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A Thesis Submitted to the Faculty of the College
of Imaging Arts and Sciences in Candidacy for the
Degree of Master of Fine Arts.

Autonomy, Well-Being, and Design

by
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1.0 INTRODUCTION

Reflecting on his father's indignant struggle to negotiate a bathroom environment, author and design critic Ralph Caplan wrote, "What handicapped him and handicapped me when I helped him bathe, was not a disease. It was design. He died of Parkinson's, but he was disabled by design."[1]

The products and spaces that we use to help us bathe, prepare food, groom ourselves and perform other necessary daily activities can have a significant impact on the overall quality of our lives. Accomplishing these activities of daily living, or ADL's, serves as a primary basis for physiological, psychological, and sociological health.[2] Research into the basic activities of daily living has shown that independence and health are directly related to one's capacity to perform basic activities without assistance.[3] When that autonomy is compromised due to injury or illness, our physical, psychological, social, and economic well-being is threatened.[4] The quality of our lives is dependent in part upon the ability of the products that support our ADL's to shoulder the burden of adaptability as our physical and mental capabilities diminish due to aging or illness. Failure of those products to react in this fashion serves only to compound the ramifications of our disabilities and diminish the

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[1] Ralph Caplan, "Disabled by Design," Interior Design (August 1992): 88

[2] Don Fabun, "The World of A+B<=>C, You and Creativity," Kaiser Aluminum News 25 no. 3, (1968): 9-16

[3] Herman Miller Research Corporation, Metaform (Printed Privately), 1988.

[4] James J. Pirkl, Transgenerational Design - Products for an Aging Population (New York: Van Nordstrand Reinhold, 1994), 87

2.0 PROJECT OVERVIEW

The objective of this thesis is to demonstrate how product design can effectively improve the quality of our lives by promoting individual autonomy in light of diminished physical capabilities due to illness and/or aging. Critical to this demonstration is an understanding of the relationship between personal well-being and our built environments. Developing this understanding became the initial focus of my research.

The link between personal well-being and physiological, psychological, and sociological health is well established. In a work exploring the dynamic relationship between older adults and daily living tasks such as cooking, cleaning, and personal care, authors Clark, Czaja, and Weber propose a transactional model of human performance which suggests, "the successful performance of a task is dependent on a match between the individual's capabilities and the demands generated by the task."[1] When a person's capabilities are diminished due to an injury, illness, or simple aging, either the demands of the task must be reduced or the person's original level of competency must be restored in order to ensure successful completion of the task.[2] In order to help restore previous levels of capability, physical therapy, training, and other rehabilitation strategies can and should be implemented to help alleviate the imbalance between task demand and personal capability. My area of interest and focus here involves investigating the opportunity to leverage

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[1] M. Cherie Clark, Sara J. Czaja, and Ruth A. Weber, "Older Adults and Daily Living Task Profiles," Human Factors (October 1990): p.537.

[2] Pirkl, Transgenerational Design, 96.

product design to help reduce the demands of the task. Designing and implementing products, spaces and procedures that can reduce, combine, or eliminate the demands of the task thereby reducing the demands and stress placed on the individual can help to restore the necessary critical balance demand and capability. By leveraging the demand side of this transactional performance model and understanding the direct relationship between health and self-reliant care, it is thus realistic to conclude that responsible and intelligent product design can directly impact the quality of living for the people they serve and support.

With an understanding of the direct qualitative link between design and well being, I sought to identify an activity of daily living(ADL) that held both personal interest and a sufficient opportunity for the qualitative and quantitative impact of design. I investigated and considered such ADL's as food preparation, personal exercise, personal grooming, household maintenance, personal transportation, vocational support, among others. Eventually I became interested specifically in the tasks supporting personal care needs due to the intuitively powerful relationship between self-reliance, independence, dignity and self esteem.

The personal care ADL with arguably the most significant, direct impact on physiological, psychological, and sociological health is personal hygiene. My research suggested that autonomy in making decisions (and actions) regarding personal care was found to have a direct influence on autonomy and performance levels in other domains.[3]

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[3]Elias S. Cohen, J.D., "The Elderly Mystique: Constraints on the Autonomy of the Elderly with Disabilities," The Gerontologist v28, (1988): 24-31.

Consequences of this inability or apprehension of an individual to adequately care for themselves not only had obvious implications for health, but for social interaction and personal morale as well.[4]

With this understanding, I chose to focus my efforts on investigating the bathing process. My intention was to identify inefficiencies in the existing relationships between people and currently available bathing support tools, and then develop a means to reduce or eliminate these inefficiencies, thus promoting autonomy, self-reliance, and well-being.

My survey and analysis of the available products and environments designed to improve safety and convenience in the bathing environment uncovered a recurring solution with a problematic assumption and an inconsistent logic that eventually formed the basis for the development of my product.

I discovered many excellent product solutions that have been developed to help aid those who have difficulty providing for their own personal bathing needs. The most impressive designs included various grab bars, hand rails, folding seats, and barrier-less entry products which improve egress and mobility and have greatly reduced the risk of injury from falling. These attractive products provide a safe, simple, dignified and affordable way to help an individual to enter, occupy, and exit a bathing enclosure without the stigma historically attached to these types of support products.

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[4]Harry T. Phillips and Susan A. Gaylord, Aging and Public Health (New York: Springer Publishing Company, 1985), 190.

The current products that support the actual bathing processes, on the other hand, are not as well resolved and functionally successful. The faucet handles are hard to adjust and difficult to understand. The fixed shower nozzles are restrictive by their nature since they can't accommodate people of different heights. The hand-held shower nozzles promise real, desirable benefits with their custom application abilities, but those customization benefits are unfortunately difficult for some individuals to realize. Though it is obvious that the extensive recommendation and implementation of grab bars, folding seats, and support rails confirm the market demand for products that compensate for a person's lack of strength, coordination, mobility and sensory competencies, these are precisely the capabilities that are necessary to effectively operate and manipulate a hand-held shower nozzle. When analyzed, the successful operation of a hand-held nozzles requires, at a minimum, acute dexterity, grip strength, flexibility, hand-eye coordination, and balance. If a person's faculties are already focused on the motor and concentration requirements of negotiating a wet, slippery, and potentially dangerous bathing environment, it is not realistic to think that adding water dispersion requirements to this situation provides any conceivable benefit. The opposite is actually the case, and consequently, the effort to improve the situation has further complicated the task and alienated many of the intended beneficiaries.

For elderly and disabled persons, the opportunity to realize the benefits of a self-positionable water source and share in the increased ease and enjoyment of the bathing process is real. The hand-held type currently

on the market simply ignores the physiological characteristics of this significant audience and the totality of the problem. I will show how this gap might theoretically be bridged without imposing inefficiencies or redundancies that would relegate the solution to only a niche audience.

2.1 PRODUCT OVERVIEW

To provide individuals the means to position the water source anywhere they choose within their bathing enclosure while eliminating the need to accurately grasp, store, see, or even hold the device, I have developed the Freehand Bathing Arm (fig.1a,b).

The Freehand Bathing Arm provides the simplicity of a fixed position shower and the flexibility of a hand-held shower while taking into account the limitations of elderly and handicapped persons. For a fixed position, standing shower, one can simply push, pull, nudge, or place Freehand's shower head to the desired height. There is no need to release any levers or tighten any screws. Simply move the shower head to the desired position and release. The unique balance created by Freehand's torsional springs and counter-balanced mass locations will allow the nozzle to "glide" or "float" to the desired location and remain precisely at the point of release until a small force is applied to relocate the nozzle. This ability to place and relocate the nozzle without need of manual or visual dexterity allows bathers to customize their bathing

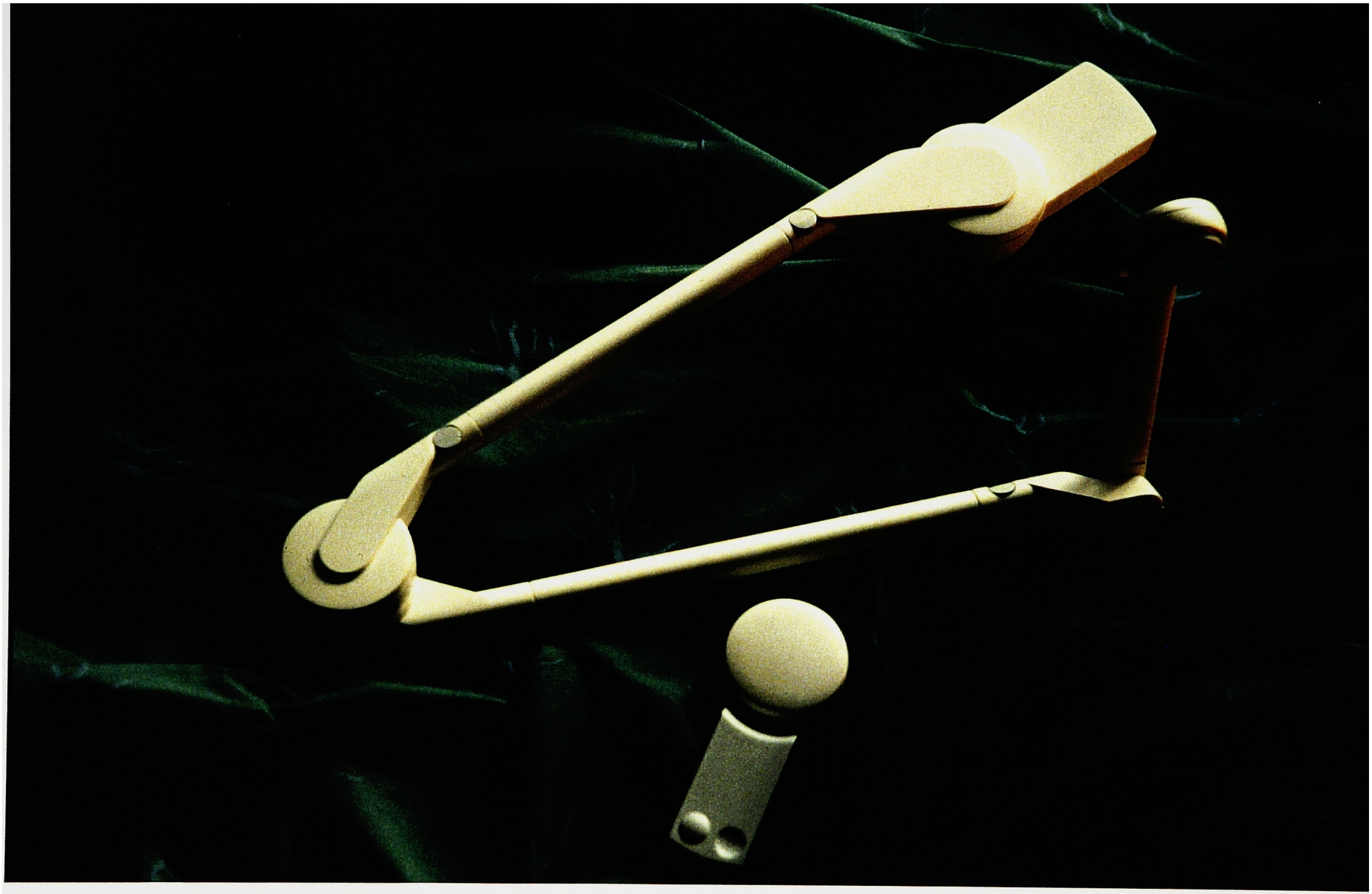

FIGURE 1A.

FIGURE 18.

process to suit their specific needs and tastes while reducing the level of "skill" necessary to accomplish the task.

For those who prefer or require a seated shower, Freehand seamlessly adapts to this application without any adjustment whatsoever. For the bather who needs a clear path of egress into or out of the bathing environment, free of tangle of hoses or piping, Freehand simply swings out of the way allowing for clear access to support rails and seating apparatuses. Once seated, the user can position Freehand's nozzle with the use of a hand, elbow, head, knee or foot while never needing to account for detaching or remounting a device that might otherwise fall to the floor or become otherwise entangled. This freedom allows the user to devote their skills to washing, relaxing and maintaining stability and balance for a safer, more enjoyable and self-reliant bathing experience.

The Freehand bathing arm provides the adaptability and compatibility an individual needs for dignified bathing. It does so in a manner that doesn't stigmatize anyone living alone or in a family because of their stature, situation, or physical limitations. In light of aging and disability, Freehand improves the quality of our lives by enabling people of all ages to be more self-sufficient with more dignity for a greater portion of their lives.

2.2 PROCESS OVERVIEW

The design process illustrated below(fig 2.) was assembled and utilized to develop Freehand. The model enabled the identification and objectification of the issues, constraints and opportunities critical to developing product concepts, specifically with universal or cross-generational design appeal. The model functioned as a framework for discussions, a way to organize research or information gathering efforts, a strategy for developing insight and fresh ideas, and a means for measuring the validity or appropriateness of a concept.

The model consists of four basic phases: Preparation, Analysis, Synthesis, and Evaluation. These particular categorizations are common to many design methods,[5] and are consistent with psychological models of human creativity.[6]

Preparation

This phase contains much of the basic research efforts that led to the generation of the project's objective. The variety of research served to establish a firm foundation of data and insight that helped to ensure the relative durability of my objective. The various secondary research surveys also served as a general knowledge learning tool, as it covered many various complementary topics focused on social, physiological, psychological, and universal design issues.

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[5] Chris Jones, Design Methods (New York: Van Norstrand Reinhold, 1992), passim.

[6] Fabun, You and Creativity , 9-16 passim.

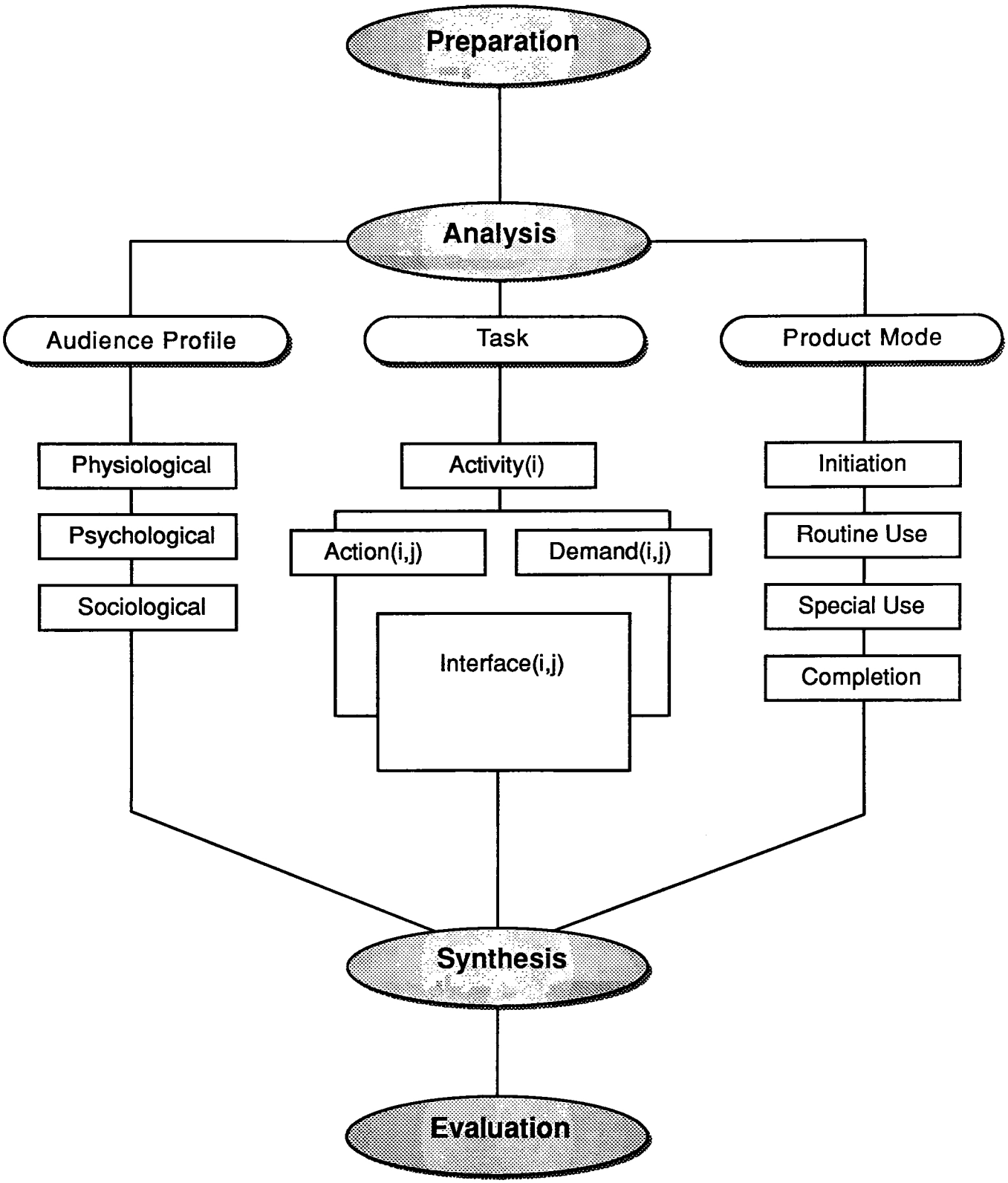

Fig. 2 Design Process Overview

Analysis

This phase consists of three parts: Audience Profile Analysis, Product/System Mode Analysis, and Task Analysis. The objective of this phase is to generate data, information, and a general understanding of all the issues that will affect the form, fit, and function of the final product concept.

• **Audience Profile Analysis** - The basic structure of this analysis is borrowed in-part from James J. Pirkl and Anna L. Babic's book titled *Guidelines and Strategies for Designing Transgenerational Products.*[7] The purpose of the analysis is to establish a complete physiological, psychological, and sociological profile of the target audience. It's meant to highlight many of the often overlooked variables such as emotional issues, cultural values, and dynamic, rather than static, human factors data. Their book provides an excellent overview of the natural human decrements due to aging and a convenient source for data and specific human factors information.

• **Product/System Mode Analysis** - The format of this analysis is based in-part on the mode analysis portion of the Structured Planning process model developed by Charles Owen at the Institute of Design at Illinois Institute of Technology.[8] The purpose is to systematically

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[7] James J. Pirkl and Anna L. Babic, Guidelines and Strategies for Designing Transgenerational Products (Syracuse: Copley Publishing Group, 1988), 96.

[8] Charles Owen, "from Course Lecture Notes by Student, Mehmet Ergelen, at Institute of Design, Illinois Institute of Technology," Spring 1991.

consider the various aspects or phases of a product's life cycle during the concept development, or Synthesis phase of the this model. This is accomplished by engaging in conceptualization activities focused around several individual life cycle phases. Phases like manufacturing, distribution, or disposal, for instance, can each have unique and often conflicting constraints and objectives that affect the products final solution. Using each phase's set of constraints as a catalyst to develop product ideas that selfishly optimize the needs of that particular phase will hopefully uncover fresh and innovative data that ,when considered in total, will generate new and insightful thinking that will drive refinement and innovation in the final solution.

• **Task Analysis** - The framework for this phase of the analysis was found in a paper by M. Cherie Clark, Sara J. Czaja, and Ruth A. Weber titled "Older Adults and Daily Living Task Profiles."[9] The process here is to isolate specific activities performed during the accomplishment of a task and distill those activities down to the particular actions performed by the individual, thus generating an understanding of the demands inherent in or generated by the environment during those actions. An exhaustive list is thus compiled describing the interaction or interface between each personal action and its associated environmental demand. This list represents the Interface portion of the model. During the generation of this list, one records any ideas, opportunities, insights, hunches, problems, or concepts that might come to mind based upon the knowledge and perspective established during the previous Audience Profile and the Product/System Mode analysis sections.

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[9] Clark et al, Task Profiles, p.537-549

Synthesis

The Synthesis phase of the model is designed to bring order, and eventually form, to the information generated during the Interface portion of the Analysis phase. With the final objective, constraints, and necessary elements as a guide, this is where the actual resolution of form and initial engineering ideation takes place.

Evaluation

This portion of the model is where the product concept's fit is evaluated against the measurements determined during the Preparation phase of the model. It is where the relative quality of the solution can be determined. I will include this analysis in the conclusion of this paper.

3.0 PREPARATION

The notion of a direct relationship between the subjective quality of an experience and the physical elements or tools utilized during the experience has always intrigued me. I may just be predisposed to enjoying neat little gadgets like my bikes, camping equipment, cooking utensils, and musical instruments, but I sincerely believe that these tools directly affect my enjoyment of the activity which they enable. This relationship, I believe, contributed to my interest not only in industrial design, but to the focus of this project.

3.1 BACKGROUND

Prior to coming to Rochester Institute of Technology, I obtained an informational interview with industrial designer William Stumpf during which he shared his philosophy about design and the role he felt it played in our society and culture. Apart from the significant overall impact this interview had on my life, I was specifically struck by a recollection he shared of a favorite daily event in his childhood. He described in fond detail a ritual his father would undertake every morning. The heating of the water, the sharpening of the straight razor, the ivory-handled boar hair brush, the worn pewter mug, the fragrant soap, and the baritone voice that hummed Scandinavian folk songs as he watched his father prepare for work. As I wondered if this could be a scene from a Norman Rockwell painting, he asked me to contrast that event with my own

preparation that morning. Aerosol can, disposable razor, late for the bus, and the monotone description of last night's homicide on the morning radio news show. His point was that the idea of process and ritual in our industrialized western culture was being lost to the seductions of technology, efficiency, and productivity. The notion he shared, and the personal aspiration that it created that day was that design could not only provide a sound and graceful solution to a problem, but it could also affect the quality of our lives by helping to bring discovery and meaning to the ordinary rituals of our existence.

This idea of somehow leveraging design to infuse meaning and enjoyment into these daily activities while enabling a successful and efficient completion of the task became the foundation for generating my thesis objective.

3.1 OPPORTUNITY IDENTIFICATION

My search for an appropriate and desirable topic on which to focus my efforts took several turns. The following schematic (fig 3.) traces my progress of thought and focus through-out the first four meetings with my advisory committee.

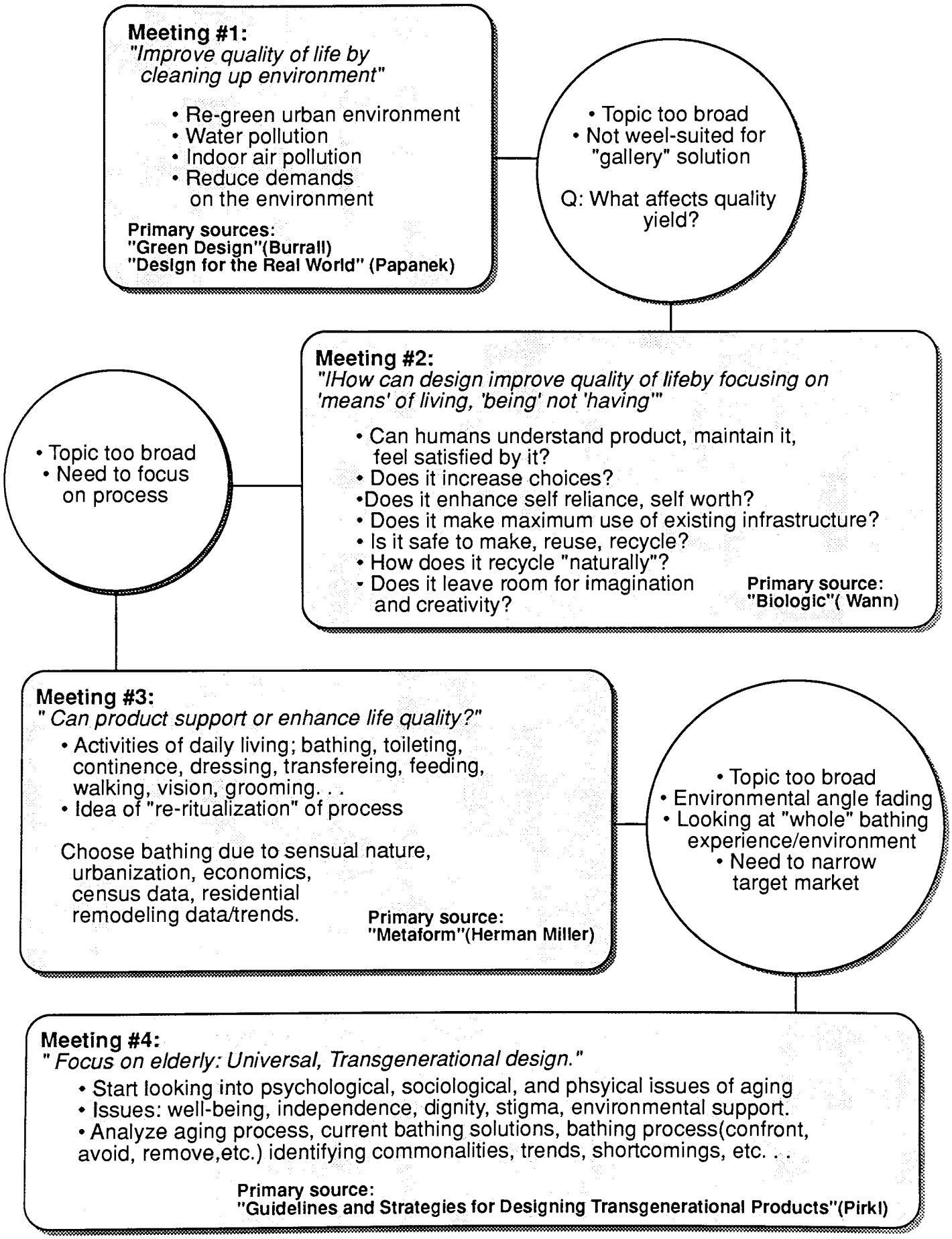

Fig. 3 Opportunity Identification Path

3.3 OBJECTIFICATION

After the fourth meeting, the final focus of this project finally became clear; to design a bathing system that improved the quality of people's lives by providing for the following:

- Help people to remain independent as they grow older by seamlessly adapting to their changing sensory and physical capabilities.

- Allow people to more easily choose the means by which they accomplish their personal hygiene needs.

- Make the system equally desirable by both fully and lessor abled individuals in order to reduce or eliminate the stigma associated with "specially" supportive products.

- Make the system easy to specify, customize, install, use, maintain, and enjoy.

With this objective established as a sort of "yardstick" by which to measure the appropriateness of product concepts, the Analysis phase of the project began.

4.0 ANALYSIS

The analysis portion of the process model is separated into three sections that generated three types of information used as input for the Synthesis portion of the model.

• The **Audience Profile** analysis helped to develop an understanding of the target audience.

• The **Task Demand Profile** analysis helped to identify the specific activities, personal actions, and environmental demands that are inherent in accomplishing the task under investigation.

• The **Product/System Mode** analysis helped to ensure the consideration of all the possible modes of a product's existence.

Analyzing all three of these areas provided a solid knowledge base from which to generate ideas for product solutions. The model could be used to organize investigations into many other product types with different target audience profiles by simply substituting the appropriate audience background information into this section of the model.

4.1 AUDIENCE PROFILE ANALYSIS

This analysis establishes a profile of the psychological, physiological, and sociological characteristics of the target audience. In this case, the audience is primarily the elderly population and secondarily the handicapped and disabled populations. As one steps through this portion of the model, it is important to record initial ideas or opportunities that might come to mind as one would naturally extrapolate how the profile characteristics relate to the objective of the project. These initial intuitions can be liberating, as they can dispel or challenge existing paradigms, since the identification of specific form or engineering constraints are not yet binding.

Historically, design and human factors specialists have been concerned primarily with the physiological aspects of elderly and disabled persons. Because of the obvious importance of the physical interface between the individual and the product, much data has been compiled that outlines the specific physical and sensory characteristics of these populations. As a result, many of the products designed for these populations have focused only on overcoming the particular physical limitations, and have neglected addressing the importance of the emotional relationships we have with our products and spaces. This neglect has led to "specialized" products that, although they function adequately, condescendingly stigmatize the user as being different. This stigma can thus render the product's possible benefits useless because of misuse or disuse. While it is critical that the product designer acknowledge the special physical limitations of the elderly and handicapped, it is just as critical to respect

the psychological and sociological needs of that audience so as not to compound the debilitating effects of physiological changes.

In their book "Guidelines and Strategies for Designing Transgenerational Products," authors Pirkl and Babic provide an excellent overview of the complex physical, psychological and sociological changes that take place in all of us as we age and confront diminished capabilities.[1] They also present a set of detailed guidelines and strategies intended to help the development of products that are sensitive to the specific physical and sensory limitations of the elderly audience.[2] The book provides a resource for developing an audience demand profile and an understanding of the elderly population. Below, I briefly outline the elemental process of creating this audience profile, and provide examples of how product ideas were generated while developing my understanding of the target audience.

4.1.1 Psychological Changes

Psychological changes can be separated into three areas: information processing, personality, and the myth of senility.[3]

Information Processing

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[1] Pirkl et al, "Guidelines for Transgenerational Products," 11-18, 27-44 passim.

[2] ibid., 50-74 passim.

[3] Ibid., 38

Information processing includes reaction time, intelligence, learning, memory patterns, and problem solving techniques.

• **Reaction Time** - Reaction time increases(response slows) with age. It is also correlated to the complexity of the task.

Idea: In the bathing environment, dangerous consequences of slower reaction times can be seen in issues related to stability and balance, falling, and dangers from scalding burns and cold water shocks. Balanced pressure plumbing loops provide resistance to sudden water temperature changes by eliminating pressure surges due to unexpected water demands elsewhere in the home.

• **Intelligence** - Intelligence does not appear to change until quite late in life. Issues of motivation, vocabulary, contemporary skills, and speed, however, decrease and do affect task performance.

Idea: If bathing spaces and products demand new and unfamiliar skills, or present other possible motivational barriers, the desire or ability to bathe could be affected. Avoid developing products that are unfamiliar in style, process, material, or function. Make bathing process as similar as possible to previous life experience, or at least equal to "normal" bathing practices.

• **Learning** - Learning appears to be unaffected by age. Reducing complexity by redundant cueing and simplifying complex tasks into subsequent sub-tasks makes learning easier, however.

Idea: What about an audible water temperature and flow control? This redundant cueing (visual, auditory, and sensory) would help learning and retention. What about utilizing tactile redundancies? Maybe the hot

water adjustment handle could be warm, and the cold water handle cold?

• **Memory** - As people age, it is proven that short term memory capabilities diminish whereas long term memory remains more intact.

Idea: A temperature preset on a water control device might eliminate a possible danger if an elderly person needs to remember to avoid overly hot baths for instance.

• **Problem Solving** - Older people are much more cautious than younger people and are less likely to use trial-and-error problem solving techniques. The absence of clear instruction or intuitive clues(i.e. size, shape, color, sequence, priority, etc.) can be intimidating and can discourage elderly people from even attempting a puzzling task that a younger person would tackle out of curiosity.

Idea: Have you ever stepped into a hotel room shower and had trouble determining how to adjust the water temperature? Push, pull, up, down, left, right, red, blue? I have had trouble. I imagine others have too.

Personality

Although it is generally thought to be true that older persons display more and more of the temperament they had as a youngster, there are wide diversities in those personalities and it is crucial that designers avoid developing concepts based on any certain stereotype.

Idea: Provide a product that allows the person the option to customize its use to whatever cultural or personal background they might have.

The Myth of Senility

The best research available disproves that it is somehow "natural" to become forgetful or disengaged from reality as one ages. Over 94% of elderly people remain independent, and the normal aging process is not congruent with mental health problems.

Idea: Provide a level of intuitive interaction that is simple enough for a child but so powerful in its refinement and sophistication as to satisfy the most discerning of tastes.

4.1.2 Sociological Changes

There are more people over the age of 65 living today than have lived at this age in all of recorded history.[4] This fact along with America's youth-oriented culture, presents an interesting situation. Gerontologists have

[4] Ibid., 40

been studying issues pertaining to this situation and have named them ageism, gerontophobia, and retirement.[5]

Ageism

Ageism refers to discrimination based on old age. It is manifest in attitudes, beliefs, financial matters, and employment. Like any other discrimination, it stems from a fear of things that are different. The fact is that older people are, of course, not different, and though they may need more environmental support, they don't want to be treated as being different.

Idea: Develop products that are appropriate for people of all ages, not just simply the young or the old. Products with this flexibility would help to highlight the similarities between the generations and eliminate the stigma attached to "special-use" products.

Gerontophobia

Gerontophobia refers to the fear or growing old. Many cultures view growing old in different ways. Our American culture places a premium on youth, and this attitude has been internalized by many people, young and old. The resulting, internalized fear is often manifest in the products and spaces that we want and use, even if those products don't serve our best interests.

Idea: Design attractive, stylish bath products that are safer and easier to use. Design youthful market desire into non-gender biased products.

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5 Ibid., 41

Retirement

Retirement marks a departure from the labor force. In our work-oriented society, this new non-productive status contributes to the view that elderly or disabled people are different. This amplifies the aforementioned problems of ageism and gerontophobia.

Idea: Make products that highlight a person's ability to be creative and productive. Instead of an automatic human bathing machine that does all of the work for you, what about a product that enables you to do more of the work yourself. Provide a feeling of accomplishment.

4.1.3 Physiological Changes

The changes that occur as a result of biological and physiological aging represent the most significant obstacles to retaining our ability to function autonomously as we grow old or succumb to injury or disease. Whether the losses are physical(flexibility, strength, coordination) or sensory(visual, auditory, tactile), they can hinder our ability to effectively interact with the products and spaces that surround us in our homes, offices, and public places. This hindrance threatens our quality of living.

A complete and easy to use resource for the physical and sensory decrements of the elderly and disabled populations can be found in Pirkl and Babic's book.[6] The book not only identifies the decrements but also suggests strategies for accommodating or designing around the

[6] Ibid., 50-99 passim.

impairments. A summary of their generic guidelines for designing transgenerational products follows.

Generic Guidelines

- Provide cross-sensory redundant cueing for all alarms, signals, and controls, e.g., combine an audio signal with a visual indicator.

- Offer redundant modes of operation utilizing the next larger set of motor movements, e.g., finger to hand; hand to arm; arm to foot.

- Establish consistent display/motion relationships, e.g., forward/up, to increase, backward/down to decrease.

- Provide definitive feedback dues, e.g., control detents should "snap" into position.

- Reduce the complexity of all operations, e.g., minimize number of tasks.

- Place critical, frequently used controls within easiest reach, e.g., cluster controls on basis of priority.

- Prevent accidental actuation of critical controls, e.g., recess or provide guard.

- Provide adjustable product/user interfaces, e.g., horizontal/incline, vertical/incline, raise/lower, push/pull.

- Design for use by a variety of populations, e.g., male/female, old/young, weak/strong.

- Design to facilitate physical and cognitive function, e.g., encourage user to practice and improve.

- Design beyond the basic physical/functional need, e.g., enhance the user's independence, self respect, and quality of life.

- Compensate for a range of accommodation levels, e.g., provide for some exercise through user interaction/participation.

- Strive to make task movements simple and enjoyable. e.g., clockwise for "on" or "increase", counterclockwise for "off" or "decrease."[7]

[7]Ibid.

4.2 Task Profile Analysis

This analysis creates a profile or list of all of the personal actions and coinciding environmental demands that take place during the successful completion of a task utilizing existing products and spaces. By utilizing this form of analysis I was able to better isolate the problems of existing bathing products and identify an area of investigation that led to the Freehand Bathing Arm concept.

The structure for this analysis was found in a paper by M. Cherie Clark, Sara J. Czaja, and Ruth A. Weber titled "Older Adults and Daily Living Task Profiles."[8] As applied here, the analysis isolates specific activities performed during the accomplishment of a task and distills them down to the particular actions performed by the individual as well as the demands inherent or generated by the environment during those actions. The goal is to generate an exhaustive list describing the interaction or interface between each personal action and its associated environmental demand.

During this analysis I was conscious of keeping notes of product ideas, opportunities, insights, hunches, problems, or concepts that might come to mind based upon the knowledge and perspective established during the Audience Profile and the Product/System Mode analysis sections. The shear number and variety of ideas generated is important here, and

[8] Clark et al, "Task Profiles," 537-549

one should avoid any tendencies towards convergent thinking. The ability to think creatively and divergently at this point is critical.

Following is an illustration of the Task Analysis structure as well as an explanation of each section, with some examples pertaining to the development of Freehand.

4.2.1 Activities

For any task that a person performs there are a certain number of activities that are done is support of that task. To bathe, for instance, one must generally get undressed, turn on the water, adjust the temperature, enter the bathtub or shower stall, move underneath or apply the water stream to one's body, possibly adjust the water flow or temperature, get away from the water stream in order to apply the soap to lift the dirt and grime into suspension, reapply the water in order to rinse away the soap and dirt, turn off the water, exit the environment, dry oneself, and dress oneself. As can be seen, the seemingly simple task of bathing involves many different stages, in this case there are twelve. These activities highlight the general stages or processes that occur during this daily task.

By dividing the task into separate activities, it is now possible to identify or isolate general areas of focus where obvious weaknesses or

opportunities exist. In my investigation into existing bathing products it was clear that egress was the main concern for safe and proper bathing. Having already found numerous well designed products that addressed this issue, however, I continued to search for an opportunity to further improve the safety or effectiveness of the bathing process. This search was facilitated by the following interface analysis.

4.2.2 Action /Demands Interface

For each activity established above there are both personal actions and environmental demands associated with it. Turning on the water, for example, requires several actions and associated demands. A person must first locate the water control device(action) by maybe seeing or feeling for it(demand), address the device(action) by possibly navigating the physical nature of the space in which it is mounted(demand), determine how to operate it(action) by, again, visual or sensory clues(demands), and then operate it(action), by either grasping, pushing, pulling, twisting, or maybe even verbally commanding it (demands) to start the flow of water.

Once the action/demand pairings were established for the various bathing activities, it became clear to me that there were a significant amount of simultaneous physical and sensory requirements during the washing process. Depending on user capability levels, these simultaneous demands posed possible conflict that could either lead to

interruption or failure to accomplish the activity, or more critically, the danger of instability and injury.

In order to bathe in a conventional manner, a person must perform four basic actions: get wet, apply soap, scrub, and rinse. Accomplishing these four steps with existing products is where I discovered an opportunity for my product concept.

Getting wet is a seemingly simple process; turn on the water, adjust the flow level and the temperature to the desired settings, and then either move yourself into the water stream or move the water stream onto you. If you're fully-abled, the process of moving yourself into the water stream is, of course, a simple task. But for the person hampered by an injury or other disability, the task of moving around in a wet, slippery environment can be a difficult and dangerous proposition, even with the appropriate support rails and fixtures. If it's necessary or desirable, then, to move the water stream onto and around you, products like the ever-popular, hand-held shower nozzle seem like the perfect solution. Because of their flexibility to allow a person to stand or sit and apply water where and when they desire, it is not surprising to find one of these products specified in every single instance where a bathing system is intended for people such as the elderly and disabled, who are less inclined, or unable to move within the bathing environment. Though this seems like a reasonable and appropriate application of a product in order to increase compatibility and reduce environmental demands, it actually does just the opposite.

My analysis uncovered the paradox that the utilization of a hand held water nozzle in order to respond to the various needs of lesser-abled people actually creates conflicting and increased demands on those individuals. Even a person with minimal impairments will find that obtaining, directing and then reaffixing a hand-held unit while maintaining balance and utilizing various soaps and accessories creates a myriad of simultaneous tasks. Even in a well designed bathing stall with appropriate seating and support rail fixtures, the bathing process is compromised. If due to these complications, then, a user simply leaves the nozzle fixed in its wall mount in order to lesson the interface demands, the inadequacies of a fixed position water source apply, and little has been gained or resolved. So, despite solving the issues of egress, even a well designed bathing environment utilizing a hand held nozzle solution may pose an intimidating and even dangerous experience for an impaired person.

It was at this point in the project that the idea of the Freehand Bathing Arm emerged. As I considered the bathing process and the need to disperse water to various desired locations for various periods of time, I wondered if a similar type of dispersion situation already existed that might serve as a model to emulate. That afternoon found me sitting at my drafting board, and attached to that surface was a drafting lamp and a movable drafting arm. I noticed that both of these instruments allowed me to distribute of disperse either light or information to desired locations for various periods of time. Once the desired location was determined and the unit was placed, I could remove my grasp and it would retain its position.

What if you replaced the light bulb with a shower nozzle? What if, like the both the light and the drafting arm, you could move the end of the apparatus by touching it at any point with either a hand or a foot? What about the fact that when I want to broadcast the light over a wide area or concentrate it closely on a detail I need merely push the light to where its needed and then focus only on the drawing and not on hanging or clamping the light fixture? After all, light and water can behave in similar ways, so why not try to disperse them similarly? This became my goal.

4.3 Product/System Mode Analysis

From a product's manufacture and sale, through eventual disposal or reclamation, the success of its design is contingent on more than merely satisfying the day to day usage needs of the consumer. Safe and efficient manufacture, profitable sales, excellent form, fit, and function, ease of repair, and ecologically responsible disposal all contribute to a successful product.

The purpose of the Product/System Mode analysis is to examine all possible phases of a product's existence and begin to consider how these issues can affect a product's form and function. The idea for the structure and objective of this analysis is patterned after the Structured Planning model developed by Dr. Charles C. Owen at the Institute of Design at Illinois Institute of Technology.[1] According to Owen's model, the modes establish focal points around which to both generate data of particular and selfish interest to the mode and distill information and insight about the product and its application across the various phases of its life cycle.

Though it may seem premature or constraining to consider these broad issues, even before any tangible concepts have been developed, there is an opportunity to consider these modes as starting points around which to develop a batch of unconstrained insight or even initial product concepts before too many commitments or prejudices are established. Each mode is meant

[1]Charles Owen, "Class Notes," 1991.

to act as a catalyst for generating unconstrained ideas. These ideas may be imaginary, idealistic, or optimal for only a given mode, but they may spark innovative ideas or at least dispel outdated assumptions and allow for a truly progressive solution.

Following is an illustration of the analysis(fig. 4) listing some of the primary issues and their possible design implications.

System Mode:	Issue:	Design Implication(example):
Initiation:	• Mass Customization	• Design for assemble-to-order (ATO), not engineer-to-order (ETO) or make-to order (MTO) strategy
	• Marketing/Sales	• Market as menu-based product for price, size, and function flexibility
	•Purchase/Specification	•Telephone/on-line specification and ordering of menu-based components
	•Installation	•Product retrofits to any existing wall-mount fixture
Routine Use:	•Bathing/Hygiene	•Interchangable snap-on bathing tools for soaps, lotions, brushes, etc.
	•Relaxation	•Recycle (recirculate/filter/reheat) water to conserve for extra long periods
	•Safety	•Utilize external-to-wall plumbing lines as hand support rails
Special Use:	•Rehabilitation	•Provide special add-on accessories for immediate conversion to highly-supportive uses
	•Cleaning/Maintenance	•Components snap apart for replacement or cleaning in dishwasher
	•Reconfiguration	•Snap apart methodology allows for ablility to change configuration in future
Completion:	•Disposal/Recycle	•Parts snap or break apart and are labeled for sorting with like-kind materials for disposal or recycling

Fig. 4 Mode Analysis Illustration

5.0 SYNTHESIS

The analysis activities resulted in identifying six key design objectives. This phase describes how the Freehand Bathing Arm came to satisfy the following criteria:

1) Make the bathing process as similar as possible to previous life experience in order to reduce stigma of "special" solutions. Create cross-generational or "universal" design and commercial appeal.

2) Minimize simultaneous task demands in order to reduce dangerous situations related to stability and balance.

3) Make product/person interface as intuitive and refined as possible(including redundant visual, auditory, and sensual cues) in order to reduce apprehension, frustration, stigma, and eventual neglect.

4) Provide a person the option to easily customize a product's specification, installation, and daily use to whatever personal, functional, environmental or cultural preference one may have. Simplify routine and special maintenance or modification of product.

5) Make the bathing process a creative and participative as well as productive process. Provide for a feeling of accomplishment, self-reliance, and dignity. Avoid the "human washing machine."

6) Offer redundant modes of operation utilizing increasingly larger motor movements in order to automatically and invisibly respond to diminished capabilities.

5.1 MANIPULATION

During this phase, all of the research data, learning, and insight established during the analysis period was integrated, or manipulated, into design concepts that attempted to satisfy the above objectives.

After considering several process scenarios designed to eliminate simultaneous tasking conditions including telescoping, flexible, and accordion-type dispersion mechanisms as well as various enclosure-specific concepts utilizing wall, ceiling, and/or floor delivery systems, I chose to pursue a solution that capitalized on the efficiency found in the drafting equipment analogy identified during my analysis. In my opinion, this concept intuitively provided the best platform capable of satisfying the above objectives due to its relatively conventional mechanical principles and inherent dimensional flexibility. A solution of this type could simply provide the level of flexibility and customization that a hand-held unit provides but without the precarious manipulation issues those devices present. It would also represent such a gentle and intuitive

evolution away from conventional bathing processes as to avoid labeling and stigmatizing the bather as one requiring "special" support.

Following are photographs of a study model that demonstrate not only the eventual articulating solution with its counter-balance and friction systems, but displays the capability and application versatility of the concept as well.

FIGURE 5A.

FIGURE 5B.

FIGURE 5C.

Figures 5a-5c demonstrate the system's capability of accommodating both "conventional" wall-mounted shower applications as well as applications only previously served by hand-held shower nozzles. Notice that issues of physical stature or personal preference can be automatically accommodated with no need to unlock, unfasten, hang up, or retighten any part of the unit. The unit can be positioned by either pushing, pulling, nudging, or grasping any one of its various segments and then releasing it to remain fixed in the desired location. Note how the bather could sit(or stand) either facing, perpendicular to, or away from the supply wall and the unit would similarly accommodate either position. Also notice how the unit can be used as an extension to access and concentrate on locations not easily reached due to flexibility, balance, or muscle fatigue and cramping issues. Once the bathing, or relaxation period is complete, the bather need only to push the unit aside, and exit the enclosure.

5.2 RESOLUTION

The final form and functional resolution of the Freehand Bathing Arm concept can be seen in the following.

Figure 6 summarizes the rotational axes that account for the articulation and configuration capabilities of Freehand.

The primary rotational plane is governed by axis "A" and is parallel to the supply wall. The bather first positions the unit "generally" in this plane in anticipation of either a standing or seated shower. This general position can be instantly altered at any time during the bathing process, but the majority of articulation needs for either a standing or seated event can be accomplished by a single positioning in this plane. Utilization of the supply tube(axis "B") traveling in this plane works well as a global repositioning "handle" when using the apparatus as an extension feature.

As the unit moves about axis "A", it is tensioned, or balanced, by two methods. First, a counter-balance mass off-setting the unit's gross component and captured water weight gives the unit a partially balanced attitude. Since the magnitude of the torsional force acting on axis "A" varies as Freehand's secondary segments move along and away from the wall (i.e. the result of a varying moment), axis "A" is further restricted by a braking system illustrated in figure 7a. This braking system is tensioned once at the time of installation (or after cleaning or maintenance) to achieve a smoothly balanced operation in any configuration, thus customizing the relative "stiffness" of Freehand's primary articulating action. This "ride" can thus be customized to suit either enclosure geometry, bathing style, or other personal preference.

As Freehand swings away from the supply wall about axis "B", it again creates a situation of varying torsional loads depending on the location of the supply nozzle. The "twisting" force is relatively

small when the nozzle is either close to axis "B" or close to the primary rotational plane, then grows steadily larger as the nozzle moves away from the wall, and reaches a maximum when positioned perpendicular to the wall when axis "B" is parallel to the floor.

To counteract this varying force so that Freehand "floats" about only in response to the user's deliberate input (grab, nudge or push), axis "B" is governed by a variable rate torsional counterbalance of the kind illustrated in figure 7b. The torsion spring "winds up" and increases its resistance if axis "B" rotates away from the wall. It creates a counter-balance that varies in size responding directly to the varying loads created as the Freehand Arm is moved about the bathing enclosure. The rate of this spring would be determined by the geometry and size of the specified configuration and preinstalled during manufacture, or simply repositioned in the field to create various preloads. This ensures that Freehand's nozzle effortlessly glides about regardless of the customized lengths of the various segments.

At axis "C", Freehand once again experiences variable torsional loads due to varying moments related to nozzle location. Here again, the braking system described above for axis "A", figure 7a, helps to counteract the forces of gravity and provide only for deliberate, smoothly controlled action designed for effortless repositioning of Freehand's nozzle.

The remaining axes, "D", "E", and "F", are governed solely by the friction created by the o-ring water seals as illustrated in figure 7c. This solution is due to the fact that the forces acting on these joints so "far out" along Freehand's length are relatively small and constant and can be accounted for by friction alone without hindering the smooth and balanced action on the apparatus. This illustration also hints at the means by which the various segments of Freehand's body can be "snapped" apart for customization of size, replacement, or for easy cleaning of the component parts in the kitchen dishwasher.

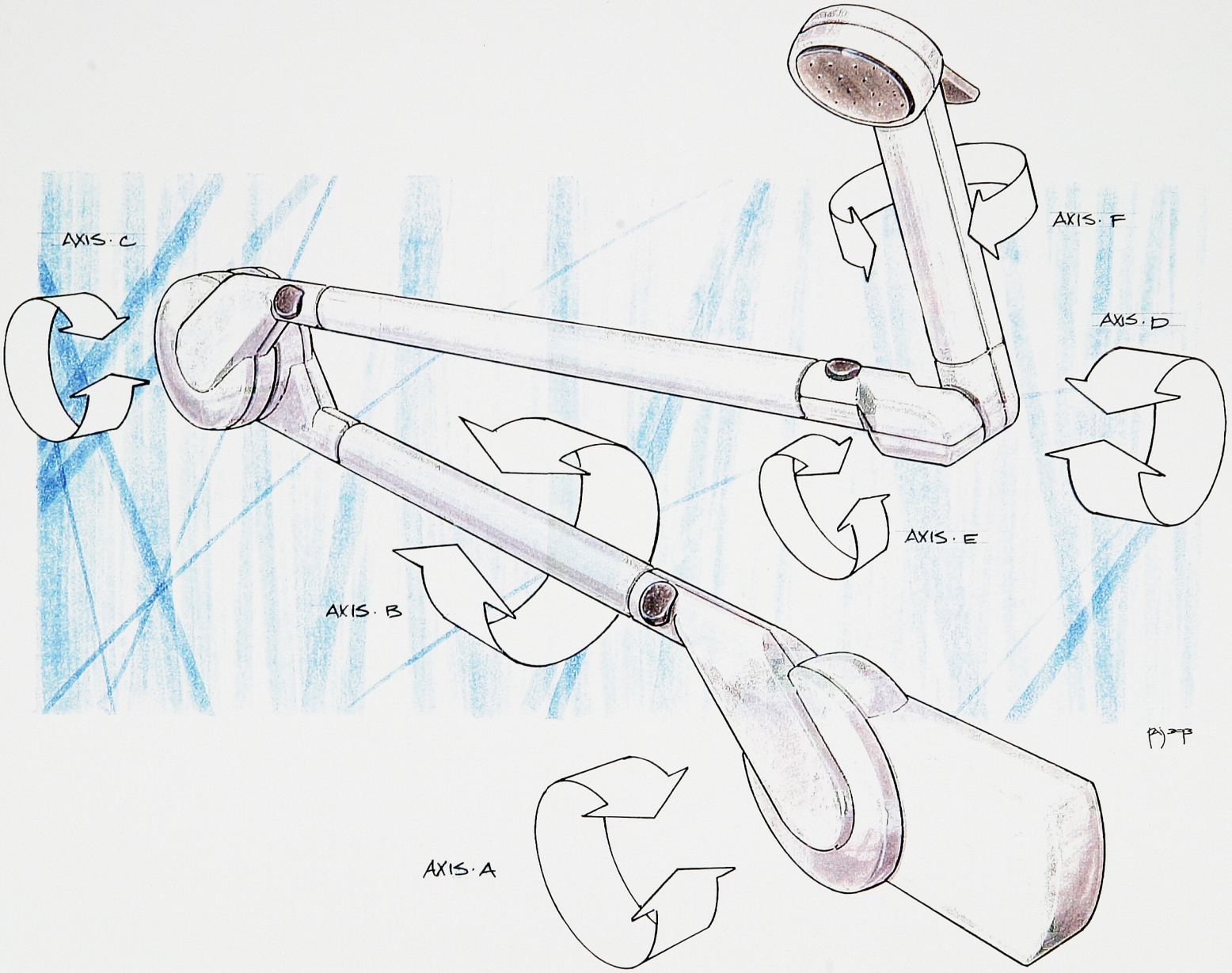


FIGURE 6.

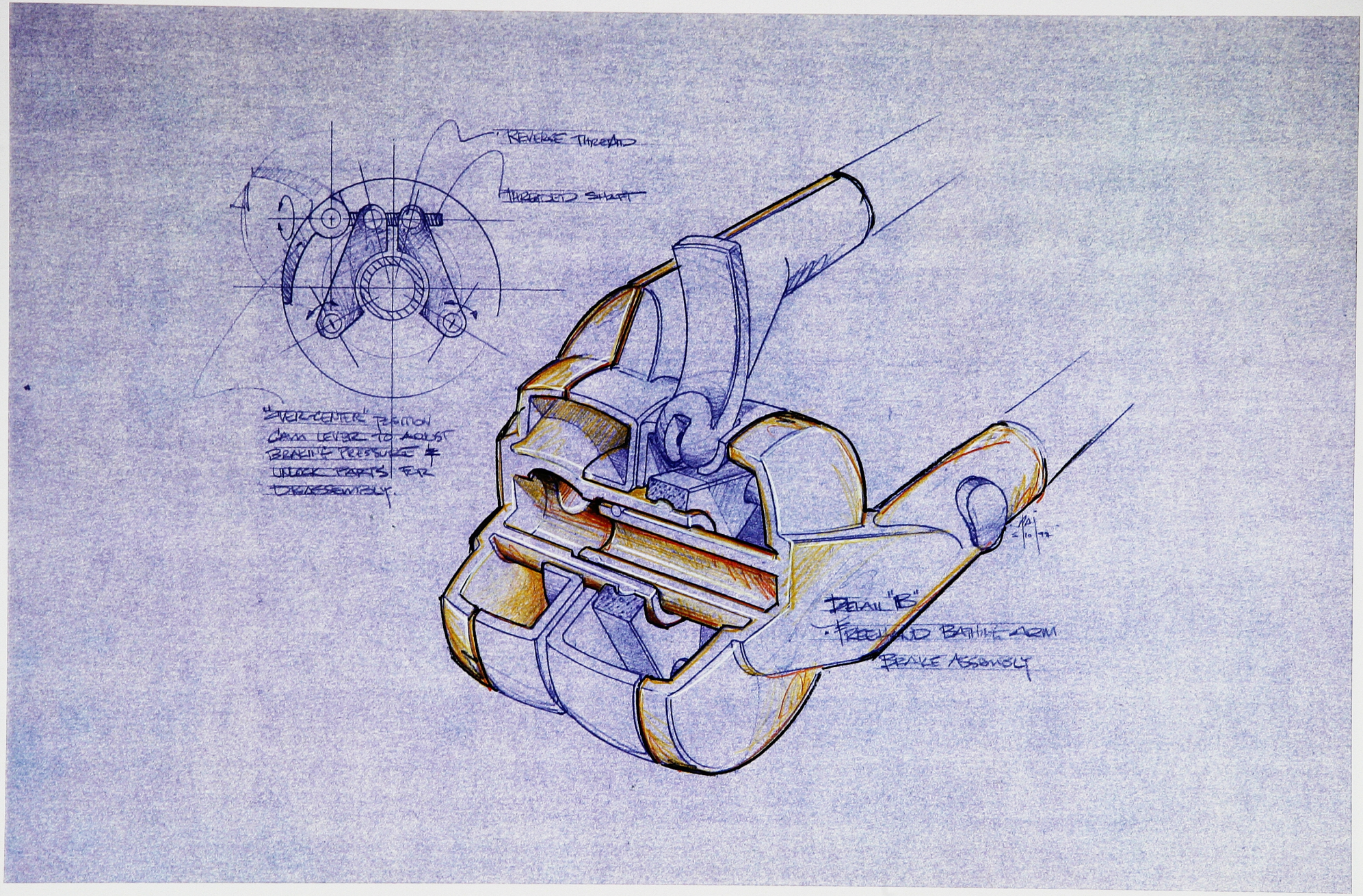

REVERSE THREAD
THREADED SHAFT
"STEER-CENTER" PEDAL ON CAM LEVER TO ADJUST BRAKE PRESSURE & UNLOCK PARTS FOR DISASSEMBLY.
DETAIL "B"
FREE-HAND BRAKE ARM
BRAKE ASSEMBLY

FIGURE 7A.

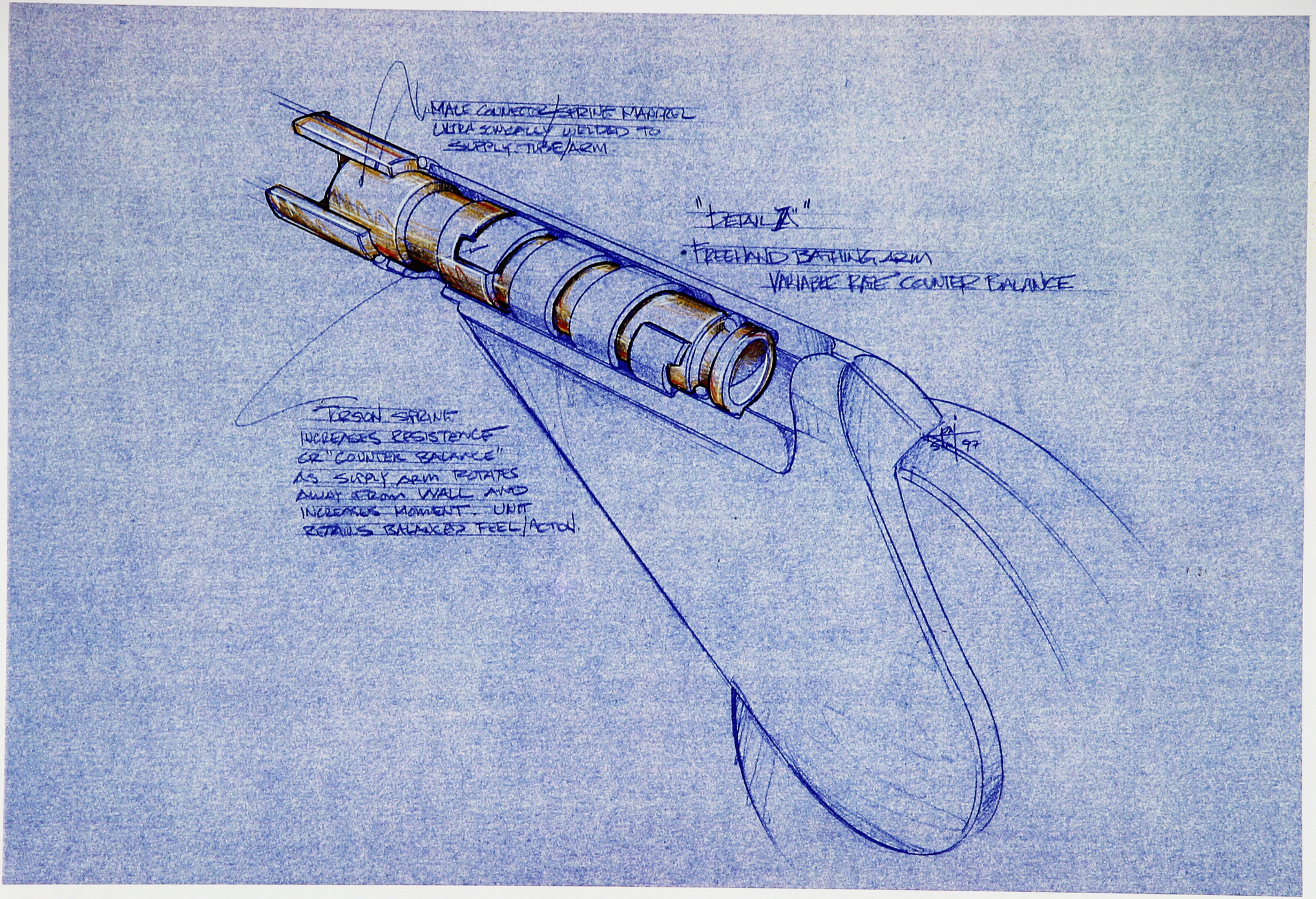
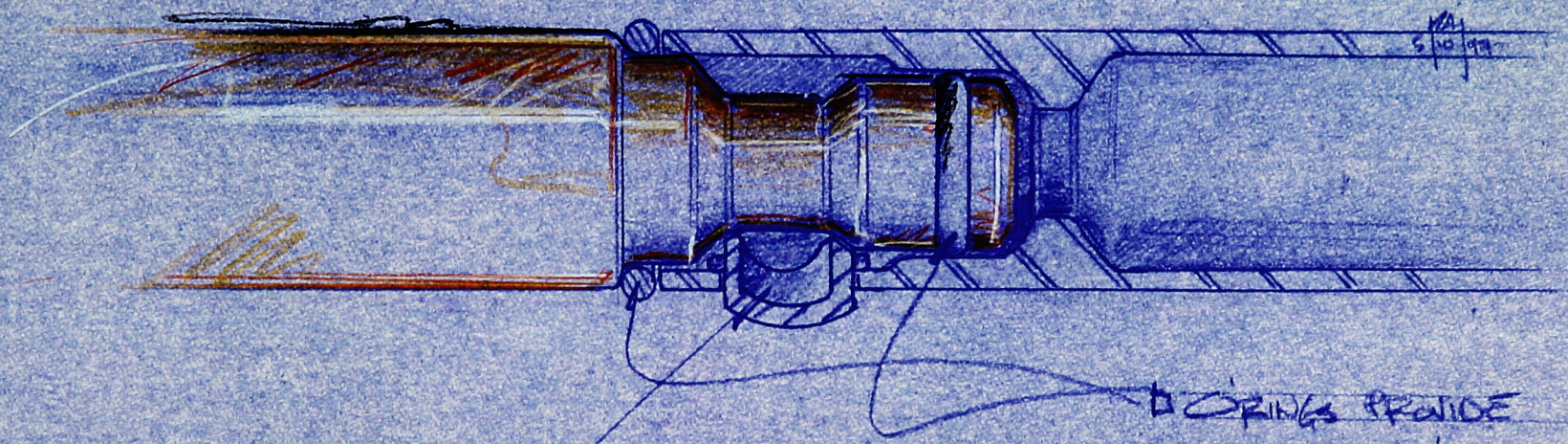

MALE CONNECTOR/DRIVE MANDREL
ULTRASONICALLY WELDED TO
SUPPLY TUBE/ARM.
"DETAIL A"
• FREEHAND BATHING ARM
VARIABLE RATE COUNTER BALANCE
TORSION SPRING
INCREASES RESISTENCE
OR "COUNTER BALANCE"
AS SUPPLY ARM ROTATES
AWAY FROM WALL AND
INCREASES MOMENT. UNIT
REFINES BALANCED FEEL/ACTION.

FIGURE 7B.

DETAIL "C"

SNAP FIT JOINTS



O'RINGS PROVIDE
WATER SEAL &
ROTATIONAL FRICTION
TO CONTROL FUNCTION

PUSH BUTTON
"ROCKS" ON OFF-CENTER
AXIS TO ALLOW FITTINGS
TO SNAP TOGETHER & APART
FOR CUSTOMIZATION OF SIZE
& MAINTENANCE

FIGURE 7C.

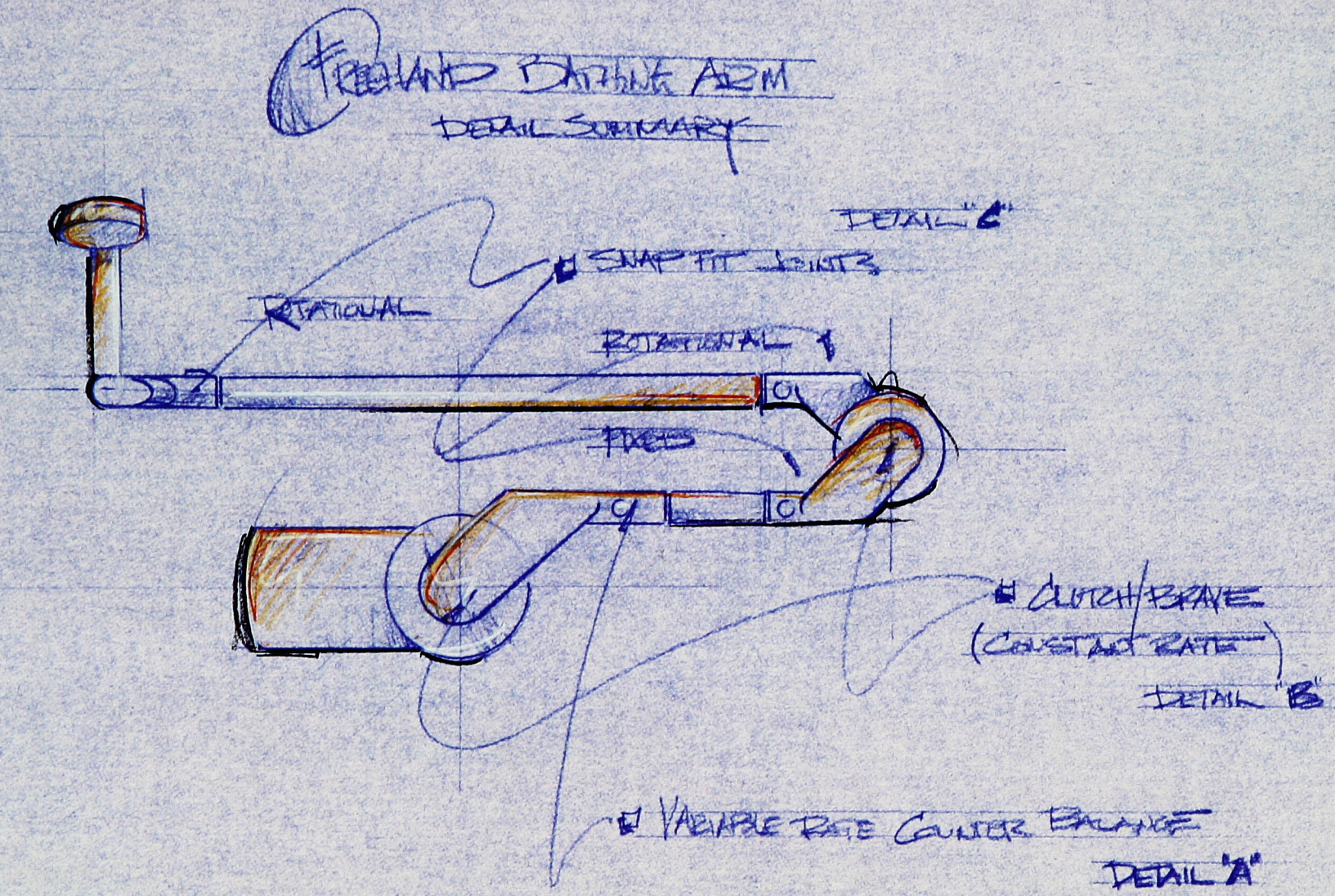


FIGURE 7- SUMMARY.

The water flow and temperature regulation for Freehand is accomplished by a single lever-type handle mixer valve seen in figures 8 and 9. The geometry and action are designed with a combination of discrete visual, tactile, and sensory cues, as well as culturally intuitive directional cues. To increase flow rate, pull up ("more"), for increased temperature, rotate clockwise("increase") in the direction of the raised emboss, the opposite for cold. The lever's simple rectangular shape stands out away from the wall so that it can easily be activated by hand, elbow, foot, or prosthetic device. The emboss and deboss along with the ratcheting-type rotating action provide sensory feedback as to direction and magnitude of movement.

The valve unit can be installed in any location within the bathing environment so that easy access can be obtained both prior to entering the enclosure, and/or during the bathing process. The unit is also intended for use with either a balanced pressure valve or plumbing loop[1] which guards against any sudden pressure or temperature fluctuations resulting from usage demands elsewhere in the home such as laundry, kitchen, or demands of other bathroom fixtures.

[1]Herbert Panzer, PE, "Operational Criteria for Balanced Pressure Shower Valves," Heating, Piping, Air Conditioning August, (1991), 59-63.

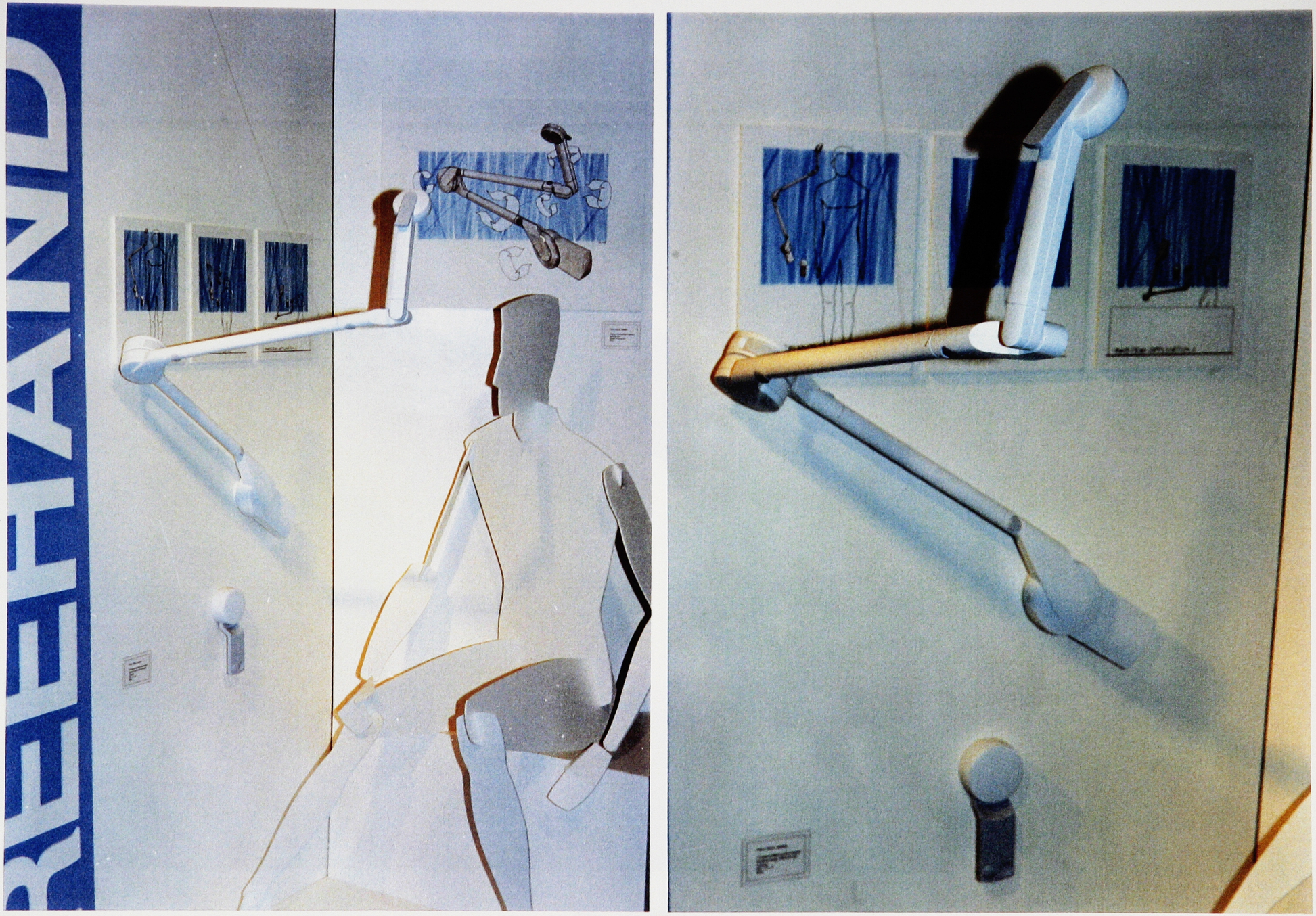


FIGURE 8.

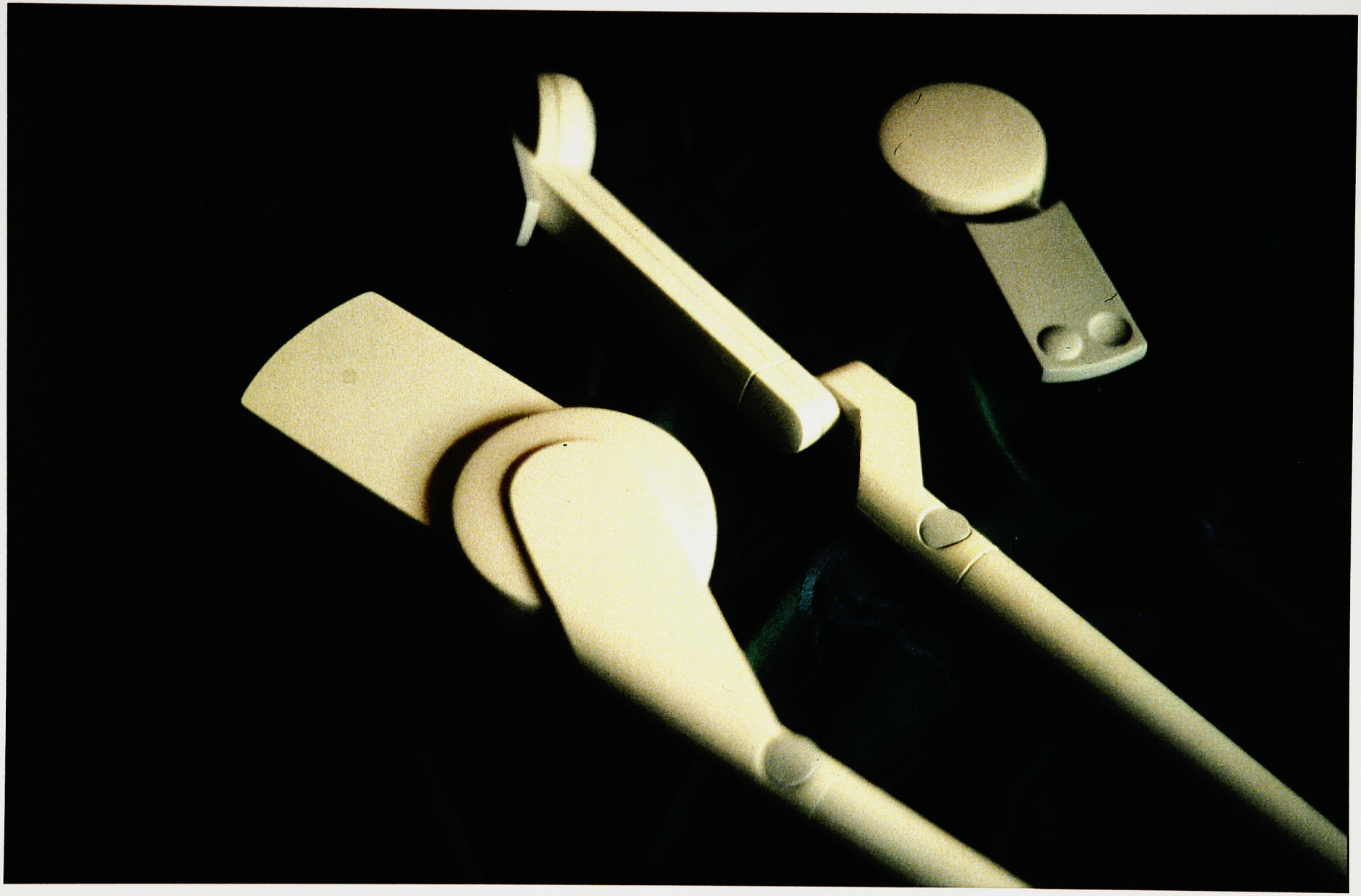


FIGURE 9.

In the area of customization, Freehand's two arm segment tubes can be specified in various lengths in order to allow system to be custom fit to any size enclosure. The counter-balance and braking systems are designed to anticipate these varying set-ups and adapt to the resulting load characteristics created by each combination. The various tube segments will simply snap into place for either installation, remodeling, maintenance, or cleaning purposes.

The Freehand Bathing Arm presents a unique, powerful, and dignified approach to reducing the demands of the bathing process. It's fresh, yet intuitive solution enables and prolongs the ability for self-sufficient bathing practices in a manner that is essentially consistent with established life experiences. This autonomy provides for a feeling of accomplishment, self-reliance, and dignity, while reducing the stigma often associated specially supportive products and processes. It allows for personal interpretation and selection, and responds to either temporary, permanent, sudden, or evolutionary changes in support needs. Freehand improves the quality and well-being of people's lives by absorbing the burden of adaptability, allowing people to remain independent and more self-sufficient for a greater portion of their lives.

6.0 EVALUATION/CONCLUSION

At the writing of this paper it is nearly four years since the gallery exhibition and defense of this thesis. Revisiting the project and finalizing this paper has been an revealing learning experience, as it has forced me to sift through the thoughts and ideas of a younger self. Though much of what I found could have benefited from my additional four years of experience and perspective, I have come to draw the following conclusions:

• First, that the notion behind Freehand's potential ability to improve the quality of peoples lives by promoting independence and self-reliance remains significant and substantially sound.

• Secondly, that the resulting design process provided a good comprehensive approach to problem identification and solution that enabled a fresh approach to a well established product metaphor. This process could certainly serve as a framework for other projects and objectives.

• Thirdly, though I find the existing articulating solution somewhat intriguing, I now recognize it to be functionally a bit too complicated and aesthetically too "machine-like" and inconsistent with the sensual nature of a bathing environment. From my current perspective, I would recommend a wholly different articulating configuration that would simplify the architecture and work in better concert with gravity and the bathing environment.

• Finally, I no longer feel that a universally designed product capable of meeting the needs of an extensively broad audience is necessarily in the best net interest of all the audience segments involved. A responsibly and intelligently designed niche product will not only better serve its particular audience due to its increased

level of customization, but can do so, I believe, without having to apologize for its special capabilities and without violating the dignity of the user.

Recalling the original project objectives, The Freehand Bathing Arm attempts to provide the following:

• Help people to remain independent as they grow older by seamlessly adapting to their changing sensory and physical capabilities.

• Allow people to more easily chose the means by which they accomplish their personal hygiene needs.

• Make the system equally desirable by both fully and lessor-abled individuals in order to reduce or eliminate the stigma associated with "specially" supportive products.

• Make the system easy to specify, customize, install, use, maintain, and enjoy.

In concept, The Freehand Bathing Arm demonstrates how the quality of our lives could be improved by shifting the burden of adaptability and compatibility away from us to the products that serve us. In light of aging and disability, the Freehand system would enable people to be more self-sufficient, with more dignity, for a greater portion of their lives.


FREEHAND

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