A Comprehensive Genetics Center for Greenwood, South Carolina

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August 4, 2006

To the Graduate School:

This thesis entitled “A Comprehensive Genetics Center for Greenwood, South Carolina” and prepared by Johnny T. Tam is presented to the Graduate School of Clemson University. We recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Architecture.

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A COMPREHENSIVE GENETICS CENTER FOR GREENWOOD, SOUTH CAROLINA

A thesis presented to the Graduate School of Clemson University in partial fulfillment of the requirements for the professional degree, Master of Architecture.

Johnny Tat-Fai Tam
August 2006
Genetics research has redefined how we view diseases, physical characteristics, medicine, health and well-being. Over 30,000 genes make up the blueprint of the human body...any of which solely or in combination with others hold the key to many diseases and physical malformations that has plagued the health of many. Genetic research is still in its infancy and has yet to fully understand and unlock the mysteries and meanings of all 30,000 genes, so there is a great need to increase and enhance genetic research to develop medical screenings and medications to cure congenital problems and diseases. However these needs are not without controversy and problems, for public scrutiny and misunderstandings surround genetic research which make public acceptance of any medical applications developed from genetic research difficult. To address and subdue these concerns, the public will need access to genetic specialists equipped to educate them about the need, importance, and benefits of this specialized field of research.

Utilizing telecommunication and information technologies, virtual identities, websites, have become the new “front doors” to many businesses and establishments. Through these virtual identities and technologies, businesses and establishments are able from great distances connect and communicate with their counterparts; draw and maintain resources and clientele; and advertise and provide goods and services to their clientele, dispelling the need to be located on or near the busy and expensive Main Streets in large metropolitan areas. Unfortunately, virtual identities
aren't without their deficiencies. Due to their immaterial nature, virtual identities lack the tactile, highly sensorial nature of its physical counterparts, for they are supported by synchronous and asynchronous forms of communication through telecommunication means – telephony, email, and video conferencing to name a few. Telecommunicating parties are not able to communicate while sharing the same space and/or time, so they must utilize different modes of communication in order to communicate with one another. Businesses and establishments with virtual identities must be able to develop an infrastructure that allows the technologies supporting these identities to be efficiently maintained and upgraded with little or no disruptions to their day-to-day operations. Though these connections will gain importance, traditional physical connections will be more cherished by adding more value to these connections. This added value can be done through the creation of architectural settings and venues for the highly sensorial and synchronous communications and interactions associated with physical connections.

This thesis examines the importance and potential of genetics in the medical community and the importance and need for collaboration and communication in this specialized field. This thesis will also look at how telecommunication and information technologies are currently changing and challenging: the way one communicates and interacts with one another, how one works and lives, where one works and lives, and how health care is practiced. This thesis proposes that architecture can provide not only an adaptable and flexible infrastructure for virtual connections,
but an adaptable and flexible infrastructure that promotes, nurtures, and enhances physical connections.

A set of design principles will be used to support this proposal. These design principles are: (1) create gradients of intimacy in the physical realm, (2) provide views to nature in areas of meeting, pausing, and resting, (3) provide spaces in the physical work that are flexible and adaptable to ongoing changing needs of its users. These principles serve as guidelines for the creation of physical and virtual identities that support meaningful physical and virtual interactions and the demanding present and future needs of its inhabitants and users.

Gradients of intimacy will promote meaningful communications and interaction both in the physical and virtual realm, while protecting the privacy of the communicating parties. Views to nature will enhance these communications in the physical realm, but since the virtual world does not have the same qualities as that of the physical, this architectural design principle must be modified in the virtual with views to nature as a default image in areas of the virtual world that are use for meeting, pausing, and resting. However since the control of one’s environment affects one’s health and well-being and the virtual world’s constructs allows it users to change and customize their virtual world, occupants of these virtual meeting, pausing and resting areas should be able to customize and personalize these areas. In the physical realm, the creation of flexible and
adaptable spaces that meet the ongoing and challenging needs of its users, will promote physical and virtual communication amongst individuals and groups of people by creating spaces in the physical realm for these interactions and spaces for telecommunication and information technologies that will allow these technologies to be easily serviced and upgraded. In order for a virtual identity, website, to be successful, it needs to be able to be flexible and adaptable to the changing needs of its users, but how does the owner of the website know what the users’ needs area? The owner of the website must provide a way for website users to address their needs.

The test case for this thesis is a genetics research facility, GSC Therapeutic Genomics, that will be located in rural Greenwood, South Carolina - a once a thriving textile hub in the South that has since economically diversified by attracting many Fortune 500 companies to the region while maintaining the nature of a small town. A virtual identity, website, will be created for this company to complement its physical identity, architecture.
DEDICATION

To my loving parents, who are the epitome of the American Dream, this work is more the fruits of your labor than it is mine. Thank you.
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INTRODUCTION

Communication technologies are not only changing how we work, play and interact with one another but also the nature of business and industries. Many businesses and industries no longer need to be located on high rent Main Street in order to maintain and attract clients and highly skilled personnel while maintaining a connection, albeit a virtual one, to their existing customers. This shift from the Main Street to the virtual world has shifted the emphasis from a physical location, built environment, to a virtual location, website. A physical address is not longer imperative to the success of an industry or business. However, there will still be a need for some workers and their clients to collaborate, communicate and interact with one another. One particular industry in which its workers and clients will need to do this is the genetic research industry.

This thesis seeks an architectural proposal that demonstrates how the architecture of a genetics research facility can respond to the changing forces of communication, health care and needs for interaction between researchers, medical practitioners, counselors, and patients [or clients] of genetic services. With over 30,000 genes in the human DNA, collaboration between many branches of science is needed to study the human genome in order to unlock many medical mysteries toward human health and diseases and to discover cures to these diseases. In order to optimize these collaborations, new telecommunication and information technologies must be utilized. Virtual identities - websites - are the new “front doors” to many businesses. These virtual storefronts enable businesses to garner and maintain clientele as well as provide goods
and services from almost anywhere, allowing them to save and re-allocate limited resources - such as time and money - into more important interactions. These virtual connections bring about the ability to synchronously - in the same time - and asynchronously - in different times - communicate and share information through new modes of telecommunications - email, telephony, and video conferencing. It is through these modes of communication that genetic specialists can more efficiently and effectively address public scrutiny over genetic research. Even though these technologies provide expanded forms of communications and interactions, they are not as powerful and effective as synchronous face-to-face communication. Genetic centers will still need enhanced venues and setting for synchronous face-to-face communications, although the nature of these settings may need to be reconsidered.

This thesis proposes a Comprehensive Genetic Research Center designed to accommodate and enhance both virtual and face-to-face interaction and communication. The proposed facility has 3 major components - (1) clinic and resource center, (2) diagnostic center, and (3) research center. It will demonstrate how improvements in planning and design of research facilities can foster meaningful physical and virtual communication and interactions. It will also show how careful planning and design can meet the changing physical and virtual demands of a genetics facility. First it will establish the value of the genetics research, and why collaboration in genetics research is important. It will examine the pros and cons of synchronous and asynchronous,
virtual and physical forms of communications. It will establish why a genetics facility needs to rely on a combination of these modes of communications. To conclude this thesis, an architectural setting will be designed that promotes, nurtures and enhances synchronous face-to-face communications while creating an infrastructure that promotes, nurtures, and enhance virtual communication.
The Case for a Genetics Research Center

Advances in computing and communication technology have allowed us to identify all the genes in the human DNA and link many of these genes to certain illnesses, diseases, and birth defects. The problem lies in the need for further research of these genes, as well as additional ones, in order to develop diagnostic tests and treatment for their related health problems as well as pinpoint and research other disease causing genes.

So far more than 4,000 genetic diseases have been discovered. 2-3% of all births result in congenital malformations. 20-30% of all infant deaths are due to genetic disorders. Over 11% of pediatric hospital admissions are for children with genetic disorders, and 18.5% are children with congenital malformations. Three of this nation's most deadliest diseases and highest health concerns - cancer, obesity, and heart disease - have all been linked to genetics.

Cancer is simply a causation of a mutated gene that is stuck on the "on" mode, causing the cancer cell to abnormally divide without control. These cells then spread through the bloodstream and invade and damage organs and tissues. According to the National Cancer Society, in 2001 the US death rate for all cancers was 195.6 cancer deaths per 100,000 people per year. Breast cancer, the second leading cause of cancer deaths in women, alone accounted for 38,900 female deaths, and 5-10% of all breast cancer is linked to heredity. Cancer is also a financial burden to the US economy. In 1996 breast cancer treatments cost the US $5.2 billion with the average
Figure 4. Current cancer treatments such as chemotherapy have adverse and debilitating effects on the human body. Medicare payments per individual in the first year following diagnosis at $9,230. Unfortunately, current cancer treatments such as chemotherapy have adverse and debilitating effects on the human body, ranging from weakened immune systems to tissue and organ damages. In order to develop treatments and vaccines against cancer, cancer researchers are searching for and targeting certain genes that are known to cause cancer. However, any cancer treatments or cures developed through genetic research are still decades away. More information needs to be gathered about these cancer causing genes as well as locate and isolate additional cancer causing ones.

Figure 5 The World Health Organization has declared obesity a global epidemic and a public health problem. With an estimated number of 250 millions obese adults around the world, the World Health Organization has declared obesity a global epidemic and a public health problem. In the US alone, 64% of adults and 15% of children and adolescents are either overweight or obese, costing the economy $117 billion alone in 1995. The life expectancy of a moderately obese person could be shortened by 2 to 5 years, for overweight and obesity are known risk factors for diabetes, heart disease, and stroke. Though overweight and obesity is primarily caused by lack of physical activity and overeating, researchers believe that 80% of obesity is genetically linked. Many hope that the discovery of the PPAR gene, which is known to control the amount and size of fat cells in the body, will lead to new treatments for those suffering from obesity as well as for...
According to the National Heart Association, in 2002 coronary heart disease affected 12.6 million Americans alone. The World Health Organization estimates that heart disease and stroke kill 17 million people a year, which is close to one-third of all deaths globally. By 2020 heart disease and stroke will become the leading cause of both death and disability worldwide, with the number of fatalities estimated to increase to over 20 million a year and by 2030 to over 24 million a year. The #1 risk factor of heart disease is heredity, for more than 70% of all heart diseases are genetically linked. Studies have shown that over ½ of the sons and daughters of people with heart disease will one day discover that they, too, are at risk of developing heart disease. Physicians and medical researchers know that heart disease is congenital, but currently have no genetic screenings that detect future onsets of heart disease. It will take more time and research to find and study the genes that cause heart disease and develop genetic tests and cures for the new found information. The development of genetic tests for heart disease will enable those with this particular genetic disposition to consult their health care providers and genetic counselors to take measurements, possibly in the form of medications or change in their lifestyles (i.e. quitting smoking and changing their diets), to better stave off or remedy the onset of this disease. Much like cancer and obesity research, genetic heart disease research involves
Figure 8. Genetic counseling is needed for those who seek and use genetic test.

Figure 9. Automated gene sequencing output like this utilizes advances in computing technology.

The collaboration and communication of a plethora of highly trained individuals of multiple specialties and disciplines.

Though many genetic tests are currently in use, testing positive for a specific disease causing gene does not always mean that these individuals will develop the associated disease. Individuals seeking and using these genetic tests will need genetic counseling, counseling that is generally associated with genetic research centers where these specialized counselors are able to work hand in hand with genetic researchers and clinicians. Genetic counseling services will only become more important as genetics research progresses and new complex forms of genetic screening tests are developed.

There are over 30,000 genes in the human genome, any of which could be linked to cancer, obesity, heart disease, or any other types of diseases. Deciphering and studying each of these genes area daunting and laborious tasks for researchers and scientists. However, advances in computing and information technologies have led to new medical analytic equipment, making genetic research more precise and efficient. These technologies enable researchers and scientists to work together efficiently, gather and store information, and share their information with others inside as well as outside of their industry and field of study. These technologies have helped acclimate and educate the public to the challenges and problems related to genetic research and
medicine, ultimately changing the way health maintenance and health care is prescribed. Specialized medical centers are able to offer their services and stay in contact with their patients from great distances or locate in rural medically under served areas whilst maintaining a connection to their counterparts in large metropolitan areas. The key to these connections will be the ability for these specialized medical centers to adapt to the advances of computing and information technologies quickly and efficiently.

Advances in genetics will hopefully lead to the next evolution of medicine and medical care where caregivers can provide screenings that will detect certain diseases and ailments in a patient while these diseases and ailments are still dormant. Caregivers can prevent or treat the patient’s diseases and ailments years before they take hold. Many of today’s medications and treatments affect people differently. Coupled with side effects, some do more harm than good. It is the hopes of many that genetic research will lead to tailored medication and treatment with little or no affects on their recipients. Unfortunately genetic screenings and tailored genetic medication is still in its infancy. Additional research capacity is needed as well as the capacity for collaboration between research facilities. To meet these demands facilities equipped with the latest and fastest computing and information technology equipment need to be developed, allowing the virtual sharing of larger amounts of information and larger amounts of virtual connections to other collaborating facilities.
There is a significant need for a design investigation into architectural solutions, for research facilities that rely upon collaboration and communication between the researchers and genetic specialists as well as collaboration and communication between genetic counselors and the public. It will be the collaboration and communication between researchers and genetic specialists that yields new information and insight about genetic diseases and how best to tackle them—both medically or physically with a change in lifestyle. Collaboration and communication between genetic counselors and the public will properly educate the public about genetics and genetic diagnosis and screenings.
THE VALUE OF THE GENE AND THE RISE OF GENETICS

The value of the gene is immeasurable. Genes hold the key to the understanding of one’s characteristics and features. The studies of them are redefining how physical characteristics, diseases, health, and health maintenance are perceived by offering new insights into biological explanations of heredity, identity and health. Long before biological explanations of heredity and identity could be justified, the notion of kinship and “blood” were used to account for social standings. It is the hopes and dreams of many, that the study of genetics will lead to new screenings and cures for many of today’s diseases. These hopes can be seen in mainstream culture today. For example during opening ceremonies of the 2004 Summer Olympics, the image of a DNA’s helical structure represented the global struggles, needs and hopes to find cures and remedies to diseases and health problems.

Access to proper genetic professionals is imperative to change and dismiss the mythology which surrounds commonly held understandings of genetics. This access will also ensure that the public gets unadulterated information in regards to genetics, for genetics research is difficult to disseminate and translate. Unfortunately, genetics isn’t without controversy. Public questions, fears and concerns encircle genetic research. For example there is an underlying public fear that genetic research will lead to cloning and genetic engineering of humans. In order for the public to fully accept and make the right choices about genetics, it needs to be well informed and educated about genetics research and its medical applications. The best ways to inform the
Using telecommunication technologies, such as video conferencing, will allow and increase access to genetic professionals to those who cannot physically meet with them.

Public stigmas caused many suffering from genetic abnormalities from seeking medical treatment.

Figure 12. Using telecommunication technologies, such as video conferencing, will allow and increase access to genetic professionals to those who cannot physically meet with them.

Figure 13. Public stigmas caused many suffering from genetic abnormalities from seeking medical treatment.

public about this are through physical and virtual communication with professionals in the field of genetics - geneticists, physicians, and genetic counselors. Access to these genetic professionals will be important to the future of genetics, for it will aid in quelling these public’s concerns and misconceptions over genetics. Telecommunication technologies - email, telephone and video conferencing - will allow and increase access to these genetic professionals and their finding to those who are unable to do so physically. Websites like the Human Genome Project Information website that is sponsored by the US government and medical websites like DrKoop.com do just this by providing medical and genetic information virtually to anyone with access to the Internet. These websites not only gives the world access to these informations but also a forum to communicate their concerns about genetics to others whom they would and would not associate within the physical world. Unlike the physical world, email and telephony provides a veil of anonymity and privacy to its users, for each parties’ physical features can be obscured or unviewable during these types of communications. In the past freak shows and sideshows exploited many individuals that were believed not to be human because of their abnormalities. Most of the abnormalities threatened the individual’s health and longevity, but due to public stigma and misunderstandings over these abnormalities, these individuals were afraid to seek treatment. Today’s telecommunication can be beneficial for those with similar abnormalities and who wish to seek treatment but are afraid to do so due to public stigma in regards to their abnormalities, for they can seek the aid of genetic professionals through the veils of anonymity.
Ron Anderson, M.D. and Chairman of the Board of the Texas Department of Health and Executive Officer of Parkland Hospital in Dallas, Texas, explained to the journalist Bill Moyer how important it is to have a clinical environment that fosters communication. Anderson says, 

"In a caring environment you're going to listen, and you're going to find out what people want, and what their value system has to say about their illness. And, therefore, you can be a better doctor because you can deliver what the patient wants, not just what your peers want" (Moyer 26). David Spiegel, M.D. is the Professor of Psychiatric and Behavioral Sciences and Direct of the Psychosocial Treatment Laboratory at Stanford University School of Medicine agrees with Dr. Anderson. In an interview with Moyer, Spiegel says, "The best medical care must always involve attention not only to the physical treatments, but also to the way the patient is coping with them. We must help patients understand what's happening to them and help them mobilize support from family and friends" (Moyer 161). Genetic professionals have an obligation to aid their patients who have genetic abnormalities and disorders and privacy of telephony and electronic mail. These individuals can utilize these forms of communications from where it is convenient, beneficial or peaceful for them - such as their home - and communicate with the genetic professionals. However, genetic professionals will need to work in facilities with an infrastructure that can handle these forms of telecommunications and adapt to new and additional forms of telecommunications technologies.
in alerting and educating their family members about their health risks, for congenital problems can be hereditary and not only affect their patients but the patients’ relatives as well. In order to efficiently and effectively do this, genetic professionals will need to utilize not only the traditional means of communication such as face-to-face meetings, but new telecommunication modes as well.

Access to genetic professionals will be imperative to properly understanding genetic screenings, for testing positive for genetic markers for certain disease does not mean that one will develop the diseases and associated problems. It only means that the individual has an inclination to develop them. Genetic tests only provide patients with a probability developing certain congenital abnormalities and diseases. The disease could stay dormant or the individual might make changes to his lifestyle to help stave off the onset of the abnormalities or diseases. However, the stress related to knowing this information about one’s health, could be more than what some can handle, so those who take genetic tests will not only need guidance from their physicians and family practitioners, but genetic professionals as well to carefully interpret and explain screening results. It will be up to these groups as well as the individual to decide what and how to deal with the information.
Since 1978, federal funding has made genetic services available to all Americans, establishing statewide systems of these services. To increase accessibility, satellite genetics clinics were established in primary and secondary sites, such as community hospitals and state health departments. Primary care providers and other health professionals began to engage in genetic referrals, counseling, evaluation, and follow-up services at these clinics. To augment these services, nine regional genetic networks were established to serve all 50 states, Puerto Rico, and the District of Columbia in 1981. The goal of this network was to collect data, provide quality assurance in laboratory programs, plan and implement continuing education programs, and to network multidisciplinary health care professionals. However, these satellite clinics have limited capacity and resources and rely mostly on external laboratories located in metropolitan areas for processing of most of their diagnostic tests. Test results take weeks to be processed and returned. However, with modern telecommunication and information technologies and overnight shipping services, the processing time can be dramatically decreased and can further be decreased by centralizing the diagnostic laboratory and clinics to under one roof. Counselors can easily extract a genetic sample from a patient and immediately have it in the hands of a diagnostic lab technician without the aid of a courier services. The close proximity will allow counselors and lab technicians to immediately answer questions that one might have in regards to the test sample. The two parties can easily meet face-to-face about inquiries about the tests
without the delay in response associated with some telecommunication technologies like email and voice mail.

It is imperative for genetic facilities to have an infrastructure that allows for ease of adaptation and utilization of telecommunication and information technologies, for the rise in genetic services has been bolstered by the rise and adaptation of modern computing and information technologies. Genetic health professionals vary within each region, but they usually include physicians, Ph.D. clinical geneticists, genetic counselors, researchers, lab technicians, nurse specialists, and social workers. Many of these groups tend to practice in large community hospitals or specialty genetic clinics where they provide genetic testing, diagnosis, counseling, and evaluations. Others are in the private sector working for large HMOs, in state and federal health departments, and commercial agencies. Computing, information and telecommunication technologies allow these groups, who are working in different areas and on different schedules, to efficiently work and communicate with one another. The success of using these technologies between geographically distant groups is illustrated in the success of the Human Genome Project where Celera Genomics, the National Institute of Health and the US Department of Energy shared large amounts of data, communicated and coordinated their DNA sequencing, to complete the Human Genome Project years ahead of schedule.
The Importance of Collaboration in Genetics

The future of genetics centers on collaboration. There are countless examples in history that illustrate the importance collaboration is in this field. Each new discovery and successful application from the knowledge gained through genetic research further cements this booming field of science into society. In the late 1960s geneticist Norman Borlaug collaborated with Mexican, Indian and Pakistani scientists to develop a new form of wheat, the dwarf wheat. Their creation was credited for feeding and saving one billion lives around from starvation. Unlike other types of wheat, dwarf wheat flourished in areas devastated with over population, droughts and over farming. Borlaug and his constituents’ work had created an agricultural revolution, dispelling environmentalists’ concerns that over populated countries like India would never be able to feed themselves. To the testament of their collaboration, Borlaug received the Nobel Peace Prize in 1970.

The importance of collaboration in genetics research can also be seen the completion of the Human Genome Project. The Human Genome Project could not have been completed without the eventual teaming up of competing private and public institutions - Celera Genomics, Department of Energy, and the National Institute of Health. Their collaboration and utilization of advanced telecommunication and information technologies to analyze, manage and share information led to the completion of sequencing of the 3 billion chemical bases that make up human DNA. The collaboration created the first drafts of the human genome, completing the Human Genome Project.

Figure 18. In the late 1960s, geneticists Norman Borlaug collaborated with Mexican, Indian and Pakistani scientists to develop a new form of wheat, saving one billion lives around the world from starving to death.

Figure 19. Craig Venter, Ph.D of Celera and Francis S. Collins, M.D. of the National Institute of Health along with the US Department of Energy collaborated to complete the Human Genome Project.
Project two years earlier than projected. Genetic specialists - ranging from genetic counselors, clinicians, laboratory technicians, and genetic researchers - are using this draft as a basis for their research. Like the institutions associated with the Human Genome Projects, these specialists will need to utilize telecommunication and information technologies to efficiently share information and communicate with one another. They will still meet face-to-face when possible, but will rely more on these technologies in order to communicate and share information with one another. They do not need to be near one another in order to work together. Since information needs no longer to be written down and kept in a journal, it can be entered into paperless, digital formats and stored in a computer databases, making it easily transferable, accessible and duplicable. However the growing dependency of these information storage devices will require an infrastructure that addresses the needs and requirements of these devices. These include climate controlled segregated areas and an information technology support staff. This support staff will need to collaborate with the other building occupants, geneticists, in order to best support the information technologies in the building. For example, alerting them in advance when information storage devices will be off-line due to maintenance services and upgrades. Those relying on the technologies will need to contact IT in order to alert them about problems with the storage devices and telecommunications modes that they serve.
Collaboration and sharing of information is imperative in the medical field. The size of one's medical and health maintenance team has increased over the years from primary help care providers, to supplemental secondary care providers like specialized physicians, person trainers, counselors, dieticians, etc. In order for these groups to properly and effectively serve their patients, they must communicate with one another about their patients' medical health status and health needs. Communication technologies have made it easier for these groups and individuals to share this type of information amongst each other in better serving their clients' needs. For example, a physician or family practitioner might order genetic breast cancer tests on a female patient after learning that he has family members who have suffered from this disease. A physician unfamiliar with the genetic tests will seek the aid of a genetics counselor and the service of a genetics diagnostic lab. The physician will extract a test sample from his patient, and have the sample delivered to the diagnostic lab. The lab will then process the test and forward the results of the test to a genetics counselor who will carefully explain the results to the patient as well as forward a copy of the diagnosis to the patient's physician, keeping the physician abreast of any findings. As the patient's primary caregiver, the physician needs to know of his patient's genetic dispositions toward breast cancer in order to properly treat and instruct her on how to deal with the dispositions. If the patient is prone to breast cancer, the physician will know to keep an eye out for signs of breast cancer by requiring his patient to have frequent breast self exams or have periodic mammograms done. The physician might also
require his patient to change her diet and exercise to stave off the disease, requesting his patient to seek the aid of a dietician and personal trainer. To make sure the genetic counselor, dietician and personal trainer properly care for his patient, the physician must communicate with each of them to properly share and address the patient’s health from succumbing to breast cancer. Since proximity and time are constraints for physical communications between these individuals, email, telephony, and video conferencing need to be exploited to effectively and efficiently communicate with one another as well as establish and maintain a continuity of patient care between the individual caregivers.

Collaboration via telecommunication and information technologies has its benefits. It saves valuable resources such as time and money. These technologies have been one of the major catalysts toward globalization, allowing groups separated by great distances to seamlessly work with one another. For example, many hospitals are gradually moving toward a PACs system in which patient medical images are transferred to digital formats, enabling the caregivers to view patients’ medical scans from a computer terminal or a handheld computer such as a personal digital assistant, PDA. Unfortunately according to the American College of Radiology, there has been an increasing radiologists’ shortage in the US. In order to meet this shortage, many US medical centers have been outsourcing their radiological readings to India where the radiologists are well-educated, speak English, and are paid a small fraction of what their US counterparts
are paid. Via telecommunication and information technologies, the diagnosis from these scans can easily and quickly be sent back to the US medical facility in which the scan originated. In order to treat the patients accordingly, the physician can view the scans as well as the radiologists’ diagnosis on a computer terminal or on a PDA. Out sourcing the radiological readings to a country that is on the opposite side of the world, allows US hospitals’ radiology departments to fully function during the late night hours, a time in which many hospital departments are off line. It is also much cheaper for the hospitals to pay for the services of a radiologist in India than to pay for those of US radiologist, for US radiologists are one the highest paid medical groups in the US. Outsourcing allows a patients’ scan to be immediately transferred to an awaiting radiologist in India for a quick diagnosis. With many hospitals financial statuses in the “red” these days, externally collaborating with others physicians in lower waged countries will enable many medical institutions to provide quality health care, save the hospitals money and time, and reduce staff workloads.

Similar to their radiological needs, medical facilities can also provide genetic medical needs without having genetic specialists in house. They can bring genetic medical care to their constituents while outsourcing their genetic operations, such as sample processing and genetic counseling, to genetic facilities. Testing samples can be extracted by the hospital and sent to a genetics facility for processing. After the sample is processed, genetic counselors at these
Figure 26. Personal digital assistants (PDAs) gives caregivers instant access to medical records and up-to-date medical resources.

genetic facilities can explain the diagnosis to the patient back at the hospital via telecommunication means or can transfer the diagnosis to the patient’s physician who will then go over it with the patient.

Utilization of digital information technologies for collaboration in the medical field is still in its infancy, but many medical institutions are beginning to see their full potential and are quickly adapting them into their systems. Brown University is requiring their medical students to carry and use PDAs. With their PDAs medical students can look up patient medical records from anywhere in the hospital and reference the most up-to-date medical information. Caregivers will save time through the use of these technologies, for they no longer need to physically search for information. Instead going to the information, the information can now go to them all from the patient’s bedside. “If we had students buy a book, by the time the book hits the bookstore, it’s outdated. And with using PDAs, they can update their software weekly.” says Laurie Lauzon Clabo of the University of Rhode Island College of Nursing. Unfortunately many hospitals do not have the infrastructure or financial means to incorporate these technologies. According to a White House January 2005 release, failure to incorporate these technologies have been closely connected to high health care costs, avoidable medical errors, administrative inefficiencies, and poor coordination. To support the use and integration of information technologies in health care and remedy some of health care’s problems, President Bush’s fiscal
Figure 27. Mechanical plants like this one at the San Diego Airport, mechanically support buildings around it.

The year 2006 budget allocates $125 million for demonstration projects that will help test the effectiveness of health care information technologies and allow for widespread adoption of it in the health care industry. This adoption will benefit genetic medicine because it will make it easier for medical facilities to utilize the services of genetic testing and counseling facilities. Via these technologies, genetic facilities can quickly send genetic test results back to the hospitals that are using their services. Genetic counselors who will be diagnosing a hospital patient’s genetic test results will need to know the medical history and current health status of the patient in order to properly diagnose and educate the patient about his genetic disorders. Since the genetic counselor does not work at the hospital and does not have physical access to the patient’s records, the counselor can digitally access the patient’s medical records.

Since the health care industry is becoming more reliant upon these technologies, it is critical for these technologies to be easily maintained and serviced with little or no disturbance to day to day operations of their facility. It is critical that these technologies run properly and efficiently so caregivers will be able to provide the highest quality care to their patients. There are architectural solutions to this problem, such as separating areas housing these technologies from the rest of the facility. For example institutional campuses have mechanical plants that feed and support the surrounding buildings with essential services such as chilled water and steam. On a
Figure 28. An efficient infrastructure allows IT staff to efficiently and effectively maintain, service and upgrade information technologies with little or no disturbance to the building’s occupants.

medical campus, mechanical personnel can service mechanical services from their source, the mechanical plant, without getting in the way of caregivers or patients.

Genetic researchers and specialists have support staff that run their facilities and equipment. For example, information technology (IT) staff maintains and services their computing and digital storage management devices such as servers. As genetic research advances, it will require additional digital storage capacity and faster computing technology. It is crucial that upgrade to existing technologies have little disruption or hindrance to the researchers’ work and day to day operations of the lab. An infrastructure that allows IT staff to efficiently and effectively upgrade, maintain, and service these technologies with little or no disturbance to their work is critical to the success of the facility.

Though telecommunication and information technologies have allowed many distantly separated groups to collaborate with one another quickly and efficiently, in some cases collaboration will be best benefited by close proximity. With genetic diagnostic tests coming online and the increasing demand of genetic counselors, there is a need for labs to process these diagnostic tests efficiently and quickly return the diagnosis to the genetic counselors. These diagnoses can be transferred electronically from the lab to the genetics counselor for output and interpretation to the patient. There should be no barriers physical or virtual between them that would hinder
their communication with one another, allowing these individuals to develop and refine new forms of genetic diagnostic tests which are currently in their infancy and need refinement. Their success will be determined by their collaboration. Kevin Sweet, a genetics counselor for a genetics center with counseling, testing and research services, the Greenwood Genetics Center (GGC), is an advocate in having genetics counselors, diagnostic labs and research labs in close proximity to one another. “In a way we really have a four pronged approach to what we do. We provide clinical services. We provide education. Then we provide diagnostic services. Then we provide research services. Having three separate buildings, we are all together in some way. We might see a patient on the clinical side and take a blood sample, which can be used for research or for diagnostic services. There are interactions between the centers for that... build off each other,” says Kevin Sweet. However, their working collaborations are augmented and complemented by formal and informal interactions and collaborations. Sharing of daily human activities between workers such as eating and dining are very beneficial to their working relationship. “We have a lot of internal fun things we do like March of Dimes hot dog cook-offs where we invite everybody to come over to this building or that building for a hot dog lunch. We try to do as many of those things together as we can,” says Kevin Sweet. At the GGC, the proximity between the three disciplines allow for ease of work and non-work related interactions, creating and increasing the camaraderie, teamwork and collaboration between co-workers.
Collaboration will be critical in informing the public about genetics. These collaborations will be through physical and virtual communications with medical professionals in the field of genetics - geneticists, physicians, and genetic counselors. Access to these professionals and genetic resources will be important to the future of genetics, for it will aid in quelling the public’s concerns and misconceptions over genetics. The US government recognized the importance to addressing public concerns over genetics, so one of the goals of the Human Genome Projects is to address the ethical, legal, and social issues (ELSI) that surrounds the study. The US government established an extensive ELSI webpage to address these issues to the public. Public access to genetic professionals will supplement the government’s ELSI program, utilizing physical and virtual means to address the public. Those who are not able to physically meet with a counselor to discuss their issues can do so via communication technologies such as resource pages, email, telephony, and video conferencing.

Many websites of clinical genetic facilities offer free genetics advice. For example those visiting the GGC website can submit questions or concerns to a genetic specialist via an email link. Unlike physical face-to-face contacts, which require a pre-arranged meeting area and time, virtual communication allows communicating parties the ability to interact with one another synchronously and asynchronously from different locations. Physical barriers, long distances, or scheduling conflicts will no longer be reasons or excuses for public genetic issues to go
unresolved or unanswered. Unfortunately virtual communications are less sensorial and thus less meaningful and experiential compared to physical face-to-face contact.

Therefore both virtual and physical forms of communication should be at the disposal of these genetic professionals, allowing more means and opportunities of contact between the two parties. For those who prefer physical means of communication, genetic specialists must have areas for face-to-face interaction such as private offices, meeting rooms, courtyards, atriums, and resource centers which are prevalent in many medical and research setting today.

Collaboration between genetic specialists and health practitioners will be imperative to the public acceptance of genetics research. Genetic professionals must educate and inform these practitioners about genetics as well, for these practitioners will help advance the acceptance of genetics research by educating their patients about genetics, genetics applications such as genetic screenings/diagnostic tests, and genetic medicines. Since practitioners are the ones who will be prescribing genetic screenings, medications and treatments, genetic specialists need to keep these practitioners abreast of genetic screenings, medications, discoveries and research. Many genetic professionals already provide continuing education services to their medical peers. “Such collaborative activities will support primary care providers in ensuring that all patients and families receive the most benefit from genetic technologies.” (Lea 18). Advanced
knowledge of medical applications and medications developed from genetics research will allow practitioners to consider prescribing new genetic medications and treatments to their patients as well as enable them to interpret basic genetic screening results without the aid of a genetic counselor. In order to educate these individuals, genetic research facilities will need to interact with them both physically and virtually. These can be through face-to-face teaching seminars at the hospital, at genetics facility or any pre-arranged meeting area. However scheduling conflicts might make it difficult to get counselors and practitioners to meet face to face, so virtual educational means would be ideal. These include online seminars, communication via email, telephony, and video conferencing. Online seminars can be pre-recorded, allowing practitioners to view these educational pieces at their own time and at their own pace.
Conclusions

Genetics brings with it hope and dreams of new forms of health screenings, medications and treatments as well as public controversy. Claims have been made that access to genetic specialists and genetic information as well as collaboration between genetic professionals, caregivers and the public will be imperative to the future of genetics. Evidence has shown how physical interactions and virtual communication through the use of information technologies by genetic specialists will be the key factors in dispelling concerns and increasing public awareness and acceptance of genetics. Collaborations and interactions with health care practitioners via both physical and virtual means will help further this public acceptance, for health care providers must be abreast of new medical treatments and research in order to deliver the highest and newest forms of care developed through genetics research to their patients. Thus the need exists for creating genetic care facilities that foster communications both virtually and physically. These facilities should be able to accommodate changing telecommunication and information technologies that are the backbone to virtual communication. These facilities should also be able to create optimal settings and venues for physical communication between genetic specialists, public, patients, and caregivers.
The highest levels of care are dependent upon communication. Health care practitioners need to be able to communicate with their specialists’ counterparts when they are unfamiliar with one of their patients’ health symptoms and need additional aid and expertise. This communication is the backbone toward collaborating with one another in order to best serve the patient. The levels and depth of communication will greatly impact the patient’s health and well-being. For example, according to a 1999 study by the Institute of Medicine, errors made by hospital staff not only injure more than a million people a year but also kill close to 100,000 people a year — more than the number of motor vehicle and breast cancer deaths combined. One of the causes surrounding these errors is miscommunication. Health care institutions can help curb this problem and advance their care through the integration of new forms of communication and information technologies such as Picture Archiving and Communications System (PACS) that manage, store, and transfer medical images efficiently via digital means. There are limitations and costs associated with every form of communication, so institutions like these must use a mixture of communications in order to succeed in their goals. However integrating such technologies in an existing environment can be difficult for these technologies have many requirements and restrictions and need constant upgrading, maintenance, and servicing. This can be addressed through architectural means by creating an infrastructure and setting that is flexible and adaptable to technology’s changing needs and requirements.
Though the highest, most sensorial form of communication is synchronous communication, synchronous communications has its limits and costs. Architectural settings create variable spaces for rich synchronous communication in which words are heard as they are spoken, allowing for immediate responses. Every party is exposed to one another visually and acoustically, making the experience richer and multi-sensorial. Because the members in the party are exposed to one another, misconstrued perceptions of each member will be lessened. The smells and noise of surroundings only adds to the experience. However, such meetings aren’t without a cost, for physical presence consumes time, money and other resources. Getting to the meeting might require one or more modes of transportation which in themselves require supporting infrastructures such as roads, parking lots, airports, bus stations, gasoline supply chains, and hotels. Time spent on travel reduces the time spent for meeting or other productive enterprises. Hence, proximity becomes an issue. The closer the communicating parties are to a pre-arranged meeting place, resources such as time will be saved. These saved resources can be re-allocated to the experience of the meeting, for example time saved from traveling to a meeting place near the communicating parties, can be used to lengthen the face-to-face meeting between them. Historically, common locations for meetings and interactions became prime locations, creating centers, squares, main streets, and communities. It is the premise of this thesis that by locating a group of genetic research facilities to a region lacking and needing their services will create a community and node for genetic medical research. The demand for genetic services in the
Once home to a bunch of fruit orchards, Silicon Valley is now home to leading electronic giants, such as Sony, Intel and Apple Computers.

Figure 35. Once home to a bunch of fruit orchards, Silicon Valley is now home to leading electronic giants, such as Sony, Intel and Apple Computers.

Since synchronous communications involve the greatest amount of time and effort of any form of communication, it should be as meaningful, fruitful and stress free with as little disturbance and distractions as possible. Architectural spaces should provide these amenities, promoting, nurturing and enhancing these face-to-face synchronous communications. Close attention must be placed on the ambiance of the space used for synchronous communication and interaction, for ambiance plays a vital role in the quality of the communication. An example of these spaces are dining areas, for “meals or snacks shared with friends in an attractive cafeteria or dining room can be a bright spot in an employee’s busy day” (Malkin 72). Such areas have

region will force the existing genetic facilities to expand as well as encourage other genetic facilities to locate in the area to meet their genetic needs. These genetic facilities will in turn attract businesses that service them. Also the close proximity of genetic facilities to one another will foster communication and collaboration between researchers which in turn will spin off and create other industries and businesses. A prime example of this is Silicon Valley, CA. Varian Electronics, Eastman Kodak and General Electronics were just a few of the companies that first settled in the area to take advantage of the young talent at nearby Stanford University. Other businesses followed suit and turned an agricultural area known as Valley of Heart’s Delight into a node for technology and home for leading electronic giants as Sony, Intel, and Apple Computers.
with one another. Variable types of seating arrangements will accommodate people who accompany the patient to their genetic counseling session.

Spaces such as these will need to be created for the resource center where patients and visitors will be doing genetic and health research. A quiet environment is ideal for this room. Different seating arrangements will accommodate individuals and groups in the resource center. Natural light will provide additional lighting for reading in the room.

Such settings can also benefit others in the facility. Individuals at the facility who decide to get together might have limited time to do so, because of scheduling conflicts, so it is best that their time together can be efficiently and effectively spent. Distractions and disturbances will only detract and take away time from their meetings. Researchers and lab technicians will need these spaces to communicate with one another away from their busy laboratory work area. Windows will not only provide natural lighting in these areas but views to the exterior with variable viewing depths that can help relieve eye strain typically suffered by those working in the laboratories.
In the past, communities could not become very large without falling apart. Residences needed to know one another, meet face to face to conduct transactions, and discuss matters of common interest, but the means to this end had its limits (Mitchell. *E-topia*. 130). With only synchronous interactions, communities could only be so large. Functions and organizations of communities deteriorate when there are too many people trying to participate within it. The solution to this dilemma is asynchronous modes of communications, which will be examined in the next section.
Asynchronous Communications and Advances in Communications Technologies

Asynchronous communication succeeds where synchronous communication fails, allowing interactions and transferring of information between individuals, groups of people and businesses between great distances and time. The advancement of genetics research and medicine will need to utilize asynchronous means of communication in order to prosper and take hold. Though synchronous communication provides the most intense, high-quality, sensual, potentially enjoyable interaction and questions asked can easily and quickly be answered, it has its drawbacks and limitations. It consumes the attention of the communicating parties as well as time and space. One only has a limited amount of time in the day for meeting with people. (Mitchell. *City of Bits*. 30). Fortunately forms of asynchronous communications were developed.

Asynchronous forms of communication allowed society to flourish beyond the borders of city-states. For example the printing press enabled the economic, social and cultural life of societies to flourish. Society needed this invention for it had grown to such a size that it was beyond its capacity to solely orally pass on its culture. Information, printed text, could now be reproduced and spread amongst the masses much more efficiently than oral transmission. “Cities came to depend on combining synchronous and asynchronous communication – speech and text, orator and scribe, live and Memorex, handshake and written contract, agora and archive” (Mitchell. *E-topia*. 131).

Figure 37. The invention of the printing press allowed information, in the form of printed text, to be reproduced and spread amongst the masses.
Just like synchronous communication, asynchronous communication has its drawbacks which the communicating parties must consider before using. Asynchronous communication is far less direct and intense and filters out a lot. “Reading Oscar Wilde is certainly not the same as meeting Oscar Wilde (Mitchell. E-topia. 137). However, asynchronous communications allows people to transfer and disseminate information in different spaces and times, allowing the communicating parties to tend to more important matters. One can conduct his end of the interaction whenever and where ever he wants. Unfortunately, questions asked are not immediately answered. Refuted information is not quickly defended. Though the information is disembodied, asynchronous communication requires a built setting to store and care for the information such as libraries, municipal buildings, and storage spaces in homes. People still have to go to these places in order to obtain the information they are seeking.

Advances in telecommunication technologies. The telephone network brought about information and communication technologies, allowing information to reside in digital formats on multiple servers in which one can access anywhere with electronic and computing devices like PDAs, computers, and cell phones. One no longer had to go to the information, but the information went to him. The medical field is currently exploiting this technology by converting patient medical records into digital formats in hopes of improving efficiency and reducing medical errors caused by miscommunication, for digital records can be transferred and shared easier.
Information and communication technologies allow digital medical records to be shared by caregivers, allowing caregivers to team up and share patient information in order to provide patients with the highest quality of health care.

Information and communication technologies are transforming consumerism, by bringing and connecting many services over great distances to consumers. One no longer needs to be in close proximity to certain businesses or industries in order to utilize their services. One industry in particular is healthcare where information and telecommunication technologies have brought medical care to medically underserved areas - telemedicine. Utilizing telemedicine in the field of clinical genetics and genetics research will enable those from afar access to genetic services such as genetic screening. Genetic counselors will translate and interpret the results back to the patient through face-to-face communication or through telemedicine means - email, voice mail, or video conferencing, advising them on how to best use the information.

An example of where telemedicine has been successfully brought medical services to a medically underserved area can be found at Logan International Airport in Boston. With over 5,000 employees and millions of travelers passing through there every year, providing medical care to this small community is difficult but imperative. The population was too small to warrant a full-time resident at the airport. Though the Airport is less than 3 miles from Massachusetts’s General Hospital (MGH), it is medically isolated for a majority of the day due to traffic congestions...
around the airport, so a clinic was setup inside the airport, staffed by a nurse, and digitally linked to a physician at MGH. Patient real time information is transmitted to a doctor at MGH for diagnosis. A doctor operates monitors and a console that controls cameras trained on the patient at the airport clinic. The physician has real-time view of the patient’s face as well as real-vitals of the patient. The airport nurse, an extension of the physician, administers and oversees the needs of both the physician and patient. (Crichton 48).

Telemedicine has also been implemented within and benefited many communities. In Rochester, New York, over a thousand inner city preschoolers can have a live visit with a doctor without leaving daycare. Using telemedicine tools administrated by a daycare staffer and a live video and audio feed, doctors at the University of Rochester Medical Center can diagnose the child’s sickness via the Internet. According to a study in the May 2005 journal Pediatrics, telemedicine has saved parents 4.5 hours of work for each telemedicine visit and have decreased health related child absences by 63%. 92% of the parents in the study said that telemedicine allowed them to stay at work when they would have typically taken their kids to the doctor or emergency room. Though largely funded by the government, insurance companies have begun to take an interest and in some cases reimburse the daycare for telemedicine. “You can do a lot of telemedicine for the cost of one emergency visit...and that is what got our local insurance on board” says Dr. Neil Herendeen of the University of Rochester Medical Center (Snow).

Figure 41. This physician at the University of Rochester Medical Center uses telemedicine to diagnose a child’s health problems over the Internet.

Figure 42. According to a study in the May 2005 journal Pediatrics, telemedicine has decreased health related child absences by 63%.
Communication technology has also made the built environment more flexible by networking and controlling entry points into a facility. Areas in such facility can be remotely opened and closed to accommodate the needs of its users. For example, if a room isn’t large enough to accommodate a certain activity, additional rooms or spaces next to it can be remotely opened to make room for these activities. Since a genetics facility will need to address the public about their fears and misconceptions in regards to genetic research, the facility should hold events and invite the community and public into their facilities for educational events like seminars and health screenings. The facility can open spaces accordingly to accommodate additional visitors while be monitored remotely to secure working private areas such as research and diagnostic laboratories. Using networked access pads and locks, entry into and exit out of these areas can easily be monitored and controlled from great distances. Genetic facilities need not only be secure because of their sensitive research and diagnostic screenings, but also be open to the public in order for genetic specialists to address public concerns over genetic research. Communication technologies will allow genetic facilities to remotely and easily monitor and quickly open areas in the facilities to the public as well as quickly secure the facility from the public or intruders. Labs and access points can be secured and monitored remotely while public areas like atriums and resource centers can be open to the public. Facilities that use remote monitoring systems to open and secure areas within it include large institutions like prisons and government buildings. Those in the monitoring rooms can easily select which areas to secure
Figure 44. Wireless communication devices such as cellular phones, allows one to move about untethered to a wired network while being connected to a network.

Figure 45. Many college campuses have wi-fi technology that allows students and faculty to constantly stay electronically connected throughout the campus.

and open. The diagnostic and research center of a genetic facility would need to utilize security devices and protocol similar that of a high security prison. These areas need to have multiple checkpoints and locks. The diagnostic center needs to protect patients' personal information associated with diagnostic testing. The State Department reports that over 6,500 incidents of industrial espionage occur in the United States each year with an average economic impact of $1.25 million each. Access to research centers need to be restricted protected from intruders and criminal elements, for tests and discoveries at the research center could have the potential of turning into a financially lucrative medical screenings and medication. Research centers need to use multiple checkpoints and locks to protect them from industrial espionage.

Information and communication technologies are currently going through another evolution. It is going wireless, allowing one to constantly stay connected to others. No longer does one need to be tethered to a phone or Ethernet line in order to make a phone call or access the Internet, mainframes and databases. Wireless technologies will economically allow their workers to stay electronically connected in areas which are unable or too expensive to be equipped with hard line connections to digital networks such as hallways, atriums, walkways, and courtyards. Staff with electronic mobile devices with wi-fi, wireless fidelity, capabilities will be able to roam around facilities while constantly staying connected to their information networks. For example many college campuses have a wi-fi infrastructure which allows students around campus the
ability to stay electronically connected while going from building to building or sitting outside. Using wireless technologies, genetic facilities will allow their workers to constantly stay electronically connected with their facility in hallways, atriums, walkways, and courtyards. Staffs do not need to be confined to their work areas to access the facilities information technology systems. Technicians, researchers and genetic counselors can stay electronically connected to their respected departments while meeting face-to-face with each other in areas away from their respected departments.
High Speed Connections and Communications Are the New Main Street

High speed connections and communications are the new Main Street. Businesses no longer need to be located on Main Street in order to attract and garner clients and resources, for physical front doors can now be supplemented by virtual ones through a virtual identity of their businesses. However the virtual front door will not take over the physical. The two will work in unison. The new front door will be virtual while the infrastructure or back door, area to carry out the work, will be physical.

Even though communication technologies have made it more convenient for people to communicate with one another over long distances and in different times, there is still a human need for physical interaction and communication, requiring health care facilities to accommodate for face-to-face communication with the public. In regards to medical care, the “human touch” and it’s comforting and healing natures can never be replaced with communication technologies. Studies have shown how important physical interaction is to the health and well-being of a patient. In a 1998 University of Wisconsin study, researchers discovered that touch improved pain, tension, mood, satisfaction and hand function in elders with degenerative arthritis. With the tension and stress associated with medical diagnostic screenings, patients would benefit from physical contact with their care givers and genetic counselors. This is why genetic facilities need to have options for their patients and clients to have physical contact with staff at their
facilities, requiring the facility to have a hospitable, friendly, and secure environment for the interaction.

Communication and information technology need not be utilized strictly for communication and interaction. It can be used to conveniently provide services and sell goods to people. Since genetic services are not generally available in most areas, genetic facilities can sell and offer their services through the use of these technologies and the Internet. A new breed of businesses, e-tailers, has emerged through the Internet by selling their goods or commodities to consumers electronically. Websites, interlinked digital documents of script and graphics known as WebPages, display and describe their items. Items can be purchased on the website using a credit card or internet based accounts like PayPal. E-tailers ship these items to buyers by way of a shipping and delivery company, breaking from the traditional brick-and-mortar merchants on Main Street. Since the buyer and seller are imbued in a remote asynchronous exchange, e-tailers do not require a physical store to display and sell their wares, so locating on a busy thoroughfare is irrelevant and non-essential. The traditional relationship between façade and backroom is changing. The façade, storefront, has become electronic, while the backroom remains architectural.
Figure 47. High bandwidth allow websites to be accessed by multiple people at one time.

A warehouse and processing and distribution center and system with high-speed digital connectivity are all that is needed. The high speed connection, broadband, is the new Main Street. In the physical world, the Main Street is the most visible and high traffic area of a town, making property alongside it highly sought after by businesses. Broadband allows websites to be accessed and used by multiple people at one time. The higher the bandwidth, the more people are able to view and use the website at a time. Higher bandwidth will also enable more information to be electronically transferred. The online interface takes over the functions of street façade, signage, display windows, and retail floor. Software now does the job of sales personnel. These factors change the criteria for location of a business’s physical identity. Since bandwidth has replaced the Main Street, the physical location of the business must be in an area with high bandwidth capabilities. Another criteria is proximity to a major thoroughfare, ensuring ease of delivery or shipment of resources to and from the business as well as ease of commute for staff. With these criteria, the physical location for a genetics clinic and research center need not be located in large metropolitan areas where they are traditionally found nor be located on Main Street. They can be located in rural areas while still attracting and serving distant clients via their website, virtual identity. The facility’s staff will be attracted to the benefits of living in a rural area such as the lower cost of living compared to that of a metropolitan area.

Figure 48. Business no longer need to be located on Main Street in order to attract clientele. Virtual Identities, websites, do this now.
One business that has successfully done this is Amazon.com, the world’s largest e-tailer. It has warehouses and distribution networks throughout the world but no physical stores. In its first 30 days of business alone, Amazon.com shipped goods to all 50 US States and 45 different countries. The company grew from one U.S. based website, one storefront, to 6 nationally based websites (Mitchell. E-Topia. 119). The backroom of administrative staff and stocks rooms are still needed, however, close proximity between the two is no longer important. The backroom can be freely distributed into new efficient patterns. Since the buildings housing the backrooms have no representational roles, the buildings need not be in high-rent prominent areas. They can be located in remote areas and anonymous as long as the location has a high-speed digital infrastructure. High-speed digital connections allows for many large businesses typically located in metropolitan areas the freedom to efficiently disperse the physical components of their business in multiple locations. Typically medical research facilities are located under one roof in metropolitan areas, but with new communication technologies, these facilities can disperse their components in different areas while still maintaining a sense of cohesion through its communication links. The company can have remote genetic counseling satellite offices in other medically underserved areas. These satellite offices can function and operate just as if there constituent components were under the same roof. Samples extracted in these offices can be couriered to the diagnostic or research center for processing. Test results are relayed back digitally to the satellite offices for distribution. These offices and laboratories can be located in areas that are feasible and best
Figure 51. With delivery networks like UPS, goods can be ordered, shipped and delivered in 24 hours to even the most rural and remote areas.

Figure 52. Peapod.com conveniently delivers groceries ordered online to their customers who are unable to go grocery shopping.

serve their needs. For example the satellite offices can be located near a large pool of potential clients such as a large metropolitan area where space is generally tight and expensive due to the large population. Testing laboratories do not need to be located in these high-priced areas, but in areas much more financially feasible for them such as industrial zones and rural areas where main thoroughfares allow for ease of access for their couriers. Close proximity between clientele and services need no longer be a priority. With delivery networks like Federal Express (FedEx) and United Parcel Service (UPS), items can be ordered, shipped, and received in 24 hours even in the most rural and remote of areas. All a buyer needs is a shipping address or a P.O. Box. Online consumers can focus their resources saved – time, money, and gas – on more important matters.

The virtual identities have empowered and made life easier for consumers. Virtual front door allows consumer to gather information about businesses and research the goods and services they provide as well as purchase these goods and services any time of the day. Unlike the physical world, consumers do not have to physically visit the businesses in order to gather information or purchase goods and services. They do so from within environments that they are comfortable in and at their own time and pace. For example, the internet has been a convenience for people who have busy schedules and are too occupied to go shopping. Peapod.com delivers groceries ordered online to households who are too busy to go grocery shopping. Unlike traditional
merchants, e-tailers stay open 24 hours a day, seven days a week. The lights are never turned off and the doors are always open. Consumer can shop at stores online at their own pace and time convenient to them all in the privacy and security of their environment. Bargain hunters no longer have to visit or call stores to find the best price for goods. They can now electronically visit these stores and compare prices. Consumers can even shop for medical services online. Bumrungrad International Hospital’s multi-lingual website allows potential patients from all over the world to research the hospital’s services as well as order some of these services. Patients are able to make appointments online to see physicians there. As a testament to their online success, this hospital in Bangkok, Thailand, touts itself as being the largest international hospital in the world with over 400,000 international patients in 2005 alone. Attracted by the lower health costs, which are posted on the hospital’s website, along with high quality of care, 50,000 of these patients were from the U.S. alone. Via their website, the patient/consumer can research and customize the services and products offered by the hospital, make appointments with a Bumrungrad physician, look up costs for treatments and medical care, read patient testimonials, and view the amenities that Bangkok has to offer. The lower cost of care and high ratio of highly educated and trained staff to patients are strong selling points to international patients. The natural amenities near Bangkok such as beaches and resorts, provide areas of respite for the patient and the patient’s support groups before, during and after treatments. (Jennings).
Another example of how the virtual world has empowered the consumer to choose and customize services and products to their needs is Dell Computers. Anyone around the world can visit Dell Computer’s website to configure and order a computer to his specifications much like a businessman orders a suit from a tailor. The producers, Dell Computers in this example, get the added benefit of significantly reducing inventory costs and storing space.

Genetic centers can better serve the public via business models of Bumrungrad Hospitals and Dell Computers. Genetic clinic and research centers are typically located in large metropolitan areas in order to attract and maintain clients, personnel and resources. However modern communication technologies have de-emphasized the need for these facilities to be located in these large populated areas. Clients of these genetic centers will be able to visit the center’s website and order genetic services. These tests are then sent back to the company for processing via courier services. The clients can then access the center’s mainframe via the center’s website to view their test results, schedule in-house office consults or virtual consults with a genetics counselor, order additional tests, and pay for services. Though the ability to access one’s medical records via virtual means might be convenient for both caregivers and patients, it does have its drawbacks. Since these records are private, securing and restricting access to them will be critical to the success of the medical industry.
High speed connections have changed the focus and need for many businesses to create and design architectural spaces to attract clients. The virtual front door, website, now garners and maintains clients. Architecture is now the back room and infrastructure that maintain and drives the virtual front door. Since many clients seldom or never physically visit these businesses, resources can be devoted to focusing on the creation of architectural spaces that benefit those working in these back rooms. These architectural spaces should encourage physical and virtual collaboration and interaction between the workers as well as between the workers and their clients. These spaces should be therapeutic, adaptable and flexible and reduce worker stress. The therapeutic attributes of these spaces are sensorial qualities that cannot be provided virtually such as physical connections to nature. Since these businesses are able to locate in rural natural areas the workers should be able to take advantage of the natural surrounding through physically and visual access to the exterior. These include outdoor gathering and dining areas as well as views to nature in areas for meeting and pausing. Monetary resources saved from not locating on expensive Main Street property, can be utilized by providing areas such as outdoor gardens with benches and tables for outdoor gatherings and respite. Businesses can also re-allocate monetary resources to enhance indoor facilities and spaces to relieve workers’ stress and encourage interaction and collaboration between their workers. These indoor spaces include seating alcoves and dining areas that have visual and physical access to exterior. These areas
can be further enhanced with access ports for laptops or wi-fi technology, allowing workers to stay connected with their colleagues and clients throughout the facility.
Legitimating Physical and Virtual Identities

False identities, both physical and virtual, can do harm in both the physical and virtual world. Ways to prove the legitimacy of these identities are important for physical and virtual communications and interactions. To do this, an examination of the relationships between physical and virtual identities is needed. Though one’s physical identity in the built environment and one’s identity in the virtual environment might have different natures and constructs, they can affect and respond to each other both directly and indirectly in order to legitimize each other. For example a company’s website is nothing without a physical infrastructure behind it. E-tailers still need a place to ship, store, and manage their merchandise and staff. Their websites are physically grounded by architecture. Amazon.com’s website is grounded by it’s distribution centers, headquarters and IT centers that house their mainframes and servers. These physical identities will expand and contract with their online needs. E-tailers will expand their website to provide additional needs and services to their clients. This expansion of service will require the e-tailer to increase his capacity to provide these services by increasing warehouse size to store and manage goods. This expansion might require additional staff to manage these additional services, requiring the facility to expand their administrative buildings.

Genetic facilities with virtual identities might need to expand or modify their testing laboratories in order to offer additional genetic screening and tests on their website. These additional services might require additional genetic counselors to interpret and diagnosis to test results. These new
counselors will need their own private spaces in order to physically and virtually consult patients in accordance to their test results. The genetic facility must accommodate these additional counselors by either building additional spaces for them or adapting and renovating existing spaces for them which makes it critical for genetic facilities to have flexible and adaptable spaces that meet the ongoing and changing needs of its users.

Identity in the physical world is determined by genetics and environment. Where one inhabits frequently tells who one is. Architectural settings - whether they be town squares, cafés, bars, malls, libraries, or offices - frame expectations on how one should present himself by his clothing, body language, speech, and behavior. They also link one to his social position and his role. As Winston Churchill once said, “We make our buildings, and our buildings make us.” (Mitchell. City of Bits. 48). Since genetic facilities will need to address the public through genetic counseling services and provide access to genetic resource materials, spaces in these facilities will need to be designed to promote interactions between the public and the facilities’ staff. There must be cues in these spaces that reflect their usage. These cues should tell the visitors and public where they are allowed to inhabit and what they are allowed to do in the spaces they inhabit. These spaces that one inhabits will reveal the identity of the person. Those in the laboratories reveal that that person is either a researcher or diagnostic lab technician with access to specific information. Those utilizing and inhabiting the resource center are typically patients or the
general public interested in researching a health or genetic topic. People inside a genetic
counselor’s office are either patients, patients’ family members or genetic counselors. Where
one is in a genetics center usually tells who one is.
Choosing Which Modes of Communication to Use

In order to best design and develop architectural and virtual settings for a meaningful communication, one must understand which modes of communication are best to use. If one prefers to communicate synchronously face-to-face, than the architectural setting must be able accommodate for this communication by creating appropriate spaces for face-to-face communication. These areas include enclosed private offices that accommodate a variable number of visitors and seating alcoves adjacent to a hallway or corridor. Genetic counselors will need enclosed private offices to discuss private matters such as genetic test results with their patients. Alcoves would provide areas for face-to-face communication next to busy work areas or corridors for staff at a genetics facility.

Each mode of communication has its own advantages and disadvantages, affecting the quality of the communication. These advantages and disadvantages must be weighed accordingly in order to choose the best mode to have a meaningful communication. Of course, the importance of the message will be crucial in deciding which mode of communication to use with the most important messages going toward for face-to-face communication. Unfortunately these types of communications use a great deal of resources. If it is much less important, a quicker, cheaper, less direct mode will suffice such as a telephone call and e-mail.
If sensitivity, confidentiality, and security is a factor, face-to-face communications in safe non-descript places are best, for you might not want to leave any records that could be discovered by others or send any messages that can be intercepted or overheard. Spaces for face-to-face communications can be enhanced through architectural means so as to provide a secure setting where they are able to survey the area for prying eyes and ears. These areas can be in an isolated area or an inconspicuous area adjacent to or down from a thoroughfare. The occupants say what they want to one another while keeping a look out for prying individuals walking along or down the corridor. “This is why mob-frequented bars have back rooms, spies talk with the shower running, and high-level lawyers and business executives need fancy but noisy Manhattan restaurants” (Mitchell, E-topia 139).

Confidentiality is imperative in regards to health care. Laws such as HIPAA, addresses security and privacy concerns of medical data protection as well as limiting access to medical records, requiring areas where a patient’s medical records are discussed to be designed with privacy in mind. These areas include physician offices, check-in desks, nurse stations, bursar areas, medical treatment bays. Treating a patient and discussing a patient’s medical records in enclosed areas will help aid in protecting the patient’s medical data from prying eyes and ears. Areas where these forms of activity occur will impact design and layouts of the built environment. In order to ensure privacy, clinical and research areas need to be arranged into gradients of intimacy where
more public areas are at the front of a building and more private areas are in the back of a building. Genetic facilities will need to locate the resource centers and waiting areas near the entrance of a building. Offices and laboratories will need some privacy and thus need to go in the back.

The mode of communication one chooses to use may also be affected by the relationships between the communication parties. If the parties have known each other for some time, then a remote asynchronous message or remote synchronous communication would be fine. Because of the relationships history, there is a less chance of a misinterpretation. If both parties are not well acquainted, than face-to-face communication is ideal to decrease the chances of misunderstanding or bruised feelings. A patient might be uncomfortable in communicating with a physician over telecommunication means like telephony or e-mail if he has not had any previous physical meetings with the physician. A physical meeting between the two would help establish a trusting relationship, so an architectural setting that supports optimal face-to-face synchronous communications is crucial in this case. A variety of private meeting areas will be crucial for the variety of important interactions and collaborations in a genetics research facility. Researchers might want to meet face-to-face with one another to discuss means of collaborations. Areas for these meetings include informal areas such as lunch rooms where they can share a common activity, eating, or areas as formal as a conference room.
However, there are extreme cases where virtual means need to be used for the first interaction between a patient and physician. For example, those needing emergency care at Logan’s International Airport in Boston may need to use the telemedicine connection between the airport and Massachusetts’s General Hospital. Chances are the patient at the airport’s clinic and the physician at the hospital have never met before, so the patient must immediately have trust and faith in the physician in dealing with his health needs. This might be the case between patients seeking counseling services from genetic counselors via virtual means such as telephony and video conferencing, requiring the spaces of these two virtual communicating parties to be able to easily accommodate the virtual communication needs of each communicating party. These spaces must be able to respond and adapt to changing communication technologies while maintaining a therapeutic physical environment. This is imperative especially for the genetic counselor. His office and work space must not only allow him to communicate with virtually with his patients but also physically with his patients, requiring the space to be conducive to the virtual and physical needs of both communicating parties - the physician and the patient. There will be times when the patient prefers to visit the counselor to communicate physically with him rather than virtually.

Architecture must provide an infrastructure that allows for all modes of communications, both physical and virtual, for it allows the users to decide upon which modes to best be used in
according to his preferences or the circumstances at hand. Since synchronous and asynchronous communication technologies are constantly evolving, the users will need to be able to adapt to these ongoing changes via an environment that has an infrastructure that easily allows them to do so. The built environment must allow for these upgrades and changes by providing an infrastructure that allows for ease of upgrades, maintenance. Support systems need to separate from the living and working areas of a building. This can be done by creating separate areas to house these technologies that run these virtual modes of communications such as telecommunication closets that service computers throughout an office building. These closets allow technicians to maintain and service the telecommunication equipment with little physical disturbance to other workers in the building. This is similar to how municipal infrastructure services such as water and sewer and mass transit systems like subway and train systems are below the streets of many metropolitan cities. Servicing some of these below ground services, have minimal affect on what is happening above ground. The separation of these systems will allow access, maintenance and servicing of support systems without crossing paths of disturbing those in the living and working areas. For example the Pompidou Center’s mechanical systems are located away from areas that are used for the displaying of artwork. Locating mechanical systems on the exterior allow the servicing of these systems to not interfere with the function of interior spaces. Richard Rogers and Renzo Piano take their scheme further by celebrating and drawing attention to these mechanical items. They celebrate the everyday and mundane building.
mechanical systems. Water pipes are colored blue and air intake valves are made to resemble oversized periscopes. Research oriented businesses should treat their information technologies the same way. These technologies represent the prowess and power the business has and what they are capable of and should be displayed as a wealthy families would display priceless heirlooms and artwork to reflect their financial prowess.

Modes of communication that require more time and resources to arrange should highly experiential. They should be more than just an exchange of words and communication. Value must be added to these modes of communication by involving a shared activity and experience. For example synchronously communicating in a pre-determined time requires three components - scheduling, synchronization, and allocation. Whereas scheduling deals with a sequence of events, and synchronization has to do with when something is to occur with respect to some other activity or events, allocation has to do with how much time is to be devoted to various activities. In synchronized communication, the communicating parties will possibly need to settle on duration of time and schedule for the interaction. In order to do this the communication information must be prioritized. The more important the communication information is, the more time will be devoted and allocated to it. Since physically synchronous communication in the same time and space requires not only coordination but also greater time, energy and resources, value must be added to the face-to-face experiences by optimizing the characteristics and
qualities associated with physical interaction not attainable nor present in the virtual world. For example, “bookstores threatened by Internet sites will fight back by creating a welcoming ambiance for book lovers, by providing cappuccinos and cozy places to hang out, and by emphasizing the sensual pleasures of snapping the spines and riffling the pages of a book” (Mitchell. *E-topia*. 142). The built environment should emphasize these sensorial qualities that can’t be replicated in the virtual world by exploiting senses that are not used or cannot be used in the virtual world. Physical interaction in architectural space must reward the participants and optimize the interaction experience by stimulating the senses through haptic connections to the natural environment. This includes providing inhabitants of the physical world with views to nature and natural light as well as spaces to enjoy the natural world, such as courtyards and manicured gardens. Experiencing a garden on a computer screen will never be the same as walking through one. Architectural spaces should be designed for multi-sensorial, tactile activities in mind. Whether it is to read a book quietly, converse with friends and family, or an activity such as dining and eating, architectural spaces should enhance these activities by adding sensorial physical elements. For example a well considered and designed window added to a space will allow natural light into the space for reading a book. The reader will sense the radiant heat from the natural light and perhaps open a window to let in a cool breeze to cool the space. These feelings are elements of the physical natural environment that cannot be transferred into the
virtual. Adding an operable window enhances the space further and brings even more sensory stimuli into play.

One company who realizes this is Nike. Though they have a successful e-commerce business, they haven’t forgotten the importance of sensorial qualities of commerce. They have taken advantage of the experience of visiting a store, examining, touching, and trying on the merchandise before purchasing it. Nike’s flagship Nike Town stores are designed to glamorize the Nike products and the athletic world as well as entertain patrons. In the New York Nike Town stores, lights in the three story foyer are dimmed every 20 minutes to show Nike-related sporting films. Memorabilia and sports related novelties are encapsulated in display stands around the store. Patrons watch their shoes being sent down to them from the stock rooms above via clear vacuum tubs. The store is dramatically lit to ever inspire “sportively unfanaticals.” Visitors go to their stores for not only the experience of the purchase but also the entertainment involved with sports. Multimedia clips of sports stars outfitted and emblazoned with Nike apparel garner large video monitors, emoting the emotions associated with victory and accomplishment through sportsmanship to its many visitors. These actions involve tactile experiences where the customer can touch and feel the product and hopefully live out their dreams of being like their sports heroes. Unfortunately, this experience cannot be translated and capitalized upon in the virtual world, for the virtual world is not tactile. Genetic facilities must likewise accommodate their
virtual patients and clients who decide to physically visit them the same way Nike accommodates their customers of their flagship stores. Value must be added to their visit to make their visit worth their time and in some cases their money. These values include a warm and inviting environment that is conducive for synchronous face-to-face communication. These environments might have access to the exterior where the communicating parties can enjoy the natural amenities surrounding the facility. Other amenities might include information kiosks and resource areas that educate the visitors about the facility while they wait for their counselor of genetic specialist.

Another store that realizes this is Apple Computers. Apple realizes that the consumer that their first must create a want or desire for their products before they can sell a product. They must begin with the consumers experience with the products in the store. They do this through their sparse interiors and modern architecture, reflecting their minimally designed products. The centerpiece of their flagship store in the San Francisco and New York is not a product but a glass staircase that draws visitors to its second floor, a goal many retail stores have trouble doing, for typically customers walk around the first floor, look around and leave if nothing fancies their eye. However, “It’s difficult to resist the temptation to set foot on that first solid glass step. Once you’re there, you can catch a glimpse of the demo theater at the top of the stairs. And the next thing you know, you’ve been swept up to the top level before you’ve even finished (or started!) looking around the first floor yet.” (Garrett 1). Even the experience of the purchase is
Figure 67. The Apple store Genius Bar gives Apple users free face-to-face technical support, creating a relationship between the user and the Apple tech staff.

unique. Cashiers take time and pride in the transaction, making the transaction not the end of the relationship between the customer and cashier but the beginning. Apple users can get free technical support at the stores’ Genius Bar, continuing the relationship between the users and stores staff. Patrons can also sit at the bar and connect with other Apple users. By creating an ambiance and environment which promotes the experience of owning and using Apple products as well as interacting with other Apple users, the Apple stores succeed in enticing consumers to their products. It is not just the products that Apple Computers is trying to sell, but it is also the relationship, the relationship between Apple technicians and Apple users. Genetic facilities should take heed of Apple Computers business plan and emphasize not just the genetic services that they provide but also the relationships that come out of the service. The communication between counselors and patients will create a bond and relationship between the two and in some cases more with patient support groups and all. To aid in creation of this bond, the genetics facility must provide appropriate physical venues and setting for these relationships to take hold. These venues and setting should be both private and semi-private and vary in size. Small private areas will allow for physically intimate one-on-one interaction and communication between counselors and their patients. These areas include private offices and exam rooms in the health care sector. Larger venues and setting will allow for physical semi-private interaction between counselors and groups of patients. Such areas will allow counselors to address, educate and share information amongst groups of patients with similar interests and genetic problems.
Since location is another important factor in deciding the mode of communication one uses to communicate with another, to foster face-to-face interactions and communications between staff members, businesses need to locate their facilities closer to one another where little effort is needed to get people together. For example the close proximity between the diagnostic and research labs of the Greenwood Genetics Center, allows researchers and diagnostic lab technicians to meet face-to-face with each other periodically to review lab procedures and tests. The close proximity also increases the chances for informal interactions and communications between coworkers. This does not mean that these workers don’t need the availability of synchronous and asynchronous modes of communications. They will need to utilize these forms of communication in order to communicate or “stay in touch” with those outside the facility or communicate with others in the facility when face-to-face communication is difficult.

It is safe to surmise with the aforementioned evidences that whatever mode of communication one decides use, the built environment should not hinder his decision but provides an infrastructure for it whether it is virtual or physical. The built environment should provide capacity for additional modes of communication by not only providing segregated areas to house the telecommunication and information technologies behind these modes of communications, but design them to allow for additional technologies. Doing so will allow new modes of communication to slip in between existing ones or new modes of communication to be able to piggyback onto existing ones.
Though the built environment should allow for all modes of communication, it must ultimately foster and reward the most sensual and direct mode of communication - synchronous face-to-face communications - by providing settings that enhance the characteristics of them, characteristics that aren’t found in the virtual world.
Conclusion - The Physical World Will Prevail

No matter how prevalent the virtual world becomes in our day to day interactions with one another, the physical world will still prevail.

Genetic facilities that rely on information and telecommunication technologies for their business will need to take heed of this and consolidate their information technologies into an area separate from their laboratories and other working areas.

A solution to this problem is to separate and segregate areas that are used to house telecommunication and information technologies from areas used for working and functional uses, allowing those servicing these technologies to easily do so without getting in the way of those in the working and living areas and vice versa. However, areas for housing these technologies should not be hidden from the public, but conspicuously located to display and celebrate the telecommunication and information technology prowess one has. It is the advancement of telecommunication and information technologies that made it possible to finish the Human Project years in advance, spotlighting the importance of them in genetic research. As genetic research advances, genetic facilities will need upgrade and service their information technologies to meet the demands of genetic research. The higher computing and storage capacity of these technologies, the greater the potential for these genetic research facilities to make important discoveries.
The capacity for one to use communication and information technologies allows one to save and re-allocate precious resources such as time and money. These resources can be put towards more meaningful activities such as face-to-face synchronous communication and interaction. Since physical and synchronous forms of communications consume valuable resources, it is best that they be as pleasurable, productive and memorable as possible. The environments and settings for these communications should be prevalent and noticeable, fostering and embracing this form of communication and interaction and taking advantage of the changing ambiance available in the physical world. Areas for these multi-sensorial meetings should be both formal and informal, ranging from offices to hallways and alcoves. Collaboration and communication will be imperative to the future and success of genetics research. Genetic personnel will need to not only communicate virtually synchronously and asynchronously but physically synchronously too. These physically synchronously meetings are vital to their collaborations with one another. There should be areas within these facilities designated for face-to-face communications and activities associated with this mode of communication. Areas for possible face-to-face interaction should be emphasized and examined to allow for the interaction. These areas include hallways, corridors, entrances, and exits where occupants can inadvertently "bump" into others and communicate and interact face-to-face with one another. These unconventional areas for face-to-face meetings should be large enough to occupy and compensate for such activities, so that
Figure 70. Hallways should be designed to all for unconventional areas for face-to-face meetings.

Figure 71. Activities, such as sunbathing, will never be diminished through online activities.

New modes of communication will never replace those of the built environment. The front door might no longer be physically dominant, but there will always be a need for the backroom. “Online commerce may diminish the capacities of downtown shopping streets to attract the public, for example, but it’s still hard to beat the beach on a warm Sunday – and teletransactions may free up more time to go there” (Mitchell. E-topia. 142). People will always gravitate toward meaningful multi-sensorial experiences not offered in the virtual world. The power and need for human touch and face-to-face communication and interaction will never be diminished. No matter how many use their services virtually, genetic facilities will still need to accommodate for synchronous face-to-face communications with their clients. “Creative ideas come from discussions that can occur spontaneously during a casual encounter, informally during a break, or formally during a meeting.... Communication between researchers, administration, and marketing is essential to staying in business” (Crosbie 11). Genetic facilities will need to make the physical forms of these communications standout amongst virtual communications by adding values to their patients visit to their facility. These added values revolve around the sensorial nature, characteristics and activities of the physical world that communicating parties won’t be an obstruction to others using these areas. Areas for day to day activities such as eating and dining should also be emphasized and examined to allow for meaningful face-to-face communication.
cannot be translated into the virtual world. Genetic facilities will need to enhance counseling meetings with views and access to the natural surroundings around the faculty to tickle their senses. It is not only the services that genetic facility is selling, but also the relationship between the staff and their clients.

Retailers have realized the importance of this. "Local foods shops that want to compete with online supermarkets will pitch themselves to the sense through foodie-magnet displays of produce, nostril-tickling aromas of coffee, spices, and baked goods, and tempting tasting stations at every aisle" (Mitchell. E-topia. 142). It is be important to create settings in the built environment that enhances the physical experiences and that “tickle our senses” a feature the virtual world is not capable of. The genetic field will need to communicate with the public in order to reduce any concerns that they have in regards to genetic research. Though some of these concerns can be addressed virtually via the company’s website, genetic facilities will still need to address these concerns face-to-face with the public. Genetic counselors’ offices and information/resource centers should have characteristics that are not prevalent in the virtual world. For example they should have access to natural light to provide for changes in ambiance as well as areas for variable sized face-to-face communications with genetic professionals. These areas should be designed to be flexible to accommodate the many activities associated with face-to-face communication and senses that aren’t utilized in the virtual world. Genetic
resource centers should be flexible so that they can be used to provide a range of multi-sensorial activities and communications.

Figure 74. Natural light provides a changing ambiance for face-to-face synchronous meetings.
DESIGN PRINCIPLES

Introduction

A successful work of architecture will have qualities that go beyond the usual and the ordinary. It should become a place for meaningful synchronous sensorial face-to-face communications and activities that are not possible in the virtual world. These forms of communications and interactions should be made more meaningful and cherished through the built environment. However with the importance of telecommunication and information technologies playing such a pivotal role in business and day-to-day life, the built environment must make concessions toward these technologies. Four design principles have been developed to illustrate how to create spaces in the built environment for meaningful sensorial face-to-face communications and activities as well as how the built environment needs to simultaneously support telecommunication and information technologies where and when appropriate. Environments for meaningful face-to-face communication will come from planning the built environments into gradients of intimacy; provide views to nature in areas of meeting, pausing, and resting; and provide spaces that are flexible and adaptable to the ongoing changing needs of its users. The built environment must acknowledge the importance of the virtual world in today’s society by creating gradients of intimacy and allow for customization and personalization in the virtual world as well as provide means to address users’ needs in the virtual world.
Gradients of Intimacy in the Physical Realm

Both Buildings and websites should be designed and constructed with gradients of intimacy. Gradients of intimacy can direct people where to go and where not to go within buildings, protecting the building’s occupants and properties from outsiders. It provides a sense of what areas of a building are public, what areas are private and a scheme to layout buildings. Gradients of intimacy define how spaces within buildings are used and the level and type of relationship visitors have with the inhabitants of the building. Gradients of intimacy are best illustrated in the home environment where the movements and depth of interactions visitors and the buildings inhabitants are controlled, but they also apply in a variety of public buildings, including those for delivering health care services and other workplaces settings. The desired result of this design principle is for gradients of intimacy to determine the levels and nature of communications and interactions visitors have with the building’s inhabitants.

To successfully utilize this design principle, begin with the building’s layout. Spaces need to be arranged in such a way as to create a sequence of public to private zones. “Unless the spaces in a building are arranged in a sequence which corresponds to their degrees of privateness, the visits made by strangers, friends, guests, clients, and family will always be awkward” (Alexander 610). Healthcare setting are typically arranged in this manner to control activities, access, and communications between patients and caregivers by creating an environments that restricts and protects the privacy of the patients and information in regards to the patients’
health and well-being. There are a variety of gradients in the health care setting that control the activities within these setting. These gradients are arranged from public, semi-private to private.

Public settings within healthcare environments include reception areas, public restrooms, waiting areas, cafeterias, retail spaces, and primary circulation corridors where patients, family members, visitors, and staff are free to roam around. These areas do not pertain to the patients’ medical records or history and there is little interaction between caregivers and patients in these areas. These areas are located at the outer perimeter of the building near the entrance and are geared to hold a large number of people. They do not provide any form of privacy between a patient and a physician, making these areas not ideal for patient-physician interaction and communication.

In regards to a genetics clinic, these public areas include the lobby, rest rooms and waiting area.

Adjacent to these public areas are semi-private areas. These areas include changing rooms, gowned waiting rooms, and secondary waiting areas and are restricted to only patients and staff. Actions within these semi-private areas are restricted. Patients are not allowed to traverse freely between these areas and public areas without the permission of the staff. In some cases patients are escorted from public areas to these semi-private areas. The activities in these areas prepare them for activities associated with the next gradient of rooms. These activities include changing out of their clothes into hospital gowns and reviewing with a nurse practitioner their current medical status such as weight and blood pressure. In a genetics clinic, the resource
center falls into this category. Though it is important for the public and patients to have access to and use the resource center to inquire about their health problems and genetic issues, they will still need to check in and register with the receptionist before using the resource center. Due to the nature of their work, the clinic will need to keep track of people within its facility and make sure visitors are supposed to be where they are.

Adjacent to these semi-private areas are private areas. Private areas are areas where intimate conversations and interactions take place such as the communication and interaction between a doctor and a patient. Since the nature of their communication is private and intimate, areas for the actions between these two parties should be in private isolated areas away from the prying eyes and ears of the public. These areas include exam rooms, treatment rooms, staff corridors, medical records, libraries, and storage areas. Access into some of these areas is for staff only. These private areas are secluded areas that provide audible and visual privacy to its occupants, allowing them to freely communicate amongst each other private matters. The more private an area is, the greater the ability to control certain aspects of that area - such as lighting levels, views to the exterior, natural light, and restricting incoming sounds and noises. All these controls increase the intimacy level and ambiance of the communication and interaction in private areas. Genetic clinics will need to provide private offices to allow genetic counselors to privately treat their patients with little to no disturbance or distractions. Other areas that fall into category are
genetic research laboratories where experiments, procedures, and information need to be kept private amongst researchers and scientists. Genetic research facilities will spend a great deal of resources such as money and manpower on research. Their discoveries and developments might be monetarily lucrative, so they will need an area that is secure and private to protect these discoveries and developments.

Gradients of intimacy can be achieved through a number of strategies such as placing controlled access points to semi-private areas such as anterooms or secondary corridors that are adjacent to private areas. These access points require users to prove their identities with an access card, key, photo ID, or biometric scan. These anterooms will limit the line of sight between semi-private and private areas as well as be a barrier between public and private areas. Due to their use these anterooms should have characteristics differentiating them from the public and private realm. These characteristics include sight lines into and out of the anterooms, allowing unobstructed visual surveillance of this area. These anterooms should house closets or storage areas for equipment and supplies for the private areas adjacent to the anteroom. These anterooms should also be an area of respite for those working in the private areas with views to nature and daylight. They should be large enough for staff to interact and informally communicate with one another without obstructing those who traverse in and out of the anteroom in order to get to the private areas adjacent to it.
Figure 83. Thick walls allow for recess of pocket doors.

The thickening of walls between semi-private and private realms, such as those found between a vault lobby and a bank vault, provide an identifiable threshold and a sense of security and protection of important and precious items. Access between the threshold and private areas are stringent. One must prove his identity with the use of keys and identification. The doors of thickened wall need not be the same thickness of the walls. The thickness of the wall will allow for the use of pocket doors. Pocket doors are efficient in that they save room by not needing to swing in either direction like conventional doors. Supplies can be moved in and out of these area easier as well, for staff with carts or a handful of supplies do not have to compensate for the door swing. For genetic centers, these doors will easily allow and accommodate for delivery carts of testing samples to pass in and out of the laboratories.

Thickened walls also provide acoustical control. Within the laboratory setting, acoustical control is imperative to the design of laboratories, for exterior noise can be a distraction to researchers and technicians. Thickened walls can be achieved by incorporating built-in cabinetry or storage in walls between semi-private thresholds and private areas. These storage areas can be used to service laboratories, private areas, on the other side of the thickened wall. Those working in the laboratories need not go far for supplies. Since these storage areas are not located within the laboratories, they areas can be attended to, re-stocked and replenished without disturbing those working in the laboratories.
A sense of privacy and intimacy is important within the context of large working spaces, such as laboratories. Typically laboratories are not conducive to private or semi-private interactions and communications, due to the size and layout of the room. Conversations can be overheard by those nearby or be difficult to maintain due to noise in the room. Furnishings and lack of gathering space in the laboratory might also hinder those working in the laboratories from having private or semi-private interactions with others in the room. However with the use of small alcoves along the edges of the large working area, small groups of people or individuals can pull away from the larger group in the larger spaces to have an intimate interaction and communication. Alcoves can provide the privacy that they need without forcing them to leave the larger group all together. On the edges of common rooms such as laboratories, make small spaces no more than 8 feet wide and deep enough to accommodate chairs and a table for 3-4 people. Additional seating can be provided with the use of built in seating along the sides of the alcoves. To set off the space from larger common spaces, treat the ceiling differently by both bringing it down from the large common spaces or change the shape and material of it. Provide windows in these alcoves to allow for daylight to accentuate the space and a vehicle for visual distractions for those in the alcove. The window should start no more than bench height, 18 inches, allowing for a bench course next to the window.
Figure 86. Patient room with access to true nature.

Provide Views to Nature in Areas of Meeting, Pausing, and Resting

Provide views to nature in public and private areas of meeting, pausing and resting. These areas include waiting areas, resource areas, offices, corridors, conference rooms, atriums, and stairwells. Face-to-face synchronous communications, experiences, and exchanges within the built environment can be enhanced by qualities associated with views to nature. Visual stimulation from views to nature allows for physical, mental and spiritual well-being.

There is no denying the therapeutic qualities of nature. Views to nature help relieve stress and anxiety as well as connect the interior with the exterior. Jane Olds states that people hold "subconscious images of nature as a primal source of nourishment and rejuvenation." (Malkin 32). In the 1990’s, Roger Ulrich, PhD conducted a study on the therapeutic effects of views to nature in a health care setting. Ulrich noted that patients whose rooms had access to views to nature recuperated faster, "had fewer negative evaluations from nurses, required fewer painkilling medications than did patients assigned to rooms that faced a brick wall" (Malkin 32). Researchers, lab technicians, and genetic counselors are under a great amount of stress to not only process, diagnose, and interpret genetic test results to their patients, but also to promote and express the importance of genetics research to the public. Genetic counselors and their patients would benefit greatly from the calming views of nature during their face-to-face meetings. Views to nature will help reduce the stress and tension associated with patients finding out about what types of diseases and illnesses they are genetically prone to.
This information can be life altering to the patient which in turn creates added stress for them, so areas in which patients might inhabit during their visit to a genetics center needs to be examined and be designed in mind with views to nature. Views to nature also provide an added benefit of natural light, which continually changes the ambiance of spaces in the built environment from morning to night. In the mornings and afternoons areas with views to nature might be flooded with natural light and radiant heat associated with it, while at nights the interior lights and the buildings' heating and ventilation system take over to light and heat the area.

The therapeutic qualities of natural views will be beneficial to the researchers, lab technicians, and other staff in the facility. They allow for a visual connection to activities beyond the built environment and a sense the surroundings and a natural developments, encouraging access and activities in the exterior natural settings. Windows and other types of openings will give staff at visual queues to use and enjoy the natural health amenities near and around their facilities. These can include parks, bike trails, ball fields, public running tracks, golf courses, courtyards and exterior swimming pools of health center - encouraging a healthy, low stress lifestyle. Views to nature will give the staff a sense of weather conditions and if they are conducive for outdoor activities like bike riding and swimming. Installing clerestory windows in the laboratories will provide the benefits of views to nature as well as warmth associated with natural light. Since the inner workings of laboratories require a controlled environment for technicians to run...
Connections to nature provide stress-relieving, healthful effects. Within the context of research, scientists and lab technicians are constantly concentrating, focusing and researching very small and minute particles. Their viewing depth of field is short, requiring the contracting of the optical muscles to visually focus on the material, resulting in eye strain and other optical problems over time. Other occupational hazards the staff may face will be the result of working on a computer day to day. According to the *Journal of Epidemiology and Community Health*, prolonged use of a computer day to day is related to nearsightedness and glaucoma, a degenerative
Figure 91. Views to nature visually extend small rooms, encouraging access to the exterior.

Figure 92. Counseling room.

eye disease. Views to nature have extended viewing depths of field that will help relieve the staffs' eye strain and stress caused by their day to day work, making it imperative to provide these views in work areas that involve the use of computers and laboratory work. For work areas requiring controlled environments and limited amount of daylight, provide views to daylight to the anterooms of these areas, giving staff ease of access to views of nature.

Views to nature visually connect one area to another, making one room seem to larger than it really is. This is helpful in small rooms that might cause a feeling of claustrophobia and crowdedness such as meeting rooms and offices. Allocate one wall to exterior openings on one side of counseling rooms to prevent claustrophobic feelings by the occupants. The openings will visually increase the size of the office by extending it to the outside as well as provide views to nature, encouraging access to the exterior environment. Enable access to the exterior through additional openings against this wall, giving the occupants the option of moving their meeting and discussion outside and enhancing the quality of the meeting.

The therapeutic qualities of nature need to be provided in areas of waiting, for people are inherently drawn and are comforted by nature and daylight (Alexander 834). This is helpful in the genetic health care environment, for patients and visitors waiting will be nervous and anxious in meeting with a genetics counselor to find out and discuss their genetic test results. Views to
nature will help alleviate some of these feelings as well as provide for visual stimulation and distraction during their time of wait in the waiting area. These views should look toward the best possible views out over life and activities - activities in street or in the parking area and entry area. Place waiting areas next to windows and openings that give them a wide-angled viewable expanse of the exterior. In areas of waiting, place seating near windows that have a large exterior view of the exterior. The windows should have low sills that begin at the finished floor level and continue to the ceiling and take up the width of the wall, allowing occupants in the waiting area a wide expanse view to the exterior. These views will be much needed distractions for those in the waiting areas.

Create therapeutic views to nature therapeutic in stairwells, areas that are traditionally used for movement, traversing and egressing, making these areas for pausing and destinations for informal gathering and conversing. In stairwells provide windows accompanied with a bench course beside it that stretches the expanse of the window. The window should start at the top of the bench course and rise up to a few feet of the ceiling of the stairwell, allowing occupants in the stairwell to large views of the exterior and giving them a visual connection to the exterior. They can stop and rest along the bench course and enjoy the views. The bench course and views to nature make the stairwells a destination point to sit down and meet with friends and colleagues.
Palladio believed in the therapeutic qualities of nature. He writes, describing the natural surroundings of his villa, "Its owner...will watch the maturing of his possessions and savor the piquancy of contrast between his fields and his gardens; reflecting on mutability, he will contemplate throughout the years the antique virtues of a simpler race, and the harmonious ordering of his life and his estate will be an analogy of paradise." (Rowe 123).

It is the position of this thesis to create architectural spaces that aid in alleviating stress, fear, and anxiety as well as create a meaningful setting for face-to-face synchronous communication. Views to nature are a vehicle by which these goals can be accomplished.
Provide Spaces That Are Flexible and Adaptable to Ongoing Changing Needs of Its Users

Architecture needs to be flexible and adaptable to the ongoing changing needs of its users. These needs include not only integrating and adapting to new forms of technology but also different activities within the built environment. Flexible space is suitable for multiplicity of programs, activities and functions. Adaptable space can be modified in order to accommodate the user’s every changing needs and activities. Through flexibility and adaptability, can spaces accommodate different needs over time. These types of spaces are reflected in the laboratory setting where “If the average duration of [a building’s] research programs is three years, it is conceivable that up to 30 percent of the building can be undergoing some level of intervention at any time” (Crosbie 10). These interventions may include cosmetic changes, upgrades within existing rooms (such as new utilities, lighting and flooring) and renovation where walls are relocated. In addition to construction costs associated with the interventions, other costs may be incurred for things such as “offline time” when spaces are not in use, relocation, and assuring ongoing operations in adjacent areas. The two areas of focus for these types of spaces are resources centers and laboratories.

The resource center must be flexible in order to accommodate public’s needs, the patients’ needs, the genetic specialists’ needs, and caregivers’ needs. Genetic specialists and caregivers will use this area to educate the public and their patients in regards to the study of genetics. The public and patients will use the resource centers by themselves with the instructions of their
caregivers and genetic counselors or they might use the resource center in a group such as health seminars. The resource center should be divided into zones for individual to small groups of 3-4 people. Since genetic disorders affect relatives as well as the patient, genetic patients might research their genetic disorders with family members, so the resource center must accommodate for these additional patients. Zones with research areas can be achieved through variable seating arrangements and furnishings. At times, small intimate zones may be required for individual or small group meetings and research. A short time later, the space may require a large group seminar or presentation. Spaces must be flexible and adaptable to accommodate for these changing needs. To adapt for these larger groups, the furnishings in the resource center must be easily moveable to make room for additional seating.

Laboratories must be flexible in order to accommodate the needs of the researchers and lab technicians. With new discoveries in genetics comes the need to use the new found information to develop tests and medications, requiring laboratories to be flexible enough to accommodate additional research activities with little or no disturbance to ongoing research activities. Researchers might also need to consolidate research activities, so laboratories will need to be flexible and adaptable to these additional activities.
As genetic research progresses, it will depend more heavily upon telecommunication and information technologies to collect, store, manage, and share their data. As data accumulates, additional and newer technologies need to be integrated to handle, store, manage, and share the additional data. It is important to integrating these technologies into research facilities with little or no disturbance to the day to day operations of the facility. Higher capacity digital storage technologies will not only allow for the collection, storage, management, and sharing of data, but also allow for an increase in capacity of registered users to their websites. The capacity increase will also allow for additional simultaneous chat rooms. The prowess of many businesses rests on their ability to adapt to these new forms of technology which in turn increases the businesses virtual prowess and provides efficient means of collecting, storing, sharing, and moving of information.

Creating flexible and adaptable spaces require building program and elements to be categorized into served and servant spaces, a concept devised by Louis Kahn in the 1960s. Served spaces are areas of human activity. While servant spaces support these activities. Offices, laboratories, and conference rooms are served spaces while telecommunication closets, mechanical rooms and restrooms are servant spaces. Kahn believed the separation of served and servant spaces creates an architecture that is flexible and adaptable to the changing needs of its occupants. Kahn utilized this principle in his design of the Jonas Salk Institute for Biological Studies in Sand
Figure 100. Section of the Salk Institute, depicting lab and mechanical floors (served and servant spaces).

Figure 101. Interstitial spaces between served floors, floors of human activity, should house mechanical services.

Diego, California. He separated served and servant spaces laterally by floors, locating mechanical systems' floors, interstitial spaces, between occupied floors. This allowed for servicing systems without disturbing inhabited floors and allow inhabited floor to be large and uninterrupted. These large spaces can then be partitioned into smaller pieces for different needs and activities, maximizing the utilization of floor space. Mechanical services can be fed from above and below making it easier to relocate mechanically dependent equipment. Common areas such as corridors can also serve as flexible space for staff and visitors. They can be used to separate served and servant spaces, allowing unfettered service to servant spaces. For laboratory floors to be flexible and adaptable to the changing needs of its occupants and users, these floors need to be separated by interstitial floors that house servant building program - mechanical and telecommunication equipment. This allows the served floors, laboratory floors, to adapt the needs of the users with little or no hindrances or limitations to the mechanical outlets. Also separating laboratories from mechanical spaces will prevent researchers and mechanical building attendants from getting in each other's way. Using casework with castors will allow laboratory workers to quickly re-configure their work areas to meet the changing needs and activities of their research. With mechanical interstitial systems above and below, researchers can easily unplug their casework from mechanical and electrical outlets, reconfigure them to new and additional activities, and re-plug them back into the laboratories mechanical infrastructure. “A
successful building has to be periodically challenged and refreshed, or it will turn into a beautiful corpse,” says Stewart Brand (Brand 209).

To address the need to adapt to new forms of telecommunication and information technologies, a flexible telecommunication and information technology infrastructure such as stackable blade servers will need to utilize. Blade servers are universally standardized to fit server racks. These server racks should be housed in the cavity of thick load bearing walls adjacent to served, working, areas such as laboratories. The cavity walls will need to be substantially thick, at least 4 feet thick, in order to house these servers, creating a display case for these technologies to show off the facilities technological prowess similar to how niches in thick walls are used as display areas for personal items. Provide access to the server racks from sides the side opposite of the laboratory, allowing technicians the ability to maintain and repair servers without disturbing ongoing work in the laboratory.

Connect these servers to the facilities individual computers terminals using an elevated floor system. These floor systems will house conduits and wireless adapters that connect the servers to individual computers in the facility both wired and wirelessly. These floor systems will also allow technicians ease of access, maintenance and service to the conduits and wireless adaptors. Elevated floor systems should be used in primary and secondary corridors that physically connect
one building or space to one another, for these corridors will also digitally connect and distribute information to other parts of the facility.

Providing for flexible and adaptable environments within the clinical and research setting enables the public, patients, genetic specialists, researchers and lab technicians to be accommodated in a variety of ways. This ability to adjust to the variety of activities, procedures, and technology helps relieves stress and pressure and provides researchers, technicians, and other staff a sense of control over their environment.
ARCHITECTURAL PROGRAM

Introduction

The intent of the architectural program presented in this thesis is to improve the genetic counseling delivery and research in South Carolina by developing the Greenwood Genetics Park. Currently South Carolina does not have a strong developed plan or setting that adequately accommodates genetics research. The following is a program intended to develop an area of the Park to accommodate GSC Therapeutic Genomics, a genetic treatment, diagnostic and research company. The program hopes to create an architecture which creates links between the physical and virtual works, establishing opportunities for meaningful, multi-sensory exchange in shared time and space. The architectural program is comprised of three components including clinic, diagnostic, and research areas.

Clinic/Resource Center. The clinic is the smallest and most visible component of GSC Therapeutic Genomics. It is the public front door for the company, providing genetic counseling and information to the public. To help ensure a sense of privacy and control this component is divided into two major areas - clinical and public spaces. The clinic area is comprised of six genetic counseling offices, supplementary staff work areas, and package pick-up and drop off. Genetic testing samples are taken and logged in here and transferred to the diagnostic testing labs. The public area of this component centers on the facilities most public area - the resource center.
Since genetic samples are delivered and in some cases extracted from the clinic and taken to the testing labs, the testing labs need to be physically nearby the clinic. Should questions or problems arise during the processing of the samples, lab technicians can easily meet face-to-face with the genetic counselors either at the clinic or in the labs to address the questions and problems. Their close proximity from each other will allow them to meet frequently and team up with each other. Lab technicians can meet with the genetic counselors and their patients to answer any questions that the patients might have with his genetics sample or tests. Their close proximity to the clinic also allows them to easily come to the resource center to address and educate the public about genetic testing.

Diagnostic test results are deposited into the facility’s mainframes and delivered via email back to the genetic counselor for interpretation and explanation to the patient. Though the close proximity makes it easy for lab technicians to address questions about a genetic tests and test results face-to-face, time conflicts might prevent them from doing so. Communicating via virtual asynchronous means will be more prudent. If for any reasons these two parties cannot leave their respective work areas but can communicate with each other at a certain time, they might communicate with each other through virtual synchronous means.
The clinic and research center need not be located in close proximity with each other, for clinicians might not work directly with researchers in the research centers in regards to their patients needs. However researchers might be invited to help clinicians and counselors educate visitors, patients, and the public at the resource center. If time permits, researchers might do so face-to-face, but if the researchers have scheduling conflicts or unable to leave their area for any reason, a conference call or video conference call between from their research area to the resource center will be ideal.

**Diagnostic Center.** Testing samples extracted in the clinic or delivered to the clinic are transferred to the diagnostic center for processing. The diagnostic center is comprised of three distinct genetic testing labs - metabolics, cyto-genetics, and DNA testing labs. The metabolics lab tests for in-born errors in metabolism in urine, plasma, and spinal fluid to determine health disorders in prenatal screenings and in late adulthood. The cyto-genetics lab analyzes chromosomes in blood, bone marrow, amniotic fluid, CVS (corenoine vili specimens), and solid tissues for deletions and disorders. The DNA testing lab analyzes DNA and RNA for defects and mutations. Each of these labs have their own procedures and requirements, dictating their own separate settings. However, they do share business offices, changing, and clean/soiled holding rooms.
Those working at the diagnostic center will work closely with both clinicians and the researchers physically and virtually, for the diagnostic center will use diagnostic tests created by the research center. Researchers will need to train lab technicians at the diagnostic center to properly use the tests that they developed. These two groups might have formal and informal physical and virtual meetings to go over new tests procedures. They will need to maintain a strong relationship with one another both physically and virtually for the facility to be viable, for researchers will need to know if the tests that they develop are effective. The lab technicians at the diagnostic center will report back to the researchers on the effectiveness of their tests. They will need to communicate with various modes of communication in order to convey the ongoing information.

**Research Center.** The largest component of the facility is the research center, combining all the procedures and requirements of the diagnostic labs into one area along with morgue components, workroom, electron microscope department, negative pressure rooms, a research library, and an atrium. The atrium is shared by the entire facility for large facility meetings and as an area for respite. Since genetic medicine is still in its infancy, its potential for being a very profitable business is high. In order to prevent industrial espionage, the research center has the highest security in the facility, making it difficult for researchers to meet with other personnel face-to-face inside their laboratory. Fortunately close proximity to the atrium, gives them a solution to this problem. The atrium provides a nice area for staff in the facility to have meaningful
face-to-face communication with each other as well as share daily activities such as having lunch and taking a coffee break with one another.

The clinic will use the atrium at the research center for large public seminars and patient gatherings that are too large to be accommodated in the research center. Since it can accommodate large amounts of people, the atrium will play host to holiday and social gatherings.
Program Area Summary

<table>
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<tr>
<th>SPACE</th>
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<tr>
<td>Clinic / Resource Center</td>
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<tr>
<td>.......................... Public Areas</td>
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<td>.......................... Clinic</td>
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<td>Diagnostic Center</td>
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<td>.......................... Shared Spaces</td>
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<tr>
<td>.......................... Metabolics Lab</td>
<td></td>
</tr>
<tr>
<td>.......................... Cyto-genetics Lab</td>
<td></td>
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<tr>
<td>.......................... DNA Testing Lab</td>
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<tr>
<td>.......................... Research Area</td>
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<td>Mechanical (Intersitial Sapce)</td>
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Figure 108. Clinic floor plan.

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<th>Space (NSF)</th>
<th>NSF Total</th>
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<td><strong>Shared Spaces</strong></td>
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<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Resource Center</td>
<td>Needs to be near entrance.</td>
<td>1</td>
<td>485</td>
<td>485</td>
</tr>
<tr>
<td>Waiting Area</td>
<td>In good proximity to genetic counselors’ offices.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Restrooms</td>
<td></td>
<td>2</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td><strong>Clinic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetic Counselor’s Office/Patient Rooms</td>
<td>Able to accommodate 5 people and be adjacent to a restroom.</td>
<td>6</td>
<td>250</td>
<td>1,500</td>
</tr>
<tr>
<td>Restrooms</td>
<td>Adjacent to each counselor’s office</td>
<td>6</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Packages Drop-off/ Pick-Up</td>
<td>Drop-off of test samples and pick-up for diagnostic test results</td>
<td>1</td>
<td>205</td>
<td>205</td>
</tr>
<tr>
<td>Copy Alcove</td>
<td></td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Total net S.F.                                                                                                   | 3,250

Net-to-Gross Factor                                                                                              | 1.3

Total Gross S.F.                                                                                                 | 4,225
**Figure 109. Diagnostic Center Floor Plan - Ground Floor, Building 1, shared spaces.**

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostic Center</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shared Spaces</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reception/Secretarial</td>
<td></td>
<td>1</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Conference Room</td>
<td></td>
<td>1</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Director Offices</td>
<td></td>
<td>3</td>
<td>130</td>
<td>390</td>
</tr>
<tr>
<td>Changing Rooms</td>
<td>Adjacent to restroom and clean and soilded rooms.</td>
<td>2</td>
<td>130</td>
<td>260</td>
</tr>
<tr>
<td>Clean &amp; Soiled Rooms</td>
<td>Adjacent to changing rooms.</td>
<td>2</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Restrooms</td>
<td></td>
<td>1</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Package Drop-off/ Pick-up</td>
<td>Located and shared with clinic.</td>
<td>1</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Biohazard Dock</td>
<td>Shared with the whole facility.</td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Water Distillation Room</td>
<td>Water is used to dilute the chemiclas used by the facility. Shared with the whole facility.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td><strong>Metabolics Lab</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab Area</td>
<td>Tests for in-born erros in metabolism analyzing proteins in plasma and spinal fluid samples.</td>
<td>1</td>
<td>1,500</td>
<td>1,500</td>
</tr>
</tbody>
</table>
Figure 110. Diagnostic Center Floor Plan - Second Floor, Building 1, Metabolics Lab.

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>diagnostic center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to diagnostic bldg. 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and research ctr.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Prep Room</td>
<td>Houses six vertical freezers. Must have room to grow.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Freezer Alcove</td>
<td>Metier balances are used to weigh small amounts. Due to vibrations, they need to be on solid flooring and away from walkways.</td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Metier Balance Alcove</td>
<td></td>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Storage</td>
<td>Stores flammable caustic materials.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Cytogenetics Lab</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab Area</td>
<td>Analyzes bloods, bone marrow's, amniotic fluids, CRS, and solid tissues.</td>
<td>1</td>
<td>1,600</td>
<td>1,600</td>
</tr>
<tr>
<td>Harvesting Room</td>
<td>Equipped with fume hoods and flame retardent cabinetry, eye wash, and emergency shower.</td>
<td>1</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Slide Making Room</td>
<td>Must be near harvesting room.</td>
<td>1</td>
<td>250</td>
<td>250</td>
</tr>
</tbody>
</table>
### Diagnostic Center (continued)

#### Cytogenetics Lab (continued)

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide Staining Alcove</td>
<td>Must be near slide making room and lab area.</td>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Imaging Room/DarkRoom</td>
<td>Has minimal access to daylight, for test probes used are sensitive.</td>
<td>1</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>1</td>
<td>130</td>
<td>130</td>
</tr>
</tbody>
</table>

#### DNA Testing Lab

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Area</td>
<td>Tests DNA for abnormalities. Must be well ventilated.</td>
<td>1</td>
<td>3,400</td>
<td>3,400</td>
</tr>
<tr>
<td>Metler Balance Alcove</td>
<td>Metler balances are used to weigh small amounts. Due to vibrations, they need to be on solid flooring and away from walkways.</td>
<td>1</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Conference Room</td>
<td></td>
<td>1</td>
<td>230</td>
<td>230</td>
</tr>
<tr>
<td>Tissue Culture Storage</td>
<td>Storage for tissue cultures created by lab.</td>
<td>1</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>
### Room Name

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DNA Testing Lab (continued)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Processing Room</td>
<td>Extraction of DNA from blood samples.</td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Dark Room</td>
<td>Equipped with fume hood.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Radiation Half-Life Storage</td>
<td>Storage of radioactive waste.</td>
<td>1</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Cold Room</td>
<td>Storage of new and unused radioactive material.</td>
<td>1</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Freezer/Refrigeration Alcove</td>
<td>6-8 large commercial freezers and one nitrogen oxide freezer.</td>
<td>1</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Director Offices</td>
<td></td>
<td>2</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total net S.F.</strong></td>
<td></td>
<td></td>
<td></td>
<td>11,890</td>
</tr>
<tr>
<td><strong>Net-to-Gross Factor</strong></td>
<td></td>
<td></td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total Gross S.F.</strong></td>
<td></td>
<td></td>
<td></td>
<td>15,457</td>
</tr>
</tbody>
</table>
Figure 113. Research Center Floor Plan - Ground Floor, Shared Space and Research Lab.

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Description</th>
<th>No.</th>
<th>Space (NSF)</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Center</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Shared Spaces</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrium</td>
<td>Accomodates 250 people.</td>
<td>1</td>
<td>4,200</td>
<td>4,200</td>
</tr>
<tr>
<td>Research Library</td>
<td>Primarily used by research personnel.</td>
<td>1</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Restrooms</td>
<td></td>
<td>4</td>
<td>200</td>
<td>800</td>
</tr>
<tr>
<td>Conference Room</td>
<td></td>
<td>2</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td><strong>Administrative Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference Room</td>
<td></td>
<td>2</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Offices</td>
<td></td>
<td>9</td>
<td>100</td>
<td>900</td>
</tr>
<tr>
<td>Workroom</td>
<td></td>
<td>1</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td><strong>Research Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab Area</td>
<td>Only 4,700 sft is needed. The rest is to be shelled for future expansion.</td>
<td>1</td>
<td>6,750</td>
<td>6,750</td>
</tr>
<tr>
<td>Workroom</td>
<td>Desk area for technicians. Must be adjacent to the lab area</td>
<td>1</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Sample Extraction Room</td>
<td>“Sterile Sanctum” for highly contagious samples</td>
<td>1</td>
<td>670</td>
<td>670</td>
</tr>
<tr>
<td>Airlock</td>
<td>Used to enter sample extraction room.</td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Room Name</td>
<td>Description</td>
<td>No.</td>
<td>Space (NSF)</td>
<td>NSF Total</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Research Center</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Research Area (continued)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Room</td>
<td>Walk-in cooler.</td>
<td>1</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Southern Blocking Reading Chamber</td>
<td>Uses ultraviolet light to expose DNA sequence that has been “inplanted” in an agarous gel.</td>
<td>1</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Radioactive Half-Life Storage Room</td>
<td>Used to store radioactive byproducts created by PCR machine</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>RNA Extraction Room</td>
<td>Equipped with fume hoods.</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>PCR (Preliminary Chain Reaction Alcove)</td>
<td>Duplication fo DNA sequence.</td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Plasmid Room</td>
<td>DNA cloning chamber.</td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Histology</td>
<td>Used for making various tissue samples. Used by autopsy personnel.</td>
<td>1</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Morgue</td>
<td>Storage for large dead samples. Primarily used for autopsies.</td>
<td>1</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Autopsy Lab and Desk Area</td>
<td>Adjacent to morgue.</td>
<td>1</td>
<td>230</td>
<td>230</td>
</tr>
<tr>
<td>Room Name</td>
<td>Description</td>
<td>No.</td>
<td>Space (NSF)</td>
<td>NSF Total</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Research Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Research Area (continued)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro Dissection Room</td>
<td>Adjacent to morgue.</td>
<td>1</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Animal Room</td>
<td>Animal sample storage and dissection area.</td>
<td>1</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Electron Microscope</td>
<td>Adjacent to the X-ray room and dark room.</td>
<td>1</td>
<td>280</td>
<td>280</td>
</tr>
<tr>
<td>Dark Room</td>
<td>Adjacent to the electron microscope.</td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Metler Balance Alcove</td>
<td>Metler balances are used to weigh small amounts. Due to vibrations, they need to be on solid flooring and away from walkways.</td>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Clean and Soiled Holding</td>
<td>Store used and new scrubs. Adjacent to changing rooms.</td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Changing Room</td>
<td>Adjacent to clean and soiled holding rooms.</td>
<td>2</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>Total net S.F.</td>
<td></td>
<td></td>
<td>21,530</td>
<td></td>
</tr>
<tr>
<td>Net-to-Gross Factor</td>
<td></td>
<td></td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Total Gross S.F.</td>
<td></td>
<td></td>
<td>27,989</td>
<td></td>
</tr>
</tbody>
</table>
Site Goals

In order for such a specialized research facility to succeed in Greenwood, SC, certain site goals must be outlined and established. These goals will center upon establishing a genetics research knode in the region, address public concerns about genetic research, improve genetic medicine in the region, and create a low stress environment that nurtures collaboration and communication in medical research.

1. Enhance the clinical and medical research needs of South Carolina in the field of genetics in hopes of developing new much-needed medical treatments through physical and virtual communications and collaborations with health care providers, the public, and other medical research facilities.

2. Bring a sense of community and group identity for genetic research to the region. The site should provide ample room for growth and location of additional research facilities of this nature, promoting collaboration between facilities with the same agendas and goals. It is the position of this thesis that for the treatment and research services of the facility to become a more influential regional genetics center, it will need to not only have its own identity but also a group identity with other medical research facilities around it.
3. Improve access to treatment and research services of genetics disorders in the region. This can be done both physically and virtually. The site location must be near major transportation infrastructures - highways, interstates, and airports. This will allow for ease of travel to and from the facility. For those who are unable to travel to the facility, broadband communication infrastructures will provide virtual synchronous and asynchronous access to the facility. These infrastructures should be able to handle communication as simple as a telephone call to high-bandwidth communication like video conferencing.

4. Enrich and nurture communication among staff by creating venues to communicate both physically and virtually, synchronously and asynchronously. It is the position of this thesis that the proposed building has different scaled meeting spaces with varying degrees of intimacy for physical contact as well as an infrastructure that can meet the demands of virtual communication. Physical meeting spaces should take advantage of the natural surroundings to minimize the stress of the facility’s personnel as well as promote interaction between them.

5. To support local outreach programs in the region. It is the position of this thesis that prejudice and fear is caused by a lack of knowledge. The research and medical practice of genetics are feared and misunderstood by many, but this fear can be abated with communication, understanding, and knowledge of the subject. The facility can use its physical and virtual resources
to communicate with and educate the community about the facility’s visions and goals in order to ease any fears and misconceptions the community has about genetics and GSC Therapeutic Genomics.

These goals dictate that the test case be explored in detail on three levels. It began by establishing an identity for medical research in the upstate of South Carolina by means of a master plan for a 1600 acre site. The physical identity of a new clinical and genetics research facility was created by applying architectural design principles to the test case. A virtual identity for this entity was created through a webpage - gscgenomics.com. The execution of these design principles and a virtual identity for the facility are intended to support the thesis position that architecture must create links between the physical and virtual worlds, establishing opportunities for meaningful, multi-sensory exchange in shared time and space.

Figure 115. 1600 acre site for the master plan for a medical research park in Greenwood County, SC.
ARCHITECTURAL PROPOSAL

The test case is a genetics facility composed of clinical, diagnostic and research components, GSC Therapeutic Genomics, for Greenwood, South Carolina. The creation of this facility will be explored at three levels. These levels are (1) master plan, (2) building and (3) the virtual "front door."

This thesis proposes that a medical research facility of this nature need not be located in a metropolitan area in order to garner and maintain limited resources and clientele. Utilizing telecommunication and information technologies, this facility can be successfully located in a rural medically underserved area where the facilities personnel can take advantage of the natural amenities of the area as well as other benefits of a rural area. Locating a facility of this nature in such an area would increase the level of specialized genetic health care in a region and attract additional facilities of this nature in hopes of creating a node for genetic research. The close proximity of these facilities to each other will help establish ties for synchronous and asynchronous, physical and virtual communications and collaborations with one another to further genetic research and genetic discoveries. Utilizing the aforementioned design principles, the proposed genetics facility will be designed to reflect the importance and need for face-to-face synchronous communication and interaction amongst genetic specialists, caregivers, genetic patients and the public. These design principles have also been modified and applied to create a virtual site for
GSC Therapeutic Genomics that reflects the parallel importance of having a virtual identity as another “front door.”
Master Plan

The architectural resolution of the master planning strategy was derived from the need to create a medical research node for the Upstate of South Carolina at Greenwood Genetics Park. The resulting master plan was derived with four main goals in mind.

(1) Create a medical research identity for the area by establishing a community of medical research facilities within the Park while still maintaining the small town qualities of the area.

(2) Provide for natural areas of respite for staff working in these research facilities to relieve stress caused by the demands in medical research.

(3) Security should be a factor in the design and layout of the master plan. However, in order for the community to embrace the work in the facilities located in the Park, the Park’s amenities should be open to the community.

(4) Allow for ease of access to and from the Park for visitors, staff, shipping as well as virtual traffic.

The final master plan is comprised of fifteen separate lots for medical research. These lots radiate around the Hard Labor Creek and the low flood plain of the site. Each lot varies in size.
and amenities. Lots running on the western side of the Park, have two forms of access - from SC Bypass 225 and DNA Parkway. However the grouping of these facilities do not make a community. It will be the interactions between the staffs of these research facilities that will make the Park a community.

According to James Rouse, the developer of Columbia, Maryland, in order to create a community, the area must have 3 main qualities (Arendt 4):

1) the greater likelihood for a broader range of relationships and friendships
2) an increased sense of mutual responsibility and support among neighbors
3) a closer relationship to nature through informal outdoor recreation opportunities

The master plan is based on these three qualities. The close proximity between research facilities and their common field of research, genetics, will aid in fostering physical and virtual collaboration and support amongst these facilities, establishing a node for genetic medical research in the area. Built and natural amenities will also foster these informal collaborations and interactions. The southern entrance and tip of the Park is zoned for commercial use such as restaurants, coffee shops, general stores, post offices, bars, dry cleaners, day-care and other places of hangouts. This commercial area is what Ray Oldenburg calls a “third space” (Arendt
5). It is these places that provide opportunities for casual socializing away from the home and workplace. Businesses in this commercial zone will provide day-to-day services for the Park’s occupants and the community. The location and proximity of these services will make some day-to-day errands easier for employees within the Park.

The Park provides venues for respite and opportunities for between those employed with the Park’s companies and the community. These venues include not only the aforementioned commercial zone in the southern tip of the Park, but a health facility, sports fields and a bike trail that is interlaced in the Park.

To create and maintain a sense of security within the Park, park security is located along the main thoroughfare, DNA Parkway, inside the Park. The Park’s access is controlled by two vehicular access points into the Park, both of which are along West Alexander Street Extension. Activities near and around these entrances will provide a continual natural surveillance into and out of the Park throughout the day. The commercial zone at the southern tip of the Park provides continual activity around the first entrance if the park. A group of small medical practices and the proposed health facility provide continual activities and surveillance at the second entrance into the Park. The facilities near these entrances guarantee activity and vitality.
Figure 119. Facilities located on the western edge of the Park have a front, SC Bypass 225, and back door, DNA Parkway.

In the Park past the normal hours of the Park's research facilities. Plus, sport fields and bike paths in the Park will be utilized throughout the year by both the staff and community. Sport fields and bike paths in the Park will be utilized throughout the week by both the staff and community.

The Park is bordered on two sides by two main Greenwood thoroughfares - SC Bypass 225 and West Alexander Street Extension. These two streets will provide ease of access to and from the Park to staff, visitors, and delivery personnel. Lots on the western edge of the Park can be accessed from SC Bypass 225 and DNA Parkway, giving the lots a front and back door. With an established bike trail running alongside DNA Parkway, the Park allows those living nearby, who are healthy and environmentally conscience, to ride their bikes to facilities in the Park. For research enterprises requiring a higher form of delivery, these facilities can tap into the existing railroad infrastructure in the Park, allowing for delivery of bulkier materials and equipment.

In conclusion, this master plan creates a secure neighborhood of research facilities in Greenwood Genetics Park with natural amenities for the staff and public. Other facilities on the site provide activities to ensure that the Park will be active throughout the week. Within the establishment of the master plan, a project site was selected with ease of access, a front and back door, and scarce water feature. The ease of access is beneficial to delivery systems and visitors coming
to the proposed facility. The front and back door to the facility would aid in respecting and protecting the privacy of the patients and researchers of the facility. The pond will provide staff a distinctive natural setting for respite. The chosen lot is the only lot on the western side of the Park with a water feature.
Figure 121. The layout of the initial parti is based upon arranging the three components of the facility from public to semi-private to private areas while taking advantage of the public and private thoroughfares flanking the eastern and western edges of the site.

The Resultant Building Form

The second area examined is the architectural proposal for the GSC Therapeutic Genomics research facility. The building form is a result of diagrammatic refinements and multiple cycles of form testing through study models and drawings. The form and layout of the final product is based upon the characteristics and constraints of the sight, the physical relationships between the various components of the facility, design principles, and the spatial requirements of the building program.

The parti is based upon a major characteristic of the site - a public entrance, SC Bypass 225 and private entrance, DNA Parkway. The three main programmatic components of the facility - clinic/resource center, diagnostic center, and research center - reflect the need to have public, semi-private and private sectors into the facility. The clinic and resource center is the most visible component of the facility, so it should be located closest to the eastern public edge of the site. The public and patients will go to the clinic to have their genetic concerns addressed by a genetic specialist or seek reference material at the resource center. Couriers delivering testing samples to the facility will do so through this public entrance into the facility, requiring the clinic to receive these test samples and distribute them to other areas of the facility accordingly.

Sandwiched between the clinic/resource center and research center is the diagnostic center. The diagnostic center works with both the clinic/resource center and the research center. It
processes genetic tests received and extracted by the clinic and at times will help educate the public at the clinic’s resource center in regards to genetic testing and research at the clinic’s resource center. The diagnostic center will also work hand in hand with the research center to develop and refine genetic tests and testing procedures.

The prospect of developing financially lucrative tests and important discoveries, require the research center to be located in a secure area on the site. The research center will need to protect its findings and experiments from prying individuals. Its experiments and procedures might be controversial to the public, so they will need to be secluded from the public. So as not to disturb the public, it will be best for researchers and the public to not cross paths, requiring the resource center to have a separate entrance into the site.

These three components are linked by a main circulation spine or atrium. The spine not only acts as a connector device, but a divider between served and servant spaces for the diagnostic and research centers. Servant spaces such as restrooms, changing rooms, clean/soiled rooms, elevators, and stairwells are located across from the servant spaces, laboratories and work areas. In the initial parti, only two entrances in the building were represented, however additional entrances were required given the building size, large number of staff, and delivery.
needs. In the final resolution, there are four separate entrances into the building - clinic, diagnostic, atrium, and supply delivery.

The staff and supply delivery access to the facility is on the eastern side of the site along DNA Parkway, the main access into the Greenwood Genetics Park. The employee parking lot is off this major thoroughfare and is an exterior room that is located in a grove of trees, mimicking the natural setting of the area. The natural canopy created by the groves of trees provides shading to the parking lot, bringing a sense of intimacy for impromptu staff interaction in the parking lot.

**Gradients of Intimacy.** It is the position of this thesis that buildings should provide gradients of intimacy for its occupants. These gradients are associated through different sized restricted and unrestricted spaces throughout the building and are illustrated from a security standpoint in the research wing of the facility. This wing is comprised of security access points that separate the main corridor from secondary corridors, and distinct thresholds, that restrict access into the laboratory floor.

The research center’s components are laid out to create a sequence of public to private spaces in order to create a secure and private area for research work. Controlled access points
Figure 126. Primary access point separating a public corridor to a semi-private secondary corridor.

Figure 127. Meeting alcove adjacent to laboratory work area.

separate the main corridor - a public area - to a secondary corridor, a semi-private area. These access points require one to verify his identity through key codes and biometric means.

An additional access point separates the secondary corridor via a controlled threshold, from the laboratory work area, a private area. Biometric and key coded locks are housed in load bearing walls separating the laboratory and the secondary corridor. Since the secondary corridor is open to and overlooks the atrium, ambient noise from activities in the atrium could disturb those working in the laboratory. Therefore the thick load bearing wall will help block exterior noise from infiltrating into the laboratory.

The laboratory is a large interior space that is over 8,000 square feet. It is unobstructed by columns and does not lend itself to semi-private or private communications or interactions. However these types of activities can be achieved by providing intimate sitting areas, such as meeting alcoves, adjacent to the laboratories. These meeting alcoves can provide a semi-private area for those working inside the laboratory to converse and interact with others with minimal disturbance to others working in the laboratory. With a table for four and a bench course along three sides of the alcove, the alcove can accommodate various sized groups. The large window against the exterior wall of the alcove provides therapeutic views to the exterior and mental respite and distractions from the day-to-day workings of the laboratory. Since these
alcoves are next to the lab work area, those working in the lab do not have to go far or exit the lab in order to find a place for respite.

**Provide views to nature in areas of meeting, pausing, and resting.** The alcoves adjacent to the laboratory work area have views to nature to help reduce stress caused by the demands associated with research and provide visual connections to activities beyond their working environment. The views in these alcoves are oriented to the natural aspects of the research park, encouraging staff to use its natural amenities such as ball parks and bike trails. These activities provide stress relief for the staff. Unfortunately these activities can be hindered by inclement weather. Views to nature will allow the staff to make connections with nature even when the weather is unsuitable for outside activities. Clerestories in the laboratories will also provide a connection to nature and exterior natural conditions. These views to nature will also be beneficial to the eyesight of lab technicians and researchers, for the extended viewing depth of these views will help relieve eye strain.

Views to nature are also provided in corridors and stairwells where the staff is likely to run into each other, pause and communicate with one another. The natural lighting in these areas will change the ambiance of these spaces throughout the day. Seating provided in these areas with views of nature encourages those moving and using the corridor or stairwell to stop and pause.
Figure 130. Seating along corridors.
Figure 131. Views to nature in the genetic counselor’s office make the room feel bigger than it actually is.
The bench built into the landings of the laboratory’s interior stairwell change the purpose of the area to more than just a place of movement, but as a place for pausing, meeting and resting.

Views to nature are also provided in the clinic and resource center. Views to nature make genetic counseling offices seem larger than they really are, reducing the likelihood of claustrophobic feelings. This is beneficial when counselors meet with their patients and their patients’ family members. The additional number of bodies in the office might make the room feel a bit small.

Since views to nature will encourage outdoor access and activities, the office has openings to the exterior in case the patients prefer to move their meetings and discussions outside.

Visitors in the waiting area of the clinic will benefit from the views to nature in this area. These views will provide a distraction and visual stimulation for nervous visitors and patients and will give them a large viewable area of the life and activities outside.

Flexible and adaptable spaces. The main purpose of the clinic’s resource center is to provide genetic and health information to address patients’ and visitors’ concerns over genetic research. The resource center is divided into zones, allowing for flexibility to accommodate for both individuals and group usages at the same time. Four computer kiosks along the eastern wall of the resource center allow for individual digital access to medical information while group seating
Movable furnishings gives the clinic's resource center the flexibility and adaptability for large group meetings. Next to these kiosks and along the western wall of the resource center accommodate small groups of visitors. Moveable book cases equipped with castors and other moveable furnishings in the resource center provide flexibility and adaptability to transform the resource center into a sizeable meeting area, giving genetic specialists a venue to address public questions and concerns over health and genetics research to a large group of visitors. The resource center has access to an exterior patio, providing its users an area for respite during their visit.

Separating served and servant spaces provide flexibility and adaptability of the facility. Since technology is always changing genetic tests and procedures, it is imperative that these laboratories remain flexible and adaptable to the center's needs over time. Large trusses spanning the diagnostic and research wings support the lab areas - served areas, creating large unobstructed lab floors much like those of the Salk Institute. This allows the lab floors to be tailored to the changing needs of the occupants. Because the lab floors are sandwiched between the mechanical floors, the labs can be mechanically serviced from above and below with little or no disturbance to the laboratory’s occupants. The height of these large trusses allow for ease of access to the mechanical infrastructure housed within them.

The laboratory trusses are supported by columns and large thick load bearing walls. These thick walls not only separate the laboratory work area from the secondary circulation area, but
house and display computing and information technologies such as blade servers. These technologies manage, distribute, and protect the center’s information. Typically these servers are located in small hidden climate controlled rooms, however it is the position of this thesis that since information is the new representation of wealth and research prowess, information technology should be celebrated and displayed. Managing, updating, and protecting these technologies are vital to GSC’s longevity. This is inherent in the location and placement of the center’s computing and information technologies equipment which allow for flexibility and adaptability to new and changing technologies. The location of this equipment allows technicians to service, maintain, and update it with little or no disturbance to the facility’s daily operations. Air conduits embedded in the wall circulate air to cool the equipment.

Flexibility and adaptability is also illustrated in locating communication conduits within elevated floor systems along primary corridors that link together the three main buildings of the facility. Elevated floor systems are also used along the diagnostic and research centers’ secondary corridors to house conduits that deposit and distribute information from the center’s information technology equipment located in the thick load breaking walls. The elevated floor systems are glazed, allowing quick visual access to conduits that need servicing and maintenance.
Figure 138. Communication conduits located within an elevated floor system electronically link the three main buildings of the facility.

Figure 139. Section a-a illustrates how the communication conduits located in the elevated floor system electronically distribute information from the center's information technology equipment located in thick load bearing walls.
The Resultant Virtual Identity - the “Front Door”

The third area examined is the virtual identity - or website - for GSC Therapeutic Genomics (GSC). Even though the virtual world will never take over the physical world, an examination and creation of a successful website is crucial to the success of many physical identities today, for the virtual identity has become the “front door” of many companies, and has become an important factor in marketing and selling of services to the masses. In order for GSC to attract and retain clients and partners beyond the rural area of Greenwood, South Carolina, it will need to create a successful virtual identity. In examination of successful virtual identities, one notices that the design principles used create physical identities can be modified and applied to creating a virtual identity. The resulting forms and layouts of the virtual identity is a result of these principles.

Gradients of Intimacy in the Virtual Realm. Gradients of intimacy in the physical world determine where one can go and what one can do in the physical realm. These gradients can be achieved through architectural devices. In the virtual world, however, gradients of intimacy refer to the amount and quality of information one is privy to and how access to this information is either made apparent or restricted. Access to various kinds of information is determined by software that links one’s virtual identity to that of his physical identity. Biometric software protects personal and private information from criminals and hackers as well as links one’s physical identification to one’s virtual identification.
On GSC’s website, visitors are able to research and look up basic information such as GSC’s clinical and diagnostic services, current research initiatives, genetic information resources, and links to additional genetics and medical website. GSC realizes the importance of public health education and access to general genetic education as being a propellant toward public health and well being as well as public acceptance of genetics research. To address public concerns over genetics research, the company provides visitors to their website an email link to a geneticist, allowing the public to have direct contact with a genetic specialist. Visitors to the website can also view the calendar of health educational programs at the facility and sign up online to attend the programs in person or virtually.

Access to additional information requires users to be registered with the company via a physician or through previous services with the facility. Users of the website will have to prove their identities by entering their user name or account number and a biometric scan of one of their fingers. Biometric software will determine if the fingerprint matches on record with those associated to these user names or account numbers. If there is a match, the software will determine who the user is (such as genetic counselor, researcher, lab technician, or client) and what information he is privy to. For example, clients will only be able to access their own personal information such past and present test results, billing information, account balances, personal contact information, and past and present emails to and from their counselor. Clients
can also have communication with their GSC counselor via email or teleconference through the website.

Depending on one’s position at the company, employees of the company will have various access to information via the website. For example genetic counselors will be able to access information solely pertinent to their position like patient records. Access to such records would be restricted to only them and their patients.

Online security will be integral to the level of communication and interaction people have in the virtual world. People will be more reluctant in discussing personal and private matters when they know that their connection is encrypted and secure. The clients of GSC will need some verification that their connection is secure before communicating virtually with their genetic counselors. To let their user’s know that their connection to GSC is secure, a padlock image and the words “encrypted connection” below the padlock will appear when a secure connection is established.

**Customization and Personalization in the Virtual World.** One’s individuality extends beyond that of the physical realm. This can be seen through personal web pages on websites like myspace.com. In light of this, GSC clients will be able to customize their personal log pages on
Figure 144. Registered users to GSC’s website can customize their log in pages by selecting and changing background images for these pages.
GSC's website. They can choose different color schemes and background images for their pages from a chosen list of colors and images. Or they can upload a personal image as their background image.

Clients will also have the privilege to choose their own personal chat name which will appear next to their chat dialogue in the chat room dialogue box.

For GSC's virtual identity to be successful, the website will need to meet the virtual needs of their clients. In order to do so, GSC will need to know what these needs are. Users can always address these needs through the “ask a geneticist” email link or go to the home page to look up contact information to the company.
Conclusions

Though virtual connections are gaining importance in the way people work, interact and communicate with one another, traditional physical connections will be more cherished through the creation of architectural settings and venues for highly sensorial and synchronous communications and interactions associated with physical connections. Many might believe that the virtual world and its connections are diminishing the importance of the physical and natural world around us. However, this thesis and architectural proposal disagrees, for virtual connectivity is allowing us to re-think where and how we live and work. With a virtual front door, businesses need not be located in a high-rent populated area in order to survive. It can now be located in a rural area, reaping and forwarding the benefits of their location to its employees.

Part of the resolution to this thesis involves the creation of a physical genetic research identity in a rural area of SC through the master plan of a genetic research park. Though the physical identity and the rural location of this research park might not be pertinent to the virtual clients of some of the businesses in this research park, the physical identity and rural location is pertinent to the workers and those living within the vicinity of it. Workers are able to take advantage of the rural settings, and those nearby benefit from the specialized medical services, services typically found in metropolitan areas. Many other businesses and services can also do the same and locate themselves in rural areas instead of metropolitan areas, bringing their services to
rural areas lacking these services. Those interested in living in metropolitan areas to take advantage of such services can now have the option of moving to rural areas for these specialized services. To further attract these individuals to rural areas, architectural spaces need to be designed to take advantage of the natural elements and benefits associated with rural settings.

Though the physical world will still prevail and there will always be a need for physical interaction and communication, architecture must address the virtual world's needs by providing a suitable infrastructure that allows the physical world to adopt to the ever-changing telecommunication and information technologies associated with the virtual world. Much like mechanical, electrical and plumbing systems in a building, these technologies are interlaced in a building and should have their own dedicated spaces and areas. However, unlike these traditional building systems, these technologies are ever-changing and advancing, requiring room to grow and change to meet the users' needs. Spaces and areas housing these technologies need to be easily accessible for servicing and upgrading of these technologies. Over designing architectural spaces to allow for telecommunication growth and servicing is imperative to the longevity of architecturally inhabited spaces. The architectural resolution outlines this, for spaces housing these technologies around the laboratories are over designed and can easily be accessed, allowing for communication technologies to be upgraded and serviced per the occupants' changing telecommunication needs with little or no disturbance to the occupants' day to day operations.
The intent of this thesis was to address and provide an architectural resolution to these issues in relations to a comprehensive genetics research center located in a rural area. Architectural spaces were designed for formal and informal interactions and communications between the staff of this facility in areas both typically and not typically associated for these interactions. Alcoves are strategically designed and placed adjacent to working areas such as the laboratories. Seated areas for interactions and communications were placed in areas typically associated for egress such as stairs and corridors. To further enhance these spaces, views and physical connections to nature were provided to accentuate these spaces and encourage respite, interaction and communication in these spaces in hopes of reducing the staffs' stress, improve their productivity, and give them visual relief. These spaces give the occupants an area for interaction that is generally not associated with the normal and mundane interactions associated with their work spaces. Architectural spaces were arranged in public to semi-private to private sequences to protect and secure intimate interactions and communications. Public areas such as waiting areas are located adjacent to the resource center, a semi-private area, which in turn was adjacent to genetic counselors' offices, enclosed discreet private rooms. This arrangement aims to protect private interactions between counselors and patients in hopes of advocating and enhancing the caregiver-patient relationship.
Flexible and adaptable architectural spaces such as the resource center and atrium allow for small to large gatherings in the facility. Moveable furnishings allow the resource center to be used for large gatherings as well as individual and group use. The large atrium can support various sized functions, allowing the facility to open its doors and hold public events for the surrounding area in hopes of calming fears and addressing issues and questions the public has in relation to genetics research.

Other architectural spaces designed for flexibility and adaptability are the laboratories. Mechanical and technology infrastructure was designed around these spaces. Interstitial spaces between the laboratory floors house mechanical units, allowing the laboratory to be reconfigured to the needs of the researchers. Laboratory equipment can easily be moved and plug into mechanical outlets above and below the lab floors and ceilings. Thick load bearing walls adjacent to the laboratories do not only provide security to these areas but also house an information technology infrastructure. These walls provide ease of access to these technologies allowing for service and maintenance of these technologies with little or no disturbance to the inner workings of the laboratories. This flexibility and adaptability of these architectural spaces allow researchers to not only change their laboratory setup to reflect their needs but also allow information and date to be continually exchanged and shared via virtual means. The flexible and adaptable qualities of the architectural spaces will increase the usage longevity of the facility.
Since the facility is located in a rural area, a website was developed to allow for those from afar to connect, purchase services, communicate and interact with those at the facility. The website is also a communication bridge for genetic professionals at the facility to other genetic professionals. History has shown us that as telecommunication technology advances, the more information will be pumped into the virtual world, translating the physical world into the virtual and requiring the technological infrastructure of the built environment to upgrade to higher forms of technology. The flexibility and adaptability of the architectural resolution will allow for continual technological upgrades and allow for architectural spaces to be re-examined and re-designed to meet future technological challenges.
Figure 148. Final site plan, east elevation, clinic south (entrance) elvation, and perspective view of clinic entrance.
Figure 149. Clinic floor plan, clinic interior and exterior views, and clinic north elevation.
Figure 150. North elevation, section a-a, lab building floor breakdown, and facility views.
Figure 151. Facility breakdown by grouping, diagnostic building 1 floor plan, interior laboratory views of diagnostic building 1, and facility south elevation.
Figure 152. Ground floor plan of diagnostic building 1 and research center, third floor plan of diagnostic building 1, interior view of atrium, and exterior view of main courtyard.
Figure 153. Pane 6a - security access alcove and walkway outside of research lab.
Figure 154. Pane 6b - server wall and walkway and courtyard.
Figure 155. Third floor plan of research center, interior lab views, views of meeting alcove, exterior view of research center, and east elevation of research center.
Figure 156. Building model - top view.
Figure 157. Building model - southwest view.
Figure 158. Building model - view from SC Bypass 255 of exterior digital wall adjacent to clinic.
Figure 159. Building model - view of diagnostic building 1, atrium, and research center.
Figure 160. Exterior view of laboratory from atrium.

Figure 161. Section of laboratory floors and mechanical area.

Figure 162. Detail model of server wall between the laboratory and walkways overlooking the atrium.
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