REDESIGNING THE HOSPITAL CRADLE TO PROMOTE PARENT-NEWBORN RELATIONSHIPS

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by

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Abstract

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This thesis explores a process of industrial design applied to the nurturing and protection of premature babies and their families. The project’s focus was established through field and scholarly research into the realm of neonatology. Onsite observations at a public maternity hospital in the city of Rio de Janeiro, Brazil, led to the identification of the thesis topic – the redesign of the neonatal cradle for hospitalized babies. Partnership with the hospital staff, and later with physicians and nurses of a regional hospital in South Bend, Indiana, led to design concepts that were evaluated by medical experts. In the beginning of the project, collaborations were also established with parents of babies that were in the intensive and intermediate care units of the hospital in Rio.

Three components guided the development of the project: content, context and collaboration. In this paper I explain how each of these components relate to my broader understanding of industrial design, while also connecting them to specific parts of the thesis project itself. Examples of former projects in graduate school are also cited to provide for a thread of development within my design practice.
It is my understanding that designers need to engage in the process of defining the very subjects they are expected to contribute to, taking part not only in the making of things, but first, in determining what things need to be made. The professional responsibility of the designer and his place in society is, then, discussed.

While the architecture of the environments for neonatal care have started to be revised to accommodate new conceptions of institutional care for sick infants, the support products utilized in these units seem to be responding at a much slower pace. This proposed solution for the hospital cradle is my attempt to engage in a necessary change that must occur within the universe of artifacts and technologies that compose neonatal care.
To my parents Maria da Penha and Frederico,

and my brothers Zeca and Nino.
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PREFACE

In graduate school I have found an appropriate environment for the exploration of a design practice that is committed solely to the development of artifacts whose purpose is to enhance the quality of life by addressing fundamental needs and challenges of ordinary human beings. Prior to this thesis work the exploration was carried out in three different projects.

The goal of my first project was to tackle the issue of emergency rescue in overcrowded urban slums. Born and raised in Rio de Janeiro, Brazil, I have witnessed the growth of these poorly constructed settlements – often in locations with high risks of landslides and flooding – and the social and economic costs of disorganized urban sprawl. The main focus was later expanded as I identified other circumstances, namely, the aftermath of earthquakes, hurricanes or tsunamis that presented similar challenges for rescuers. The solution to carry the injured to safety was a simple harness mechanism that took advantage of the ability of the lower body to withstand and carry loads, while diverting weight from the spine and lower back. When wearing the device responders had the advantage of free-hands carriage, allowing them to utilize their upper body and arms for balance and additional support when traversing on uneven terrain.
My second semester of graduate school was devoted to the development of a tactile navigation system that enables a visually impaired person to swim independently and safely. The system provides lateral guidance and awareness of end-wall proximity through perceptible physical stimuli and so dispenses with the need for a sighted helper\textsuperscript{1}. Following this exciting experiment in applying design solutions to the needs of people with disabilities, I worked on the creation of a system that provided for topographical orientation for people visiting or working on the university campus. This system integrated visual, tactile, and auditory information. Both projects were made possible by collaborating with people from different backgrounds and expertise, including two design colleagues from the graduate program.

It is not without larger purpose that the subject of accessibility manifests itself repeatedly in my design research and practice. As a citizen of a country whose social and economic inequities approach the worst in the world, I firmly believe in design as a force for social change, and for the achievement and promotion of human dignity and well-being. Design has the potential to transform the social landscape into one that welcomes and empowers all humans, regardless of their economic means.

In developing these ideas and strengthening my technical skills I have come to focus my energy and expertise on a thesis project within the health field, my greatest area of interest, and one whose ever-changing nature demands constant novel design solutions.

\textsuperscript{1}These helpers, called “tappers”, stand at each end of the pool holding a stick with a soft end. As the swimmer approaches the turning point the “tapper” taps them on the head, back or shoulders to prevent collisions with the walls. “Tappers”, however, have no means for providing lateral guidance in mid-stream. Thus, visually impaired swimmers often zigzag within the lanes, scratching their bodies on the harsh plastic material of the lane dividers.
My thesis work focuses on neonatology and the continued care of premature babies as they progress from Intensive Care to Intermediate Care. The work is grounded in recent shifts in the understanding of the preterm baby, and the ways in which the physical and social environments of care influence the therapeutics and development of these babies and their families.

The evolutionary paths of neonatology and industrial design are connected in interesting ways. To start with, the invention and development of the incubator – the archetypal apparatus associated with neonatal care – were of major consequence in the creation of a perceptual difference between premature infants and other feeble newborns. As the medical community struggled to establish itself within a realm historically dominated by mothers and midwives, the incubator and the therapeutic outcomes it provided were decisive in enabling physicians to identify the “premature infant” as a distinctive clinical entity.

The development of the incubator was not the only agent in the changing conception of the preterm baby; the contexts in which the incubator emerged and advanced – first in France, in the 1890s, then in the US, in the early 1900s – were also important for this process, as well as for the specific evolution of the incubator. As noted by Baker in his seminal book on the history of neonatal technology:

The evolution of the incubator illustrates how a given artifact may be perceived quite differently by individuals in different social contexts [...] The incubator did not emerge in response to an objective problem posed by an entity called ‘the premature infant’. Instead, individuals responded to their own notions of what such infants required, drawing from a

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3 Ibid, 30-31.
reservoir of artifacts, concepts, and models found in their own environments.

This is fundamental to my deeper interest in context as a determinant factor in
the practice of design, and it serves as a historical example of how it influences the
shaping of things and interactions. The contrasting understanding of French and
American physicians concerning health in general as well as contrasting populations of
newborns dictated different perspectives on neonatal care and technology, resulting in
different therapeutic strategies.

The care of sick newborns has undergone several changes over time. From
domestic care based on practical experience to institutionalized care based on scientific
evidence, the delicate relationship between professionals, mothers, babies, and artifacts
has been continuously transformed and reinvented. Technology, to address one of the
components of this relationship, has been alternatively referred to as threatening, life-
saving, inefficient, revolutionary, superfluous, and essential, depending on the time
period, and the ideologies of the specialist. Furthermore, the very concept of neonatal
technology has dramatically changed; more so recently, in the effort to accommodate the
“soft” technologies of breast milk and parental care and love as indispensable agents in
the recovery of weak or immature infants.

During the early years of neonatology, doctors, chemists, inventors, and curious
souls took charge of the development of the artifacts that supported the institutional care
of babies, particularly the incubator. Its design was reinterpreted numerous times

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4 Ibid, 84.
5 “In developing countries, supporting mothers to provide expressed milk may be the most
important intervention available for preterm infants.” William McGuire, Ginny Henderson, and Peter W.
according to the mastery of the growing technology of the early 20th century, the changing concept of therapy pursued as being more advantageous for the newborn and the caregivers, and the various interests of the investors behind the creative muscle.

Within my design philosophy, three components shape the making of things: content, context, and collaboration. To utilize the early years of neonatology, again, as an appropriate analogy I will render the following picture: Content was defined by the emergence of institutional care for newborns which generated rising interests in the sick infant. Context was represented by the multiple views of French and American doctors that evolved side by side, allowing for the individuals involved to debate, through theoretical discussion and material solutions, which strategies better responded to the emerging challenges of caring for premature babies. Collaboration was imprinted in almost all early iterations of the incubator, making evident the collective work of doctors and inventors.

Collaboration in the history of the incubator has shown how to combine specific knowledge of the subject matter (provided by doctors) and technical understanding of the material world (offered by the inventors) when tackling challenging problems. In my design work to this day, especially this thesis, I have sought to explore contexts and establish collaborations to achieve purposeful solutions regarding contents that matter to me, such as the provision of ever-better healthcare to all, particularly to those in most need like premature babies and their families.

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6 From its first predecessor, the 1880’s Tarnier-Martin couveuse to later American developments, such as the Rotch-Putnam brooder model of 1893, the making of this machine has proven the importance of partnership in the accomplishment of complex designs.
Acknowledgments are due to a number of people that made this thesis and my experience in graduate school as a whole much more interesting and enjoyable. First, I would like to thank my advisor and mentor, Professor Paul Down, who has been not only a constant source of inspiration, knowledge and support, but also an invaluable friend. Professor Ann-Marie Conrado provided motivation and creative insight. Professors John Sherman, Robert Sedlack and Ingrid Hess were instrumental in providing periodic feedback. All professors in design were also key in assisting my growth as a professor as well as a student. Professor Robin Rhodes’ insightful comments offered fresh perspectives and constructive criticism. Thanks to Ramiro Rodriguez and Greg at the Snite Museum of Art for the installation of my work. My colleagues in the graduate program, especially those in design, as well as all technicians, were an integral part of my learning process and my social well-being. The help of undergraduate seniors Audrey Marier and Katharine Cummins was instrumental in the completion of the multimedia piece featured in my exhibited work at the university museum.

This project would not have been possible without the collaboration, continued support, confidence and participation of the staff members of the Maternity Hospital of the Federal University of Rio de Janeiro, especially doctors Regina Carino, Maura Castilho, Ivo Basílio, and Rita Bórnia, and nurses, Laura Johanson, Lúcia Rosa,
Lindalva, Trícia, Sandra Valesca, Rosemery, Gustavo, Vânia Trinta, and Antonia Lúcia. To all of you, my most sincere appreciation.

Thanks also to the Research Ethics Committee that approved this project, making it possible for me to conduct onsite observations and prototype testing at the Maternity Hospital’s Neonatal Intermediate Care Unit.

The babies and their parents who kindly participated in interviews, brainstorming sessions, and testing were all fundamental to the realization of this work. I hope the project lives up to your immense contribution.

Staff members at the Memorial Hospital of South Bend, Indiana, Doctor Robert White, chief of the neonatal intensive care unit, and doctors Vitaly Soloveychik, Basharat Buchh, and Femi Okanlami, the nursing unit director Diane Freel, and the developmental therapist Victoria Vierling helped evaluating the final features and forms, as well as determining some of the priorities of the project towards its conclusion.

My former professors and friends Cristine Nogueira and Renata Mattos offered logistical support in Rio and helpful comments on the work in progress. Marcia Hennig, my undergraduate thesis co-advisor, was also extremely helpful in choosing the paths for the final solutions.

Thanks are also due to Vanessa Barbosa, occupational therapist at the Hospital of the University of Illinois at Chicago, and nurse Rosemary White-Traut, head of the Department of Women, Children and Family Health Science at the same university.

Also important to this project was the help of Gary Mast and Don from GS Plastics, whose support in vacuum forming the bathing bassinet prototype contributed to the
successful onsite testing, and Richard Derenne from Stryker Medical, who provided me with a bassinet from their product line for research purposes.

The field-testing was made possible by a grant from the Institute for Scholarship in the Liberal Arts (ISLA) of the University of Notre Dame that assisted with travel expenses.
CHAPTER 1:

INTRODUCTION

1.1. Overview

This thesis is structured in five chapters that describe the trajectory of my work from field research to the development of the proposed solutions and achieved results. My intention in the first chapter is to provide the reader with a set of general information that permeates my design thinking and activity. In chapter two I focus on the research and methodological choices that led to the identification of the thesis topic, while continuing to build on some of the concepts presented in chapter one. Chapter three is devoted to describing the nature of premature infants and the emotional challenges for their parents; the physical environments that support the care of hospitalized newborns; some important changes in medical thinking that affected the dynamics of neonatal care and how design research fits into this context. The proposed solution is scrutinized in chapter four, where design decisions are explained as they relate to the needs of the subjects involved, the requirements of the environment of use, and how my work responds to some of the challenges unmet by other available products. The final chapter is devoted to a discussion of further possible developments for this and other projects in the field of medical design, more specifically in product design and neonatology.
1.2. The Importance of What (content)

*In whose interest and to what ends?*

The statement above - offered by a graphic design scholar - encompasses most of what I understand to be the beginning of any design work. Every project is a commitment to an idea and a decision to put forth effort and skill towards a particular goal. Though the political and social implications of our practice are rarely addressed, even by designers themselves, design is amongst the professions that can most effectively, and directly, impact daily life. Throughout history, the discovery, invention, implementation and evolution of objects have deeply changed the ways in which humans interact with and perceive the surrounding environment. From the invention of the wheel to intrauterine fetal surgery, the world has been shaped – and will continue to be – by the metamorphic process of human intervention in the physical towards the achievement of a preferred version, an improved alternative, a better solution. The development of technological implements helps shape relationships within and across cultures, transform the ways we perceive the world beyond ourselves, and determine how we experience time and place.

Essentially, any design is a political choice in that it assumes, from departure, a desired arrival point that will “disturb” or change the previous order of things. Now, it is

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10 Bauman, for example, talks about the perception of shrinkage of time or shortening of space with the invention of faster transportation devices. Zygmunt Bauman, *Liquid Modernity* (Malden: Blackwell, 2000).
11 Jesse S. Tatum phrased this beautifully: “Every design serves certain interests, certain objectives, to the relative disadvantage of other real or possible interests and objectives. Ignoring this fact is no less a
true that, more often than not, the designer cannot determine what or where that point is, but there is an intention to accomplish something that is envisioned as being better than what preceded it. I have embraced the political implications of my design practice in every project I have been involved with in graduate school, and particularly now for this thesis work. In my conception, the design activity must occur from the beginning, from the process of identifying and describing the challenge to its final systematic and material solution. That said, designers play a role in the determination of content as well as in the form and logic of the solution.

In contemporary design practice, the designer is usually subordinated to needs or conditions determined by third parties. Design “always must have a patron. And those who are best able to pay for it necessarily will have their perceptions and interests more actively represented.” This statement is true as long as designers exist only as secondary components in an inflexible system that works under the premise that goods need to be delivered by the industry to consumers in the market. But perhaps the “commercial arena” is not the quintessential environment for the industrial designer.

Design seems to have assumed the core function of an element for the aesthetic enhancement of products, or as a vehicle to provide companies with a competitive advantage in a marketplace flooded with a myriad of gadgets that, in essence, are very similar. Such a narrow perspective on what designers ought to be doing sets aside what I understand to be the primary contributions the profession may offer in contemporary times: (a) the critical exercise of questioning how the material world should respond to moral or value-based position than attending to the matter explicitly.” Jesse S. Tatum, “The Challenge of Responsible Design,” Design Issues (2004): 76.

This is critical to my work, and I’ll further discuss it when addressing methodology, in the next chapter.

Ibid 11, 77.
the requirements, needs and desires of humanity – many of which have little correspondence with previous historical challenges; (b) the ability to identify opportunities for improvement of situations where the human and artificial components are in dissonance; and (c) the responsibility to facilitate our task of preserving the ecosystem by helping humanity to envision and accomplish a greener future.

*Human-centered design is fundamentally an affirmation of human dignity.*

My approach to product design also derives from my agreement with the following premise: Design should serve humanity above all things. To accomplish this objective, it is necessary to work with people and for people.

The definition of human-centered design is embedded in Buchanan’s definition of design as “the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes”\(^\text{15}\), and is also explained by Hanington as “an activity inherently tied to human needs and concerns”\(^\text{16}\). Since all human activity is somewhat concerned with humans or humanity, the title of this section *The Importance of What* – requires further explanation.

My objectives focus on engaging in content, as opposed to plain application of skill toward a pragmatic goal. A significant addition to the definition provided by Buchanan would better delineate “individual and collective purposes” in light of ethical


and ecological principles\textsuperscript{17}. To support my criticism of his lack of specificity, I will quote McCoy:

Should one help sell tobacco and alcohol, or design a memorial library for a man who reads only pulp cowboy novels? Does society really benefit from a strategic plan for plastic housewares or fast-food? The answers may be more subtle than a yes or no. But one thing is clear: Design is not a neutral, value-free process\textsuperscript{18}.

If designers are unable to envision what endeavors are worth pursuing, someone else will do that for them. Historically, that third party has been the industry. I will not develop arguments about the implications of mass production in this paper, however I must point out that I find the general understanding that industrial designers work for the industry to be problematic.

The reason for this is, in my view, two-fold: On the one hand, the system of serial production has its own challenges to be addressed and those have to do with achieving productivity goals, sales quotas, and minimizing the costs to generate profit. By definition, success in those realms translates into higher benefits for a small group of people, downplaying the importance of “collective purposes” in favor of individual profit. The second problem – a consequence of the first – is that, in order to accomplish its goals, the things that can be addressed by the industrial system are much narrower than the actual universe of problems, unmet needs, and challenges of real people in their everyday lives.

\textsuperscript{17} Buchanan does develop each part of his definition in the paper, but he does not offer a theoretical framework to qualify or categorize certain purposes as being more worthy than others. He does get more specific about which overarching issues designers should be involved with in a different essay: Ibid 14, 35-9.

\textsuperscript{18} Ibid 8, 4.
The next section describes the methodological paths that were taken in order to identify the specific topic for my thesis work, stemming from observations I made at a public maternity hospital in my hometown of Rio de Janeiro, and from bibliographic scholarship that provided specific information on neonatal care. I will also discuss the importance of collaborative work as it plays a fundamental role for the development of products in three main ways: a) it provides qualitative feedback on the designer’s ideas, making it possible for new ideas to arise from the interaction with “non-designers”, and facilitates on-site empirical testing; b) it keeps in perspective how the work extends beyond the designer’s social and psychological universes; and c) it helps assure that the primary objective of the design process is to serve people in their daily challenges.
In this section I will articulate my view on the role of research for designers. First I will address the critical importance of context as a determining factor for the identification of design challenges, as well as a component that helps frame the specific interactions and dynamics into which the outcomes of the design development ought to be incorporated. Subsequently, I will discuss how collaborative work provides the designer with invaluable information and criticism. This chapter is grounded on practical experience in conducting field observations and testing, as well as on the writings of scholars that have focused on the evolving field of research through design, and other theorists that discuss the broader political implications of the design activity.

2.1. The Importance of Where (context)

Earlier in section 1.2 I acknowledged that many times, in the beginning of a project, designers are ignorant of what the end point of their work will be. Now, I find it necessary to clarify exactly what that statement means. Commonly, this lack of awareness is associated with the formal and functional aspects of a previously named
Object or service the designer is to (re)design. What this implies is that the object of study has been defined without the participation of the design team, at an earlier moment in time. Examples of this praxis encompass most products we see everyday being launched in the market, and it portrays the rooted relationship of design and industry, also discussed in the section The Importance of What, where I comment on the current dominant understanding of designers as an inseparable part of the mass production system.

The lack of awareness I am interested in is of a different nature. It has profound impacts on the ways I believe designers should conduct research. In my view, the designer should begin his research by placing himself within the context of use, among the people who live, work or play in such contexts. The design opportunity emerges from the context, and the developed solution will take the form and shape that better suits the context and the people that are part of it.

Hanington recognizes the importance of context to the design process by asserting that “at the beginning of a project, when the user group and its tasks are unknown to the design team, it is critical for members to immerse themselves in the user’s world to develop a functional literacy of the material with which they will be working.”19 The specifics of how the design work will be configured can only be provided by external sources, namely: people, processes, and products – the three research loci for designers according to Cross20. I must add a fourth source: context – the environment in which the three components identified by Cross are found together.

19 Ibid 16, 11.
20 Nigel Cross, Designerly Ways of Knowing (Berlin: BIRD, 2007), 14.
Designing without acknowledging the reality of the context in question results in a reversed process through which the designer will do all necessary to force his/her vision into a context that has its own organic existence, values and meanings. Those dynamics are what define the very cultural and social identities of the communities and they will prevail regardless of the designer’s opinions or beliefs. Without knowing the specifics of the context of use, the designer can only rely on his own preconceptions of the subject matter.

In the following lines I will describe the two contexts that were determinant not only in guiding the development of the project, but first, in defining the very subject the project was to address. I will also briefly explain the nature of my working relationship within the two environments.

2.1.1 The Maternity Hospital of the Federal University of Rio de Janeiro, Brazil

The Maternity Hospital of the Federal University of Rio de Janeiro (Maternidade Escola da Universidade Federal do Rio de Janeiro) was founded in 1904, under the name of Maternity of Rio de Janeiro. Its main purpose was to assist pregnant women and newborn infants from the most economically disadvantaged classes of the city.

Ever since its creation, the Maternity has been at the front-end of technical and therapeutic practices in Brazilian obstetrics and neonatology. In the 1970s, the director of the Maternity, doctor Jorge de Rezende implemented important innovations on the

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21 The text in this section is an adapted translation from a copy provided by doctor Ivo Basílio, the president of the Research Ethics Committee of the Maternity Hospital of the Federal University of Rio de Janeiro.
techniques of child delivery, and was also responsible for the introduction of the graduate program in the institution. His contributions were of major importance to the teaching of obstetrics in Brazil, and served as a starting-point for many undergraduate and graduate programs in that discipline throughout the country.

The Maternity Hospital is a public institution integrated with the Federal University of Rio de Janeiro. The hospital is national reference in medium-complexity care for women and specializes in pregnancy with high-risks for babies and mothers. The institution offers emergency care, prenatal care, family planning, pediatric follow-up, nutritional support, and psychological and social services. The Maternity Hospital also offers inpatient facilities, and obstetrical and neonatal surgery.

Numerous diagnostic and therapeutic services are available for both mothers and newborns, including forty beds for obstetrical surgery, sixteen beds for neonatal intensive care, and ten beds for neonatal intermediate care. All services provided are free of charge to the population, as the institution is a part of the United Health System (Sistema Único de Saúde) of Brazil – a country that provides universal healthcare.

2.1.1.1. Observations at the Maternity Hospital

In accordance with my understanding that designers should derive their objects of study directly from people, processes, products and contexts, and embracing my overarching interest in the medical field, I proceeded to place myself into the environment in which I wanted to contribute: Hospitals.
In a hospital I would find all elements necessary to identify possible opportunities for design intervention: 1) *People*: staff, patients and their families, 2) *Processes*: caregiving practices, patient-staff interaction, patient-family interaction, family-staff interaction, staff-staff interaction, people-objects interaction 3) *Products*: all objects and technologies in use at the built environment, and 4) *Context*: the sum of the three previous components with the addition of cultural idiosyncrasies determined by geographic location, and the socioeconomic backgrounds and personalities of the people in question.

My observations at the Maternity Hospital were concentrated in two spaces: The Neonatal Intensive and Intermediate Care Unit, and the Kangaroo Mother Care Nursery, both located on the second floor of the three-story building. Their physical proximity facilitates the interaction and transit of staff and patients, as the Kangaroo Nursery is utilized to further the care of newborns that are clinically more stable and will be living in the unit with the mother until discharge. This type of inpatient unit is one of few in the country and its main objectives are to build confidence and train the mother in the care of their premature infants, to give the babies time to reach a safe weight for discharge$^{22}$, and to establish breastfeeding as the primary feeding practice for the neonates.

Exploratory fieldwork was conducted from June through August of 2008, including eighteen visits and interviews with ten mothers of babies that were hospitalized at that time, or had been discharged shortly before the interview.

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$^{22}$ The minimum weight may change according to the institution’s standards. The Brazilian Ministry of Health recommends a minimum weight for discharge of 1500 grams, though some institutions will adopt higher values. The Maternity Hospital’s discharge weight is equal or greater than 1700 grams (3.75 lbs). Weight is not the only criterion for discharge. Babies also need to be free of infections, be able to be fed orally, and be steadily gaining weight. Mothers need to be capable of recognizing their babies’ signals, and be proficient and independent in the routine care of the infants.
At the time I began the fieldwork, my ignorance of the particular challenges I was to address led me to branch out laterally for as many opportunities as I could grasp. As a result, I ended up taking a three-day course on breastfeeding practices at a major public hospital in the Greater Rio area. I would later benefit from the lessons learned for the course presented breastfeeding in the context of the development of the relationship between mother and infant, which turned out to be the main focus of my thesis.

Given my continued interest in neonatology and my motivation to concentrate on the mother and the baby, as opposed to focusing mainly on the needs of the premature infant, the majority of my observations took place at the Intermediate Care Unit, where the mother starts to take charge of some important caregiving activities, such as routine hygiene and feeding. Within that environment, I rapidly realized how much of the relationship between mother and baby is mediated by objects that are not only very foreign to lay people, but many times even intimidating or frightening. Furthermore, babies are frequently wired to machines and monitors, which can increase the perception of severity and fragility, constituting another obstacle for positive mother-infant interaction.

My understanding of design, informed by my knowledge of contemporary trends in neonatology, led me to hypothesize that many of the objects I was seeing in that environment had been designed from a starting point that has dramatically changed in the last decades. I began to think that the primary concern of many of the products was

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sanitation, and with displaying a technical language that makes sense only for those who are proficient in medical practices. That vantage point has little relevance to the current praxis of institutional neonatal care, and to the accompanying design of its objects and its physical and social spaces.

It appeared to me that some of the designs were not efficiently responding to the new practices and ideologies advocated by contemporary medicine regarding the care of hospitalized newborns. First, a very important component of the new equation is the parent – particularly the mother, but also the father and other family members. As a primary caregiver to the sick newborn, the presence of the parent in the unit is no longer viewed as temporary or unexpected; it has become fundamental. The needs, expectations, and capabilities of this new “user” of the products and technologies in the environment of care are extremely different from those of trained professionals. This differentiation has major design implications that need to be taken into account.

The other issue that requires urgent attention and that apparently has been disregarded in the available designs for neonatal cradles, is that the primary users of these objects are premature and low weight infants, not term babies. The identification of this distinction was one the main outcomes of my exploratory observations, which was confirmed and supported by collaborators, as well as field-specific literature.

The needs and particularities of premature and low weight newborns are significantly different from those of (sick or healthy) term infants and require dedicated therapeutic approaches and specialized designs. Healthy babies will remain in cradles for an average of one to two days, while the mother is recovering from the

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24 I will address this topic in more depth in section 3.2 of the following chapter.
delivery process; premature babies might live in such objects for weeks or months depending on the severity of their clinical condition and/or their weight. In addition, healthy term babies will not go through intense or repetitive procedures while in those objects, whereas premature babies are constantly being manipulated and disturbed.

My presence in the environment of care granted me access and exposure to an extensive amount of information and human resources without which the object of study could not have been singled-out. In observing the interactions that take place within that context I was able to raise a number of questions (or design opportunities) that were subsequently narrowed down to a specific concern: current hospital cradles are designed to accommodate healthy newborns, attending to rules of proper sanitation and the technical requirements of specialized workers. Since the object’s main users are not healthy babies or sick term babies, but rather premature and low weight babies, and the primary caregivers of these babies are, now, lay users (i.e. parents and family), the premises for the design of the cradle have dramatically changed. Hence, a different design, one that takes the new set of requirements into account, is necessary.

The ways in which my proposals for the cradle respond to the identified challenges will be explained in chapter four. At this time, I will proceed to describe the second part of my field research, which took place in January of this year.

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25 All babies of the ten mothers I interviewed were preterm and they remained in the Intermediate Care Unit for at least three days, some up to a month. Furthermore, they all stayed in the KMC Nursery – where they remained in cradles for the majority of the time – between four days and two weeks. In the Intermediate Unit they might be inside incubators or in cradles depending on their ability to maintain their body heat and the availability of incubators. While incubators usually provide a quieter environment and controlled temperature, they hamper physical contact and access, which are better provided by open cradles.
2.1.1.2. Prototype testing at the Maternity Hospital

In the last paragraph of section 1.2 I referred to the importance of collaboration as it facilitates, among other things, onsite testing, leading to direct assessment of the functioning and interaction of proposed designs. Testing is analyzed by the design team in conjunction with end-users who generate discussion on the objective aspects of the design, simultaneously revealing both, its impact, and its reception within the physical and social context for which it was created.

Due to the complexity of the project, the available timeframe for generating prototypes built to the sanitation requirements of the Maternity Hospital, and the delicate nature of premature babies, testing was limited to a few components of the solution being developed.

As the time for testing approached I decided to focus my efforts on building a functional model of the bathing bassinet, given that it was a key component of my proposal which presented a substantial shift in design from current bassinets in use. While growing trends in neonatal care advise that premature babies be bathed by full immersion, most bassinets are not designed to support such practice.

The experimentation with the prototypes taken to Brazil was documented in photographs and video footage. The material was shared with staff members at the

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26 Due to the academic schedule and the fact that I have been residing in the United States while the Maternity Hospital is located in Brazil, testing had to be conducted over Winter Break, between late December 2008 and mid-January 2009. It is worth mentioning that the logistics of the testing included obtaining permission from the Research Ethics Committee of the Maternity Hospital, a process initiated in July 2008, thus demonstrating why testing in a different institution would be rather difficult to pursue during the course of the semester.

Maternity Hospital in a presentation/brainstorming session conducted at the institution involving nine health professionals including doctors, nurses and therapists. The images of these experiences are presented in a four-minute multimedia piece featured in the MFA exhibition at the Snite Museum of Art as part of my thesis installation.

Prototype testing was instrumental in confirming the effectiveness of immersed bathing for premature infants, and was particularly helpful in determining the final dimensions for the bathing bassinet and the nesting bassinet, and the comfortable height for caregivers to work when standing.

Pickles, Hide and Maher talk about “co-designing” when describing the positive outcomes of experience-based design (EBD)\(^\text{28}\), a concept that relates to many of the practices described in this section. The authors outline the benefits of EBD: 1) it emphasizes the importance of all agents; all voices are represented, 2) it focuses on good and bad aspects of the subject, using both as guidance for future changes/improvements, and 3) it fosters relationships and encourages creative collaboration among patients and staff.

Field-testing also operates on another level. It is the most effective way of establishing long-lasting partnerships. Confidence is built as the challenges are tackled collectively, imprinting meaning into objects that, otherwise, would likely be mere material representations of the designer’s personal taste. When expertise on the subject matter meets form-giving and problem-solving skills within the context of use, the likelihood of achieving positive outcomes increases exponentially. Furthermore, I believe

reality must be the result of a collective construction, and shared responsibility leads to shared authorship.

2.1.2. The Memorial Hospital of South Bend, Indiana

The Memorial Hospital of South Bend traces its roots back to 1894, when the Women's Home Missionary Societies of the Methodist Churches of South Bend founded Epworth Hospital and Training School. By 1901, the hospital had grown from three patient beds in a converted house to a 50-bed “modern” hospital - complete with a maternity room and an operating room - in the first building in South Bend designed specifically as a hospital. The name officially changed in 1945 to Memorial Hospital of South Bend. Today, Memorial serves as a 526-bed regional referral center for cardiac, cancer, childbirth - including newborn intensive care, emergency and trauma medicine and rehabilitation services. It has a level IIIB NICU\(^{29}\) with 36 beds and over 400 admissions annually. There are 3300 deliveries per year at Memorial\(^{30}\).

Memorial’s staff was instrumental in providing validation and criticism on some of my ideas. In January 19\(^{th}\) of 2009 I presented to the staff the latest developments of the project, which had already been refined based on my interaction with the collaborators from the Maternity Hospital in Rio and on empirical testing conducted in that institution ten days earlier. Among the professionals who attended my presentation

\(^{29}\) As defined by the American Academy of Pediatrics (AAP), neonatal care provided by hospitals is categorized, from level I to IIID, according to the availability of specialized equipment and staff capabilities. Level I constitutes well-newborn nurseries. Level IIIB includes units capable of providing continued respiratory support and some newborn surgery. For a comprehensive description see: Committee on Fetus and Newborn “Levels of Neonatal Care,” Pediatrics (2004): 1341-1347.

\(^{30}\) Part of this paragraph was provided by Dr. Robert White, head of the NICU at Memorial; the additional information was transcribed from the hospital’s website – http://qualityoflife.org (accessed February 21, 2009).
at Memorial were two registered nurses, one occupational therapist, and the four main physicians responsible for the Neonatal Intensive Care Unit, including Dr. Robert White. Dr. White has been the chairperson of the Consensus Committee on Recommended Design Standards for Advanced Neonatal Care for the past seven years.

In learning the therapeutic approaches of doctors and nurses from both institutions, representing two quite different contexts, and listening to their perspectives on my proposals, I could evaluate my concepts on a much more solid ground, to determine what was of greater importance, what was recurrent, what was distinctive, and what was still unanswered by the proposed designs.

I could also, to a certain extent, compare how the technological infrastructure of each facility helps shape the interactions and caregiving practices. Despite many differences, the object-focus of this thesis – the neonatal cradle – was, unsurprisingly similar in both institutions, as well as in all other institutions I have visited to this date.31 My research on the available models of hospital cradles and bathing devices for newborns, including objects with comparable functionality for domestic use, confirms the overarching functional and aesthetic similarities of most devices according to my six criteria of evaluation: shape; structure; material; color/finish; features and accessories; and use.

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31 Since 2005, I have visited approximately eleven NICUs, two of which were in North American hospitals; all others were in institutions in my hometown of Rio de Janeiro, Brazil.
2.2. The Importance of Who (collaboration)

There is a common belief that the role of designers, architects, engineers and artists – those who manipulate matter to shape the world – is to shed light on the lives of “ordinary people”, by proposing how the world should look, based on their improved understanding of aesthetics and functionality. An alternative view with which I am sympathetic, is that the building of a complex, simultaneous world is inherently a collective process that must, necessarily, include the end-users, “lay” people.

Malcolm Miles presents an interesting example in his essay “Picking up Stones” when discussing urban planning research and the role of people (dwellers) in determining city plans. Miles and others (Winner, Tatum, Buchanan, and Bauman, for example) address how every design carries a political bias that favors the dominant vision of how things should be organized and managed. Miles’ perceptive understanding of the urban planning process as a political act of power in which space is designed according to an exclusive agenda is illustrated by his metaphor on how urban planners represent space:

The God’s eye viewpoint of the city plan is, then, a metaphor for a position of power, and is in its utilization by urban planners a position of real power to conceptualize the city and implement their concept through civic institutions, a process in which the dominance of professionals over non-professional ‘users’ is affirmed through the opacity of the planning process, the exclusivity of technical language, and the unavailability of information to those who might object.32

Bauman has also voiced his opinion on the ways in which power is exerted through the designing of social space and the structures that support and make it

possible for human activity to develop. In *Liquid Modernity* he points out one of the consequences of the prevailing ordering of our societies as societies of consumption:

For at least two hundred years it was the managers of capitalistic enterprises who dominated the world – that is, set the feasible apart from the implausible, the rational apart from the irrational, the sensible apart from the insane, and otherwise determined and circumscribed the range of alternatives inside which human life trajectories were to be confined. It was therefore their vision of the world, in conjunction with the world itself, shaped and reshaped in the likeness of that vision, that fed into and gave substance to the dominant discourse.33

Collaboration builds confidence, which makes possible two fundamental things for designers: 1) people feel comfortable with the presence of an outsider in their working environments, observing their actions, learning about the way they operate; and 2) they will not only talk to you, but also listen, establishing a dialogue.

My relationship with the doctors, nurses, and parents at the Maternity Hospital and the Memorial Hospital made it possible for me to frequently visit, for long periods of time, restricted environments in which all the interactions that define the situation of use occur. Without access to such environments – the Neonatal Intensive and Intermediate Care Units, and the Kangaroo Mother Care Nursery – as well as the partnership of many people within those contexts, the realization of this project would not have been possible. Furthermore, the very identification of the subject matter would have been out of question.

The collaboration extended beyond the issue of accessibility. Nurses, parents and doctors became critics and co-creators of my design work. Through interviews, conversations, presentations and brainstorming sessions the challenges of providing

33 Ibid 10, 55.
parent-inclusive neonatal care for hospitalized newborns was gradually defined and framed as a design problem.

Collaboration assures that the resulting construction will reflect a collective view. Communal meanings derive from the collective process of interfering in reality to rebuild the artificial landscape as new challenges emerge. This type of design practice denies Bauman’s suggestion that the dominant discourse of those in power prevails, leaving ordinary people with little room for participation. Collaborating with end-users helps frame the problems to be addressed by taking into account first and foremost the interests and needs of the context of use and those who are a part of it. Contrary to passive consumers, people become active co-creators. The end result is, then, the concrete manifestation of political participation, instead of political exclusion.
In this chapter I will describe some aspects of the environments I visited, as well as characteristics of the individuals within these spaces, and the dynamics of their interactions among each other and with the surrounding artifacts.

Pierre Budin established the first neonatal unit in 1893, in Paris, France, emphasizing thermal regulation and breastfeeding. Budin was a student of Stéphane Tarnier – the pioneer in scientific neonatal care and inventor of the first incubator in 1880. In America, it was not until 1922 that a similar unit for sick infants was implemented, and only in 1975 a certifying examination for physicians within the new specialty was created\(^{34}\). Since the late nineteenth century, when neonatology started to develop as a scientific discipline, many changes occurred, both in the technological infrastructure and the therapeutic practices that characterize this field.

From a design standpoint, the current practices in neonatology can be best

described by the prevalence of three main movements: 1) the environments of care are morphing from a strictly clinical aspect to a more welcoming, home-like space; 2) infants are being considered holistically as individuals with particular needs. Their therapy is being dictated by their developmental stage and clinical condition; procedures take into account first the babies’ state of readiness, as opposed to following a rigid schedule that is convenient to the staff; and 3) parents are now primary caregivers and their presence in the units is expected and encouraged.

The implications of these practices are very important to the design of the neonatal care units, and the artifacts that compose the technological infrastructure of these units. Hospitals that have started to adapt their spaces to such changes now offer single-family rooms for newborns in intensive care, a growing trend that could likely define the future of institutional neonatal care. These types of rooms allow for individualizing many aspects of the caregiving activities, such as illumination and noise control, while assuring proper accommodation for parents to room with their babies.\(^\text{35}\)

Despite these forward-thinking changes, the redesign of the objects that support newborn care is proving to be, surprisingly, a slower process of change than that of the architectural spaces of care. Incubators, cradles and accessories are still being designed, as they have always been, assuming specialized users (hospital staff) as the primary users, and ignoring the fact that premature and low weight babies constitute the most significant population of neonatal intensive care units worldwide. One of the conclusions

\(^{35}\) The Kangaroo Mother Care Nursery at the Maternity Hospital of the Federal University of Rio de Janeiro is an example of facility that allows mothers to room with their babies in the hospital, while being trained to take full responsibility for their infant’s care after discharge. Though there is no individual room and the nursery is not part of the NICU, it is still impressive to me that this public institution has been adopting such forward-thinking practices for a decade, when similar approaches have just started to emerge in the first world. Furthermore, the Maternity Hospital’s KMC nursery is neither the first nor the only one in Brazil; the first unit of this type was implemented in the country in 1994.
of my thesis investigation is that these design premises must change soon. My proposition for a new cradle is an effort to participate in this necessary development of more appropriate designs for both the newborns and their parents.

3.1. The Environments of Care

The environments of neonatal care include the objects, spaces, technologies and human resources employed for the therapy of sick or maturing babies. These consist of Neonatal Intensive Care Units (NICU), Neonatal Intermediate Care Units, also known as Neonatal Convalescent Care Units (NCCU), Kangaroo Mother Care Nurseries, and Well-Newborn Nurseries. Within these environments, the specialized body of professionals involves physicians, registered nurses, nurses practitioners, physical, occupational and speech therapists among others. In addition, these spaces also need to accommodate parents and other family members and visitors.

Each of these environments is equipped with a number of machines and accessories, such as incubators, radiant-heat cradles (or radiant warmers), open cradles, oxygen therapy equipment, nutritional support equipment, diverse monitoring machines, phototherapy, and diagnostic imaging scanners which comprise the “hard” technologies of neonatal care. Plus, many of these units are capable of performing various levels of newborn surgery, and are supported by other units within the hospitals that provide supplementary laboratorial and pharmaceutical services.

The Consensus Committee on Recommended Standards for Advanced Neonatal Care recognizes that there is no national agreement on what constitutes a NICU. The
Committee offers an overarching definition for neonatal intensive care as “care for medically unstable or critically ill newborns requiring constant nursing, complicated surgical procedures, continual respiratory support, or other intensive interventions.” The Committee also defines intermediate care, which “includes care of ill infants requiring less constant nursing, but does not exclude respiratory support”. Recognizing that both often occur in the same physical space the Committee proposes that whenever “hospitals mix infants of varying acuity, requiring different levels of care in the same area, intensive care design standards shall be followed to provide maximum clinical flexibility.”

Though a clear definition of what constitutes the environments of care is yet to be established, many scholars have been studying the ways in which such environments impact the development of the infants, as well as observing how parents are affected by these units. In the words of pioneer developmental care researcher Heidelise Als:

Since infants born at 24 weeks of gestational age currently have a survival rate outside the womb of about 50%, much of this neuronal maturation and organization occurs for preterm infants in the interaction with an evolutionary unexpected extrauterine environment. [that of the NICU]

Also remarked by Gottfried et al.:

Several investigations have hypothesized that the intensive care unit provides an environment that is inadequate in amount and pattern of stimulation.

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36 Consensus Committee on Recommended Design Standards for Advanced Neonatal Care, “Recommended Standards for Newborn ICU Design” (report of the Seventh Consensus Conference on Newborn ICU Design, February 01, Clearwater Beach, United States of America, February 01, 2007), 8.
37 Ibid 27, 23.
In my design exploration I have categorized the intensive and intermediate care units according to three sub-environments: *the macro environment*, *the intermediate environment*, and *the immediate environment*; and two comprehensive types of interaction: *professional interactions* and *parental interactions*. My categorization can be generally assessed in the figure below:

**FIGURE 3.1**

CATEGORIZATION OF ENVIRONMENTS OF CARE
Professional interactions occur between the staff members and the infants, between staff members and parents, and among the staff members themselves. In relation to the delivery of care to the neonates, these include all medical interventions and procedures, exams and tests, non-social touching and handling. What characterizes these interactions is the impersonal relationship between the caregiver and the newborn. That is not to imply that staff members do not worry about the babies, but to state that their relationships are limited to the performance of caregiving activities.

Parental interactions comprise primarily the interactions between parents and their newborn child. These consist of bathing and cleaning the baby and its space, feeding – which can include tube-, cup-, bottle- and breast-feeding – skin-to-skin contact, social touching and bonding. These interactions are characterized by the building of the parent-infant relationship and the constant concern of parents with the health condition of their hospitalized child while trying to adapt to an unexpected situation and environment. These tasks are performed by staff members whenever parents are not present in the units, or are incapable or unwilling to take charge of caregiving practices.

The environments of care are influential in the development of the infants and in the ways whereby parents cope with having their child at risk. They also provide for all specialized human resources and high-technologies required to support the life of the newborns. There is an evident tension between the human and the technological components of this equation. Single-family rooms are an attempt to alleviate this tension on the architectural level; my redesign for the cradle is an attempt of improving parent-

39 Parental feelings will be better explained in section 3.3.
infant relationship on the object level.

3.2. Babies

There are approximately four million neonatal deaths every year worldwide, twenty four percent of which are due to complications of prematurity. Therefore, prematurity-related conditions kill roughly a million infants each year\textsuperscript{40}, most of them in developing countries. Weekly, in the State of Indiana, there are two hundred and twenty five premature births, and more than half of these babies are born under 2500 grams\textsuperscript{41}. Of every one hundred births in America, between six and ten are premature\textsuperscript{42}. Worldwide, the incidence of preterm birth and low birth weight has remained virtually unchanged for the past twenty-five years\textsuperscript{43}.

All infants born before thirty-seven complete weeks of gestation are considered premature. Most babies born preterm are below the minimum weight considered adequate for a human newborn. Prematurity “cannot be described as a singular concept, or a singular syndrome with well-defined characteristics and developmental sequelae.” However, it is consensus among most scholars that premature babies are affected by the environments of care in different and more severe ways than term infants\textsuperscript{44}.

In the literature, the rate of low birth weight (LBW), which is intimately related

\textsuperscript{40} Ibid 34, 166.
\textsuperscript{41} In http://www.marchofdimes.com/indiana (accessed February 15, 2009).
\textsuperscript{44} Ibid, 88.
to prematurity, is constantly referred to as the main criterion for measuring infant mortality and morbidity\textsuperscript{45}. The five “top neonatal killers” are: disorders related to prematurity, asphyxia, hypothermia, infections, and lack of adequate feeding\textsuperscript{46}. It is noteworthy that both hypothermia and poor feeding can be aggravated by preterm birth. Humans usually do not develop the ability to suck, breath and swallow in a coordinated fashion until after thirty four weeks of gestational age (GA)\textsuperscript{47}, making it hard, if not impossible, to administer oral feeding of any kind. Thus, parenteral and enteral\textsuperscript{48} feeding may be required for as long as twelve weeks.

Though a few authors question the impact of LBW in the percentage of neonatal deaths\textsuperscript{49}, a growing body of literature has been pointing to further complications in the later development of surviving preterm infants. The pioneer in this field is Heidelise Als who has been, since the early eighties, researching the behavioral organization of neonates. Als is the founder of the Newborn Individualized Developmental Care and Assessment Program (NIDCAP), whose focus of study is on the particular characteristics of premature newborns and their neurobehavioral growth as they are affected by the environments and protocols of care.

\textsuperscript{45} In the early twentieth century, American physician Thomas Rotch replaced temperature by weight for keeping track of the infant’s daily healing process (Baker 1996). Ever since, weight has been the primary measure for assessing the general health status of a newborn. Low birth weight is less than 2500g; very low birth weight is less than 1500g; and extremely low birth weight is under 1000g.


\textsuperscript{48} Parenteral feeding involves the intravenous injection of amino acids with electrolytes, minerals, vitamins, glucose and fat. Enteral feeding, also know as gavage feeding, consists of a continuous infusion of breast milk or formula through a catheter inserted into the infants nostrils or mouth delivering the nutrients directly to the stomach. Further descriptions in William McGuire, Ginny Henderson, and Peter Fowlie, “ABC of Preterm Birth: Feeding the Preterm Infant,” \textit{BMJ} (2004): 1227-1230.

The iatrogenic effects\(^{50}\) of neonatal intensive care are of great concern to Als and other researchers of developmental care. Their findings on how the extrauterine artificial environment of the NICU influences the development of premature babies are of major relevance to my design work regarding this thesis project. Furthermore, the hospitalization process has lasting consequences also for parents, who commonly experience difficulties in coping with an unexpected early birth. Trying to accommodate the needs of both, the hospitalized infant and the parents, while still observing the internal restrictions and requirements of the institutions that provide for the context of care has been the primary challenge of this project.

A point that should also be made clear is that prematurity has consequences for the health status of individuals and nations that extend beyond the immediate hospitalization experience. A premature birth and the subsequent institutional care of the neonate can affect childhood development, as well as adult life outcomes. Prematurity has been repeatedly related to the incidence of blindness, deafness, delays in neurologic development, mobility impairments, as well as reduced intelligence and inability to concentrate or engage in abstract intellectual activities. As noted by Ramey and Shearer:

Medical technology solved the immediate problems of survival faced, for example, by 23- and 24-week-old fetuses [...] As we have redefined and accepted limits of viability, we have also created a population of infants at increasing risk for retinopathy of prematurity, short gut syndrome, hydrocephalus, to name a few; and whose ultimate developmental and intellectual status is cause of serious concern\(^{51}\).

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\(^{50}\) Iatrogenic effects result from medical procedures or therapies.  
\(^{51}\) Ibid 43, 93.
Premature babies are more susceptible than term babies to the changes in the environmental conditions of the NICU space. Temperature, noise and light variations can disturb their sleeping patterns and further harm their immature central nervous system. There are conflicting requirements between what is best for the infant and what is best for the machines and workers within the environments of care. For instance, while a temperature of ninety-eight degrees Fahrenheit and a dark quiet ambient is preferred to protect the babies’ development, the NICU should be kept between seventy-two and seventy-eight degrees to avoid the proliferation of bacteria and optimal functioning of the machines. At the same time, enough light should be provided to enable sheer visibility for the caregivers to work, while beeps and alarms constantly monitor the infants’ physiological condition.
TABLE 3.1*

COMPARISON OF SOME CHARACTERISTICS OF PRETERM AND TERM BABIES

<table>
<thead>
<tr>
<th></th>
<th>23 – 25 weeks</th>
<th>29 – 31 weeks</th>
<th>37 – 42 weeks (Term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birthweight (50th percentile)</td>
<td>At 24 weeks = Females – 620g, Males – 700g</td>
<td>At 30 weeks = Females – 1.400g, Males – 1.500g</td>
<td>At 40 weeks = Females – 3.400g, Males – 3.550g</td>
</tr>
<tr>
<td>Breathing</td>
<td>Respiratory support needed. Apnea is common</td>
<td>Sometimes need respiratory support. Apnea is common</td>
<td>Need for respiratory support is uncommon. Apnea is rare</td>
</tr>
<tr>
<td>Sucking and swallowing</td>
<td>No coordination</td>
<td>No coordination</td>
<td>Coordinated at 34-35 weeks of gestational age</td>
</tr>
<tr>
<td>Feeding</td>
<td>Usually need total parenteral nutrition (TPN)</td>
<td>Gavage. Sometimes TPN</td>
<td>Oral feeding</td>
</tr>
<tr>
<td>Interaction</td>
<td>Seldom available for interaction. Easily overloaded by sensory stimulation</td>
<td></td>
<td>Make eye contact; alert wakefulness</td>
</tr>
</tbody>
</table>

*Adapted from Lissauer and Fanaroff52.

Prematurity is a historical challenge to humankind. As mentioned above, the incidence of preterm births seems to have remained unchanged for, at least, the past quarter of a century. For years, the issues of prematurity and low birth weight were considered to be problematic only in developing countries, whose percentage of births within these categories can reach very elevated numbers53. In reality, providing quality care, and quality of life, to preterm infants is a global challenge. As technology and therapeutic protocols advance at a fast pace, infants who had little chance of survival in a

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52 Ibid 34, 68.
recent past are now crowding the neonatal intensive care units of many industrialized nations. These ever-more immature newborns will experience the “evolutionary unexpected” environments of the intensive care units for longer periods of time, being continually exposed to loud noises, bright lights, excessive meaningless stimuli, and diminished meaningful interactions. The developmental impacts of caring for such fragile babies outside the protection of their mothers’ wombs, as well as the consequences for these infants’ adult lives are yet to be fully comprehended.

3.3. Parents

During pregnancy, the family, and especially the mother, begin to establish and develop relationships and expectations regarding the yet-to-be-born child. These feelings come to term following the delivery, when parents and baby first meet. The experience of attachment that started with the baby still inside the womb is reinforced and grows with the experience of caring for the infant.

A premature birth, or the birth of a sick infant, disrupts this cycle of expectations. Coping with the hospitalization process is difficult, as it not only involves the risks and possible complications faced by the neonate, but it also requires parents to go through such an experience within an unfamiliar and often unwelcoming environment—the neonatal intensive care unit. As noted by Blackburn:

Families have their own reactions to technology in the NICU. Such units certainly look, sound and feel much different from the usual newborn nurseries, and the NICU may heighten parents’ fear, anxiety, guilt,
concern, and feelings of helplessness and hopelessness\textsuperscript{54}.

Wilgert et al. define the mother’s experience in neonatal intensive care units in terms of three comprehensive feelings of participation and exclusion: 1) feeling of interaction, 2) feeling of belonging or not belonging, and 3) maternal feelings\textsuperscript{55}.

Interaction with staff is important for mothers primarily to understand what their babies are going through, their health status, and the potential risks and complications of their condition. Furthermore, it also facilitates the navigation of parents within the foreign NICU environment, familiarizing them with the equipment and technology, and making them feel part of the team that cares for the child.

The feeling of belonging derives largely from this interaction with staff members, as well as from the ways in which the NICU space supports the presence of parents by providing appropriate furnishings to accommodate their needs and personal effects.

While providing the best care for the feeble newborn, hospital staff must acknowledge the needs of parents as well. Maternal and paternal feelings can be disturbed by the dynamics of the environments of care. Sentiments of guilt or failure emerge and parents may question whether the infant belongs to them or to the hospital. Conversely, active participation and inclusion on the caregiving practices have shown to increase parents’ confidence and promote bonding to the child\textsuperscript{56}.

\textsuperscript{54} Ibid 42, 1709.
\textsuperscript{56} Ibid.
Additionally, most of what stabilized premature infants need can be better provided directly by the parents: breast milk, warmth and containment can be offered by mothers and fathers with little need for technological support. Hence, facilitating parents’ access to their babies should be a primary concern for the design of products and spaces in which newborn and parents interact and begin to establish meaningful relationships.
My primary concern when defining the features and forms of the new cradle was with the relationship between the newborn and the parents. The main purpose of the *Elo* is to improve caregiving practices by facilitating physical and visual access to the infant, while providing for optimal performance of routine care tasks, such as feeding, cleaning and bathing, and comfortably accommodating the infant. The object was designed in response to the realization that parents need to be encouraged to actively engage in the daily care of their babies within the intermediate care unit, as well as in other facilities where the constant presence of parents is supported, such as in Kangaroo Mother Care Nurseries and single-family rooms. The proposed design also takes into account that the main users of the hospital cradle are premature and/or low weight infants. These users have different needs than those of mature babies, and some of these needs had major influence on the proposed design. The name chosen for the product, *Elo*, is the Portuguese word for *bond*, reinforcing the importance of parent-newborn relationships.

Physical proximity and visual contact with the infant are central to the bonding process. They encourage and facilitate touching and skin-to-skin contact, also concurring
for early opportunities for breastfeeding. As noted by Fegran et al: “Proximity through touch and visual contact are the most powerful communication tools parents utilize to interact with their infant.”

The structure of the Elo has important features that facilitate such interactions. To begin with, the cradle is supported by a central stem that provides for three main interactive functions: 1) it allows physical closeness for parents by freeing space for their feet and legs under the bassinet in which the baby rests, minimizing the barriers for close approach; 2) it makes it possible for the bassinet to be rotated 360 degrees, so the baby can always be facing the caregiver; and 3) it simplifies height adjustments which are essential to the comfort of the caregiver.

The height adjustment function is particularly critical as the majority of cradles available today do not provide this fundamental feature. Variable heights are useful for caregivers standing up, as they can adjust the position of the cradle for comfortable interaction when changing diapers, performing exams and engaging in other routine procedures. Since nurses, doctors, therapists and parents have different statures, the optimal working level of the cradle can vary according to the caregiver’s height. In addition, consideration also needs to be given to parents, family members or staff that are seated by the bedside. Often mothers will still be recovering from a cesarean delivery or extensive stitching when first visiting their babies in the intensive or intermediate care.

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59 In my product research I found only one cradle which height could be adjusted. It was not till very recently that incubators started to incorporate this feature. See for instance Giraffe family of microenvironments by GE in http://www.gehealthcare.com/usen/perinatal/products/micro_environment.html (accessed March 11, 2009).
unit. For mothers in such condition, as well as for fatigued parents, standing up to interact with the infant might be difficult. The cradle can be readily adjusted placing the baby’s surface a minimum of twenty nine inches from the ground to a maximum of thirty eight inches.

Accessibility was also improved by diminishing the height of the bassinet’s walls, while still observing the safety of the infant. An entirely new proposal for the overall shape of the realm of the newborn was also designed aiming to accomplish a fresh, contemporary look.

The walls of available bassinets average between eight and ten inches in height, and the forms of these bassinets are rectangular with very little distinction or visual appeal. The contours of the nesting bassinet of the Elo are round and the highest edge of its walls is less than seven and a half inches above the surface that supports the baby. Length and width are also reduced to better accommodate smaller babies. The bassinet’s largest point is over one inch smaller than the narrower bassinet benchmarked; the length is five and a quarter inches shorter than the shortest bassinet found in research. Premature and low weight babies are smaller, and when placed in bassinets that were designed for term babies, they look even more petite. Small size can be perceived by the parents as a sign of fragility, hindering their motivation to engage in physical contact. By diminishing the overall size of the bassinet babies are better nested and they appear less frail.

It is common practice to position infants within a U-shaped nest formed by rolls of fabric in order to better provide physical limits and containment similar to that provided by the mother’s womb. Diminishing the dimensions of the bassinet results in a
more snuggly immediate environment for these babies as the boundaries of the surroundings are in close proximity to their bodies. The bassinet’s round profile softens the appearance of the object and recalls to the shape of a woman’s belly. Rounded shapes and corners also make cleaning much easier and can alleviate sound reverberation, as there are no parallel surfaces for the sound to bounce off of.

Reflux is a common and potentially dangerous occurrence among premature babies. In order to diminish the frequency of regurgitation, they should always be placed on surfaces with their heads higher than their feet. Some incubators and cradles provide for a ten-degree angle variation, which is not enough for premature babies. Nurses and therapists often put wedges or cloth under the bed’s header to provide for a more significant incline. Building on these recurrent practices and consulting my collaborators I adopted an angle variation twice as great. The Elo can be adjusted from zero to twenty degrees.

Supporting work surfaces and storage areas are also provided. These are meant to assist in the performance of tasks such as blood draws, cleaning and patching bruises, feeding, and other daily procedures. The structure presents three plastic, stackable, rotating trays that can store accessories frequently utilized, like stethoscopes, syringes, catheters, thermometers, and gauze. The rotating mechanism allows for easy access through the entire perimeter of the cradle, while minimizing noise and impact that can disturb the baby’s sleep.60

The same structure that supports the nesting bassinet, where the infant will

60 Cradles usually have metal drawers or cabinets under the baby’s area. Drawers’ operation can generate loud squeaking noises and mechanical shocks that can easily disturb and wake the baby up.
spend the most time, also accommodates a dedicated design for the bathing bassinet. As advised by developmental therapists and mentioned on page fifteen, premature infants should be bathed by full immersion, unlike term babies. The water eases the effects of gravity on their weak bodies and helps sustain their core temperature, simulating the aqueous environment of the womb.

The proposed design of the bathing unit incorporates this practice, featuring a deep area that allows for immersed bathing without requiring a large volume of water. The bassinet incorporates a soap and bottle holder for ready access to cleaning products at the baby’s level.

Another major concern of the proposed design is with aesthetic appeal. The visual impact of neonatal products is perceived as a desired quality even in the early history of the incubator, as outlined by Baker:

The Lion incubator represented the climax of incubator design at the turn of the century. To begin with, the device presented an imposing sight visually. Not only was the infant’s chamber enlarged, but the entire apparatus was situated on sturdy metal legs that had the incidental effect of rendering its overall size comparable to that of the nurse. In response to the absence of color and the overwhelmingly clinical aspect of most cradles (and incubators), one of my goals was to introduce friendly visual elements to present the cradle as a warmer, more inviting object. That was accomplished in the shape of both the nesting and the bathing bassinets, through the incorporation of color and patterning in the structure, the exploration of glossy plastic surfaces to minimize the exposed stainless steel parts, and through an overall appearance that is less rigid and

\[61\text{ Ibid 2, 78.}\]
institutional than presently available products.

The base of the structure has a polka-dots pattern application that matches the color palette of the plastic parts of the structure. Green was chosen as the preferred color as it relates to nature and it inspires calmness and peace. Pink is also proposed as an appropriate option for baby girls. Hospital staff stated that, in general, parents would not have a problem placing a baby girl in a cradle in which colors are considered more masculine, but they would commonly object to placing a baby boy in a more feminine-colored cradle. Green seems to be an excellent alternative since this color is gender neutral.

Additional strategies for the aesthetic enhancement of the cradle include picture holders and a slot for a name tag. My research identified a common trend among parents of adorning their baby’s space with family pictures and drawings taped to the bassinet’s walls. The nesting bassinet of the Elo has the capacity to hold two 3.5”x5” pictures, without tape, thus images are easily replaced and sanitation is improved, as tape leaves glue traces on the plastic material of the bassinet. The bathing bassinet has water-themed inlays that also contribute for a better visual assessment of the object.

The proposed solutions build on the successful achievements of existing products, but most important, they respond to new therapeutic practices and challenges of contemporary neonatal care. These opportunities were identified through field research and close collaboration with the end-users – hospital staff and parents. While the methodology adopted and the development process support the relevance and effectiveness of the achieved results, I must acknowledge that introducing a new device into such a complex environment requires extensive testing and constant assessment.
and reassessment of the actual functioning of the product within the contexts of use. As recognized by the Institute of Medicine of the National Academies:

The adoption of a new device in widespread clinical practice does not signal the end of the development process. In fact, widespread use is typically a prerequisite for garnering insights about the technology that provide important feedback to the R&D sector, either in industry or academia, about necessary improvements to optimize ease of use and the associated outcomes.

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CHAPTER 5:

FURTHER DEVELOPMENTS AND OTHER DESIGN OPPORTUNITIES

Given my broader interest in pursuing industrial design and healthcare, one of the most significant outcomes of my field explorations, my continued partnership with hospital staff and my research into medical scholarship was the identification of numerous other opportunities and challenges for the design of products, spaces and services related to neonatology and the environments of newborn care. In the following section I discuss some aspects of this thesis that require further attention, while the final section identifies design opportunities yet to be addressed.

5.1. Additional Components of the ELO

While focusing primarily on the interaction of parent and infant, I acknowledged the need for other accessories that would largely alleviate the effects of the hospital environment on the developing metabolisms of preterm babies. I have also identified a major issue regarding parent-assisted enteral feeding. Some of these concerns have been addressed to a certain extent, but they would need to be developed in greater depth for a more holistic and effective solution.
5.1.1. Light and Sound Management

Lighting is adjusted to support each individual infant’s and family’s best sleep and awake organization and to deliver care without impinging on the development, comfort, and care of other infants. Individualized, controlled bedside lighting with dimmer capacity should be available. It is suggested that the general nursery lighting be indirect and readily adjusted in terms of brightness.

Ideally light and sound in the NICU should be controlled, providing individualized levels of luminance and noise that are appropriate to each infant’s developmental stage, and to suit the caregiving activities as they occur without disturbing other infants’ sleeping state. With the growing trend of single-family rooms gaining acceptance, these ambient stimuli should be harnessed and adapted with more ease. Machines should be redesigned to output vital information without compromising the auditory environment; overall and bedside lighting should allow for dimming and directing as needed.

Since, for the most part, the macro environments of care do not yet provide for individualization of ambient stimuli, nurses and families need to utilize whatever resources are available to provide the infants with a quieter and darker immediate environment. Quilts, blankets and sheets are commonly used in intensive care units over incubators and cradles to ameliorate the light and noise conditions at the bedside. Although these adaptations do work, they hinder visibility, often totally blocking the view of the baby, while also breaking with the aesthetic integrity of the objects and the units as a whole.

One of my further developments includes an overhead canopy; its distance from

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63 Ibid 27, 56.
the infant and its angle would be adjustable to diminish the incidence of light over the baby. By approximating the canopy to the body of the baby, the caregiver creates a darker environment without necessarily blocking the view completely. When light is coming predominantly from one side, the angle variation feature would allow the canopy to be rotated toward the light source, thereby opening the opposite side to the caregiver’s gaze.

Accepting that the environments of care lack aesthetic appeal and an uplifting visual appearance, the outside of the canopy could be utilized for the application of culturally-meaningful imagery, contributing to a more domestic feel to the mom, while keeping the side that is seen by the baby free of unnecessary overloading visual stimuli.

Another concept included in some of my development sketches that was welcomed by staff members in both partner institutions was a bedside LED\(^\text{64}\) lamp. The lamp would be attached to the structure of the cradle allowing for focused individualized light at the baby’s level. The LED lamp does not require electricity, and thus no wiring is needed. Current LED can, in addition to being dimmed, provide for a range of different colors, which could potentially benefit some medical procedures and exams. The lamp would function with a malleable arm that allows the light to be shed only where needed, thus contributing to a darker overall environment. Concerns were raised by some collaborators as to whether more developed babies would be able to knock the lamp down when moving their arms and legs. This concern should be taken into account when defining the final design of this accessory.

\(^{64}\) Light-Emitting Diode.
Further research in strategies to alleviate noise are necessary, thus no specific designs are proposed to address the issue at this time.

5.1.2. Gavage Feeding

Feeding a newborn for the first time can be an event of major importance for the parent. In my interviews, most of the ten mothers made reference to this experience and related it to a significant feeling of caring. Many mothers’ experience of feeding their hospitalized baby will first involve gavage (enteral) feeding, then cup- or bottle-feeding. It can take several weeks until baby and mother are ready to engage in breastfeeding, a practice of primary relevance, among other things, for the establishment of bonds between mother and infant.

Gavage feeding consists of allowing gravity to pull milk or formula from a container directly to the baby’s stomach via a fine catheter. This procedure is necessary when the baby cannot efficiently coordinate sucking, swallowing and breathing, or when some medical condition impedes breastfeeding. The container utilized is usually a syringe with no needle. Sometimes, the contents of the syringe will not flow naturally into the baby’s stomach, in which case a gentle push with the plunge might be necessary.

Once the milk starts flowing, the distance of the container from the body of the neonate, as well as how empty their stomach is, will dictate the speed of the flow – the higher the container, the faster the flow. What that implies is that someone needs to hold the container during the procedure. In my field-observations I have timed gavages that lasted for more than twelve minutes.
Ever since gavage feeding was first proposed by Marchant of Charenton in 1850, this life-saving procedure has undergone very little change. I have several concerns with regard to the logistics and performance of this task; for the purposes of this brief account of further developments on design and neonatology, however, I will focus only on the task of holding the milk container.

In the Maternity Hospital, infants are fed at least every three hours, totaling eight feeds per day, and fifty-six feeds per week. In realizing the frequency of feeds and their importance to the establishment of a positive relationship between parent and newborn, and considering that parents coping with the hospitalization of a fragile infant are often physically exhausted and in a very delicate state of mind, I consider it absurd to leave parents with no alternatives to holding the container, while they wait for gravity to finish the job (as quick as possible).

One of my proposals includes a support for holding a milk container for gavage feeding. Like the aforementioned bedside LED lamp, this support would also feature a malleable arm that would facilitate controlling the flow of milk by adjusting the distance of the container from the body of the baby. The parent would not be required to hold the container for the entire time. The attachment system of the support to the structure of the cradle would also be adjustable, allowing the parent to place the container around the perimeter of the structure in a convenient position for both him/her and the infant.

While some staff members expressed concern that if the container is not held by the caregiver the flow of the liquid might be too fast and thus encourage reflux, I will

65 In http://pediatrics.aappublications.org/cgi/content/abstract/70/3/425 (accessed in March 10, 2009).
counter by affirming that the likelihood of parents leaving their infants during feeding and not carefully monitoring the speed of flow approaches zero. This argument can be supported by two facts: 1) feeding is, as voiced by mothers I interviewed and the consulted literature, a moment parents look forward to, and they enjoy performing this important caregiving practice; 2) parents in that environment will abide by the rules established by the staff; hence, if taught to always observe the infant while executing the procedure to anticipate signs of reflux and never leave the bedside while feeding, parents will do so. Freeing parents from the negative aspects of this procedure will enable them to utilize that time for connecting with and learning from their babies, helping to build their confidence as primary caregivers of their infants.

Though I strongly believe that providing a flexible support to assist parents when gavage feeding their newborns is an effective strategy, I recognized that there are other issues involved in this complex routine procedure of primary importance to the babies’ recovery, requiring further design investigation before a definitive design solution is proposed.

5.2. Correlated Ideas for Design Projects within Neonatology

This section contains a list with three other opportunities that represent potentially interesting topics for design exploration, some of which, I hope I will be able to address in the near future, employing methods similar to those used for this thesis.
5.2.1. Parental Accommodations at the Infants’ Bedside

Opportunities for skin-to-skin holding and nesting are expected to be available at all times and to all families of NICU infants, including ventilated infants. Reclining chaise longues with foot and head rests and large enough to accommodate two parents should be available at each bedside. It is an important finding that duration of visit rather than frequency of visit best predicted maternal involvement in these [cleaning and feeding] activities.

Until single-family rooms are a reality in all hospitals with neonatal intensive care units, some transient measures should be taken to support the extended presence of parents within the units, at the infant’s bedside.

Accommodating one or more family members in close proximity to the baby will certainly result in therapeutic gains for the infant, and will likely reinforce the bonding between parents and newborns. However, it poses a challenge to designers and architects with regard to the optimal utilization of space, and raises issues of privacy. In addition, increasing the number of individuals that remain within the units for longer periods of time has implications for the levels of noise generated in those environments, which can ultimately work to the detriment of the infant.

Unlimited parental access to the infant is fundamental, and multiple family units should provide space to facilitate the presence of parents, as noted in the third standard – Minimum Space, Clearance, and Privacy Requirements for the Infant Space – of the Recommended Standards for Newborn ICU Design: “The width of aisles in multiple bed

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66 Ibid 27, 55.
rooms should allow for easy movement of all equipment that might be brought to the infant’s bedside, as well as easy access for a maternal bed."\textsuperscript{68} How that will be brought to fruition without compromising the functioning of the units is still a design question to be explored.

5.2.2. Design of Positive Distractions

Increasing the time parents and family members spend in the environments of care will also demand that institutions provide these people with interesting, uplifting things to do whenever interaction with the infant is not possible, or in order to alleviate the tension of the experience as a whole. The \textit{Recommended Standards} suggest that such activities and access to nature have “important psychological benefits to staff and families in the NICU.”\textsuperscript{69}

Designing lounging and relaxing areas, integrating the outside landscape with the NICU space, utilizing lighting, music, and artwork to create an elevating, heartening atmosphere is an exciting opportunity to integrate design and architecture to provide positive experiences for families within the hospital setting.

\textsuperscript{68} Ibid 36, 12.
\textsuperscript{69} Ibid, 30.
5.2.3. Access, Update, and Exchange of Information

Conflicting or inconsistent information given to parents results in barriers to their involvement in caregiving activities. In a study with two hundred and nine mothers of premature babies, Bialoskurski et al. found that asymmetrical communication with nursing staff led to uncertainty and increased stress among mothers, and that better instructions on how to navigate the foreign environment of the NICU was necessary: “The results of the study showed clear maternal priorities in relation to infant related information, and communication support from hospital based professionals.”\(^{70}\)

The importance of information within the environments of neonatal care is also referred to in the *Recommended Standards*. The inclusion of a library with relevant volumes on neonatal care and access to the Internet in lounging/family areas\(^{71}\) are suggested as ways to empower parents by educating them about the situation of their hospitalized child.

Another important topic regarding information and the participation of parents in daily caregiving activities has to do with the recognition that parents become experts in “reading” their infants. In that capacity, their impressions of the baby’s behavior become critical in helping professionals decide whether or not therapeutic approaches need to be changed. Hence, parents should be encouraged to report on their infant’s behavior and development. Within the same topic, Heidelise Als also underlines the legal aspects of this issue:

\(^{71}\) Ibid 36, 19.
Since an infant’s medical and nursing record (chart) are the parents’ property, parents should be guided and encouraged to read the chart regularly and encouraged to enter their own observations and comments on a regular basis. This facilitates communication, builds mutual trust, and enhances the success of collaborative care.\textsuperscript{72}

How information will be made available, updated and exchanged between parents and staff will likely have major consequences in the dynamics of care. Design, particularly graphic design, can improve the flow and documentation of relevant communication between professionals and family.

\textsuperscript{72} Ibid 27, 57.
CONCLUSION

This work emerged in response to recent changes in neonatal care. These changes were identified through onsite observations in the context of the Maternity Hospital of the Federal University of Rio de Janeiro, Brazil, and collaboration with hospital staff and patients at that institution. Scholarly research and further collaboration with health professionals from the Memorial Hospital of South Bend, Indiana, confirmed the necessity for redesigning the newborn cradle to meet the requirements of premature and low weight babies and their parents when interacting within the hospital environment.

Content, context and collaboration were brought together to achieve a meaningful solution that stems from the end-users’ activities within their working environments. The evolving practices in neonatology are causing the environments and artifacts that compose the hard-technologies of care to change. Architecturally, these changes are being translated into single-family rooms that facilitate a more individualized approach to healthcare. On the product level, the necessary changes are coming at a much slower pace. The solution proposed in this thesis intends to be part of the changes that need to occur in the design of the accessories and products that support contemporary neonatal institutional care.
BIBLIOGRAPHY


