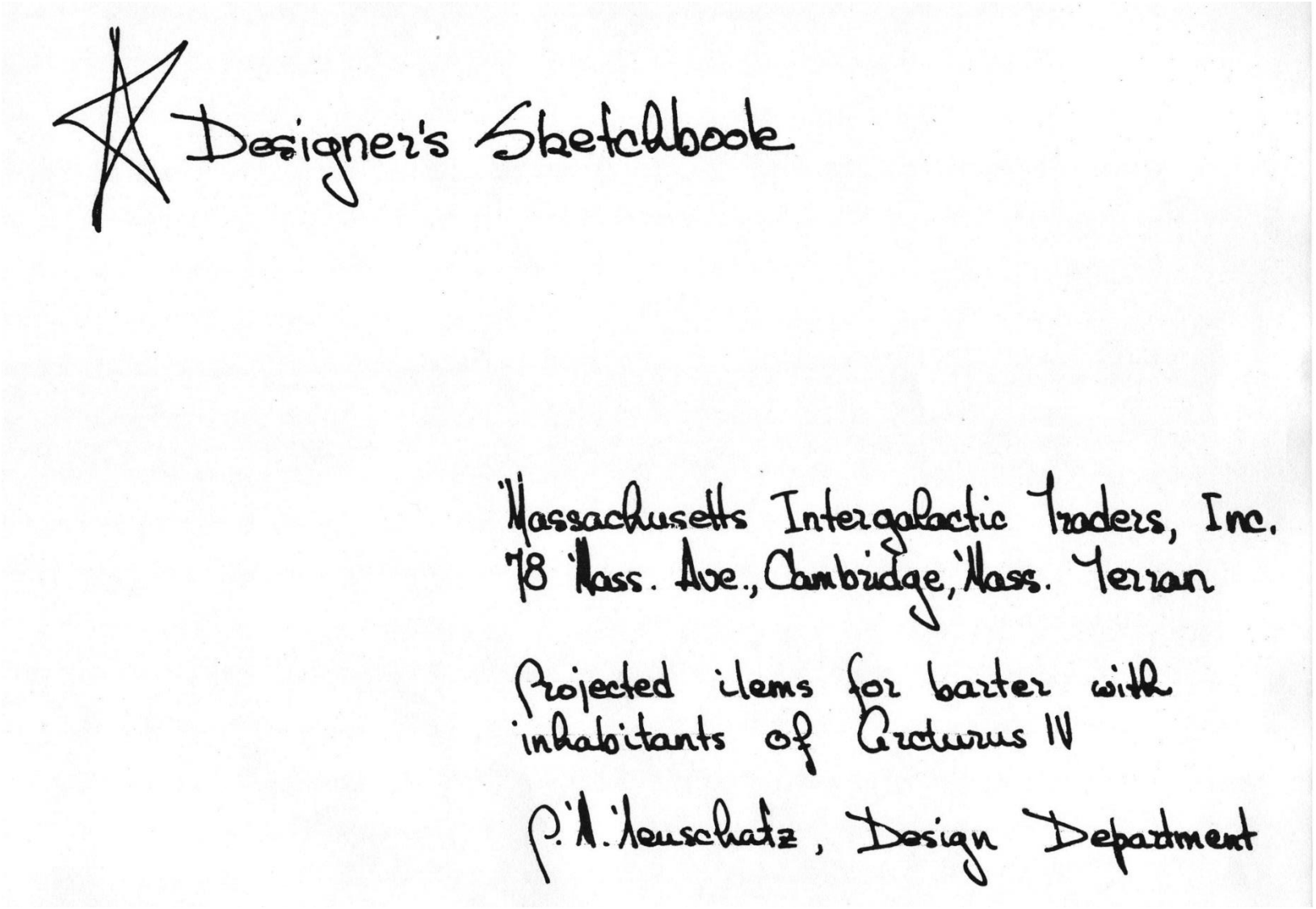


FIG. 12: DESIGNER'S SKETCHBOOK

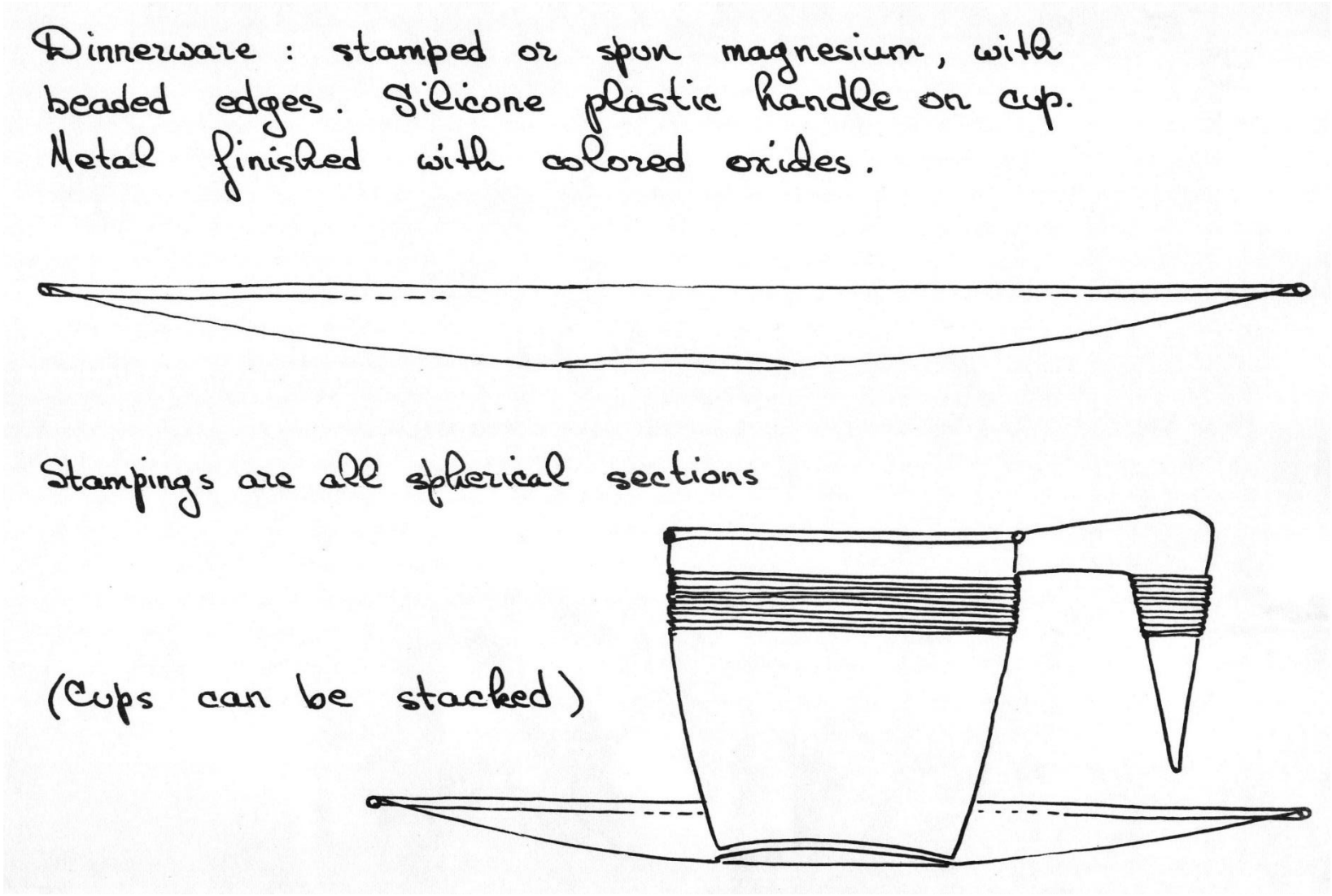


FIG. 13: DINNERWARE, DESIGNER'S SKETCHBOOK

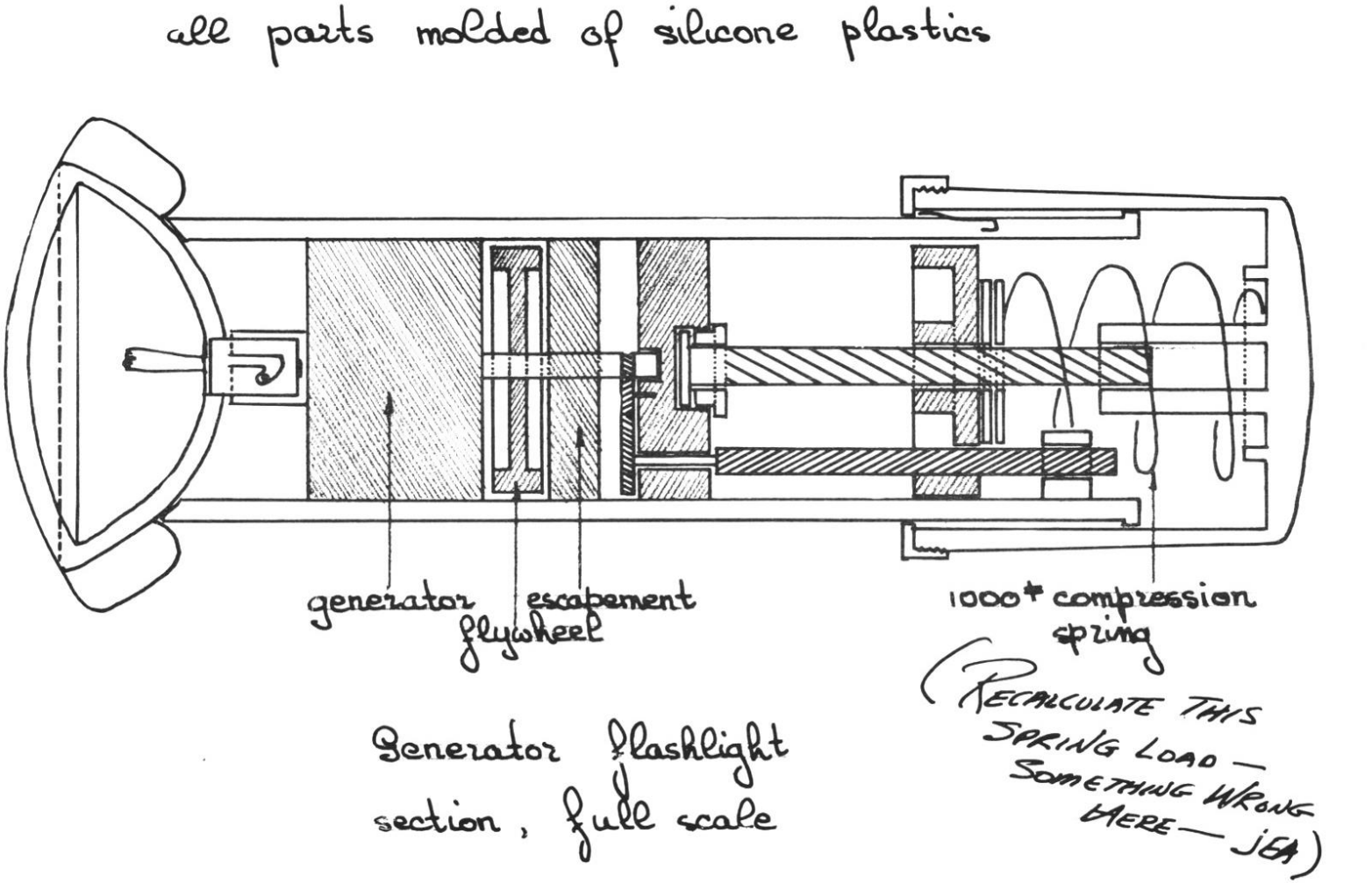
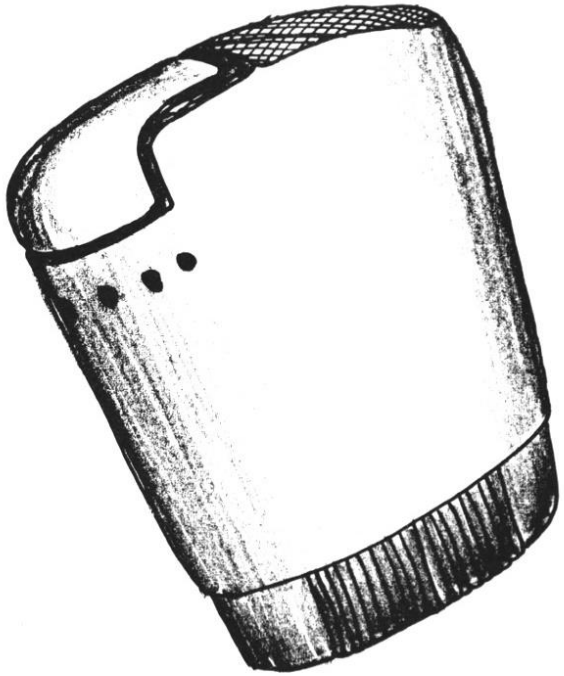


FIG. 14: GENERATOR FLASHLIGHT, DESIGNER'S SKETCHBOOK



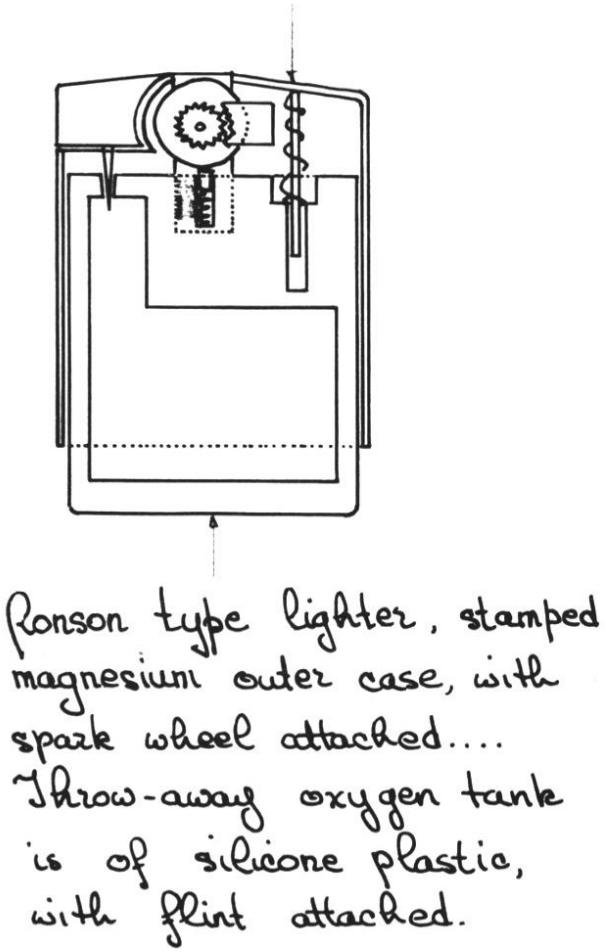


FIG. 15: RONSON-TYPE LIGHTER, DESIGNER'S SKETCHBOOK

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: Furniture Design Division To: Arnold Edward, Chief Designer

Subject "Project Dishpan" File No. 3463

10 December 2951

In reference to Mr. Hollenhead's letter dated 20 August 2951, this section is considering furniture design for "Project Dishpan".

Before going into any detailed design work we would appreciate a detailed report on present day Methanian furniture on Arcturus IV. An analysis of the various positions of relaxation and physical habits of the Methanians would also aid us in our design.

Please look into this matter at your earliest convenience. Thanks.

CONFIDENTIAL

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: Arnold Edward To: Furniture Design Division

Subject: "Project Dishpan" File No. 3463

24 December 2951

Attached herewith is a copy of the report which you requested of 10 December 2951. I hope that the information provided in this report is sufficient.

Since the 21st of this month an inter-solar telephone system has been hooked-up between the Solar and Galactic Explorers Union and our front office to expedite work in Operation Arcturus. If any additional information is needed please inform me by phone, it would take about four days for information to be routed to this office from Arcturus IV.

Please keep in mind the deadline for the initial design project 17 January 2952. On that date all departments will meet in my office to discuss various designs for possible manufacture and sales.

A Merry Christmas to you and your family.

CONFIDENTIAL

Terran Exporting Counsel Headquarters

Spaceport 17 **Snafu** **Arcturus IV**

Office of General Information

Mr. Arnold Edward, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts
Terran

CONFIDENTIAL

Dear Sir:

At your request a survey was made on Methanian furniture at various private homes, libraries, theaters, schools and public auditoriums.

Much to my surprise Methanian furniture is quite standardized, but crudely built.

Methanian chairs are what might best be described in Terranian language as "saddle chairs". Due to their extreme arm and leg length the Methanians straddle their chairs as cowboys in the Western Terranian Plaines straddle their horses. See enclosure one (1) of this letter.

Easel-type tables at a forty-five degree incline (similar to Terranian drafting tables) are used in the public schools and libraries, and conventional flat-top table are used in the homes. The flat-top tables are usually about three feet high.

There are no lounge chairs to speak of, but a few crudely built chipped-stone chairs were found in several homes. They were almost impossible to move. The Methanian man seems to be most relaxed in chairs with seats in them like those found in Terran, but their physical make-up makes it almost impossible for them to do any active work in a sitting position.

As you can see furniture design is badly needed in Arcturus and it is heartening to know that your group is interested in this field. I am sure a good market can be found for your product.

I hope that the above information and enclosure will aid you in your work. Please do not hesitate to inform me if additional information is needed.

Received
Mass. Intergalactic Traders
18 Nov. 2951

Methanianly yours,

/s/

Will Tellum
Asst. Director of Information

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: Ronald Yoshida To: Arnold Edward

Subject: Arcturus IV File No.

17 January 2952

After receiving Mr. Harry's report on Methanian furniture our group decided that our first design product would be in the line of lounge chairs, which are so badly needed in Arcturus IV.

A careful study of the skeletal structure of the Methanian was made by my staff and the enclosures of this letter show the Methanian in a relaxed position.

Although my staff submitted a number of designs, Mr. Lame's chair was selected out of the lot. Sketches of other possible designs are shown in the enclosure.

Stresses and approximate weight calculation were made by my engineer and these values are quite agreeable to Methanian environment. Since price estimates were not available, they will be submitted at a later date.

Hoping that this design meets with the committee's approval, I remain

Aesthetically yours,

/s/

Ronald Yoshida
Chief of Furniture Design

CONFIDENTIAL

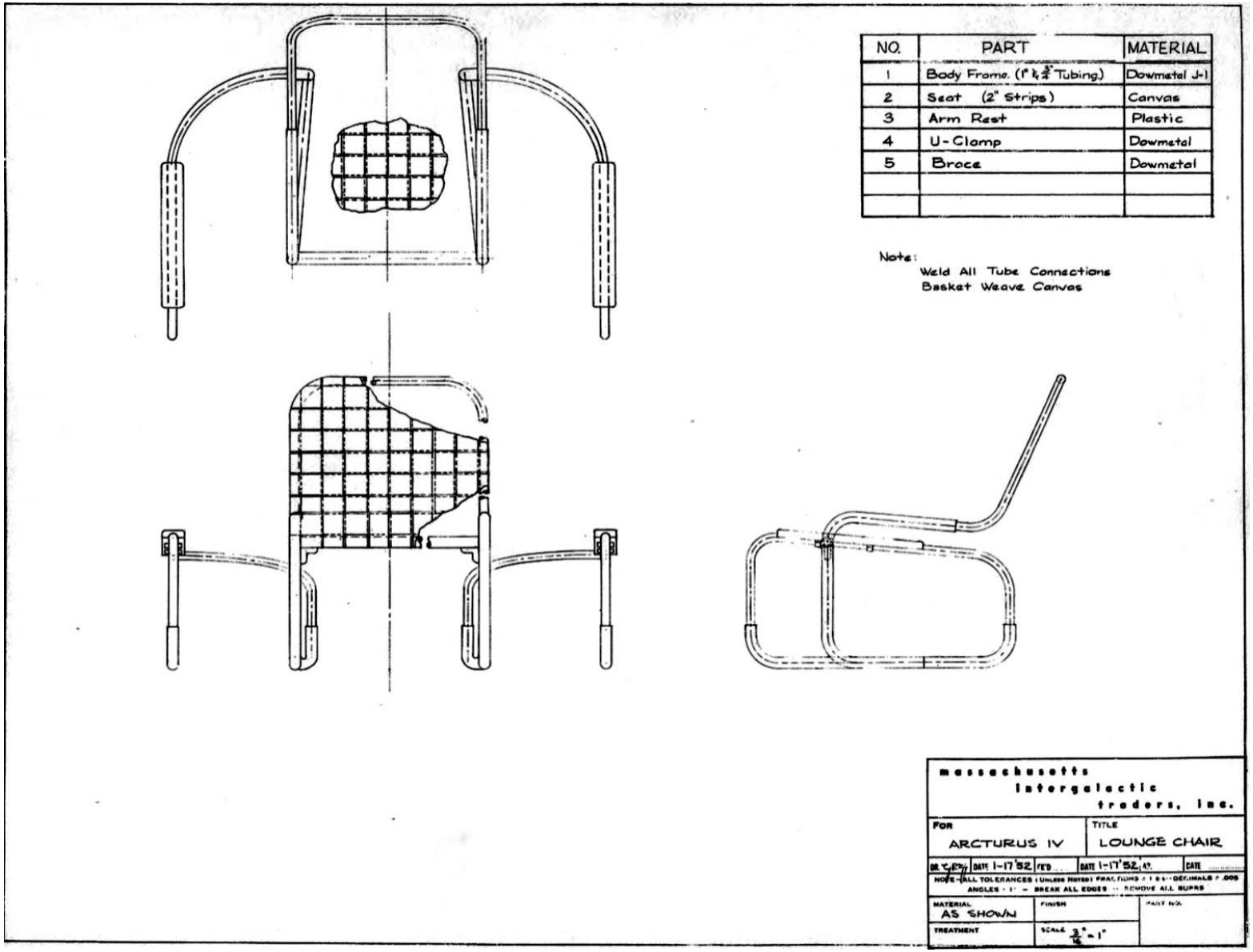


FIG. 16: LAME'S LOUNGE CHAIR

ENGINEERING REPORT

Calculation of maximum stress on Lame's Chair:

Maximum load (approximately)..... 200 lb. (Terran)
Distance from front edge of chair
to C.G. of body (approx.).....10 inches
Maximum stress taken in one inch tubular section
O.D. = 1 inch I.D. = 0.750 inch

$$I = \frac{\pi (d_o^4 - d_i^4)}{64} = 0.0836 \text{ in}^4$$

$$S = \frac{Mc}{I} = \frac{200 \times 10 \times 1/2}{0.0836} = 29,800 \text{ P.S.I.}$$

At room temperature of 70 degrees Fahrenheit Dowmetal Tubing (Magnesium alloy) have the following characteristics:

DOWMETAL ALLOY	* T E N S I O N (P.S.I.)			COMPRESSION
	ULTIMATE STRENGTH	YIELD STRENGTH	% ELONG. IN 2"	YIELD STRENGTH
FS-1	33,000	16,000	8	10,000
J-1	36,000	16,000	7	11,000
M	28,000	13,000	3	6,000

Since alloy J-1 has the greatest strength properties it was selected. Although the calculated stress is much higher, magnesium alloys increase in strength at lower temperatures. Although data for the temperature range of -50 degrees C. to -110 degrees C. (or -58F to - 66F) were not available the following list of properties at reduced and elevated temperatures for Dowmetal alloy J-1:

Temperature deg. F	TENSILE PROPERTIES		
	ULTIMATE STRENGTH p.s.i.	YIELD STRENGTH p.s.i.	ELONG. IN 2" (%)
-100	48,000	38,000	13.0
70	45,000	31,000	14.0
200	42,000	26,000	21.0
300	30,000	20,000	40.0
400	21,000	15,000	42.0
600	8,000	5,000	70.0

* Minimum values

The nominal combination of Dowmetal Alloy J-1 is:

Aluminum	6.5
Manganese	0.2
Zinc	1.0
Magnesium	remainder

Magnesium alloys are not recommended for use with any of the nitrates, chlorides or acids, but it is highly recommended for ammonia (gas or liquid).

Weight Calculation: (Lame's Chair)

Dowmetal J-1 1" tubing 1/8" wall thickness 0.264 lb./ft. approx. 146 in. used	3.20 lb.
Dowmetal J-1 3/4" tubing 1/8" wall thickness 0.189 lb./ft. approx.150 in. used	2.36 lb.
Plastic arm rest	2.00 lb.
Weld, bolts, braces, canvas, etc.	2.00 lb.
	9.56 lb.

Note: All data on magnesium was obtained from the Dow Chemical Company, Midland, Michigan, booklet "Magnesium Design" and "Magnesium Alloys and Products".

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
C H I E F D E S I G N E R

16 January 2952

R. Z. Hollenhead
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge 39, Massachusetts

Dear R.Z.:

As you know, our experience in the design field is great and varied, or you would not have employed us. We reviewed the possible products that have been suggested to us, and have selected a few that we believe will aid the Methanians considerably in their way of life on that hellhole.

It occurred to me the other evening that the Methanians must beautify their yards in one way or another. I realize everything grows upside down, but I suppose roots can be beautiful, too. Look at the potato! Our experience with the lawn implements, lawn mowers, lawn rollers, and sprinklers (heh-heh) has given us the design know-how in this field, and we should capitalize upon it.

We would appreciate any additional information concerning the Methanians' yards, their substitute for grass if any, and how they manage the up-keep of their lawns.

With respect,

/s/

D. F. Rib

Lawn Sprinkler Sub-Division
Design Department

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
B O A R D C H A I R M A N

17 January 2952

Mr. D. F. Rib
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge 39, Massachusetts

CONFIDENTIAL

Dear D.F.R.:

We have inquired from our out-post on Methania concerning your suggestion. First good one you've had in decades. The following information has been given to us concerning the condition of the Methanians' yards. We hope it is satisfactory.

The Methanians have large yards because of the sparse population; therefore, they have sought to beautify their surroundings as much as possible. After years of cultivation, they have come up with the following species that is used universally upon their yards.

The species is known as herbiverous carniverous arnoldious. It is tough and strong, although upon smoothening and ruffling it is soft and pliable. It becomes brown during the winter and greenish-brown during the summer months. The actual physical structure is shown on the accompanying sketch.

There is one serious draw-back to the use of this species of lawn covering. It requires careful planting and maintenance to keep the ground sufficient porous to grow the arnoldious and to realize the beauty of its full growth. Then the heartbreaking situation exists. The arnoldious, unlike our grass in Terran, does not grow continuously and, therefore, does not require constant cutting. It grows to full height (3¼ inches) and then uniformly remains at that height. However, the growth is not stagnant. The plant continually sends up new shoots which grow from the fibrous base and contribute to the density of the surface area. After a period of one year, the surface is so clotted with fiber that it becomes coarse and undesirable, and soon a mass dying takes place. The roots in an area of three or four square feet die simultaneously because of strangulation, leaving bare, unsightly spots upon the lawn which are dotted with the large dead fibrous roots. They're pure hell to walk on, even for the hoof-footed Methanians. The only solution is to pull out areas of the grass to allow for new growth. This must be done at randomly spaced intervals to insure a uniform root surface, and the amount pulled out must be very small. Because of the toughness of the roots in tension, pulling too large a clump will uproot—oops—upstem-a large portion of the plant, and the result is an open space to be planted again. The vertical force to be applied to the surface fiber to uproot it cannot exceed six pounds. This force is enough to pull out a tuft of root ½ inch in diameter.

As you see, the Methanians cannot have large yards because of the physical impossibility of weeding them, or cleaning them, or whatever you want to call it. When one heads home from work after a hard day at the office, he sees one Methanian after another plucking away at their lawns, most of them using their own wonderful cussing that they've developed. If you could develop a machine to simplify this job, we could make a mint. More power to you.

If you need more information, let us know soon.

Returning your compliments,

/s/

R. Z. Hollenhead
Chairman of the Board

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
C H I E F D E S I G N E R

17 January 2952

R. Z. Hollenhead
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge 39 Massachusetts

CONFIDENTIAL

Dear R.Z.:

Enclosed please find the requested design for a lawn conditioner for the Methanians. We hope it fulfills your expectations. The following is a description of its operation.

The "Cleenpull" Lawn Conditioner is designed to perform three functions; (1.) to pull forty tufts of root at once, (2.) to pick these tufts up and deposit them in the drawer provided, and (3.) to smoothen and ruffle the roots which pass under the mechanism.

The machine is fitted with two carriages under the forward portion. Each carriage contains forty semi-circular prongs which are forced together to grip tufts of roots in a vice-like fashion. The hydraulic system provides the necessary vertical force to extract the tufts from the remainder of the lawn. The hydraulic system closes the jaws about the tufts as well. These two actions are produced simultaneously. Springs are provided to open the jaws and return the carriages to their proper locations during movement of the Conditioner by spring systems.

Because of the large mechanical advantage required, the hand lever on the handle of the mechanism must be pumped 2.86 times before the tufts are extracted. A ratchet system is therefore required to hold the cylinder plunger in place while the hand actuating lever is returned to its former position prior to beginning another power stroke. A simple ratchet is affixed to the piston rod. This is released by a reel arrangement upon the handle.

The vertical motion piston and the horizontal motion piston are both connected to their respective carriages by yokes. These yokes are provided because of the large forces involved, resulting in large moments.

The tufts which are extracted from the root bed are picked up by the pronged wheel which is rotated by a chain or belt connected to the rear wheel. The tufts are collected in a removable drawer on the side of the mechanism. The ruffling and combing action provided by the device is accomplished by a hemp brush attached to the rear wheel axle.

Weight was conserved wherever possible. The body of the mechanism is of cast aluminum. Upon it are fitted all of the parts: the carriages, wheels, brush, pronged wheel, and collection drawer.

Aesthetic beauty was added by the aluminum case which covers the working mechanism and protects it from the elements. The case is also of cast aluminum. It is clamped to the base by projections cast into the base upon manufacturing. A handle is provided in the case to lift it from the base. The handle also adds to the aesthetic appeal of the product by providing variety for the otherwise plain surface.

An aluminum-tungsten alloy was utilized where strength and lightness had to be combined. Steel was used only in the parts where large forces would prevail or where manufacturing difficulties would be met if the part were manufactured of other metals (for instance, the springs).

The weight of the entire assembled product is estimated as 15 or 20 pounds.

It is noted that the bottom of the base is considerably above the wheel bottoms. This is provided because the machine, due to its weight, will sink into the root surface until it rests upon the second layer of branches. The base of the machine will therefore be in its best position to grasp the roots. After experimentation on Methania, the wheel height can be adjusted so that the optimum height is reached. The operator will not experience undue resistance to movement of the machine through the roots if the weight of the machine rests completely upon the wheels, which of course, is desired.

<u>It must be emphasized that the device is stopped before it is operated.</u>

We of the design department sincerely hope that this creation will help the Methanians to acquire a living standard comparable to ours.

Sincerely,

/s/

D. F. Rib

Lawn Sprinkler Division
Design Department

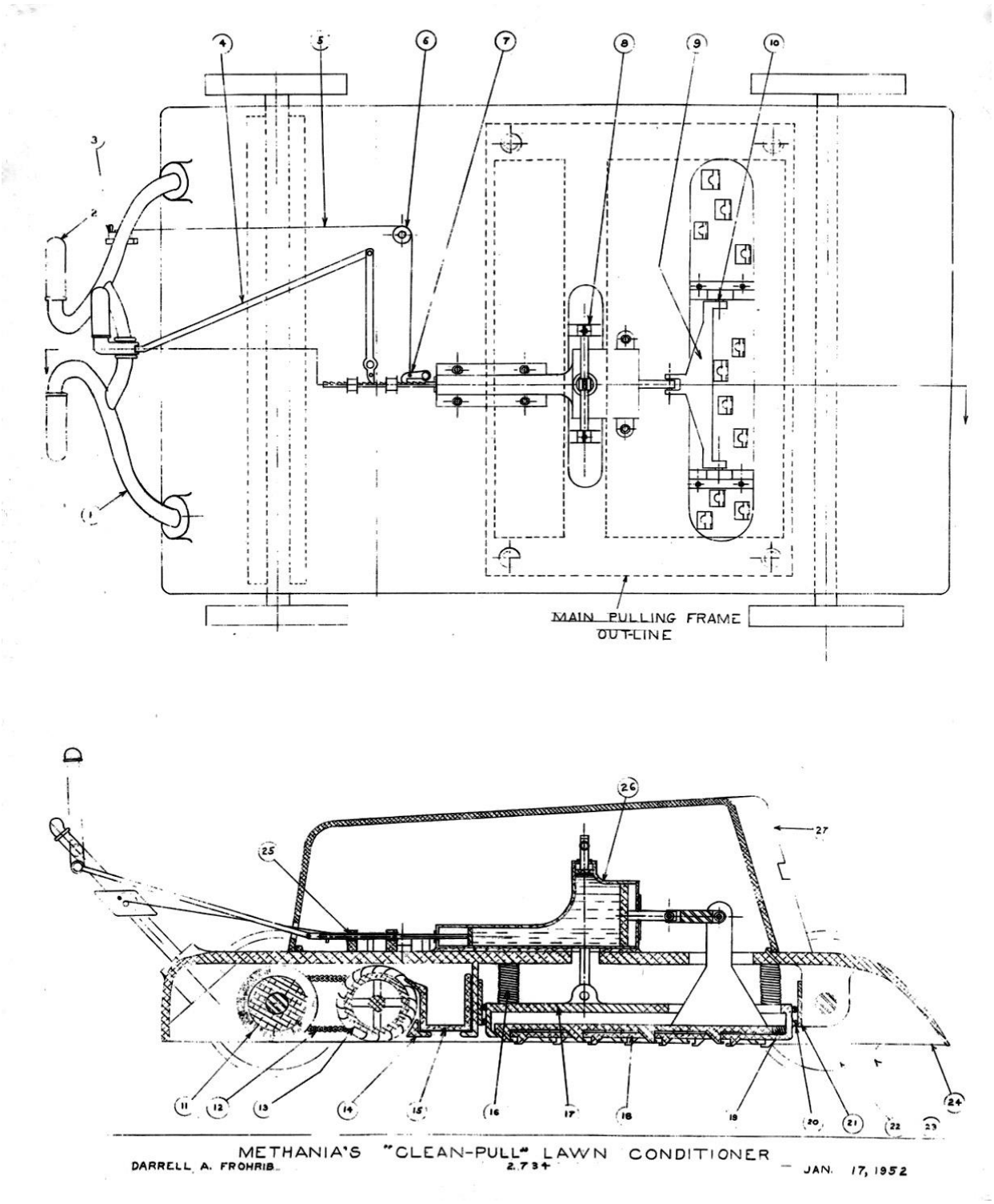


FIG. 17: "CLEAN PULL" LAWN CONDITIONER

METHANIA'S "CLEAN-PULL" LAWN CONDITIONER

Parts List

Part Number	Number of Parts	Material	Part Name
1	2	Drawn aluminum	Handle
2	2	Nylon	Handle grip
3	1	Aluminum	Pressure release
4	1	A1.-Titanium alloy	Ratchet assembly
5	1	Steel	Release wire
6	1	Aluminum	Pulley wheel
7	1	A1.-Tit. alloy	Ratchet
8	1	A1.-Tit. alloy	Pulling yoke assembly
9	1	A1.-Tit. alloy	Clamping yoke
10	2	Steel	Clamping yoke bearing
11	1	Hemp	Combing brush
12	1	Steel	Driving chain
13	1	Steel wire	Tuft catcher
14	1	Aluminum	Pan support
15	1	Aluminum	Catcher pan
16	4	Steel (spring)	Pulling mechanism drop spring
17	1	Aluminum	Main pulling frame
18	1	Aluminum	Sliding grasping frame
19	2	Steel (spring)	Grasping frame spring
20	8	Steel	Main frame bearing wheels
21	4	Aluminum	Bearing wheel track

METHANIA'S "CLEAN-PULL" LAWN CONDITIONER

Parts List, Continued

Part Number	Number of Parts	Material	Part Name
22	4	Aluminum	Wheel
23	4	Nylon	Tire
24	1	Aluminum	Main frame
25	2	Nylon	Ratchet assembly bearing
26	1	Aluminum (Oil filled)	Hydraulic actuating cylinder
27	1	Aluminum	Cover

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT₃

78 massachusetts avenue - cambridge, massachusetts - terran

OFFICE OF THE
SALES MANAGER

17 September 2952

R. Z. Hollenhead
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge 39, Massachusetts

CONFIDENTIAL

Dear R. Z.:

As you pointed out in our last board meeting, the sales picture on those latest designs has been terrific! Our sales organization has been doing a swell job in the furniture and household appliances division, and our Methanian pals are snatching up our entire output even before it hits T.E.C.H. Spaceport!

I think it is time we really hit the big time, though. As an old used turbocar salesman, you know I have been itching to have some transportation devices developed for sale on Arcturus. They have got their battery - powered scooters, I know, but if I had a couple of really slick vehicles to offer them, we would really put some life into this business.

These vehicles need not be too fancy, at first - at least nothing like the '53 Turboglides we bat around in on Terra. I don't think they would be able to handle speeds we can coax out of our induction accelerators, either. They are a slow moving bunch, and their roads are pretty sad affairs, don't forget, but the Design Division should be able to come up with something safe and comfortable, with the kind of styling that will make them stand up and take notice when we take them into the showroom. I know of a couple of hotshot salesmen that I think I could shanghai from Generalized Motors if the opportunity were here. We have already got the distribution problem licked, and have the showrooms already set up, so it is a natural for doing a bang-up job with transportation units.

Give it some thought, R. Z., and let me know how you feel about it. Who knows - you are liable to be the Henry Ford of Arcturus IV!

Very truly yours,

Lean Dent

Lean Dent ("The Smiling Terranian")
Sales Manager
Massachusetts Intergalactic Traders

Received
Mass. Intergalactic Traders
1 Oct. 2952

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
B O A R D C H A I R M A N

CONFIDENTIAL

27 September 2952

Mr. Arnold Edward
Chief Designer

Dear Arnold:

This letter will confirm the talk we had over the weekend on the possibilities of developing suitable transportation for the inhabitants of Arcturus IV.

After reconsidering your ideas, and the strong feelings of the sales division, I would suggest that you proceed at once with the program you have outlined. All material connected with the project should be classified as "Secret". You can imagine the reaction among our competitors if word leaks out. We are starting from scratch in this transportation game, and we will need all the head start we can get.

The development work will be called "Project Anti-Freeze", and you can draw your expenses from order NO. OK 2735 until we have the accounting department set the project up on the budget. You can see that I want this thing to get under way immediately.

Drop your work you have been doing, and get some people to take the administrative work off your neck. The preliminary design deadline is tentatively set for 6 November, and I am counting on you to crack the whip.

Received
Mass. Intergalactic Traders
1 Oct. 2952

Yours very truly,

R. Z. Hollenhead
Chairman of the Board

CONFIDENTIAL

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

OFFICE OF THE CHIEF DESIGNER

29 September 2952

Mr. Will Tellum
Assistant Director of Information
T.E.C.H. Spaceport 17321
Snafus, Arcturus IV

Dear Mr. Tellum:

It seems that I never have enough technical information about the Methanians to keep me happy. This time we are doing some classified work called "Project Anti-Freeze" and I need some help again.

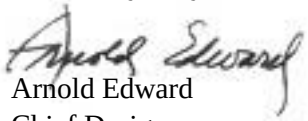
I contacted J. S. Wick on Terran, but he did not have the information on hand, and he suggested that I write to you direct. The work that I am doing requires some knowledge of the stimulus-response time characteristics of Sub-Human type SH-1406-A. Since we are designing equipment which must be manually controlled by the average Methanian, and where a safe margin of response time must be provided to insure danger-free operation, I will need a breakdown of audio and visual response times. While you are collecting this information, it might also be worthwhile to explore the possibilities of using tactile stimuli as a warning signal.

In addition to the psychological information cited, I would also like to know something of the machinery repair facilities available on Arcturus, as well as the average skill of the Methanian mechanic as compared to Terranian workmen, including their ability to adapt themselves to new tools and techniques.

If there are any unusual conventions of Methanian machine design, such as thread sizes, keys, rivets, or gear profile, please let me know so that I can avoid unnecessary confusion on Arcturus.

Thanks for your cooperation, and I will appreciate having this information as quickly as possible.

Yours very truly



Arnold Edward
Chief Designer

Terran Exporting Counsel Headquarters

Spaceport 17321 **Snafu** **Arcturus IV**

CONFIDENTIAL

Office of General Information

12 October 2952

Mr. Arnold Edwards, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Mass. Terran

Dear Arnold:

Busy as I am, I sent some of my boys out to see if they couldn't dig up the information you requested in your letter of 29 Sept. I don't know what's the matter with J. S. Wick these days. He never has the information you fellows want and makes no effort to get it. He must think that because my days are 159 hours long I can do anything and everything — the rat.

Now to answer some of your questions. (See the enclosed report on the S-R time investigation.) Apparently intelligent life is much the same the galaxy over when it comes to accepting innovation. Whether we are descendants of birds or monkeys we seem to identify ourselves with the present and past and resist, as much as possible any change. Therefore, I'm sure you'll have to go very slowly as you introduce powered transportation devices. Their present electric scooters are very slow moving vehicles and are limited to very small ranges. Don't be "too advanced" in your thinking. Bring them along in easy stages.

The Methanian workmen are very patient, conscientious and skilled mechanics. With the necessary materials and equipment they can copy practically anything you send up here, but they like ourselves, prefer to work on things they understand. Let' s advance their technology gradually and we'll have less trouble and quicker acceptance of our ideas.

Do not worry about thread sizes, gear profiles, etc. The Methanians are well acquainted with the helix and involute.

Best regards,

Will

Will Tellum

CONFIDENTIAL

Received
Mass. Intergalactic Traders
21 Oct. 2953

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 10 October 2952

FROM Special Investigator X **TO** Will Tellum

SUBJECT Methanian S-R Times **FILE NO.** SR 1001

This report covers the tests carried out on Methanian Type SH1046-A males and females to determine the value and range of stimulus response time using various stimuli and responses. The stimulus which evokes a motor response usually involves some type of sensory discrimination — visual, auditory, factual, or kinesthetic. The stimulus is specific to a task to be performed and may be a single signal or, more commonly, a complex situation; several stimuli, or a continuously changing stimulus. The responses all involved movement reactions and they can be classed as (1) discrete, involving a single unitary movement of any member of the body; (2) repetitive, discrete movements performed a number of times; (3) serial, a number of discrete movements involving starting and stopping, and changes in direction, each of which is stimulated by changes in the stimulus, and; (4) continuous, constantly changing motor adjustments made in response to constantly changing stimulus condition.

Both simple RT and complex (or disjunctive) RT's were measured. Details of all tests are included in Report SR-1002, Sect. A-B, Appendix Q. This report briefly summarizes some of the more important results.

Test I. Experiment: Subjects were required to respond as quickly as possible by pressing a bell-button when a visual or auditory stimulus was presented.

Experimental Conditions: Apparatus: d'Arsonval clock. Stimuli: bell and light. Stimuli presented in fairly rapid sequence, at irregular intervals, with no other "ready" signal. 25 dials per series. Subjects completed from 1 to 21 series. 178 male subjects, ages 1 to 6 Arcturian years.

Results:

Stimulus	Mean RT (in msec)	Range (in msec)	SD (in msec)
Auditory	1151.4	726 - 2592	112.7
Visual	1731.6	1140 - 2856	118.9

All tests seemed to go in much the same pattern as the one above and in general the RTs for the Methanians were from 5 to 6 times those measured in normal Terranians. It appears to be perfectly safe for design purposes to multiply Terranian SRT data by a factor of 5 when applied to Methanians

This data, of course, imposes some very serious design limitations which must be given careful consideration by all designers. WARNING: It is the consensus of all concerned that this slow S-R time should not be compensated for by the addition of complicated electronic control equipment at this stage of the Methanian culture. Consider the safety of the operator of any machine or product by limiting the performance of same.

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

O F F I C E O F T H E
C H I E F D E S I G N E R

CONFIDENTIAL

30 October 2952

Mr. R. Z. Hollenhead
Chairman of the Board
Massachusetts Intergalactic Traders

Received
Mass. Intergalactic Traders
1 Nov. 2952

Dear Mr. Hollenhead:

I think you will be pleased with the results of "Project Anti-Freeze" which I have enclosed with this letter. The research program we have been carrying out is, of course, incomplete, but I think we are well on our way.

In view of the urgency of getting the first transportation units in the hands of our M.I.T. salesmen on Arcturus as quickly as possible, I should like to recommend that we proceed at once with preliminary full-scale models of the "Eggomobile" and the "Acustom Coupe". As you know, we have not completed the production engineering for these two vehicles, and the performance characteristics are still somewhat uncertain from our drawing board studies. I believe, however, that we have come to the point where we should have some trial machines built, or at least prefabricated, for assembly on Arcturus IV. The biggest handicap in designing machines of this size is in attempting to duplicate Arcturian gravity and weather conditions on Terra. A road and field testing program has been arranged in cooperation with Will Tellum's group on Arcturus, and it awaits only the approval of funds for the project by the Board.

I have taken the liberty of having an animated film made up by our art department which should be of considerable aid in "selling" the ideas to the Board members. When the date for the meeting has been arranged, I can plan to be present to further explain some of the technical aspects of our program to the group. It is going to take a Monorail-car full of credit units to do it up right, but I am sure the cost will be justified when we get these vehicles on sale.

Yours truly

Arnold Edward

Arnold Edward
Chief Designer

23 October 2952

CONFIDENTIAL

Mr. Arnold Edward
Chief Designer
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge 39, Massachusetts

Dear Mr. Edward:

Subject: Consulting services rendered, "Project Anti-Freeze", report on.

Enclosed please find the preliminary drawings we have prepared for your approval. We have tentatively called our design the "Eggomobile", and we herewith present a brief description of the device.

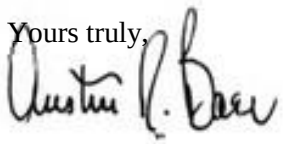
The machine consists of two basic components; the spherical, silicone-rubber covered tread on which it rolls, and the outer egg-shaped passenger shell. The outer shell is supported by a transverse axle through the sphere which propels the vehicle. This axle is fixed with respect to the outer shell, while the sphere is free to rotate on internal bearings. Power is provided by an internal combustion engine of the oxygen burning type, geared to revolve the sphere around the fixed axle. The engine is supported by this axle, and is thus permanently located with respect to the outer shell, although it is wholly inside the sphere. By means of suitable counterweights below the centroidal axis of the entire vehicle, the machine remains stable, and is steered as shown in the drawing.

The egg-shaped appearance was selected for safety in operation as well as the psychological appeal which we plan to stimulate. Although the machine travels at an average speed of six miles per hour, the slow stimulus - response pattern of the Methanian people will probably make an occasional collision inevitable. The shape of the vehicle would provide maximum safety, since the outer shell presents no sharp projection which might injure pedestrians, and it would suffer hardly more than a glancing blow should two vehicles collide. The "Eggomobile" would absorb the greater part of the impact energy by rolling with the blow, and automatically righting itself. Naturally, the egg shape should be an asset in selling the machines, since the Methanians are egg laying creatures, and this design suggests the protective security they enjoyed before hatching.

Received
Mass. Intergalactic Traders
25 Oct. '52

We at the Studios feel that the design is simple and attractive, and should be readily saleable as an introductory vehicle. The outer shell could be finished in a nice selection of colors, with any suitable Methanian symbolic decoration optional at extra cost for those who want a distinctive "look". Please let us have your comments, so that we can proceed with the working drawings.

Yours truly,



Austin R. Baer
President
Baer Design Studios

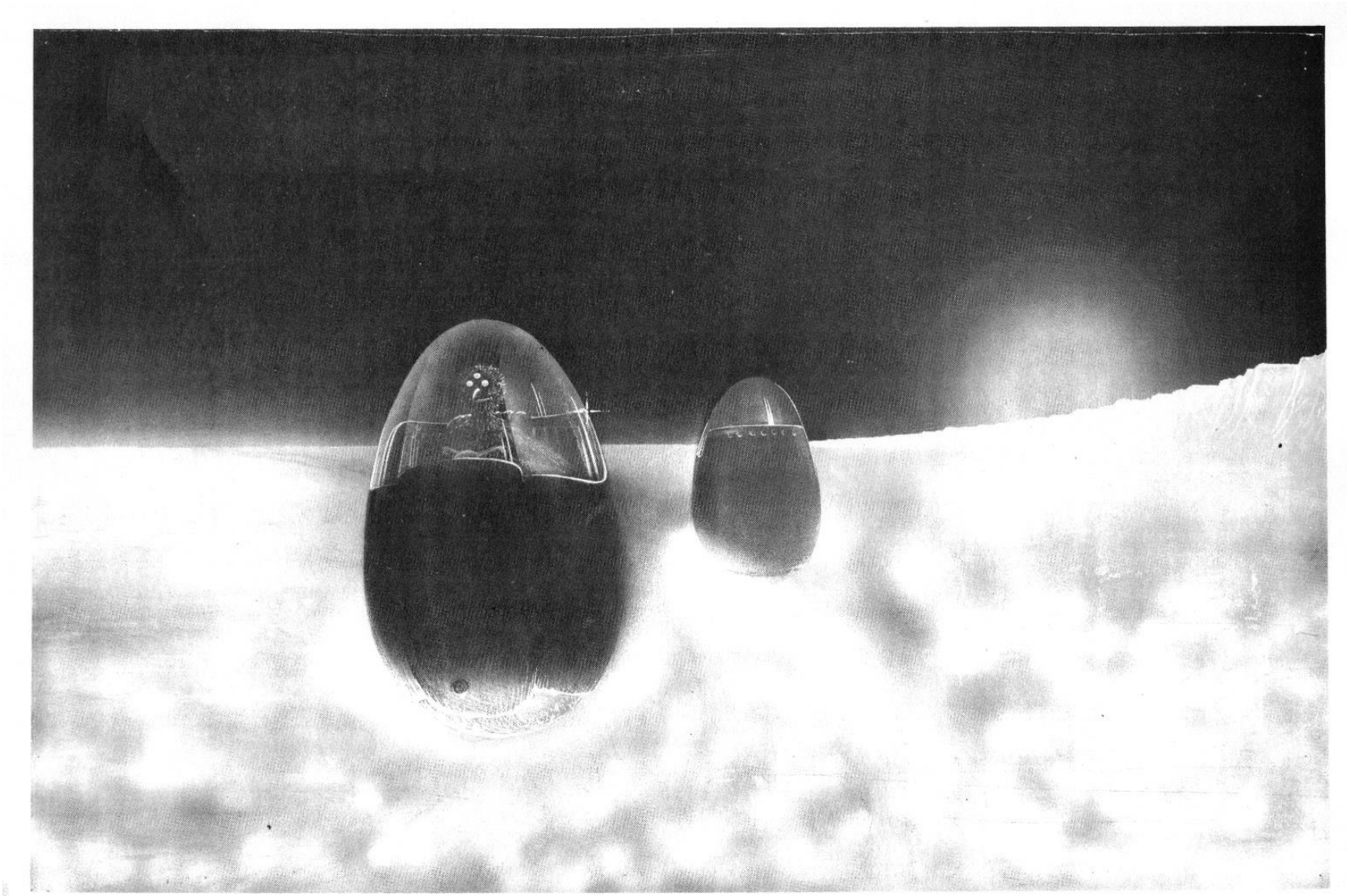


FIG.18: EGGOMOBILES

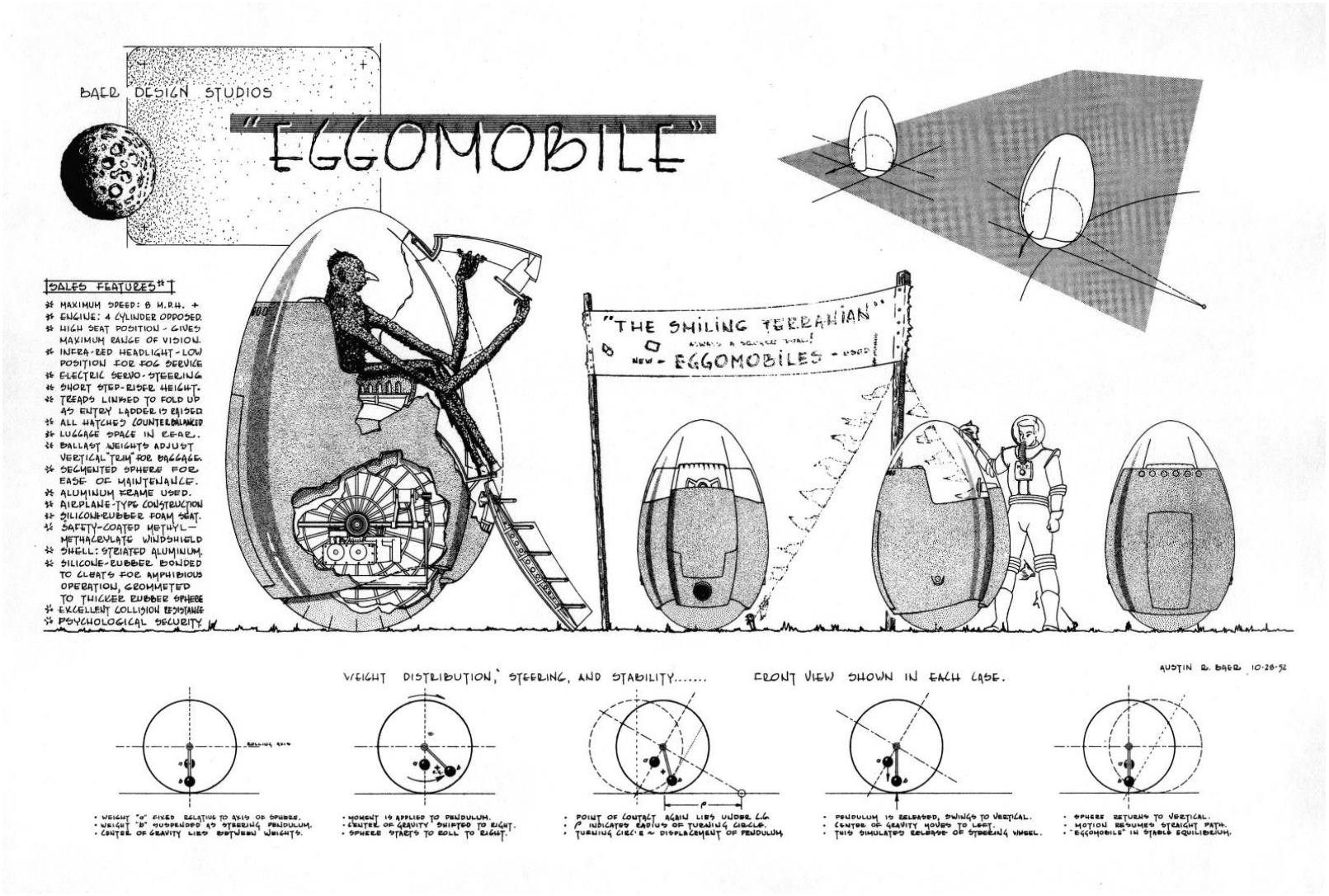


FIG.19: EGGOMOBILE FEATURES

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: Geochani To: Arnold Edwards

Subject: Project Anti-Freeze File No. GG. 432

26 October 2952

CONFIDENTIAL

In spite of all the discussion and the general consensus that the vehicular design for Arcturus IV must be quite primitive in order that it be readily accepted by the Methanians, the attached design (as you will easily see) is quite to the contrary.

The writer says "to hell with history" — let's see if it isn't possible that a relatively primitive culture will accept a radical, advanced design. The "Acustom Coupe" is limited at present to a slow 15 mph maximum, but is so designed that it can easily be converted to travelling at much higher speeds.

It is a two passenger conveyance, streamlined to the n^{th} degree. It is powered by an electric motor which is supplied by a dual conductor cable and trolley. The large, flexible driving wheels (which provide traction as well as differential steering) adapt the vehicle to any type of terrain in the same manner as the tracks of a tank.

Although, as it is presently sketched out, the Acustom coupe is limited to previously laid out cable paths, this limitation could be overcome by providing ample storage battery capacity for short runs away from the cable. Something of this nature would probably be necessary for passing or meeting another car on the same line.

The writer hopes that M.I.T. will give this design the "green light" in order that we can test out this "resistance to innovation" theory.

CONFIDENTIAL

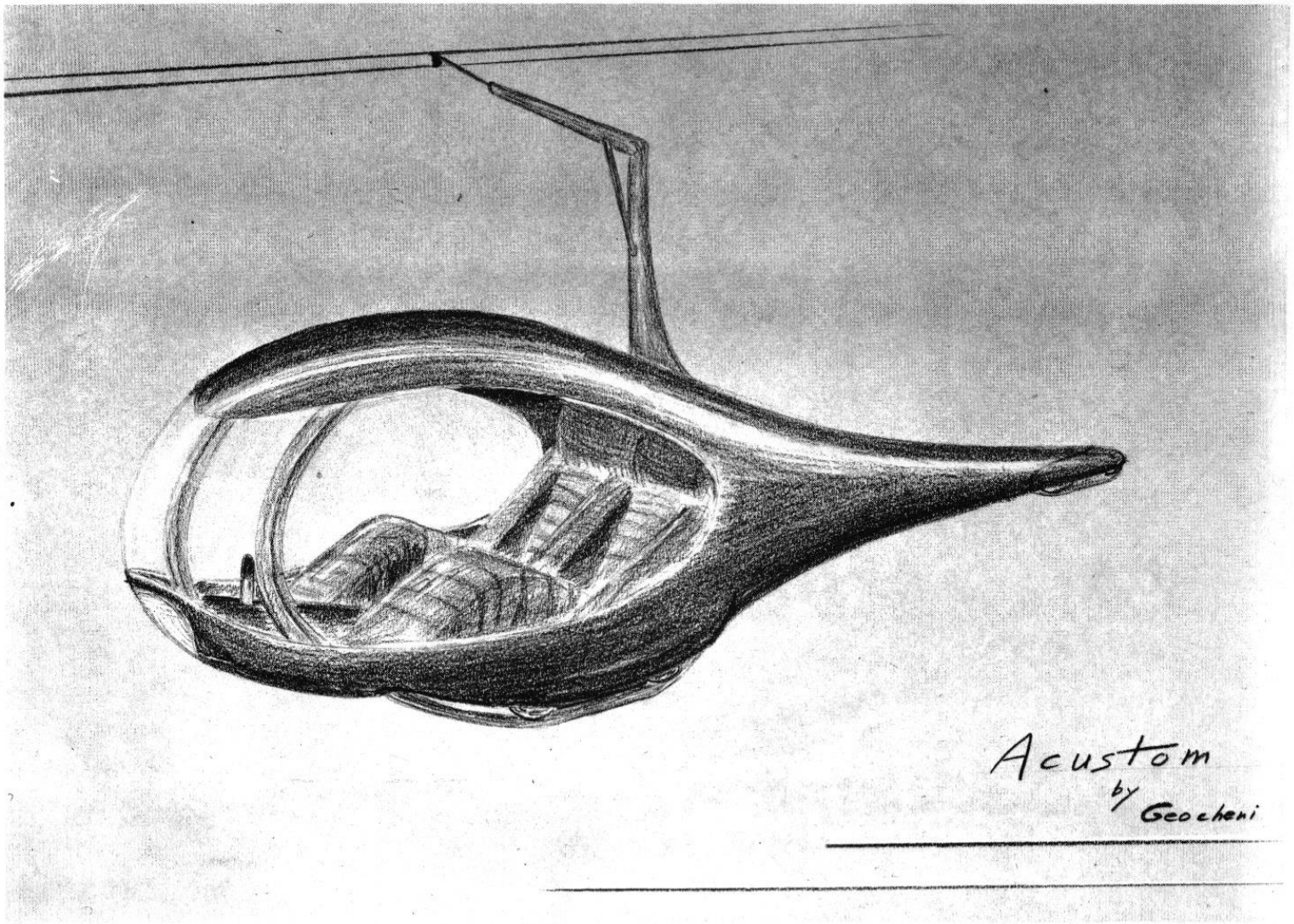


FIG. 20: ACUSTOM COUPE

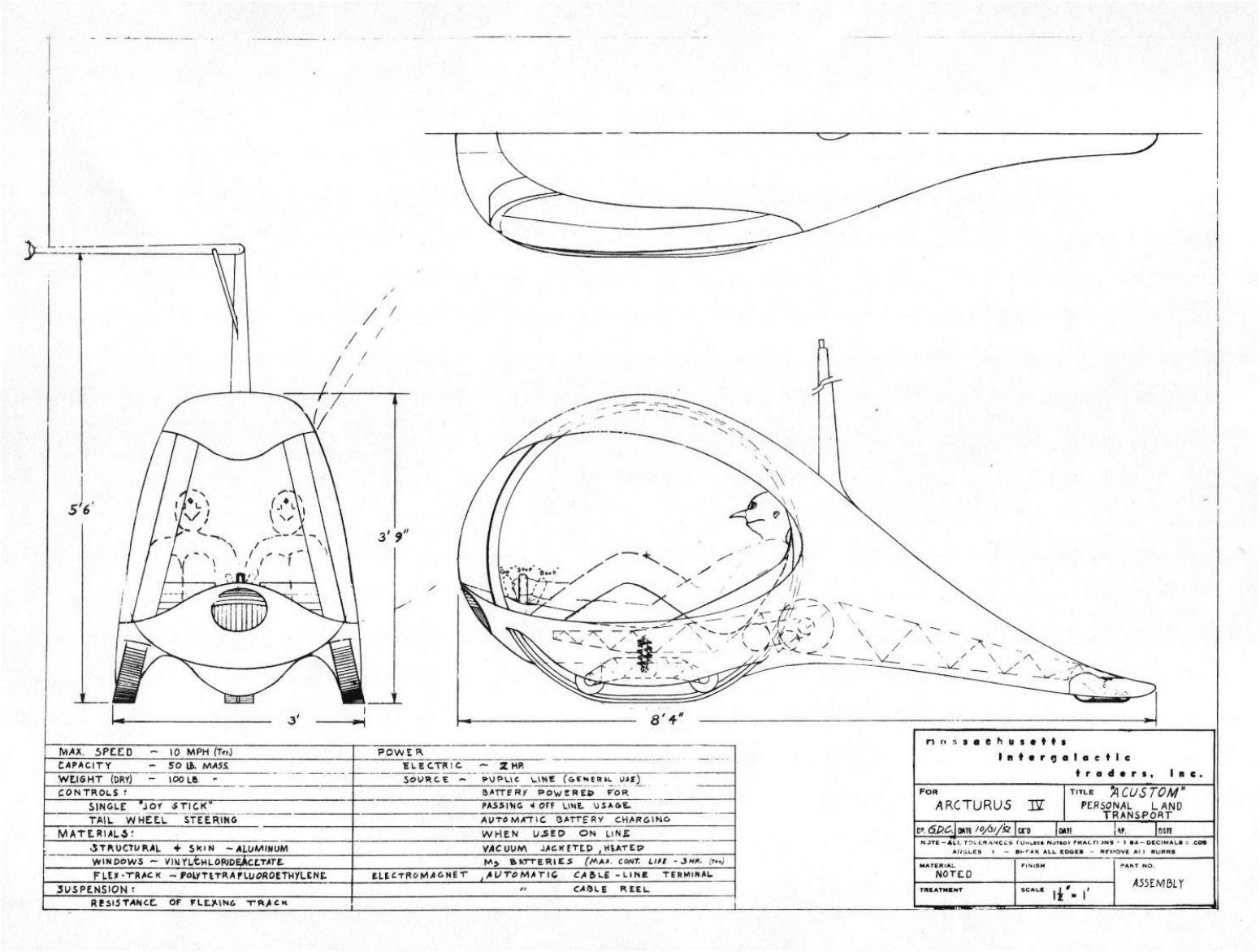


FIG.21: ACUSTOM PERSONAL LAND TRANSPORT, ASSEMBLY

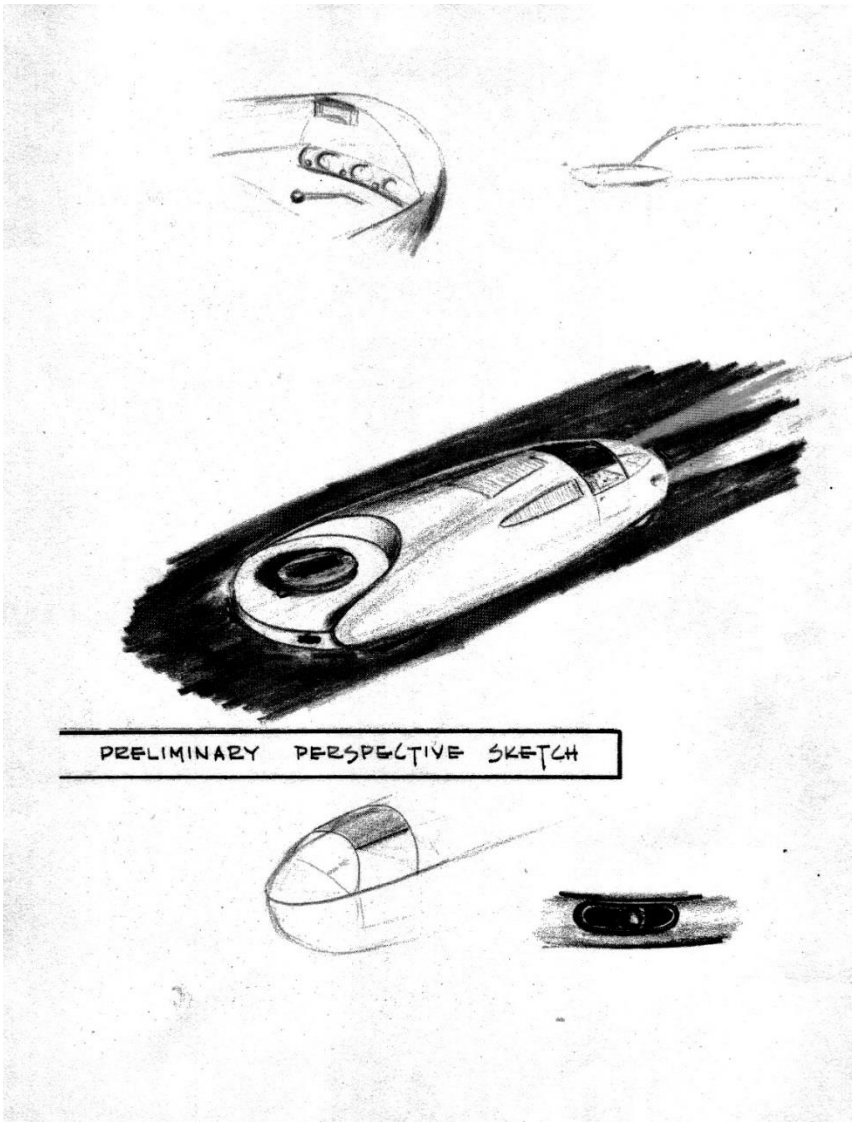


FIG.22: PRELIMINARY PERSPECTIVE SKETCH, INTERURBAN UNDER

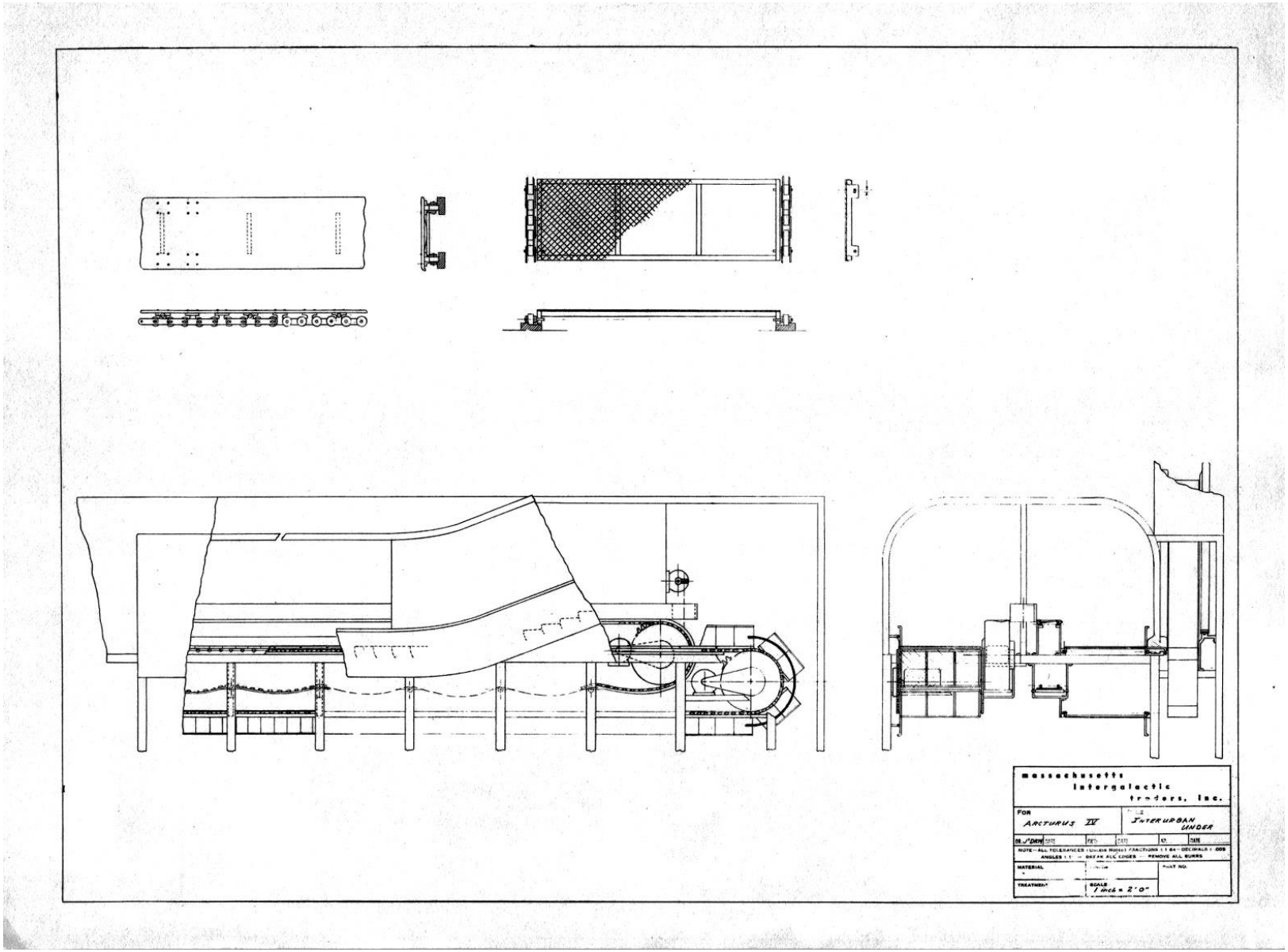


FIG.23: INTERURBAN UNDER

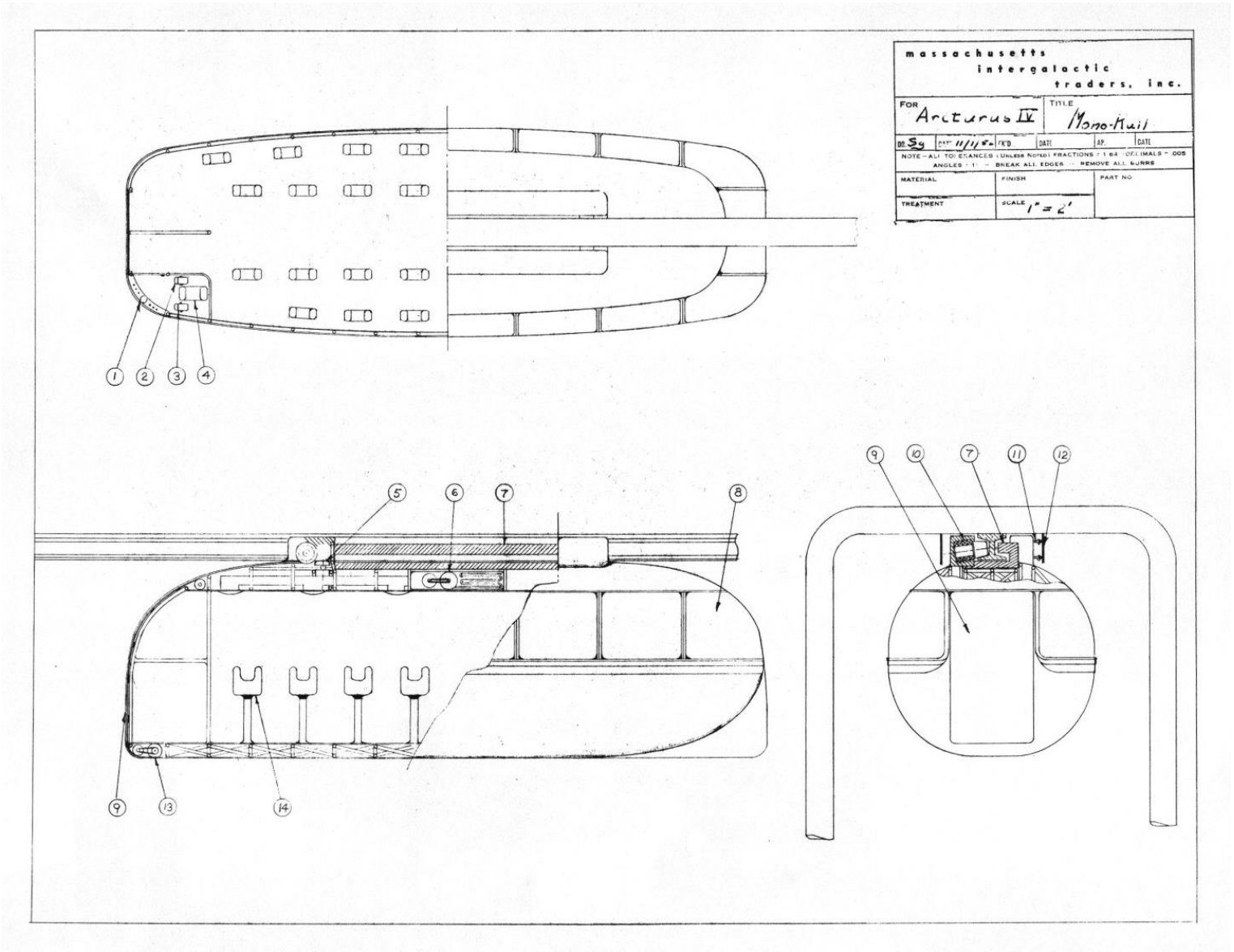


FIG.24: MONO-RAIL

T E R R A N

E X P O R T I N G

C O U N S E L

H E A D Q U A R T E R S

INTERGALACTIC CODE NO. 19
ADDRESS TECH

H e x a g o n B u i l d i n g - 1 8 7 L e v e l - W a s h i n g t o n 9 9 – T e r r a n

23 January 2953

Mr. R. Z. Hollenhead
Massachusetts Intergalactic Traders
78 Massachusetts Avenue
Cambridge, Massachusetts

CONFIDENTIAL

Dear Zepp:

I have just received word from J. H. Rones, who, as you may know, has been on Arcturus IV for the past three weeks. John, as you remember from that weekend we spent together in New York, is quite the gourmet. How he keeps from getting ulcers from the weird foods he eats is beyond me. At any rate, he has been dying to sample some Methanian "Mulp". So far he has not been able to find any in Snafu, although they are in season at this time of their 2720 day year. The plant seems to be so high in food value that the entire crop is reserved for Methanians, so the Spaceport restaurant does not serve any.

John talked to Will Tellum about it, and Will told him that the entire harvesting situation is pretty poor on Arcturus because of the upside-down growth of the plants, together with rather primitive harvesting methods. He suggested long ago that it might be a wonderful field for development by your organization, and I think he is right. If your designers get busy with some of these vegetation problems, it would make your outfit a byword among Methanian farmers, who, after all, make up most of the population. I am sure you could set up the same type of spacemail-order business that Rears Sawbuck does here on Terra.

If you would like to get together on this, next weekend would be a swell opportunity. The wife is going to be out of town with the kids, and I thought I would run up to the country house for a few days. You could meet me there Thursday night. Don't forget to bring along that cute secretary. I am sure we will have lots of dictation for her.

Very truly yours,

K. "Snowbound" Wad Lee

Received
Mass. Intergalactic Traders
25 Jan. 2953

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: R. Z. Hollenhead To: Heads of all Departments

Subject: Arcturus IV File No. 5482

14 February 2953

Gentlemen:

A new design project planned to facilitate the harvesting methods employed by Methanian farmers has been inaugurated.

The project will be under the direct supervision of Mr. Arnold Edward, our Chief Designer. It will be referred to in inter-office communications as "Project Harvest Moon."

Information pertaining to design will be made available in the engineering library. In view of past experience with regard to haphazard communication with the Director of Information by all department heads, all further inquiries will first be cleared with Mr. Edward before mailing. This will eliminate the confusion and ease the burden on Mr. Will Tellum's staff.

CC: A. Edward - Chief Designer
Shelton Maw - Production Manager
Showen Leare - Chief Engineer
Lean Dent - Sales Manager
J. Sapmill - Associate Designer
Randy Toot - Field Engineer

m a s s a c h u s e t t s
i n t e r g a l a c t i c
t r a d e r s , i n c .

INTERGALACTIC CODE NO. 76
ADDRESS MIT$_3$

78 massachusetts avenue - cambridge, massachusetts - terran

OFFICE OF THE
CHIEF DESIGNER

21 February 2953

Mr. Will Tellum
Assistant Director of Information
T.E.C.H. Spaceport 17321
Snafus, Arcturus IV

Dear Mr. Tellum:

We are finally getting to work on your pet project. I just received authorization to go ahead on "Project Harvest Moon", and I need some dope on the agricultural situation on Arcturus.

Please forward a list of the edible plants on Arcturus, especially those which have not been readily available to the Methanians because of harvesting difficulties. I would like to have samples, if possible, which you might ship in the frozen state. No specific information about plant growth or soil consistency is available as yet in the T. E. C. H. library, so I would appreciate detailed descriptions of those plant forms which would be worthwhile developing from a marketing standpoint. Any psychological data on Methanian food prejudices, as well as existing farming methods, the size of Methanian farms, whether they work their land in groups or alone, and the speed with which they now harvest would certainly be a great asset in planning our program.

Thanks very much for your help. Hope we will be able to get you and John that "Mulp" dinner you have been wanting.

Yours very truly,

/s/

Arnold Edward
Chief Designer

Terran Exporting Counsel Headquarters

Spaceport 17321 **Snafu** **Arcturus IV**

Office of General Information

7 March 2953

Mr. Arnold Edward, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Massachusetts
Terran

CONFIDENTIAL

Dear Arnold:

Until our investigation of the various types of Methanian plant life is ready, here is some general information for you to start with.

SOIL -- Volcanic ash - much like ground Mica.
density on Terran - 24 lbs. per cubic ft.
density on Arcturus - 270 lbs. per cubic ft.

THE PLANTS - All plants bear fruit underground, therefore it is necessary to harvest by some digging process. The fruit ranges in size from that of a golf ball to that of a watermelon. It grows at depths of ½ foot to 10 feet underground. (Note - each plant seems to have its own depth.)

METHANIAN HARVESTING METHODS - The Methanians simply dig down to the fruit with crude shovels and pick the fruit by hand. One of the biggest problems is the breaking up of hard spots in the ground and cutting the tendrils of the underground weeds. This is because the Methanians move too slowly to give impact loads to their shovels necessary to cut and break easily. With a shovel a Methanian can move about 5½ cubic feet of soil per hour. (See accompanying study.)

I will soon have a more detailed report for you. Good luck.

CONFIDENTIAL

Yours,

Will Tellum
Asst. Director of Information

Received
Mass. Intergalactic Traders
21 March 2953

Terran Exporting Counsel Headquarters

Spaceport 17321 **Snafu** **Arcturus IV**

Office of General Information

CONFIDENTIAL

14 March 2953

Received
Mass. Intergalactic Traders
21 March 2953

Mr. Arnold Edwards, Chief Designer
Massachusetts Intergalactic Traders, Inc.
78 Massachusetts Avenue
Cambridge, Mass. Terran

Dear Arnold:

Some of the detailed information that you requested is beginning to filter into my office here at the Spaceport and as fast as it comes in I will relay it on to you. I am including in this letter some reports and drawings on two of the important Methanian plants for which we would especially like to see some harvesting equipment. These designs should carry a rather high priority number as these poor Methanians are in desperate need of a large quantity of high energy food. You too would be damn sick of eating mostly worms, insects and low quality meats.

In addition to the information I sent you last week on the Methanian soil, I am sending you a sample box of soil with a little surprise in it. Something for the kiddies (ha-ha).

Your pal,

Will

Will Tellum
Asst Director of Information
T.E.C.H

CONFIDENTIAL

See enclosed photo for the surprize -!! a petrified Methanian head -!!

W.T.

FIG.25: ARCTURIAN PETRIFIED HAND, J.P. JOHNSTON

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 14 March 2953

FROM Will Tellum **TO** Arnold Edward

SUBJECT Methanian "Mulp" Plant **FILE NO.** HM3463

While the mulp is not a staple food of the Arcturians it is believed that if better means of harvesting could be devised, it would become one of the main items in their diet.

The fruit is quite small (see sketch), and in appearance is quite similar to the terranian plum, except that it has a rather tough, horny skin. It is very high in food value; so high, in fact, that the average Methanian can live for several weeks on less than a bushel of them. The tree on which the fruit grows is perennial, and the present method of harvesting is as follows: The ground is dug up with hand shovels around the tree to a depth of some 1½ feet, and about half of the crop is "picked" with trowels. The balance of the crop is left to rot, because if any more of the "branches" were exposed, the tree would die from overexposure to the atmosphere. Even with this method of harvesting, it is necessary to let the following year's crop go unpicked, to permit the tree to regain its strength, for digging to a depth of even 1½ feet permits enough Methane to seep through the soil to weaken the tree considerably.

If some method could be found to extract the fruit without excavating or exposing the tree too much, the entire crop could be picked every year, which would effectively quadruple the output of each tree. (Incidentally, a device which could accomplish these ends would prove successful saleswise).

It must be remembered, however, that the Methanians are somewhat similar to we Terranians with respect to acclimating themselves to rapid changes in technology, and thus, the device must be simple enough so they can understand it readily, and should not be so rapid in operation that it will displace too large a portion of their labor force, upsetting their economy.

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 9 March 2953

FROM Will Tellum **TO** Arnold Edward : Mass. Int. Trdrs.

SUBJECT Methanian "Mulp" Plant **FILE NO.** HM 37649

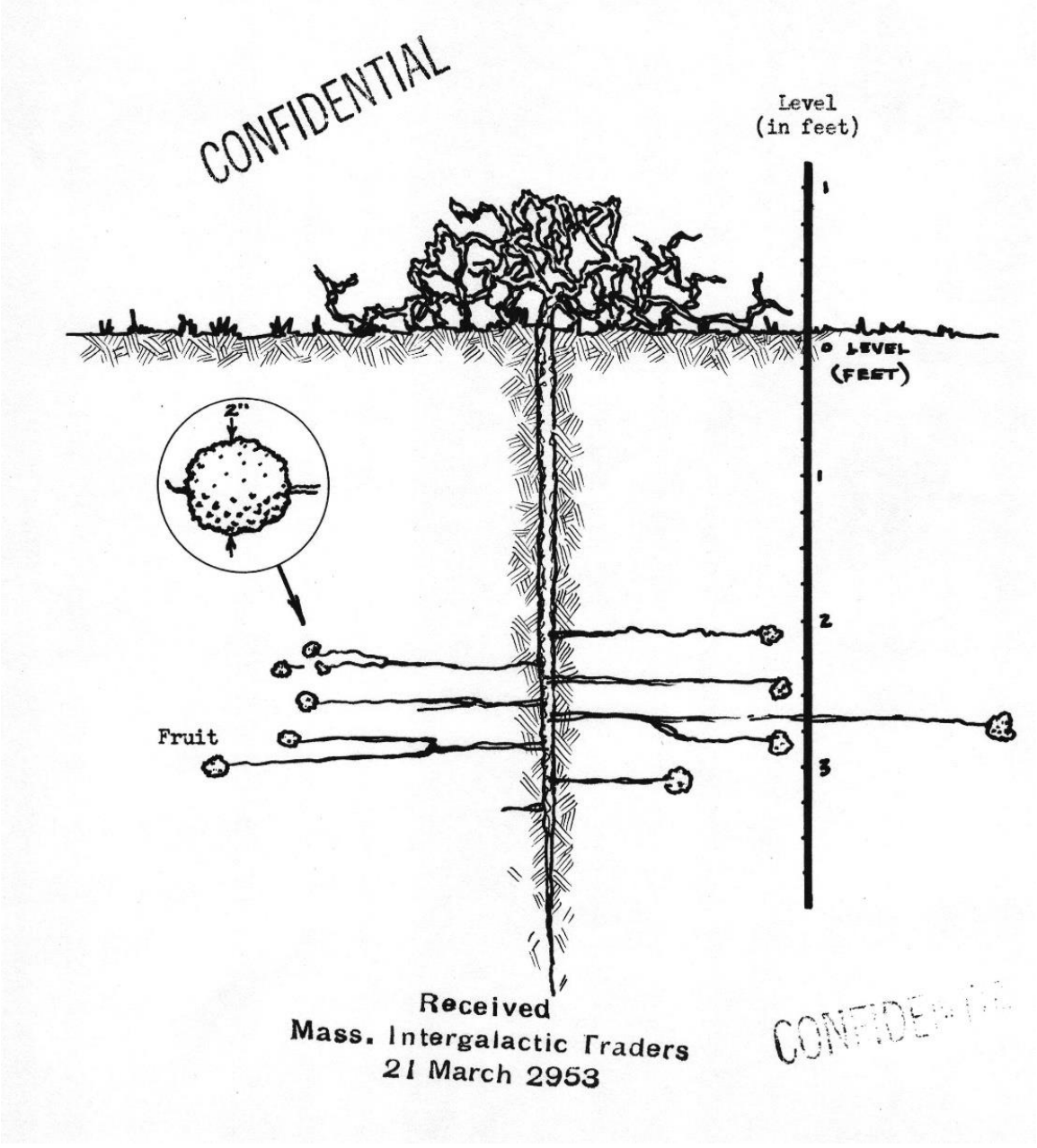


FIG.26: METHANIAN "MULP" PLANT, SKETCH

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE 14 March 2953

FROM Will Tellum **TO** Arnold Edwards

SUBJECT Methanian Lohocla Plant **FILE NO.** HM 37648

One of the most sought after delicacies on the planet Arcturus IV is a hard-shelled fruit known as Lohocla. This is a fruit of very high energy content, being very rich in alcohol. This fruit grows about one to two feet below the surface of the ground. It is about four inches long and two inches in diameter. Each plant bears about ten to fifteen lohoclas two times a season. (See attached sketch.)

The root structure is most unusual, as the sketch shows, and is in the shape of a hemispherical paraboloid. At the focus of the paraboloid a second part of the root receives the concentrated reflected rays of Red Arcturus and by some (as yet unknown) chemical process transmits this radiant energy to the developing fruit.

The plants are annuals but could as mentioned before, bear two crops per season if the fruit could be harvested without destroying the plant. At the present time only one crop is realized as the plants are dug up and destroyed at harvest time.

CONFIDENTIAL

Received
Mass. Intergalactic Traders
21 March 2953

CONFIDENTIAL REPORT

Terran Exporting Counsel Headquarters

DATE _____

FROM Will Tellum TO Arnold Edward : Mass. Int. Trdrs

SUBJECT Methanian "Lohocla" Plant FILE NO. HM 37648

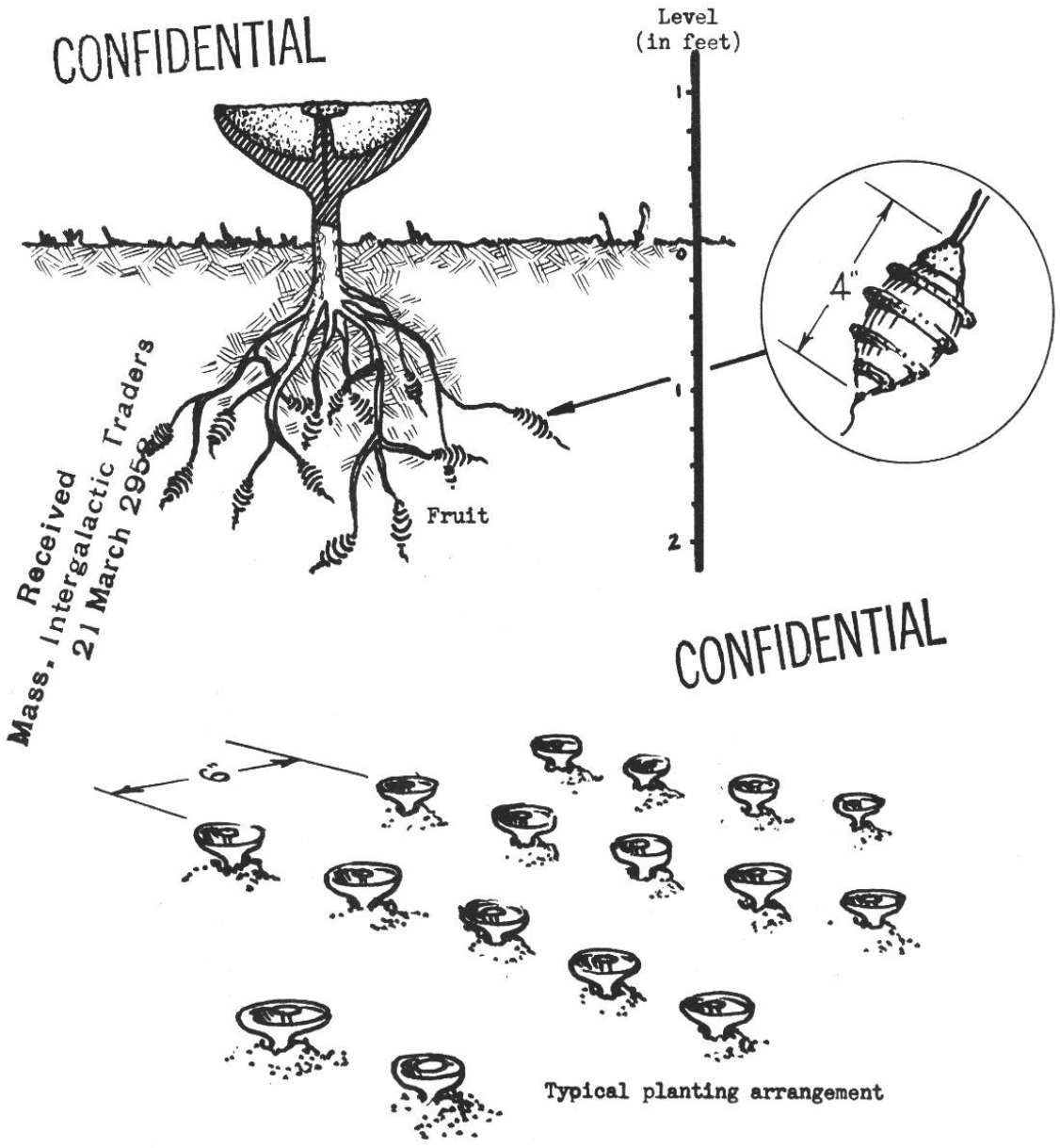


FIG.27: "LOHOCLA" PLANT, SKETCH

INTER-OFFICE MEMO

Massachusetts Intergalactic Traders, Inc.

From: J. P. Johnston[1] **To:** Arnold Edward

Subject: Project: Harvest Moon **File No.** 3463

13 March 2953

CONFIDENTIAL

After receiving your instructions, I have acted on the memo to try to improve existing methods of harvesting on Arcturus IV.

As I gathered from you, some simple device which would have a ready sale on Arcturus until some more efficient harvesting equipment could be developed was the chief prerequisite of this design. Therefore, we decided to work on some hand tools to supplement the shovels of the Methanians.

Since the most pressing problem at the moment is the inability of the Methanians to develop impact loads for cutting and breaking, we worked out a hand operated impact hammer to be used on an improved shovel.

The hammer is simply a cylindrical weight, which, under the force of a spring compressed by the operator, falls on an anvil attached to the shovel handle. The hammer gives an impact load of approximately 3000 lbs. to break a root ¼ inch in diameter, for example. (See accompanying calculations.) The overall weight of the impact hammer is 28 Arcturian pounds and it takes about 100 pounds to compress the main spring through its 4 inch travel.

As shown in the rendering, several improvements have been made on the Arcturian shovel. One is the "Dee" handle just above the foot rests on the back of the shovel blade. This handle helps the farmer to lift the dirt out of the hole he is digging. The foot (or I should say hoof) rests consist of the flat on the back of the shovel blade with a built up edge in front to keep the toe of the hoof from slipping off the shovel.

Also shown on the rendering are a small pronged hand tool for loosening and prying fruit out of the ground if the fruit is near the surface, and an attachment for use with the impact hammer to cut heavier objects than is possible with the shovel blade.

I am submitting this design with the hope that it meets with the committee's approval.

CONFIDENTIAL

Nocturnally yours,

James P. Johnston

[1] The petrified hand seen in Fig. 25 was the work of Johnston, created for his redesign of Methanian shovels (Johnston, 2016).

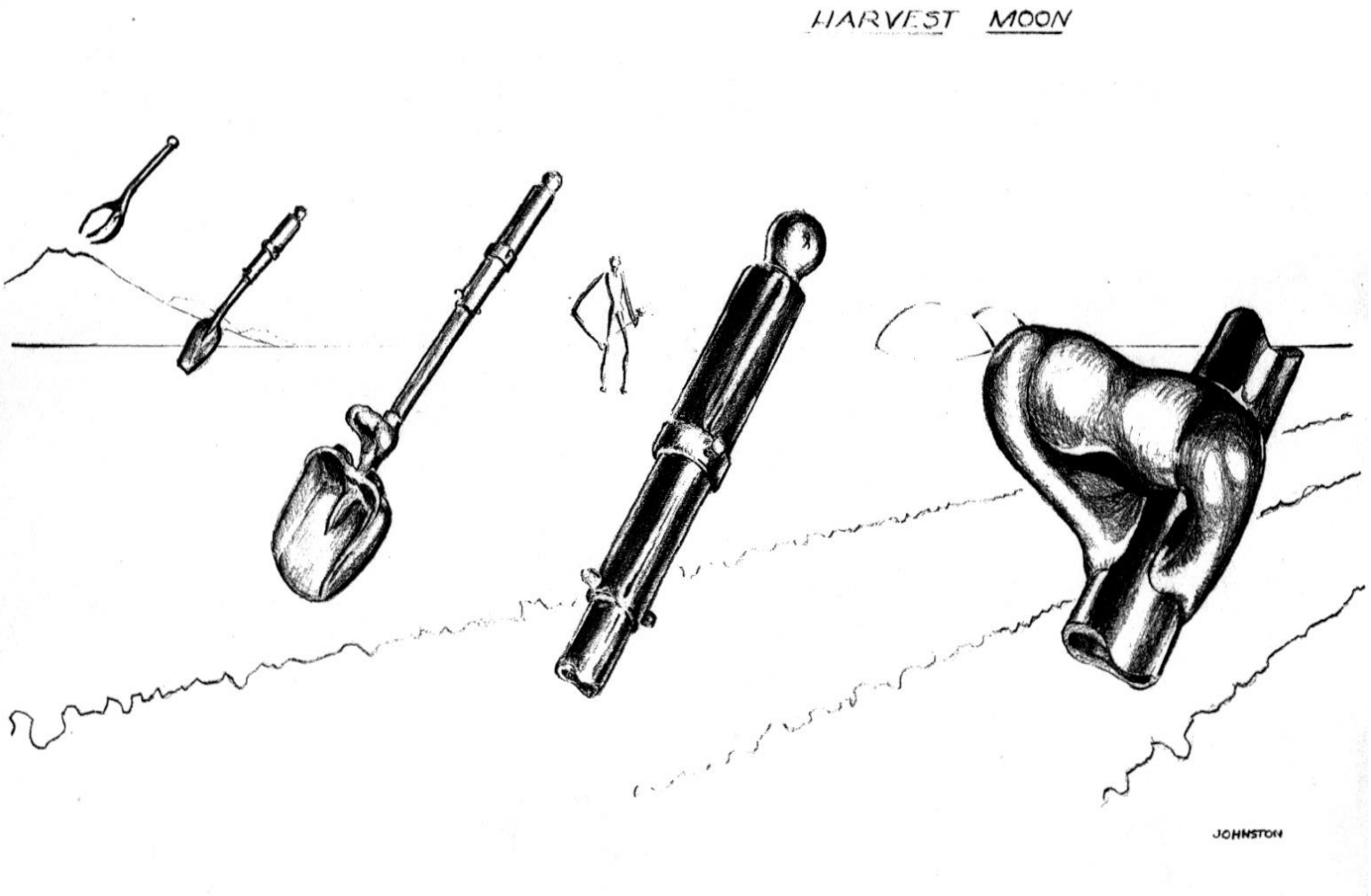


FIG.28: "HARVEST MOON" SHOVEL-TYPE TOOLS DETAIL

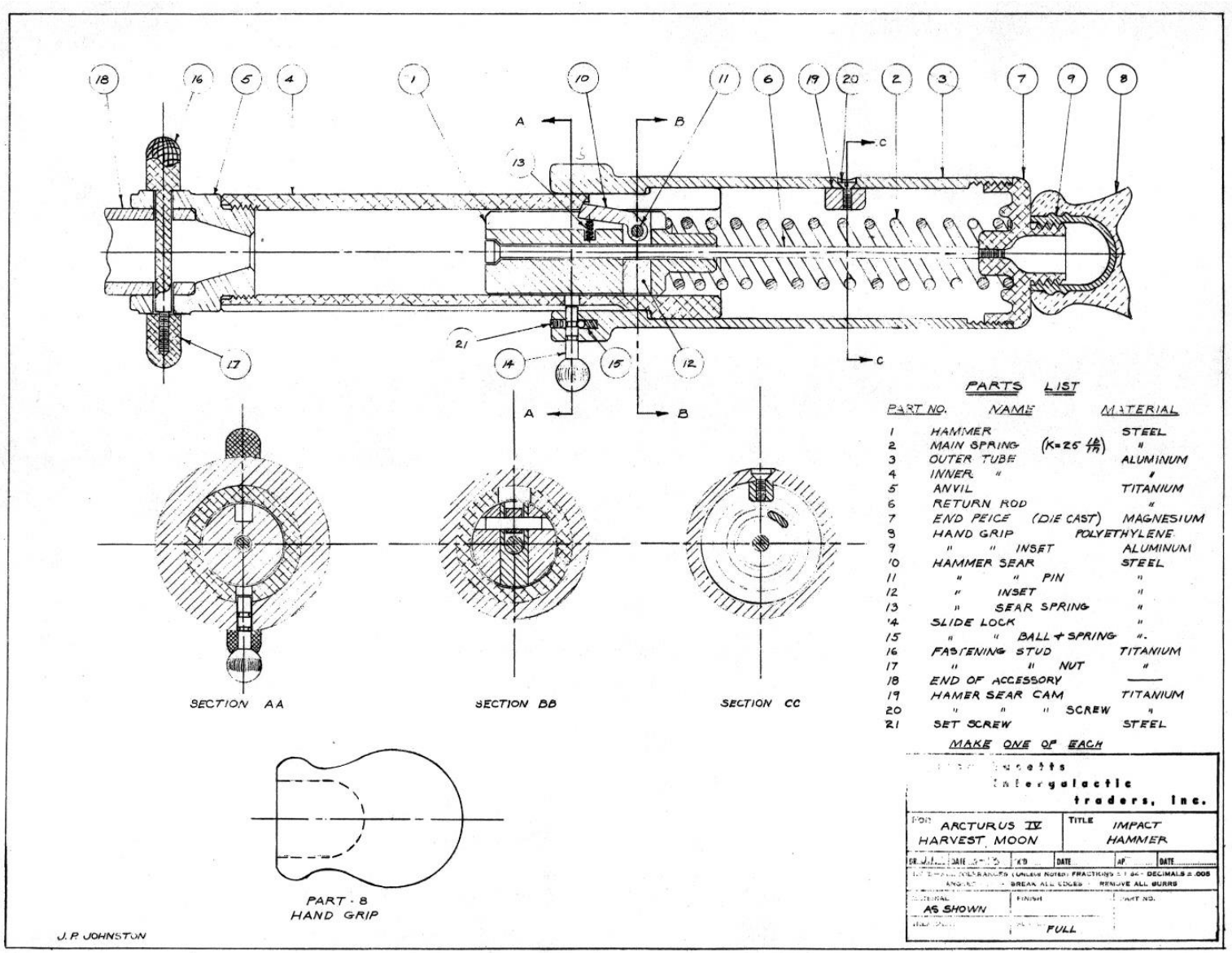


FIG.29: "HARVEST MOON" IMPACT HAMMER

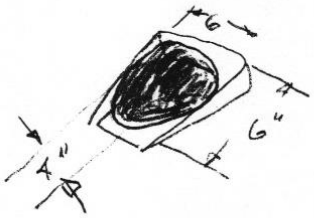
(1)

TIME STUDY DATA

SHOVEL CAPACITY

$4'' \times 6'' \times 6'' = 36'' \times 4'' = 145''^3$

$CAP. = \frac{145}{1730} = 0.083\ ft^3$



$\gamma_{SOIL} = 270\ lb_{(M)}/ft^3$

WT OF 1 SHOVEL FULL ≈ 22#

TIME TO MOVE $1\ ft^3$ OF EARTH

CYCLE		TIME
1)	PUSH SHOVEL INTO GROUND	= 2 sec
2)	TILT TO FILL	= 20 sec
3)	PICK UP FULL	= 10 sec
4)	DEPOSIT DIRT	= 5 sec
	TOTAL TO MOVE $0.083\ ft^3$ →	= 37 sec

TIME TO MOVE $1\ ft^3$ WITH 1.0 sec REST BETWEEN CYCLES → $= \frac{47}{0.083} \approx 570$ sec

TIME = 9.5 minutes / ft^3

FIG.30: TIME STUDY DATA, REDESIGNED SHOVEL

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: M. Deitz To: Arnold Edwards

Subject: Project Harvest Moon File No. MZ 4621

The following is a brief description of the Ordywalc harvesting tool and its use. It seemed to the writer that a portable tool capable of being handled by a few Methanians and obtaining its power from a mobile power source would be the best solution. It also seemed very desirable to have a harvesting tool that could be used without destroying the plants. The Ordywalc is such a mechanism.

A claw mechanism was devised to clasp the fruit. The claw functions as a drill until it surrounds the fruit, its jaws are then closed and the machine started again and drawn out of the earth. A hydraulic system was chosen to power the rotating claw head and also to close the claw jaws. The head is rotated by means of a hydraulic motor (5000 psi) directly coupled to the main torque tube through a gear reduction. This gives constant torque with speed dependent on the setting of the flow control lever. This one lever controls the rotation - e.g. off — on, with intermediate points having linear speed deviations.

The claw is opened and closed by means of another lever which governs the flow of fluid to a hydraulic ram. This ram is linked to the claw operating rod which is inside the torque tube. The motor and ram both use tetrasilicance fluid as their driving medium. This is obtained from a self-powered unit which serves as the base for three Ordywalc units and tows them on their auxiliary dollys to the harvesting location. The Methane internal combustion engine powers a heavy duty pump which feeds the Ordywalc units through Teflon cables reinforced with aluminum.

On arriving at a harvesting location the self-powered pressure generating station is stopped and the three dollys bearing the Ordywalcs are removed. The three man Ordywalc crew then wheel up one unit to a plant and go to work. Two men function as guide men and grasp the tubular handle while the other man directs them. The guide men steady the unit and follow the instructions of the leader who controls the speed and watches the fruit with his x-ray eye. When the drill head reaches

the fruit, the claw grabs it, the machine is reversed and the fruit is harvested. The three man crew rotate their positions - - - thereby resting one Methanian from the physical effort of guiding the unit, and assuring that the leader, who must use his x-ray eye throughout the cycle does not suffer eye fatigue.

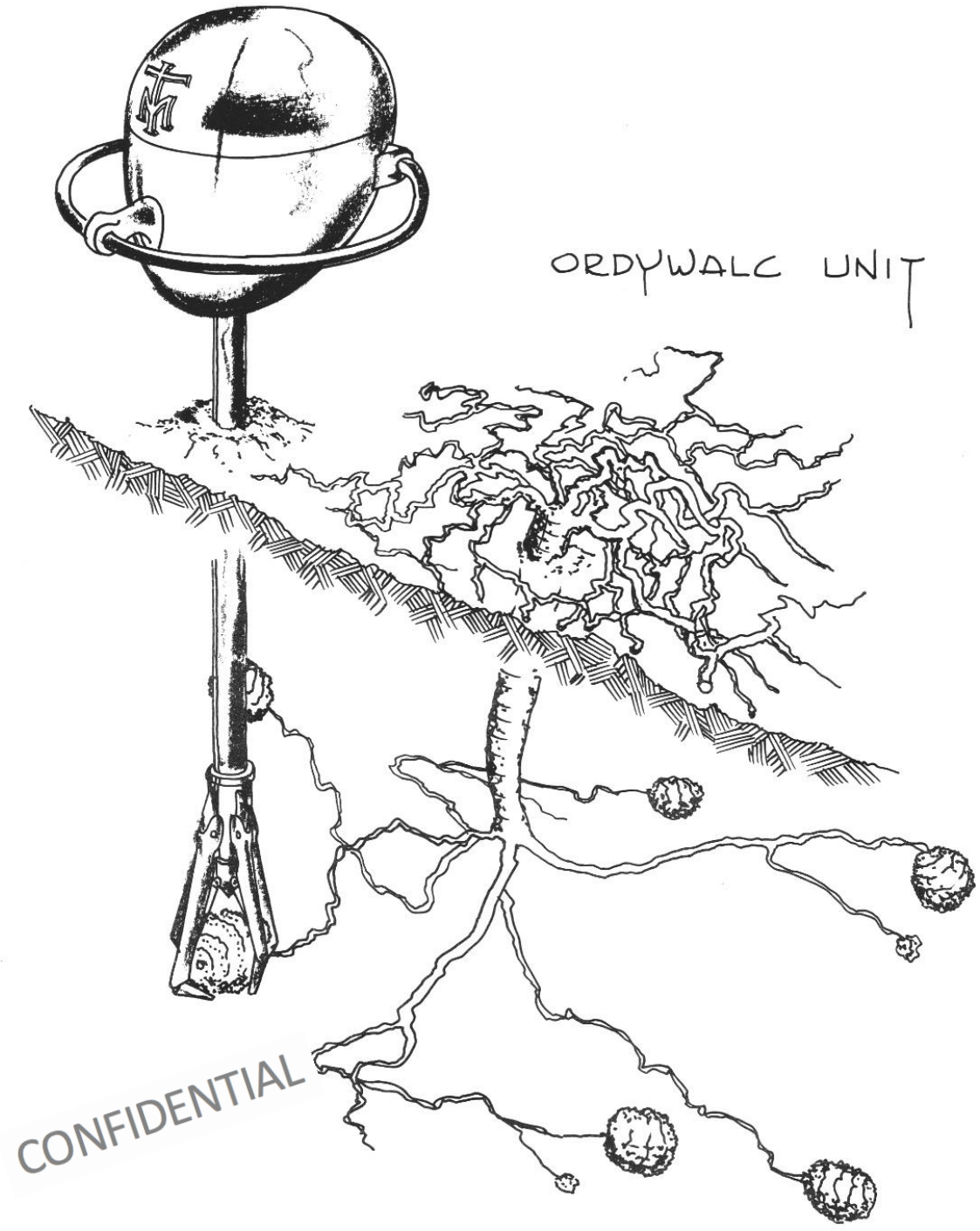


FIG.31: ORDYWALC UNIT

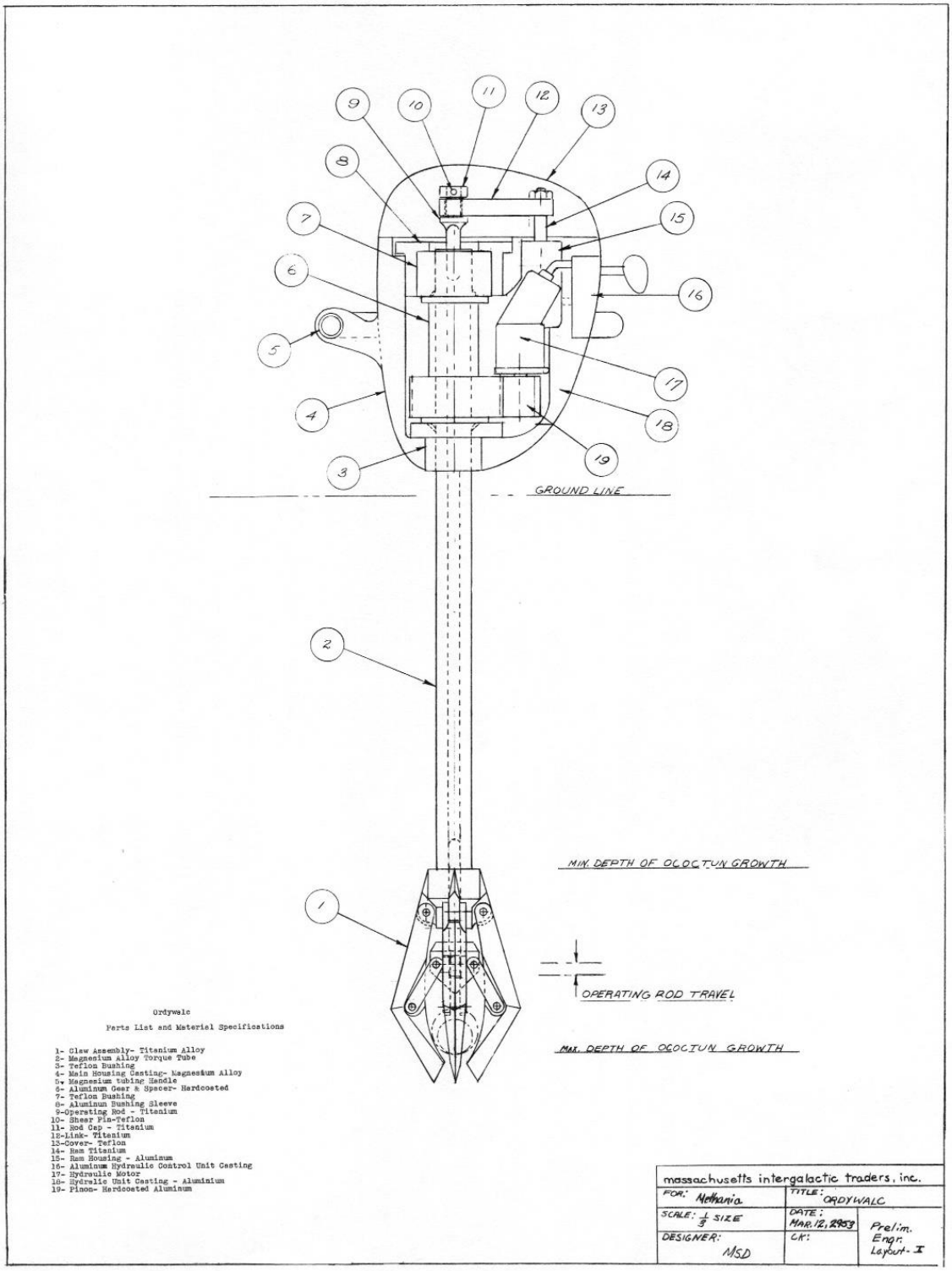


FIG.32: ORDYWALC – PRELIMINARY ENGINEERING LAYOUT

CONFIDENTIAL REPORT

Massachusetts Intergalactic Traders, Inc.

From: Reiter To: Arnold Edwards

Subject: Project Harvest Moon File No. RQ 1375

This device, designed along the lines of a pneumatic hammer, is intended to aid in the cultivation and harvesting of the Arcturian plants which are characterized by their growth in hard, compacted soil. Under such conditions a great amount of labor must be expended simply in breaking up the soil in either the process of cultivation or in the initial steps of removing soil for the purpose of harvesting.

Due to the fact that all previous Arcturian agricultural work has been carried out with hand tools, I have felt it advisable to retain as far as possible the scale and character of the hand tool in designing a powered device, since some reaction may be experienced against the more complex and advanced mechanisms. This soil breaker is intended both to supply an intermediate step between hand work and full mechanization and to allow easier handling of such plants as require individual cultivation and harvesting. I believe that by holding size and weight (86 Arcturian pounds) to a minimum, a useful tool may be created which will, in addition, form a development stage in the Arcturian conversion to mechanized agriculture.

This pneumatic agricultural tool gains a degree of flexibility, since the blades themselves may be changed to suit conditions encountered, and since the large shoulder braces, intended for work against the soil, may be removed, allowing the device to extend its usefulness to construction work and special tasks which must be carried out in close quarters.

All calculations and supplementary design sketches may be found in design folder ZQ 1735.

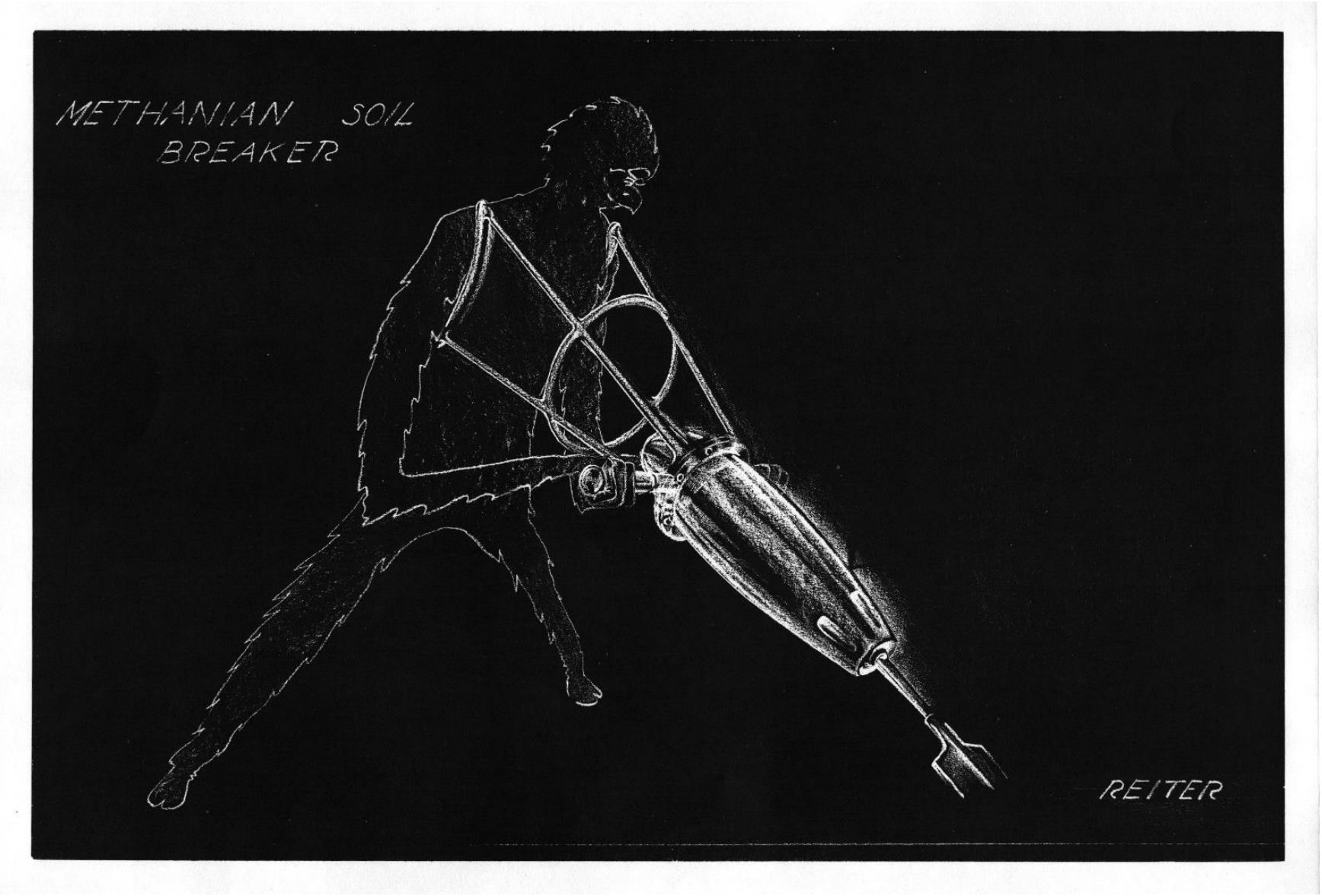


FIG.33: METHANIAN SOIL BREAKER

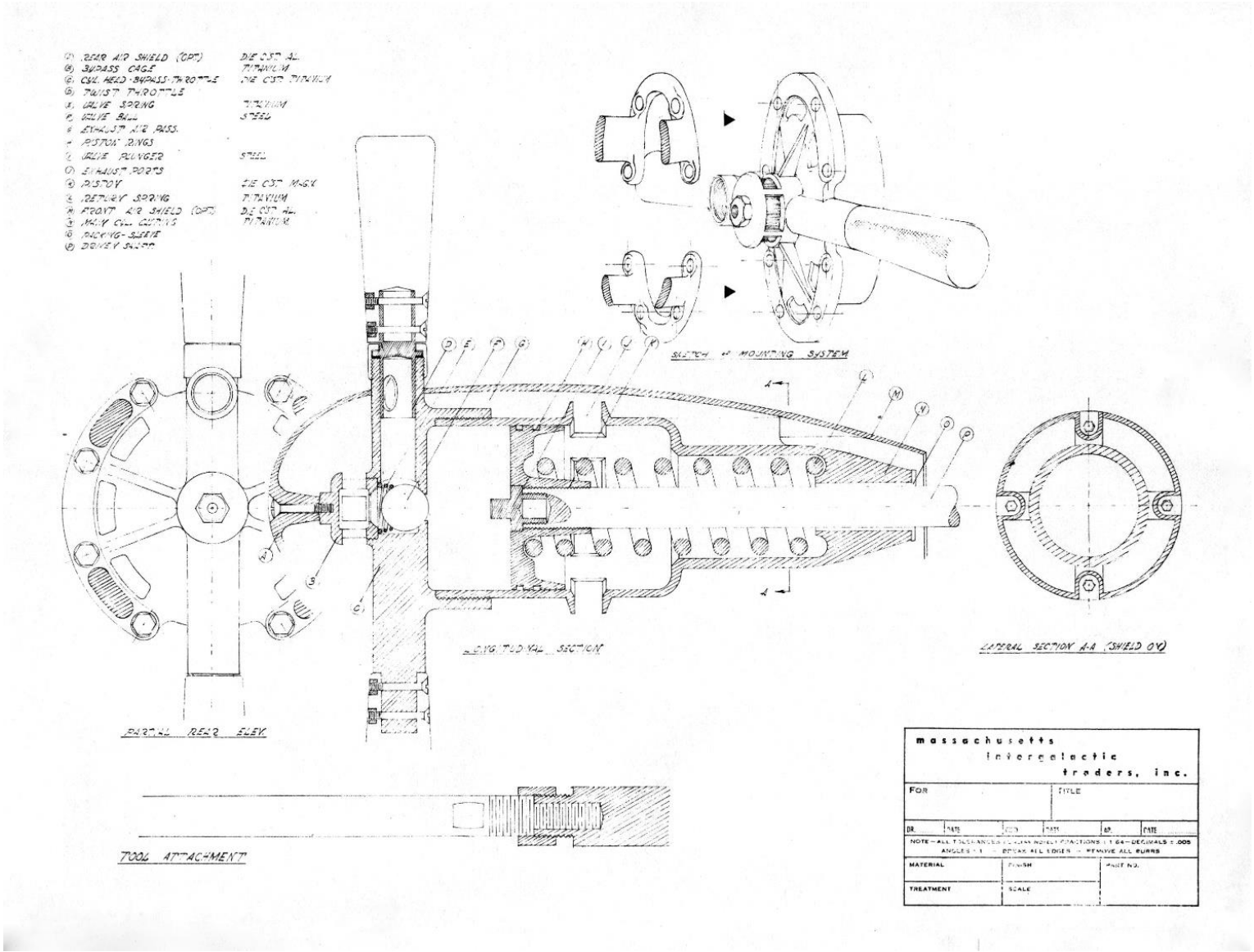


FIG.34: METHANIAN SOIL BREAKER, INTERIOR VIEWS.

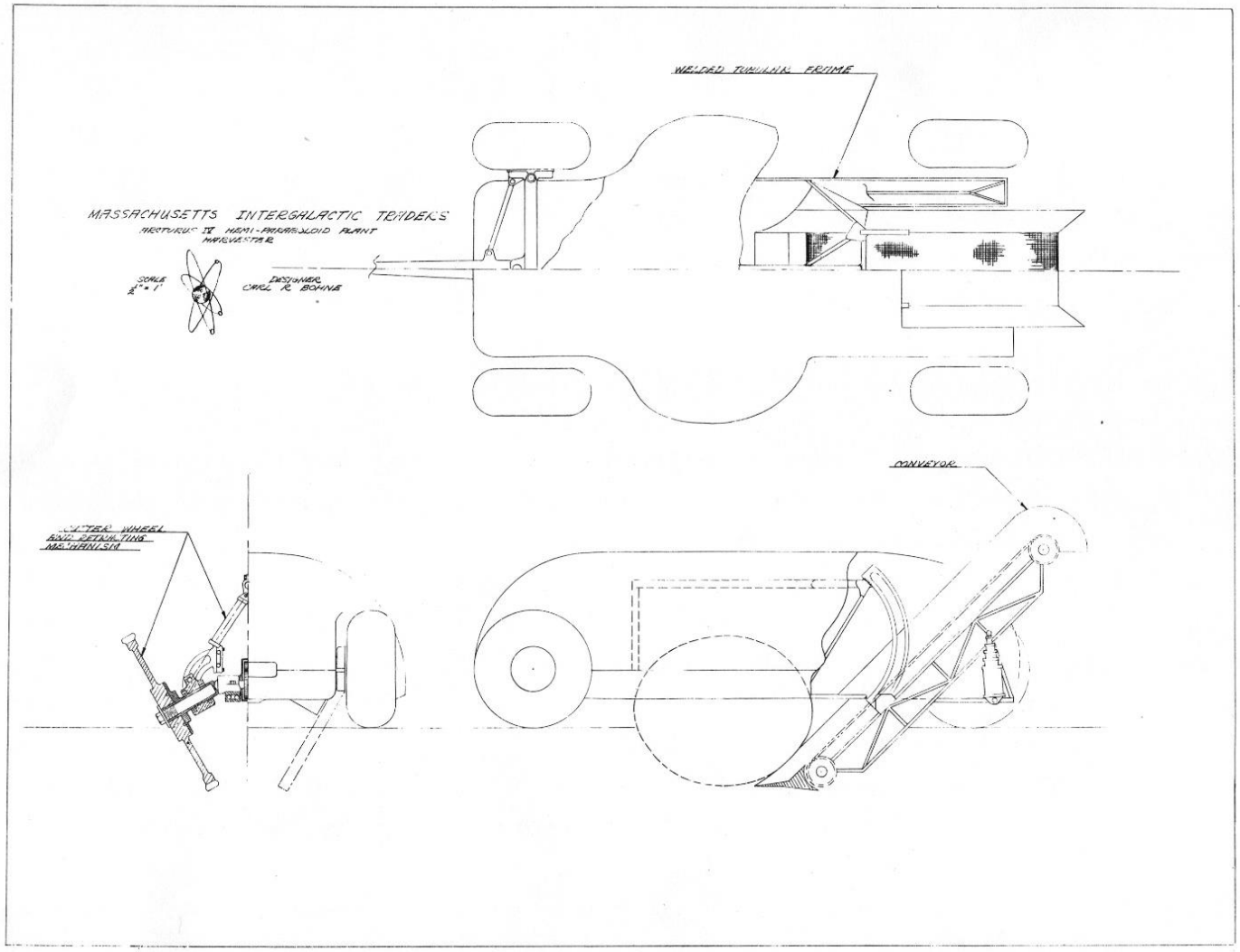


FIG. 35: HEMI-PARABOLOID LOHOCLA PLANT HARVESTER

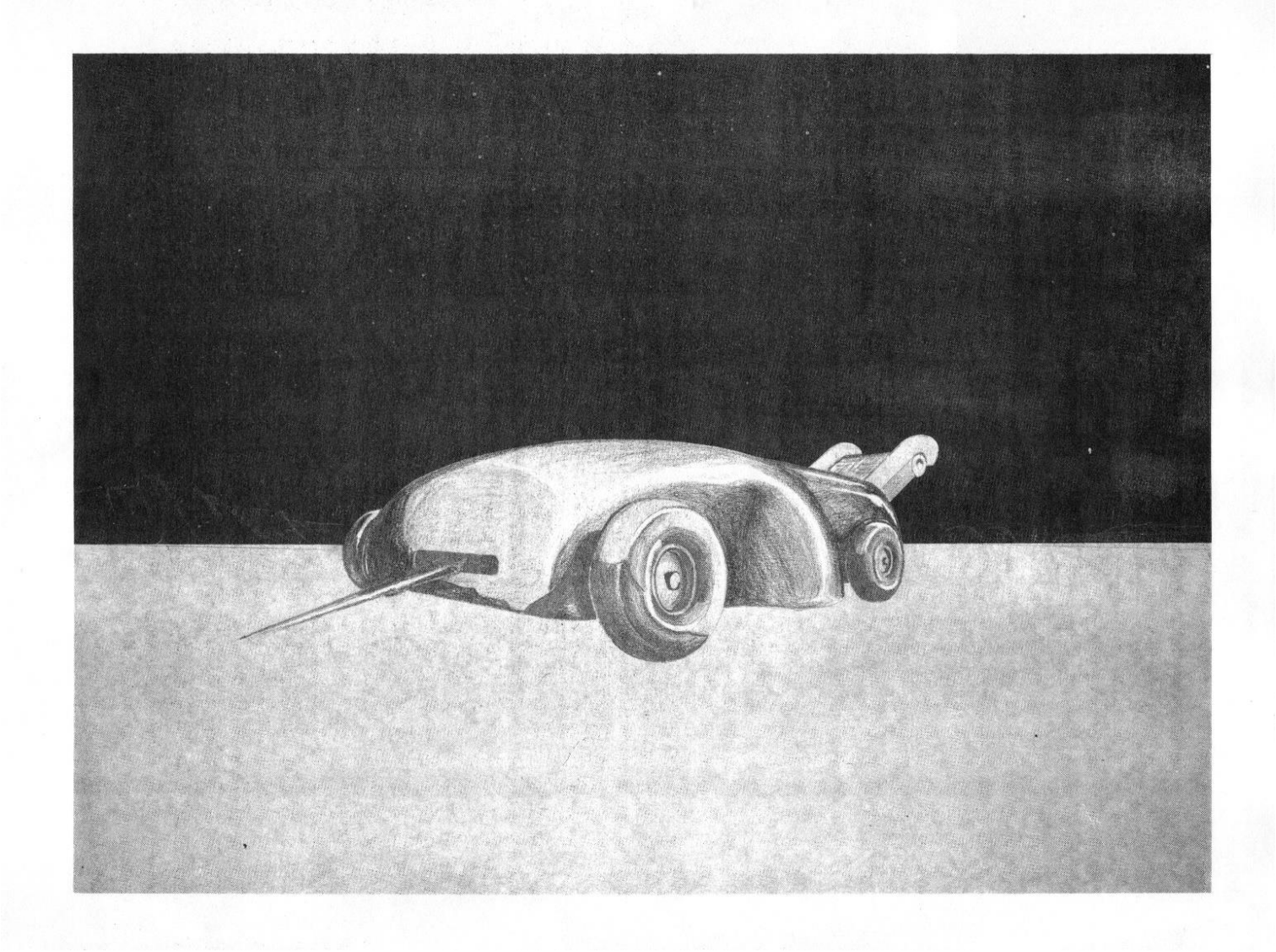


FIG. 36: LOHOCLA PLANT HARVESTER: QUARTER VIEW

Appendix 1: Index Tables

Letter Writers and Affiliations

Individual	Pages	Group	Division & Title
	1, 2	MIT	General Manager
	60, 61	MIT	Furniture Design Div.
Baer, Austin R.	81-84	Baer Design Studios	President
Deitz (Dietz), M.	105-108	MIT	OCD, Designer
Dent, Lean	75	MIT	Sales Manager
Edward (Edwards), Arnold	29, 30, 48, 61, 77, 80, 93	MIT	OCD, Chief Designer
Gardineer, Bayard	49-52	b-g Design Associates	President
Geochani	85-87	MIT	OCD, Designer
Hollenhead (Hollenbach), R. Z.	3, 12, 25-28, 35-40, 68, 69, 76, 92	MIT	Chairman of the Board
Johnston, J. P.	101-104	MIT	OCD, Designer
Lee, K. Wad	4, 5, 9, 91	TECH	Director General
Nold, J. R.	20-22	TECH	Design & Prd, Director
Reiter (Rieter)	109, 110	MIT	OCD, Furniture Div. Designer
Rib, D. F.	67, 70-74	MIT	OCD, Lawn Sprinkler Subdiv., Designer
Rones, J. H.	10, 11, 17-19	TECH	Engineering, General Director
Sapmill, J.	23, 24, 41, 44	MIT	OCD, Associate Designer
Tellum (Tehlum), Will	31-34, 62, 78, 94-100	TECH	Information, Assistant Director
Toff, Gare E.	7, 8, 16	Solar & Galactic Explorers Union	Explorer
Wick, J. S.	13-15, 43, 45	TECH	Psych & Physiology, Director
X	79	TECH	Special Investigator
Yoshida, Ronald	63-66	MIT	OCD, Furniture Design Chief

Abbreviations:

1. MIT: Massachusetts Intergalactic Traders, Inc.
2. OCD: Office of the Chief Designer
3. TECH: Terran Exporting Council Headquarters
4. ("name"), an alternate spelling

Groups, Divisions, & Members

Group	Division & Title	Individual	Pages
Baer Design Studios	President	Baer, Austin R.	81-84
b-g Design Associates	President	Gardineer, Bayard	49-52
MIT	Chairman of the Board	Hollenhead (Hollenbach), R. Z.	3, 12, 25-28, 35-40, 68, 69, 76, 92
MIT	Furniture Design Div.		60, 61
MIT	General Manager		1, 2
MIT	OCD, Associate Designer	Sapmill, J.	23, 24, 41, 44
MIT	OCD, Chief Designer	Edward (Edwards), Arnold	29, 30, 48, 61, 77, 80, 93
MIT	OCD, Designer	Deitz (Dietz), M.	105-108
MIT	OCD, Designer	Geochani	85-87
MIT	OCD, Designer	Johnston, J. P.	101-104
MIT	OCD, Furniture Design Chief	Yoshida, Ronald	63-66
MIT	OCD, Furniture Div. Designer	Reiter (Rieter)	109, 110
MIT	OCD, Lawn Sprinkler Subdiv., Designer	Rib, D. F.	67, 70-74
MIT	Sales Manager	Dent, Lean	75
Solar & Galactic Explorers Union	Explorer	Toff, Gare E.	7, 8, 16

Group	Division & Title	Individual	Page
TECH	Design & Prd, Director	Nold, J. R.	20-22
TECH	Director General	Lee, K. Wad	4, 5, 9, 91
TECH	Engineering, General Director	Rones, J. H.	10, 11, 17-19
TECH	Information, Assistant Director	Tellum (Tehlum), Will	31-34, 62, 78, 94-100
TECH	Psych & Physiology, Director	Wick, J. S.	13, 14, 43, 45
TECH	Special Investigator	X	79

Abbreviations:

1. MIT: Massachusetts Intergalactic Traders, Inc.
2. OCD: Office of the Chief Designer
3. TECH: Terran Exporting Council Headquarters
4. ("name"), an alternate spelling

Letterheads by Group

Group	Letterhead	Page
b-g Design Associates	b-g Design Associates	49, 50
Baer Design Studios	Baer Design Studios	81-82
MIT	Confidential Report	23,26,35,36,85, 105,109
MIT	Inter-Office Memo	1, 2, 12, 25, 28, 60, 61, 63, 92, 101
MIT	Massachusetts Intergalactic Traders, Inc.	3, 27, 29, 41, 44, 48, 67, 68, 70, 75-77, 80, 93
Solar & Galactic Explorers Union	Solar & Galactic Explorers Union	6
TECH	Confidential Report	14, 16, 18, 21, 32-34, 79, 97-100
TECH	Extra-Solar Planet Report	7, 8
TECH	TECH, Snafu, Arcturus IV	31, 62, 78, 94, 95
TECH	Terran Exporting Council Headquarters	4, 5, 9-11, 13, 17, 20, 43, 45, 91

Abbreviations:

1. MIT: Massachusetts Intergalactic Traders, Inc.
2. TECH: Terran Exporting Council Headquarters

Faculty & Students Associated with *Arcturus IV*

An incomplete List

***Arcturus IV* Name**	**Faculty**	**Student**	**Notes**
J. R. Nold	John Arnold		
Arnold Edward	(John) Edward Arnold		
J. H. Rones	John Hrones		
	Thomas B. Sheridan*		Research Assistant, Instructor
Gare E. Toff	?		***Information only
J. S. Wick	James Reswick?		Information only
K. Wad Lee	?		Information only
Lean Dent	Deane Lent?		Information only
Will Tellum	?	?	Information only
Austin R. Baer	Austin R. Baer**	Austin R. Baer**	Eggomobile, Instructor
Bayard Gardineer		Bayard Gardineer	Kitchen appliances
		Carl R. Bohne	Plant harvester
D. F. Rib		Darrel Frohrib	Lawn Conditioner
Geochani		Geocheri?	Acustom
J. P. Johnston		J. P. Johnson	Harvest Moon shovels Impact hammer
J^2 DKM		J^2 DKM	Interurban Under
Joe Sapmill		Joe Millsap**	Carriage-Incubator Stereoscope ?
M. Deitz		M. Deitz	Ordywalc
		P. A. Aeuschatz	Designer's Sketchbook
Reiter (Rieter)		Reiter	Soil Breaker
R. Z. Hollenhead		Robert Hollenbach**	Clock
Ron Yoshida		Ron Yoshida	Lame's Lounge ? Class of 1952

* (Sheridan, 2015) ** (Hunt, 1955)

*** *Arcturus IV* characters tagged with "Information Only" are believed to be principally John Arnold in his role as "information provider" to his design students. Yet it is also known that students, at times, played a similar role. Other insructors, e.g., Sheridan and Baer, may have filled such a role. Regardless, the names used in the case study likely were often inspired by actual faculty members and students.

A Few Examples of Playful Names Found in the Case Study

J. H. Rones, derived from J. Hrones, MIT Professor of Mechanical Engineering

Herbivorous Carnivorous Arnoldious, Arcturus IV plant

R. Z. Hollenhead (Hole-in-Head) for student Bob Hollenbach

Lame's Lounge Chair: Fig. 16 and Case Study Page 66; a pun on the famous Eames Lounge

Locations of Known Case Studies Associated with John E. Arnold

Case	Year	SU[1]	ECL[2]	Other
Box Car Design	1952	✓	✓	
Chinese Typewriter	1952	✓	✓	MIT[5]
Rice in Burma	1952	✓	✓	MIT[5]
Arcturus IV	1953	✓	✓	
Ceres Project	1954	✓	✓	UC Berkeley[5]
Antarctic Mining[3]	1955			
Ion Exchange	1955	✓	✓	
Arcturus IV Part Two[4]	c 1955			
Sick Room Equipment	1956	✓	✓	
Telephone Information Service	1959	✓		
Zylerium Blindness	c 1961-1962	✓	✓	

[1] Stanford University Archive
[2] ASEE Engineering Case Library, The Internet Archive
[3] Discussed in (Hunt, 1955)
[4] Based on a captured Internet screenshot of the cover
[5] Based on a WorldCat Internet search

Arcturus Project Sessions

At the time Professor Arnold was teaching his Product Design course, MIT was using a two semester (term), plus summer session, academic year. It is known from what Arnold has written that the Arcturus IV portion came at the beginning of the course. The elective course was offered twice each year. Arnold said that the Arcturus component had been offered three times by the publication date (May 1953) of the *Astounding Science Fiction* article (see Appendix 3).

Arnold has also stated that the course, with each offering, focused on one of three broad design themes, the first being Home and Yard Items, followed by Transportation, and then Farm Equipment. The Case Study did not make explicit the term, the academic year, and the students enrolled in each particular offering of the course.

Fortunately we can deduce some of that by noting the dates and names on many of the students' engineering drawings and/or on the notes that accompanied the drawings which were sometimes included in the Case Study. Any of the dates that were in the 30th century had 1000 subtracted from their date before being entered in the below tables. For those drawings that were undated, their theme and grouping location in the Case Study permits us to surmise when they were submitted. The tables below reveal when the Arcturus segment of the course was taught :

1950 — 1951 Academic Year			
Quarter	Drawing	Student	Date Submitted
Term 1 September - January			
Term 2 February - May			
Summer[1]	Food Mixer & Base Base & Motor Unit Food Mixer Attachment Designers Sketchbook	Gardineer Gardineer Gardineer Aeuschatz	8/30/1951 8/19/1951 8/17/1951 ?

[1]No Product Design course was offered in the Summer session. Rather it appears that Arnold hired Gardineer to offer some early designs of kitchen appliances to help prepare the students for their own design work (Pages 48-55).

1951 — 1952 Academic Year			
Quarter	Drawing	Student	Date Submitted
Term 1 September - January	Clock drawings (4) Carriage-Incubator Stereoscope Viewer Lame's Lounge Lawn Conditioner	Hollenbach Millsap[1] ? Millsap[1]? Yoshida[1]? Frohrib	12/27-28/1951 12//24/1951 1/15/1952 1/17/1952 1/17/1952
Term 2 February - May			
Summer			

[1]The drawing was unsigned but the text associated with it strongly suggests the designer's name.

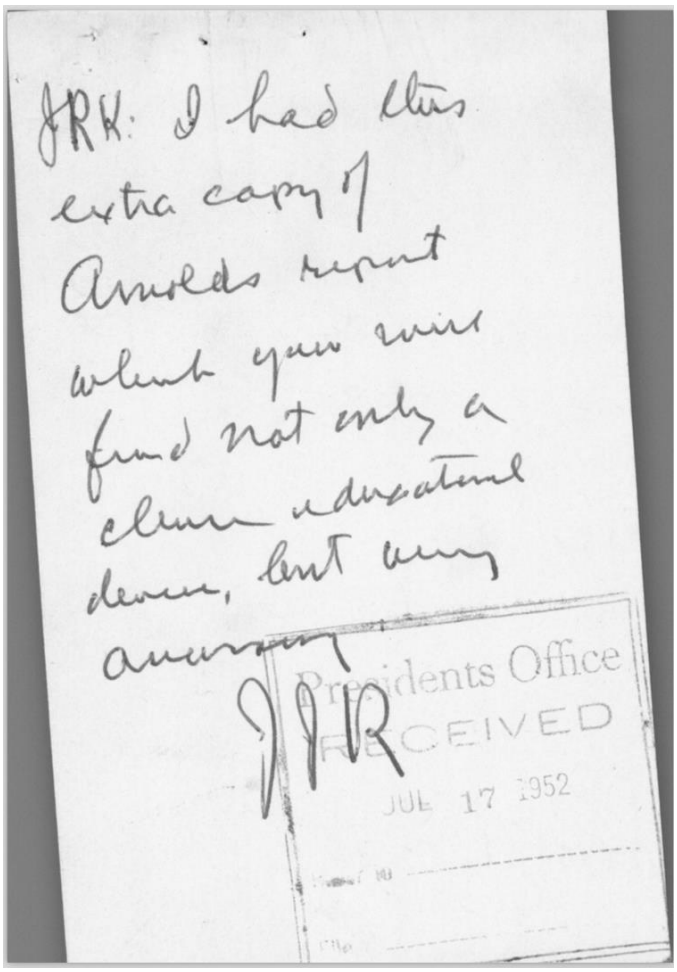
1952 — 1953 Academic Year			
Quarter	Drawing	Student	Date Submitted
Term 1 September - January	Eggomobile Acustom Interurban Under Mono-rail	Baer Geocheri ? J^2 DKM SY	10/28/1952 10/31/1952 ? 11/1/ ?
Term 2 February - May	Ordywalc Harvest Moon shovels Impact Hammer Soil Breakers (2) Harvester (2)	Deitz Johnston Johnston Reiter Bohne	3/12/1953 3/13/1953 ? ? ?
Summer			

Appendix 2: Introduction to Case Study on Arcturus IV

Editor's Note: This report was discovered in the MIT Museum with the following note attached:

JRK: I had this extra copy of Arnold's report which you will find not only a clever educational device, but very amusing.

JJR



The note was stamped: "Presidents Office, RECEIVED Jul 17 1952"

"JRK" refers to James R. Killian, President of MIT from 1948 to 1959.

The bottom initials, "JJR," quite possibly belong to John James Rowland, who was Director of News Service during this time period.

INTRODUCTION TO CASE STUDY ON ARCTURUS IV

John E. Arnold, 1952

How can we raise the level of creative thinking? How can we train engineering students to use their imaginations, to speculate? These and similar questions have plagued us of the Machine Design Division of the Department of Mechanical Engineering at M.I.T. for a number of years. We are not as convinced as some that creative ability is something one is born with and to which no power can add or detract. Of course, it is an inherited trait and the capacity for creative thinking varies from person to person just as the capacity for analytical thinking varies.

Psychologists have shown us, however, that even the best of us utilize only a small fraction of our intellectual capacity. For one reason or another we just begin to develop the brain that we were born with. George Bernard Shaw once remarked that most people think at least once a week and built up an international reputation in the process.

Now we contend that a similar situation exists in our capacity for imaginative creative thinking. We are all born with a greater or lesser amount of curiosity and imagination. All through childhood we rely heavily on these related traits in order to learn about the world that we live in and to adapt ourselves to it. But as we gather more facts and information our thinking processes become more analytical and imagination plays a less important role. Less important, that is, in adapting ourselves to a static or slowly changing environment. Place an adult, however, in an entirely new and different environment and the one with the most imagination will make the quickest and most successful adjustment.

A parallel can be drawn from history in the development of past civilizations. During the early growth of a civilization men of great creative ability sprang forth in great numbers as leaders in all fields of endeavor. But as the civilization grew older and became better established the desire for a status quo seemed to negate the desire for progressive change and the former wealth of creative ability disappeared. A similar situation can and is taking place in America. The need for men of creative ability is as great or greater than at any time in our history yet it is becoming increasingly difficult to find them. An emphasis on security is strangling our pioneering spirit.

If we admit then that all children are born into this world with a certain amount of curiosity and imagination (the two prime prerequisites of creative endeavor) what happens between childhood and adulthood that the great majority lose or fail to use these talents? And is it a question of actual loss or do we bury it so deeply in the recesses of our minds, piling on fact after fact, that for all practical purposes it may be assumed lost. If it is the latter, then it may be possible to provide the proper atmosphere and stimulation and bring forth at least a part of this hidden talent. Then by careful and continuing exercise the quantity and quality of this mental ability may grow and develop into a useful and sorely needed tool.

It is certainly important to provide an enthusiastic stimulating atmosphere in which speculation is encouraged. After that courses must be provided in which the student is required to use his imagination and exercise his creative ability. Courses in which not too many new facts are presented, but in which all the student's past experience and education is drawn upon in order to solve new problems must be included in the group of electives offered to students and in at least one required course. During the past five years our courses in Machine Design have emphasized the creative aspects of design. Problems are presented in such a way that they do not have one unique and correct solution. Synthesis is stressed more than analysis and a premium is placed on imagination. All mechanical engineers must take at least one course in machine design. Other similar machine design courses are available to seniors and graduate students as electives.

Two years ago in response to student demand and requests from individuals and groups in and out of the Institute a two term sequence was inaugurated in the field of Product Design. Here again, creative thinking is stressed and the student is compelled to draw on many fields of activity in addition to his general engineering background of scientific fundamentals. The student is introduced to the psychological and marketing and production aspects of design and expected to combine them with his scientific knowledge into a program of creative engineering.

Included in the course are four major design projects, each carefully planned to bring out certain aspects of the course. The projects are presented to the students as case histories in such a way as to make the problem as real as possible. All the necessary background material is given the student in the form of a complete report. In some cases a complete set of drawings of one solution to the problem is included in the report. In all cases to date the problems deal with products that are not on the market (at least in no great quantity or in exactly the same form) so that the students are not faced with the problem of redesigning a product that has already gone through a long evolutionary design process.

Of the various problems that we have given, the one that elicited the most interest and enthusiasm from the students was an imaginative type of problem that was attempted purely as an experiment. In this case history, time has been advanced a thousand years. Space travel is well established and intra and inter galactic trade is actively pursued. The government of Terra has established a special Bureau (Terran Exporting Counsel Headquarters) for the gathering of information relative to and regulating trade with other planets. Terran firms wishing to trade with others must work through this Bureau.

The case material is presented to the students in the form of a file of letters and special reports, printed on the special letterheads and forms of the various agencies and people involved in order to add to the realism of the problem. A fairly detailed story unfolds as one reads through this file and sufficient information is given so that design projects can be undertaken.

The story starts out with a letter from the Chairman of the Board of the Massachusetts Intergalactic Traders, Inc. requesting from the Terran Exporting Counsel Headquarters information relative to the discovery of intelligent life on Arcturus IV. The T.E.C.H. file on Arcturus IV is sent to M.I.T. Inc. and includes a letter from the Solar and Galactic Explorer who first discovered Arcturus IV. This letter briefly describes the type of life found there and the conditions under which it exists. A special form on new planet discoveries gives detailed information on the physical aspects of the planet, such as its size, density, temperature extremes, atmosphere, length of day and year, etc. It turns out that this planet has

a gravity of eleven times that of the earth; the mean summer temperature is -50°C and the mean winter temperature is -110°C; the atmosphere is composed primarily of methane.

T.E.C.H. sends out three groups of experts under "Project Arcturus" to learn more about the planet and its life, and these groups send back special "Confidential Reports". The engineering group is charged with the establishment of a branch office on Arcturus IV and the gathering of facts pertaining to the physical aspects of the planet. From them we learn something about the geography of the planet; how the people live in the cities and farms; the metabolic process of plant and animal life; a description of plant and animal life (plant life grows upside down, the roots extending into the atmosphere and the fruiting portion growing below the surface); and a description of the materials used for construction.

A second group is interested in the physiological and psychological aspects of the people and their culture. These people are called Methanians and apparently evolved from birds. They are short and relatively light. Mr. J. S. Wick in his report stated, "The Methanians weigh very little compared to us. One of the largest we met was weighed on a Terranian spring scale at 187 pounds. Their bones are hollow and apparently filled with hydrogen and helium. There is no question but that these people have evolved from a race of bird-men, their appearance seems to indicate it, their history proves it. Their long arms and claw like hands (two five jointed fingers and a four jointed thumb) are vestiges of once great wings. The only anomaly is their single-toed foot like that of a horse. This adaption to ground living evolved very rapidly once the power of flight was lost."

Among many other interesting features of this race one finds that they have a very slow stimulus-response time of two seconds; that they have an extremely large auditory, vocal and visual range; and they have a limited amount of telepathic ability. They are very stable emotionally. They are monogamous and very gregarious.

The third group in "Project Arcturus" studied and reported on the marketing and production. The state of the culture found there was comparable to early 20th century American culture. Electricity was used, for example, for light and power but nothing was known of electronics. The group reported that the opportunities for trade were unlimited.

The Massachusetts Intergalactic Traders, therefore, decided to go into production on goods for Arcturus IV. They set up the design "Project Dishpan" to include all designs of a personal or household nature.

The students were required to design articles of this type using present day materials and technology. These articles were to be built on earth and shipped to Arcturus IV for trade.

Now there are three reasons for a case of this type. First, it is a powerful stimulus to imaginative thinking. There are not many places in the curriculum of a technical school where speculation can be indulged in, yet speculation has been responsible for most of our scientific advancements. Second, it makes the student extremely aware of the environment into which his design must fit. This consciousness of environment is, of course, just as important for present day designers, yet too many of them take our earthly conditions for granted without too much thought being given to the effects of temperature, atmosphere, gravity, etc. on the products they are designing. Third, a case of this type

dramatizes the importance of the individual's role in the design of products. During and since the war a great deal of effort and thought has gone into the study of "Human Engineering". They have tried to determine how the human body limits designs; how the way we see, hear, feel, and react should modify the products and machines we use.

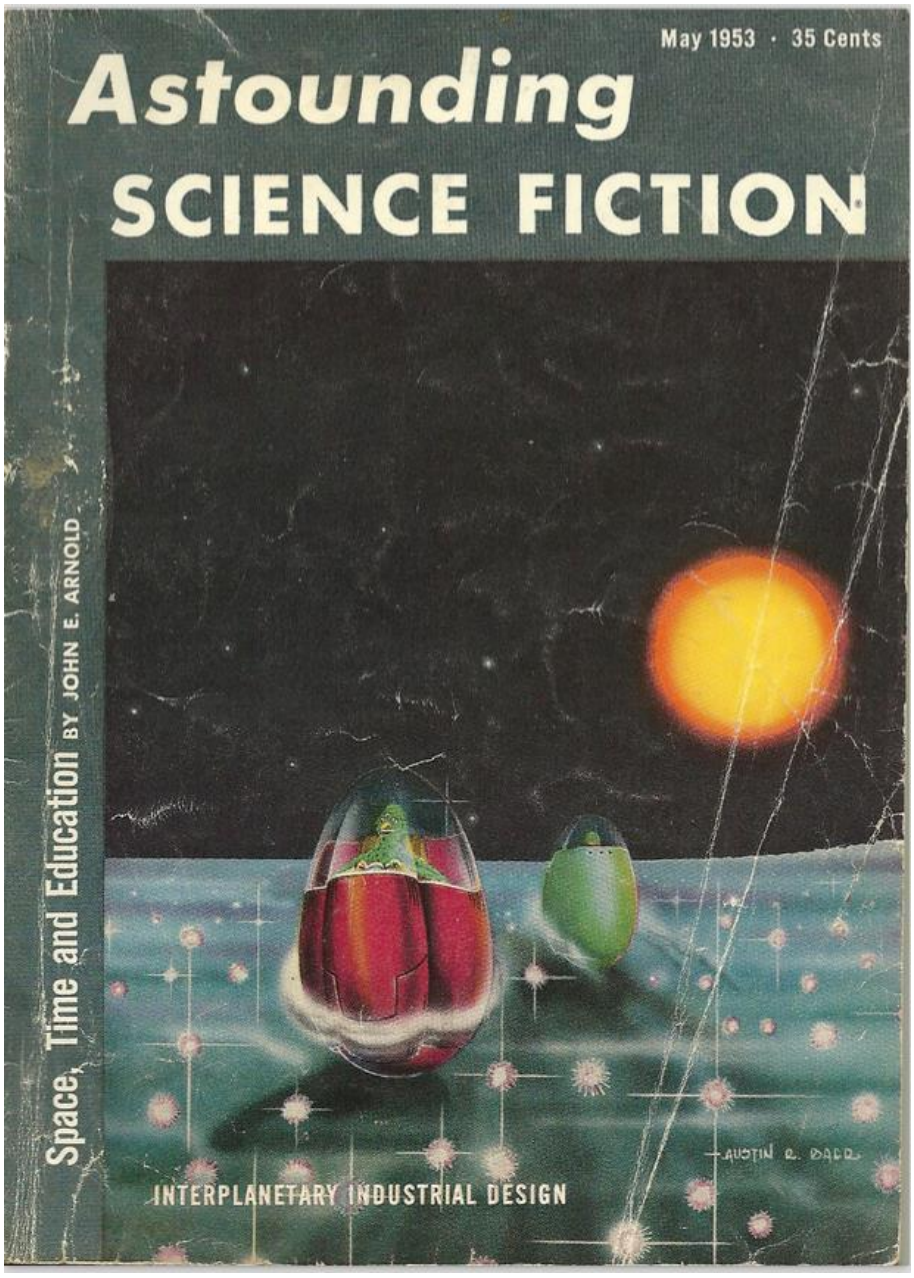
This case covered a little over three weeks of the term's work. During this period the lectures were devoted primarily to "Human Engineering". The psychology and physiology of human beings were discussed and comparisons were drawn between humans and the Methanian.

Taking everything into consideration it was a very successful experiment and we plan to continue it in the coming years. The best work of the students of each term will be added to the file, thereby increasing our knowledge of the Methanians and more closely defining the design conditions.

Appendix 3: Space, Time and Education

Editor's Note:

On the following page is a note by *Astounding Science Fiction (ASF)* Editor John W. Campbell that accompanies Arnold's article. According to Kizilos-Clifts (2009, p.209, unreferenced), the MIT Science Fiction Society (MITSFS) made a deal with Campbell. He agreed to speak before MITSFS if MITSFS could convince Arnold to write an article for ASF, the most widely read and highly regarded Sci Fi magazine of its day. The magazine's stature in large part was due to Campbell's talent for recognizing promising new writers like Isaac Asimov, Robert Heinlein, and Theodore Sturgeon—a talent made easier perhaps by Campbell's own success as a science fiction writer in the years before he became Editor of *ASF* in 1937.



Campbell is widely credited with being the dominant force that led to the Golden Years of Science Fiction after the end of World War II. His ability to promote a writer's career gained him considerable influence. His love of ideas (science fiction is "the literature of ideas") and his interests in psychology, as well as his age and educational background—MIT and Duke University—must have facilitated the interaction between Campbell and Arnold. Certainly Campbell's enthusiasm for Arnold's work was noteworthy, as you will see.

An ASF Factual Article

SPACE, TIME AND EDUCATION

BY JOHN E. ARNOLD

A unique type of course in creative thinking is in operation at the Massachusetts Institute of Technology — science fiction as a laboratory technology!

Professor John E. Arnold, in this article, gives one of the first discussions of the unique, and highly interesting educational technique he and his co-workers have developed at M.I.T.

Most of the articles we run in this magazine have to do with developments of physical science; there are very, very few social-science inventions available for discussion, wherein a clean-cut break-away from traditional methods can be defined concretely, the reasons for the break-away stated clearly, and the theory behind the change made definite.

Yet in our present world of gadgets, machines, and highly developed physical technology, social inventions are the crying need of Mankind. Perhaps a major reason for the extreme paucity of social invention is the lack of just such training in creative thinking as Professor Arnold's course is specifically designed to provide.

There is a curious and confusing paradox in the nature of human progress; men have, down the ages, been willing to fight and die for the ideals they hold valid and important. Men have shown full willingness to total self-sacrifice in defense of their heritage.

Yet by the very meaning of the concepts, it is impossible, and forever will be impossible, to maintain the "Ancient Heritage" and progress in any way! No man today can defend the democracy that Washington and Jefferson established, because America has developed, has learned greater wisdom and invented new social ideas, the "heritage" of Washington and Jefferson is forever gone!

For example, in their day, their concept of democracy held that no man who owned less than five thousand dollars' worth of property had a right to vote. Their concept of democracy has long since been changed; they would never have accepted the idea of woman voters.

The very fact that men are idealists, and will fight for their ideals, makes social inventions extremely difficult under our present-day understanding of what actually constitutes "our heritage." The more strongly and deeply idealistic a man is, the

more genuinely and sincerely he holds his honest beliefs, the more valiantly he will defend these "truths" that are, to him, self-evident.

Social inventions are most desperately needed today—and are hardest of all to make, because each man, within himself, has limited his own creative thinking. By failing to find the fundamental core of his ideals, he may sacrifice everything in a pointless defense of a nonessential.

Fifty years ago, the engineering student was considered something of a second-class citizen of the college campus; only the Liberal Arts student was considered a true student. A social invention was making its way, however. Where major corporations and businesses were uniformly directed by lawyers and Liberal Arts students only one generation ago—today the technical man is taking a bigger and bigger part in executive control.

Educational methods, more than any other single factor, will determine what our world is like in another half century. Of all possible forms of education, it seems to me that the most critical is education to understand, use, and evaluate creative thinking.

It is my feeling that studies of creative thinking itself—such work as Professor Arnold and his co-workers at M.I.T. have started—are basic to understanding our Research Age civilization. Where such work as Newton did was necessary to understanding the physical world, studies of creative thinking are necessarily more fundamental; understanding gravity did not necessarily lead to understanding creative thinking. But if ever Mankind learned to understand creative thinking, that necessarily implies ability to generate an understanding of all physical forces.

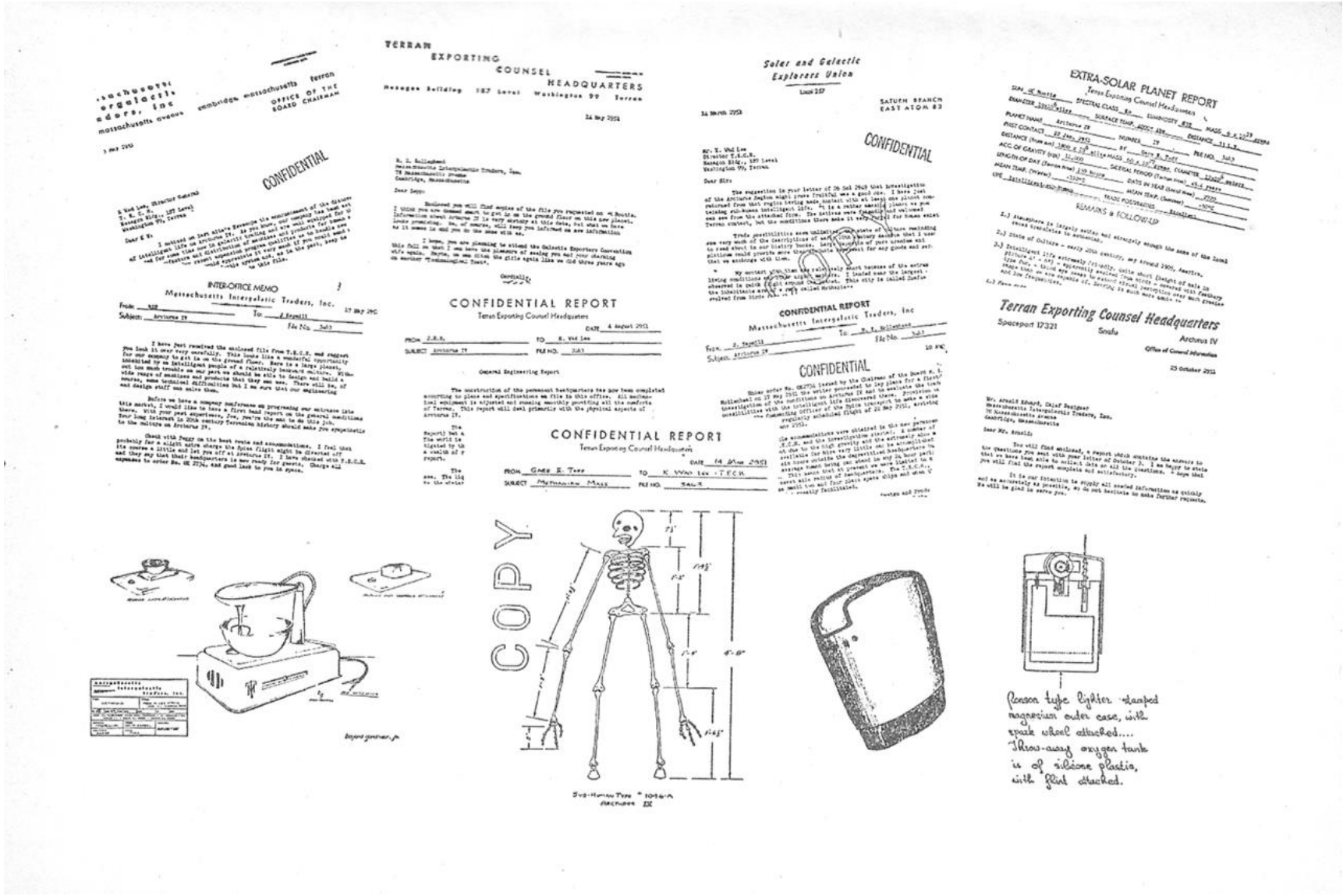
No full solution to the problem of understanding creative thinking yet exists—but the M.I.T. group has launched a solid, conscious and directed attack on that problem. It's an engineering attack—"A theory that works may not be true, but it's useful until a better theory can be developed."

THE EDITOR

Science fiction in the classroom? What! You're designing for non-humans on far distant planets? Aren't there enough unfilled human needs that you could design for and thereby better use your time? These are some of the typical questions that are asked when people first hear of the Arcturus Project used in the Product Design at M.I.T. After explaining the project and the course, however, questions usually change to exclamations such as, "What an idea, I wish I could have taken a course like that!"

This course is relatively new at M.I.T., just three years old, and is part of a rapidly expanding program in creative engineering. The program started with one course elected by seniors and by next fall it will consist of a sequence of courses starting in the sophomore year. This rapid expansion is the result of the encouraging evidence presented by the initial experimental course. It *is* possible to train students to think more creatively; one *can* develop his imagination. The most encouraging aspect of the experiment is that this is as equally true for many who originally thought that they had little talent for design as it is for those who had previously exhibited a high order of imagination. The students claim that they leave the course with a new perspective with which to face a broad variety of problems.

Before describing the course in some detail it would be wise to define some of the terms that will be used repeatedly. Science and engineering like most other fields of endeavor use two main thinking processes,


CONFIDENTIAL
INTER-OFFICE MEMO
Massachusetts Intergalactic Traders, Inc.
TERRAN EXPORTING COUNSEL HEADQUARTERS
CONFIDENTIAL REPORT
Terran Exporting Counsel Headquarters
Solar and Galactic Explorers Union
CONFIDENTIAL
CONFIDENTIAL REPORT
Massachusetts Intergalactic Traders, Inc
CONFIDENTIAL
EXTRA-SOLAR PLANET REPORT
Terran Exporting Counsel Headquarters
Terran Exporting Counsel Headquarters
Spaceport 17321
Sendu
Arcturus IV
Office of Consul Information
CONFIDENTIAL REPORT
Terran Exporting Counsel Headquarters
COPY
Reason type lighter stamped magnesium outer case, with spark wheel attached.... Throw-away oxygen tank is of silicone plastic, with flint attached.

analytical and creative. They are quite different and should be carefully defined. There is a third important process, the judicial, that contains aspects of the two above and is used in conjunction with them to help insure meaningful results.

There are three ways to distinguish whether a problem is analytical or creative: first, the statement of the problem; second, the approach used in its solution; and third, the results obtained. An analytical problem is stated in quite definite terms—determine the deflection at the center of a given beam under uniform load conditions. The creative problem expresses a need—it is desirable at times to have the surfaces of sliced bread browned, heated and dehydrated. The approach used in the first problem is as definite as its statement. Knowing all the physical properties and dimensions of the beam, its span, and constraints and load per unit length, the straightforward application of $\frac{d^2y}{dx^2} = \frac{M}{EI}$ will yield the desired result. A second type of approach is frequently used in the analytical problem, that of building a model of the prototype, or using the prototype itself, loading it per specifications and then measuring the desired result.

The approaches to the solution of a creative problem may be without limit. Everyone knows that the use of the radiant energy of an electrical resistance element will solve the type problem listed above, but this is by no means the. only way to solve that problem. It is possible that some chemical mixed with the butter—or any other spread—might do the job as well or even better. Maybe high frequency heating, or slicing the bread with heated wires would be equally as effective. Changes in the structure or composition of the bread itself should not be overlooked in solving the expressed need.

Looking at the results obtained is probably the easiest way to distinguish between an analytical and creative problem. Taking into account the state of the art of any particular time, there is only one right answer to an analytical problem. The solutions to a creative problem, on the other hand, may form a complete spectrum, depending on the thoroughness with which it has been investigated. It is impossible to say that any one answer is the right answer, continued investigation may lead to a better one.

To summarize then, the analytical problem is very specific in its statement; two approaches are usually employed in its solution, a process of logical reasoning or one of empirical testing; and, within the existing state of the art, there is only one right solution. Ninety per cent or more of all the courses taught in our public schools and colleges deal with problems of this type. The creative problem, in contrast, is stated in very nebulous, very general terms. It implies or expresses a need in such a way that almost an infinite number of specific approaches may be formulated and carried out in search of a solution. The results obtained run the gamut from good to poor and there is always room for new approaches to better solutions. Very few courses attempt to handle problems of this type although the need for creative thinkers is as great, if not greater, than for those of the analytical type. The statement of this need implies a creative problem from the very start and the solution described below, by definition, is not the one, right solution. The results obtained indicate that it is a good one, but the search goes on for a better one.

The aim, then, of the M.I.T. Creative Engineering program is to provide an ever increasing number of young men trained, not only in the basic concepts of science and engineering but also in the use of their creative imaginations, to help solve the ever increasing problems, both in complexity and in numbers, that continue to face the nation

and the world. Design courses provide an ideal vehicle for this kind of training, but by no means should this training be restricted to this field.

The Product Design course is conducted in an informal seminar fashion. Three two-hour seminars are held each week. These are devoted to discussions, demonstrations and laboratory work, so that the student will learn first, how does one think creatively and what is the creative process; second, what tools does the creative engineer work with and what factors should he take into consideration in the solution of his problems; and third, that through, constant practice he will become more proficient in exercising his imagination and will gain confidence in his ability to solve difficult, challenging problems.

It is not. within the scope of this paper to discuss in detail the creative process and how it works. For those interested, a bibliography of recent papers and books on the subject is included at the end. A specific example, however, of how nonanalytic factors influence design will be given. Take for example the influence of semantics on the creative process. The students had been assigned, as one of their major design projects, a case study on a "Dual Sander." The case described in some detail some of the various types of sanding machines on the market, pointing out their good and bad features. Two types of machines were singled out for specific analysis, the rotary disk type and the vibrating plate type. Sufficient technical data and a list of desirable design specifications were included so that the students could confidently design either type of machine.

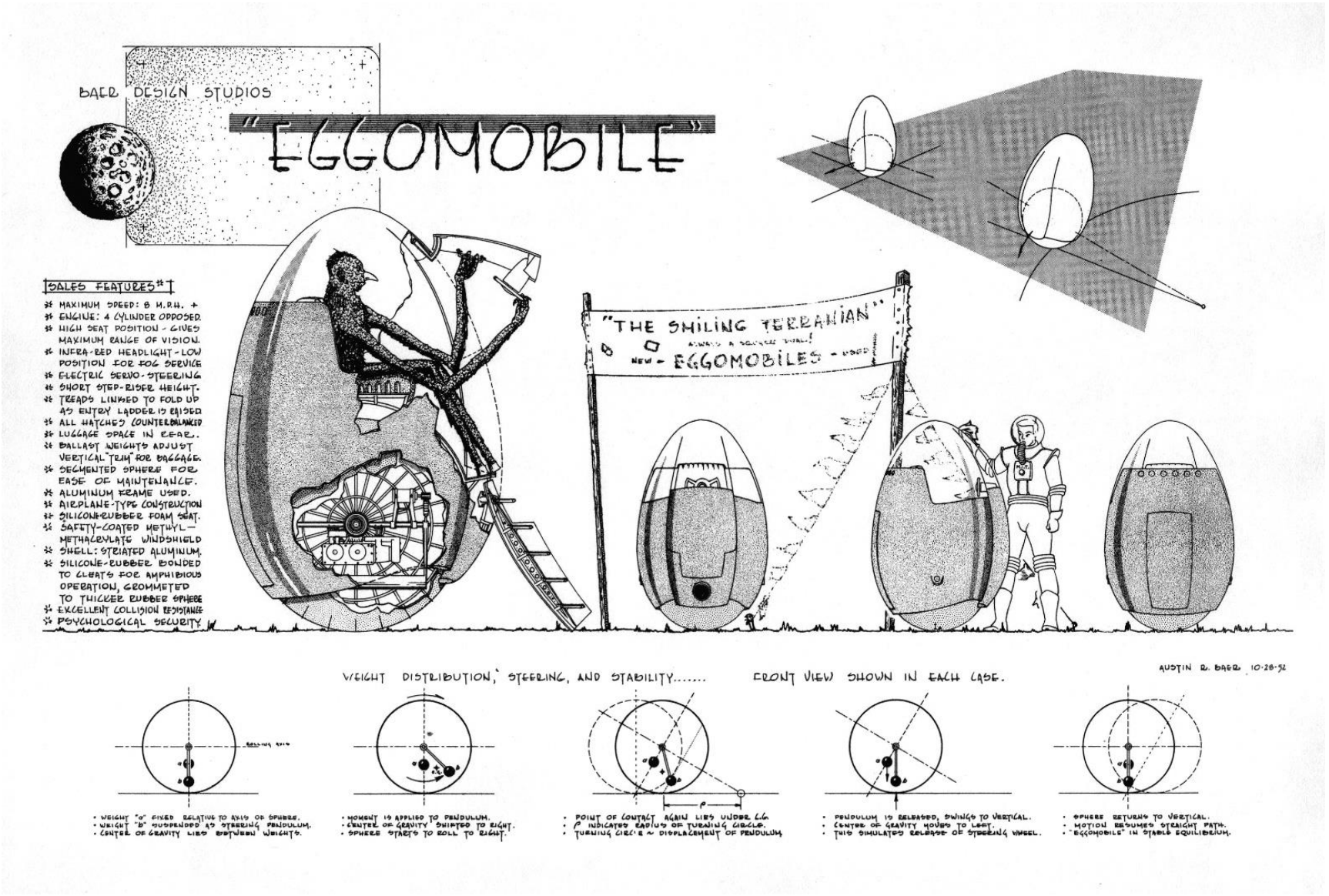
The case then pointed out the desirability of combining the two types of motion into one " all-purpose " machine. This machine would provide fast, rough sanding—disk type—and fine, finish sanding—vibrating type. Layouts for three possible solutions to this problem were included for the students' guidance or criticism.

After the students had had an opportunity to read the case, one full seminar session was devoted to discussing the case in particular and finishing methods in general. At the beginning of the next seminar session the students were asked to write in their own words in as general terms as possible the aim of this project. They were also asked to list in outline form a method of attack for solving their listed goal.

The majority of students put down quite specific aims and very definite modus operandi, this in spite of previous seminars on semantics and the very definite instructions given them before they were asked to write. A typical aim listed by this group was, "The aim of this project is to design a dual purpose sanding machine, to provide rough and fine sanding." A prosaic, standard approach was listed as the method of attack. These students without realizing it were greatly limiting themselves at the beginning of the creative process. This was in part due to the pre-conditioning effect that the case study had on their thinking.

A small group of students, however, were able to ignore the original statement of the problem and set up for themselves a new goal that gave almost unlimited scope to the problem. "The aim of this project is to design a multipurpose smoothing machine or process. Smoothing may be accomplished by either adding or removing material." A statement of this type naturally leads to a very general approach and the search for a solution would enter every technical field, electrical, chemical as well as mechanical.

The remainder of this seminar was devoted to exploring the possibilities opened up by the more general type of goal. This was accomplished by everyone first listing


BAER DESIGN STUDIOS
"EGGOMOBILE"
SALES FEATURES*
* MAXIMUM SPEED: 8 M.P.H. +
* ENGINE: 4 CYLINDER OPPOSED.
* HIGH SEAT POSITION - GIVES MAXIMUM RANGE OF VISION.
* INFRA-RED HEADLIGHT - LOW POSITION FOR FOG SERVICE
* ELECTRIC SERVO-STEERING
* SHORT STEP-RISER HEIGHT.
* TREADS LINKED TO FOLD UP AS ENTRY LADDER IS RAISED
* ALL HATCHES COUNTERBALANCED
* LUGGAGE SPACE IN REAR.
* BALLAST WEIGHTS ADJUST VERTICAL "TRIM" FOR BAGGAGE.
* SEGMENTED SPHERE FOR EASE OF MAINTENANCE.
* ALUMINUM FRAME USED.
* AIRPLANE-TYPE CONSTRUCTION
* SILICONE-RUBBER FOAM SEAT.
* SAFETY-COATED METHYL-METHACRYLATE WINDSHIELD
* SHELL: STRIATED ALUMINUM.
* SILICONE-RUBBER BONDED TO CLEATS FOR AMPHIBIOUS OPERATION, GROMMETED TO THICKER RUBBER SPHERE
* EXCELLENT COLLISION RESISTANCE
* PSYCHOLOGICAL SECURITY
"THE SMILING TERRANIAN"
ALWAYS A SCARCE ITEM!
NEW - EGGOMOBILES - USED
WEIGHT DISTRIBUTION, STEERING, AND STABILITY.....
FRONT VIEW SHOWN IN EACH CASE.
AUSTIN R. BAER 10-28-52
• WEIGHT "A" FIXED RELATIVE TO AXIS OF SPHERE.
• WEIGHT "B" SUSPENDED AS STEERING PENDULUM.
• CENTER OF GRAVITY LIES BETWEEN WEIGHTS.
• MOMENT IS APPLIED TO PENDULUM.
• CENTER OF GRAVITY SHIFTED TO RIGHT.
• SPHERE STARTS TO ROLL TO RIGHT.
• POINT OF CONTACT AGAIN LIES UNDER C.G.
• ρ INDICATES RADIUS OF TURNING CIRCLE.
• TURNING CIRC'F ~ DISPLACEMENT OF PENDULUM.
• PENDULUM IS RELEASED, SWINGS TO VERTICAL.
• CENTER OF GRAVITY MOVES TO LEFT.
• THIS SIMULATES RELEASE OF STEERING WHEEL.
• SPHERE RETURNS TO VERTICAL.
• MOTION RESUMES STRAIGHT PATH.
• "EGGOMOBILE" IN STABLE EQUILIBRIUM.

all possible ways by which any material could be smoothed by adding or subtracting material. The listing was done without any critical evaluation of the method as to its practicality or even feasibility or to its economics. As the lists were individually read off new ideas were added until it was felt that the various fields had been fairly well exhausted. Then and only then was critical analysis applied to the many suggestions.

Of course, many of the proposed schemes had to be discarded because of their impractical nature or the possible high costs associated with them, but many of the suggestions were developed to a point where they looked as though they would be very profitable avenues for further research. A few had rather limited fields of application and were far removed from sanding machines. In, many cases it was discovered that the proposed methods had already been incorporated in various machines and processes, e.g. smoothing by adding material, metal spray guns, and smoothing by mechanical compression, calendering of paper.

It was decided that actually Emerson's advice "to build a better mouse trap" would not have led to the "path-beating act" unless the inventor had restated his problem in more general terms. Emerson's statement would have insured a trap being built but would have precluded the possibilities of electrocuting, poisoning, drowning or even frightening the mice to death.

The case that has had the widest publicity and engendered the most discussion is the Arcturus IV Project. It was designed, in part, to free the student of all preconceived notions about man-machine relationships and to strengthen the influence of environment on design. There are many other reasons for introducing a case of this type and they will all be discussed after describing the case.

Arcturus IV is the fourth planet out from the sun, α Bootis (Arcturus), thirty-three light-years from our solar system. It was first contacted by a member of the Solar and Galactic Explorers' Union on January 22, 2951. It is a large planet, 12 x 106 meters in diameter, having a mass of 60 x 1027 grams and the acceleration of gravity at the surface is eleven thousand centimeters per second squared. It is a distance of 1800 x 106 miles from α Bootis and its sidereal period is 49.4 Earth-years. The length of day is one hundred fifty-nine hours; the atmosphere is largely methane; and the mean temperatures range from -50° C in the summer to -110° C in the winter.

All the information about the planet and its inhabitants is obtained from the files of the Massachusetts Intergalactic Traders, Inc. and each student receives a copy of this file. M.I.T. Inc. is engaged in the manufacture and distribution of products for extrasolar consumption. (For the students' benefit the products must be manufactured using Twentieth Century technology and materials.) This company and all others like it operate under the rules and regulations of the Terran Exporting Counsel Headquarters, a government agency. T.E.C.H. sets up a branch office on all planets with which Terra is doing business and its divisions such as the General Engineering Division, Physiological and Psychological Division, and the Design, Production and Marketing Division carry out detailed investigations and write and publish reports for all who might be interested. These are included in the files.

In drawing up this case study every effort was made to make everything as realistic and consistent as possible. So far no glaring errors have been discovered. All information in the file is on specially prepared stationery and report forms,

stamped and handled in the best businesslike manner. The only thing that is lacking is reliable market reports on the sales and acceptance of the products designed.

The race of people—subhuman, of course—that inhabit the contacted portion of Arcturus IV are called Methanians. A good description of them is contained in a report from J. S. Wick, Director of the Physiological and Psychological Bureau of T.E.C.H. "Strangely enough the Methanian metabolic process is similar to Terran plant life. Carbon is obtained from the Methane atmosphere and oxygen from the plant and animal life eaten as food. There is no liquid water anywhere on the planet and due to the very cold temperature, little in the atmosphere. The water that is present is in the solid state resulting in a foggy condition both winter and summer. Ammonia is the Arcturian substitute for water.

"The Methanians weigh very little compared to us. One of the largest we met was weighed on a Terranian spring scale at one hundred eighty-seven pounds. (They are relatively strong, however, being able to lift twice their own weight.) Their bones are hollow and apparently filled with hydrogen and helium. There is no question but these people have evolved from a race of birds, their appearance seems to indicate it, their history seems to prove it. Their long arms and clawlike hands—three fingered—are vestiges of once great wings. The only anomaly is their single-toed feet like that of a horse. This adaption to ground living evolved very rapidly once the power of flight was lost.

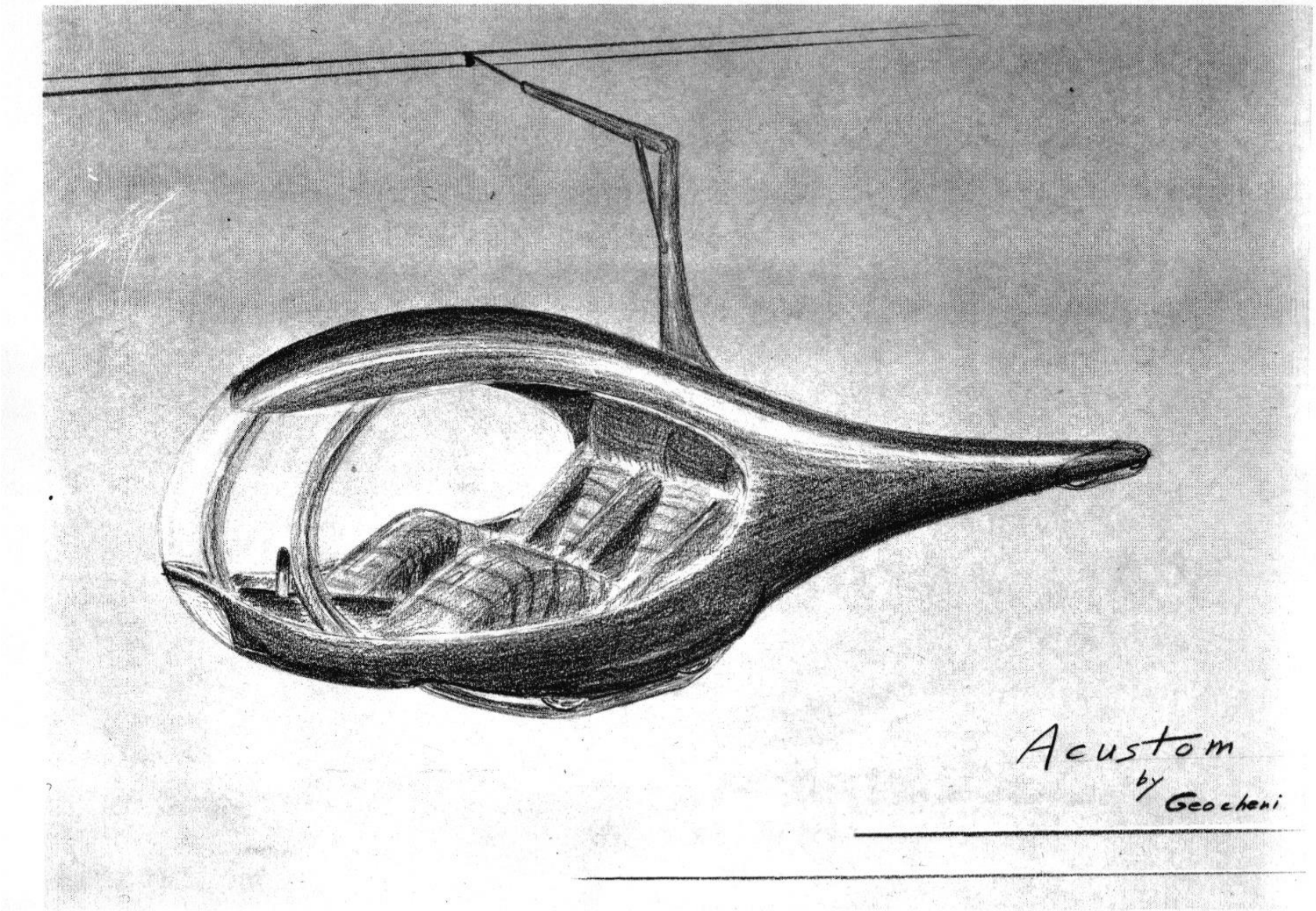
"The young are born in eggs and the eggs are carried around in skin pockets or pouches similar to those of the now extinct Terranian Penguin until the egg hatches. Both male and female take turns in the hatching process. The young grow rapidly at first and are ready to take care of themselves in about twenty Terranian years. They seldom leave home, however, before physical maturity is reached, 49.4 Terranian years.

"The Arcturian normal body temperature is -40° C and their pulse rate is five times per minute. As a result they are very slow-moving and they frequently walk using one or both arms as a cane or pair of crutches. Their normal walking pace is about one fourth mile per hour, but if pressed can go almost eight times as fast for very short periods. Even with HI-G units we don't travel much faster than they do. This slow pace does not seem to bother them since their whole system is geared to it. Their response time is about two seconds.

"Their auditory, vocal and visual range is extremely large. They can hear sounds with frequencies as low as 1/100 cycle/second up to 50,000 cycles/second. Their vocal range goes from 1/50 to 25,000 cycles/second and their visual range extends from the infrared up through the ultraviolet.

"As you might expect they are very stable emotionally, very slow to anger and with tremendous patience measured by our standards. They have a limited amount of telepathic ability but seem to use this form of communication only under duress. In the ESP tests we thought we had discovered a race with exceptional talent but later found out that their high, almost perfect, scoring was due to the X-ray-like vision of the third eye."

The reports and letters in the file try to cover briefly, of course, most of the important phases of the life and culture of the Methanians and the physical features of the planet. As the students design, however, new information is frequently needed and it is part of the student's job to provide this information consistent with that already given. The first design project was limited to products of a household or personal use


Acustom
by Geocheni

classification. One of the students wanted to design a clock for the Methanians and consequently was forced to devise a logical subdivision of the Methanian day and a numbering system for them. A portion of his report follows:

"The number system is based upon six (6), as would be suspected upon considering Methanian three-digit hands. The number system definitely evolved from finger counting. Thus 1, 2, and 3 are |, V, and Ψ. An alternate symbol for three was the closed fist, which gradually deteriorated into a small circle. Thus, four would be one finger and one fist or O |. This gradually became O|. Similarly, five is OV and six would be two fists. This ultimately became two circles, one on top of the other, or. 8. This is, of course, our figure "eight" exactly. The idea of building up larger numbers by arranging symbols in sequence, and allowing the position of the symbol to indicate its value—as we do in Arabic notation—was introduced about eighty-five Methanian years ago and the symbol 8 became the zero. The complete history of the development of the number system is interesting, but only the final result, is given here:

O=8

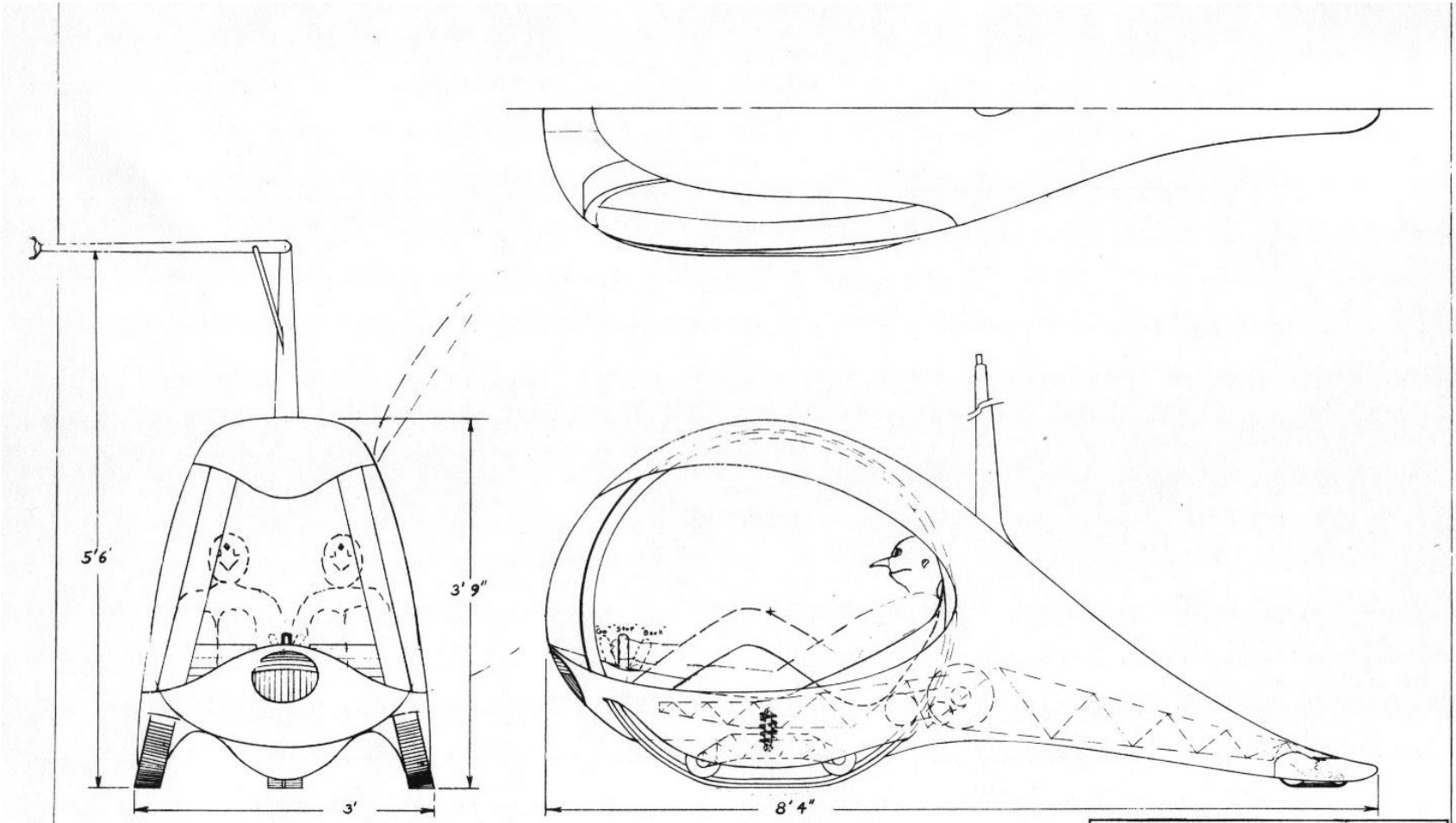
1	I	7	II	13	VI	19	ΨI	25	αI	31	OVI
2	V	8	IV	14	VV	20	ΨV	26	αV	32	OVV
3	Ψ	9	IΨ	15	VΨ	21	ΨΨ	27	αΨ	33	OVΨ
4	α	10	Iα	16	Vα	22	Ψα	28	αα	34	OVα
5	OV	11	IOV	17	VOV	23	ΨOV	29	αOV	35	OVOV
6	I8	12	V8	18	Ψ8	24	α8	30	OV8	36	I88

etc.

The reports in the file indicated that the Methanians used electricity generated from atomic power plants, but. no details of the system were given. This same student, in order to power his clock with electricity, had to fill in the missing details. "Alternating current is generated. The frequency of the current is 1296 cycles per NAHLO—the shortest subdivision of the Methanian day. Note that $1296 = 6^4 = 18888$ in Methanian notation. This is analogous to 10000 in Terranian notation. Since one NAHLO = 7.37 minutes = 442.5 seconds, then 1296/ N = 1296/442.5 = 2.926 cps which is about 1/20 of standard Terran frequency of 60 cps. The Methanian electrical science is based upon the concepts of emf, current and resistance. Their unit of emf is called the GINT and is equivalent to 2.378 ± .001 volts. Electrical transmission over great distances is accomplished with an emf of 1296 GINTS = 3080 volts. Individual house voltage is stepped down to 1/36 of this, 85.6 volts. This standard emf of thirty-six GINTS seems to be available in almost every Methanian structure which uses electricity."

The description of the electrical system above combined with the information previously given about the Methanians gives rise to one possible inconsistency which is left to the reader to argue out for himself. Considering the very slow stimulus-response time, the wide range of auditory and visual reception and the very slow electrical frequency, would the Methanians be bothered by flicker from their electric lights? Another similar question is, at what frequency should motion pictures be projected?

Some of the other designs carried out by the first group of students subjected to this problem were chairs and tables, two different telephone designs, kitchen food-mixers, combination egg-incubator and baby-stroller, a stereo slide viewer and a complicated "lawn-conditioner" for the upside down Methanian vegetation. In all cases the designs had to work and had to meet the exacting conditions of the Arcturus IV environment as well as being adapted to



MAX. SPEED – 10 MPH (Tes.)	POWER
CAPACITY – 50 LB. MASS	ELECTRIC – 2 HR.
WEIGHT (DRY) – 100 LB.	SOURCE – PUPLIC LINE (GENERAL USE)
CONTROLS:	BATTERY POWERED FOR
SINGLE "JOY STICK"	PASSING + OFF LINE USAGE.
TAIL WHEEL STEERING	AUTOMATIC BATTERY CHARGING
MATERIALS:	WHEN USED ON LINE
STRUCTURAL + SKIN – ALUMINUM	VACUUM JACKETED, HEATED
WINDOWS – VINYLCHLORIDEACETATE	M_3 BATTERIES (MAX. CONT. LIFE - 3 HR. (Tes.)
FLEX-TRACK – POLYTETRAFLUOROETHYLENE	ELECTROMAGNET, AUTOMATIC CABLE-LINE TERMINAL
SUSPENSION:	" CABLE REEL
RESISTANCE OF FLEXING TRACK	

massachusetts intergalactic traders, inc.

FOR ARCTURUS IV			TITLE "ACUSTOM" PERSONAL LAND TRANSPORT		
DR. GDC.	DATE 10/31/52	CK'D	DATE	AP.	DATE

NOTE – ALL TOLERANCES (UNLESS NOTED) FRACTIONS ± 1/64 – DECIMALS ± .005 ANGLES 1° – BREAK ALL EDGES – REMOVE ALL BURRS

MATERIAL NOTED	FINISH	PART NO. ASSEMBLY
TREATMENT	SCALE 1½" = 1'	

the Methanian's physical and psychological limitations. They had to be built with present-day technology and with materials now available on Earth. Weight limitation was hard to meet; temperature limitation caused the most trouble in getting reliable information on materials.

The second group of students to design for Arcturus were all asked to design means of powered transportation for the Methanians. The idea of introducing "automobiles" to a primitive culture that had never used anything but foot-power and domestic animals caused a great deal of discussion in the seminars. Would it be possible and desirable to introduce a highly perfected machine or should the introduction follow the history of the development of the automobile on Earth? An expert on primitive cultures was brought in to lead one of the seminar sessions and a furious battle was fought. Neither side won a clear victory so that designs following the two approaches were submitted. The Eggomobile pictured on the cover and in the accompanying plate was typical of the "conservative" approach. Due to its shape and resulting stability problems it is limited to very low speeds and changes in momentum. But again, its egg shape would be psychologically desirable and give the Methanians a sense of complete security, a very important factor in introducing these "demons" of the road.

The little Acustom Coupe pictured on page [11] on the other hand, is capable of very high speeds and accelerations-— see limitations below-— is very efficient in design and is typical of the "damn history" approach to design. The problem of roads is a difficult one that must be faced by the designer when he attempts to introduce a powered vehicle into a society that is used to going about slowly on foot on narrow paths. The large spherical drive unit of the Eggomobile and the flexible treads of the Acustom would make them adaptable to most any terrain. The Acustom is limited by its electric motor and trolley pickup to previously laid out paths and brings up the question of what one does when he meets or wishes to pass another vehicle. Most of the vehicles were powered by internal combustion engines or gas turbines, the fuel being hydrogen peroxide.

One of the students felt that due to the Methanians egg-birth they would hold the egg and all similarly shaped objects in the deepest reverence. It would, therefore, be bordering on the sacrilegious to use the wheel for such a lowly job as transportation. As a consequence, he designed a machine that propelled itself by walking. It was a comparatively simple design with an ingenious system for turning. The ride was described as being similar to that obtained with a Terranian Camel although not quite as comfortable.

The major limitation in this car design was the very slow stimulus-response time of the Methanians. Without the use of automatic controls — that was too much of a new concept to introduce at this time — how fast should they travel and still be able to avoid hitting stationary or moving objects? In starting this discussion it was argued for some time whether or not the Methanians could even stand upright and walk. Considering the slow s-r time, the high acceleration of gravity and their high center of gravity, the poor Methanian might be flat on his face before he knew he was falling. It was finally decided, however, that the Methanian would have developed some anticipatory sense similar to that developed by the human child when learning to walk. The use of his long arms in walking, of course, increases his stability. Is it possible to apply similar reasoning to driving a car? The answer was yes.

The human being in learning to drive a car is consciously dependent on stimulus-

response mechanisms to keep him going in a straight line and frequently overcorrects the detected errors. With practice, however, the subconscious soon takes over and errors are corrected almost before they are large enough to be detected. The amazing computing capacity of the brain is able to solve in a fraction of a second the many simultaneous equations that must be solved in order to pass safely through an intersection loaded with pedestrian and vehicular traffic. The equations involved might take days of conscious effort to solve. It was decided, therefore, that the Methanian could develop in a similar fashion over a period of time.

There was some question as to whether the Methanian brain could ever work as fast as the human brain because of the low metabolic rate and s-r time. It was arbitrarily decided that the maximum speed of all vehicles—subject to subsequent testing—be limited to fifteen miles per hour. It is very likely that this high speed would not be reached until a number of years of adjustment had passed by.

The reader can very likely imagine many other points that should be considered in designing for the Methanians but he can be assured that the chances are very good that the designers of the Massachusetts Intergalactic Traders, Inc. have given them due consideration. Do you think that the average, present day Terranian designer gives as much thought to human limitations?

The Arcturus IV project accounts for about one-fourth of the student's time in this course. The other three- fourths of the time is devoted to more prosaic, earthly designs. Yet the three weeks or so spent out in space are richly rewarding and have a distinct carry-over value and a profound influence on the remainder of the course. The case was first set up because the answer to the question posed in the paragraph above seemed to be no. It was hoped that a dramatization of this type would forcibly bring home to the student the importance of the man-machine relationship and the influence of environment.

Some of the seminars held while the Arcturus case was in progress were devoted to examining some of the results of the Applied Psychologists of the Tufts College group and of the Special Devices Center for the Navy on Long Island. The students were amazed to see how much had already been done in the field of human-engineering or bio-mechanics, as it is sometimes called. They also realized that there is a great deal more to be done.

It is very difficult to accurately measure the influence of this one case on the students' subsequent thinking in the field of human engineering, but a qualitative measure can be obtained by sitting in on any one of the later design seminars, be it on Sanding Machines, Rug Shampooers or Turbo Cars, and comparing it with any other typical design group, in or out of schools. The enthusiasm for detail and the relentless search for all the factors, nonanalytic as well as analytic, that might influence a design is a very encouraging sight.

There have been many other beneficial results obtained with this first experiment with science fiction in the classroom. First of all, it provides a very stimulating jolt to the imagination, a jolt which some students probably couldn't survive. The more imaginative a boy is the quicker he adjusts himself to this new situation. The big adjustment demanded by the Arcturus case makes the subsequent adjustments relatively easy. He has to stretch his imagination to such a limit that it doesn't quickly shrink back to its former inconspicuous self.

In the second place, since it is almost impossible to prove or disprove some of the controversial issues that are raised by the

Arcturus case, a student who conscientiously bases his design on principles which he thinks are logical and sound gains a confidence in his ability to design rationally and creatively that the most vicious design jury cannot destroy. This confidence in one's ability is one of the prime prerequisites for all good designers. If one doesn't have it or can't develop it, he had better look for something else to do. The weight of evidence that could be brought to bear by a design jury against a mistaken design principle used in an Earth-consumed product could materially affect the quality of the designer's subsequent work by shaking his confidence in himself. In the Arcturus case the student designer can always rationalize that he is as much entitled to his opinion as the jury is to theirs and everyone lives happily ever after.

And lastly, a great many of the students with imagination are already science-fiction fans or else take to it very readily. The result is that the first case he works on is fun and not work; he learns while he enjoys himself. There may be some theory that education must be solemn and serious but the Creative Engineering Group at M.I.T. do not subscribe to it. The results of the informal seminars and lab sessions indicate that it would be desirable to hold all classes in a similar fashion. The Arcturus case is an excellent ice-breaker and strangers at the beginning of the course are good friends three weeks later.

It was indicated at the beginning of this paper that the program in Creative Engineering is expanding rapidly. This is due in part to the encouraging interest shown by all industries aware of the work that is being done. A number of grants have been received to be used for the preparation of new case material and other research and in one instance a large corporation went to considerable trouble and expense in the preparation of a very complete case history for one of the projects. The future of the program is limited only by the imagination of those participating in it, and this includes students as well as instructors. The course is designed for them, as every course should be, and they are encouraged to enter into its formulation which they freely do. The course then becomes a case study in Creative Engineering.

BIBLIOGRAPHY

Chapanis, Garner and Morgan—"Applied Experimental Psychology"; John Wiley and Sons, New York, 1949.

Easton, W. H.—"Creative Thinking and How to Develop It"; Mechanical Engineering, August, 1946.

Flesch, R.—"The Art of Clear Thinking"; Harper & Brothers, New York, 1951.

Killeffer, D. H—"The Genius of Industrial Research"; Reinhold Publishing Corporation, New York, 1948.

Nine Authors—"Creative Engineering"; A.S.M.E., 1944.

Osborn, Alex. F.—"Your Creative Power"; Charles Scribner's Sons, New York, 1950.

Tufts College—"Handbook of Human Engineering Data for Design Engineers"; 1949.

Weinland, C. E.—"Creative Thought in Scientific Research"; Scientific Monthly, December, 1952.

THE END

References

Arnold, J. E. 1952a. *Box Car Design Project.* Cambridge: MIT Dept. of Engineering; ASEE Engineering Case Library, Internet Archive. Available at https://archive.org/stream/ECL1-5/ECL-1-5-Box-Car-Design-Project#page/n0/mode/2up.

Arnold, J. E. 1952b. *Introduction to Case Study on Arcturus IV.* Cambridge, MA: Unpublished, MIT Archives.

Arnold, J. E. 1953a. Space, Time and Education. *Astounding Science Fiction*, May, pp. 9-25.

Arnold, J. E. 1953b *Case Study: Arcturus IV*, Creative Engineering Laboratory, Creative Engineering Laboratory, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Massachusetts. Available at https://archive.org/details/casestudyarcturu01john.

Arnold, J. E. 1955. Creative Engineering. *Third M. I. T. Mid-West Conference*, (pp. 1-10). Cleveland, Oho.

Arnold, J. E. Undated. *A Case Study: Zylerium Blindness*. Department of Mechanical Engineering, Stanford University. Available at https://archive.org/details/arnoldzyleriumblindness.

Arnold, John E. (1953) 2016. Case Study: Arcturus IV. In J. E. Arnold (Ed.), The Arcturus IV Case Study, Edited with an introduction by John E. Arnold, Jr. Stanford University, Engineering Case Program (1948- 1972), Case Files, Stanford Digital Repository. Available at http://purl.stanford.edu/rz867bs3905 and https://archive.org/details/ArcturusIvCaseStudy.

Arnold, J. E. (1959) 2016. *Creative Engineering: Promoting innovation by thinking differently*. Edited with an introduction and biographical essay by W. J. Clancey. Stanford Digital Repository. Available at http://purl.stanford.edu/jb100vs5745.

Arnold, J. E., & Wood, G. H. 1956. *Sick Room Equipment.* Cambridge, Massachusetts: MIT Department of Mechanical Engineering. Available at https://archive.org/stream/ECL1-6/ECL-1-6-Sick-Room-Equipment#page/n1/mode/2up .

Arnold, J. E., & Ling, A. T. Undated. *Case Study: Rice in Burma.* Creative Engineering Laboratory, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Massachusetts. Available at https://archive.org/details/SC0269B01109RiceInBurma.

Arnold, J. E. , & Ling, A. T. Undated. *Case Study: Chinese Typewriter*. Creative Engineering Laboratory, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Massachusetts. Available at https://archive.org/details/SC0269B01111ChineseTypewriter.

Arnold, J. E., & Welther, R. S. Undated. *Ion Exchange Case Study*. Creative Engineering Laboratory. Massachusetts Institute of Technology. Available at https://archive.org/details/ECL1-4.

Arnold, J. E., Babcock, H. W., & Davis, E. L. Undated. *Case Study: Ceres Project*. Creative Engineering Laboratory, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Massachusetts. Available at https://archive.org/details/SC0269B01ECL001008ArnoldCERES

Baer, A. R. 2015. Personal Communication with William J. Clancey, February 26.

Howe, H. E. 1952. 'Space Men' Make College Men Think. *Popular Science*, October, p. 124 ff.

Hunt, M. M. 1955. The Course Where Students Lose Earthly Shackles. *Life Magazine*, May 16, p. 186 ff.

Johnston, J. P. 2016. Interview with J.P. Johnston. W. J. Clancey, Interviewer, February 20.

Jordan, S., Lande, M., Cardella, M., & Ali, H. 2013. Out of their world: Using alien-centered design for teaching empathy in undergraduate design courses. *IEEE Frontiers in Education Conference*, pp. 907-913. Oklahoma City.

Katz, B. M. 2015. *Make It New: The History of Silicon Valley Design.* Cambridge, Massachusets: The MIT Press.

Kizilos-Clift, P. J. 2009. *Humanizing the Cold War: The Battle for Hearts and Minds at MIT, 1945-1965.* Ph.D. Dissertation, University of Minnesota.

Mendoza-Garcia, J., & Cardella, M. E. 2014. Using alien-centered design for teaching iteration in the design process in undergraduate design courses. *IEEE Frontiers in Education, Oct. 22-25.* pp. 1-8. Madrid, Spain: IEEE.

MIT Science Fiction Society. 2016. Retrieved January 7 from Wikipedia, The Free Encyclopedia. Available at https://en.wikipedia.org/wiki/MIT_Science_Fiction_Society.

Sheridan, T. B. 2014, December 3. Personal Communication with William J. Clancey.

Society, MIT Science Fiction. 1951. Minutes of the First Meeting. MIT Archives, AC 331.

Strong, L. 1954. Design for Living in Outer Space. *Pageant*, June, pp. 44-49.

Woodbury, D. O. 1953. They solve problems never tackled before—'Constructive imagination' makes MIT a pilot plant for leadership. *Readers Digest, December.* Condensed from *The Christian Science Monitor,* November 10, 1953, pp. 129-132.