Dr. WHO?: The Science and Culture of Medical Wear Design

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DR. WHO?
The Science and Culture of Medical Wear Design
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Dr. WHO?: The Science and Culture of Medical Wear Design

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts at Virginia Commonwealth University

by Patricia Duignan

Thomas Modeen
Acting Director, MFA Design Studies
Thank you to all the wonderful people who helped me along this path.

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The multi-million-dollar medical uniform industry has not utilized advancements in garment and textile technology that could positively impact the protection of healthcare professionals and patients. In most cases, the uniforms meet basic requirements – they clothe the professional in a recognizable way. Little innovation in design, function, and performance, has been applied to these garments. This is particularly evident in the case of the stereotypical white lab coat worn by many physicians, despite evidence indicating that these lab coats may carry contamination and play a role in the spread of deadly bacteria. Healthcare Associated Infections (HAIs) are among the most serious problems facing modern medical care, costing millions of lives and dollars annually worldwide. This research investigates the design and use of the physician’s lab coat – an immediately recognizable symbol of Western medicine. The research identifies the medical, functional, cultural, and symbolic roles of the lab coat within the hospital environment and beyond, to the larger the global society. This thesis examines the extent to which the design of medical wear can impact the effect of hospital-acquired infections, support doctor/patient relationships, and enhance the performance and behavior of the healthcare professional by envisioning a future lab coat which offers increased protection for physician and patient, aids in communication, and enhances the performance of the doctor by utilizing digital technologies incorporated into the lab coat whereby the lab coat becomes the only tool necessary for the physician.

ABSTRACT

The multi-million-dollar medical uniform industry has not utilized advancements in garment and textile technology that could positively impact the protection of healthcare professionals and patients. In most cases, the uniforms meet basic requirements – they clothe the professional in a recognizable way. Little innovation in design, function, and performance, has been applied to these garments. This is particularly evident in the case of the stereotypical white lab coat worn by many physicians, despite evidence indicating that these lab coats may carry contamination and play a role in the spread of deadly bacteria. Healthcare Associated Infections (HAIs) are among the most serious problems facing modern medical care, costing millions of lives and dollars annually worldwide. This research investigates the design and use of the physician’s lab coat – an immediately recognizable symbol of Western medicine. The research identifies the medical, functional, cultural, and symbolic roles of the lab coat within the hospital environment and beyond, to the larger the global society. This thesis examines the extent to which the design of medical wear can impact the effect of hospital-acquired infections, support doctor/patient relationships, and enhance the performance and behavior of the healthcare professional by envisioning a future lab coat which offers increased protection for physician and patient, aids in communication, and enhances the performance of the doctor by utilizing digital technologies incorporated into the lab coat whereby the lab coat becomes the only tool necessary for the physician.
As principal investigator of a large-scale project to design the clinical wear uniforms for the new Sidra Medical and Research Center in Qatar, I discovered that the field of medical uniforms is characterized by a lack of innovation almost unheard of in the fashion industry. Much of the literature on medical uniforms focuses on the policies, symbolism of uniforms and on standards authorities and the medical profession. In contrast, the research carried out by uniform manufacturers is lacking, and what design-based research there is, has typically been developed with only minimal input from the people who will wear the end product. Within the design industry, professional garments such as medical uniforms are designed to accommodate the existing manufacturing capabilities of the producer, which can limit a critical design approach and innovation. One consequence of this is the lack of focus on garment performance, resulting in a classic fashion approach offering seasonal product updates that have minimal aesthetic variations, typically changes only in color and simple styling details. Manufacturers tend to stick to tried and tested fabrics, working with the same materials and textile makers who produce cloth consistently year after year. Having served both as an in-house fashion designer at a garment manufacturer and as a client, I am aware of the commercial limitations placed on designers. In the commercial world garment cost is the bottom line, and if a design threatens profits it is typically either disregarded or is stripped of its expensive components to achieve the price target. Price targets are dictated by previous selling prices and competitor prices. All of these factors combine to create a heavily standardized market of commercial designs. The aim of this research is to creatively investigate design options for a medical uniform, in this case the physician’s lab coat, and develop a conceptual prototype that will break free of the bonds of market standardization to present a garment that is designed to assist physicians in carrying out all aspects of their role. Data for this research was collected through a triangulation of personal observation, interview and document review with informants medical professionals, administrators, textile engineers and garment manufacturers.
BACKGROUND

The physician’s lab coat and clothing has been the subject of much debate. The “bare below the elbow policy” (BBE) was introduced by the UK’s Department of Health in 2007 to tackle nosocomial infection, and banned the wearing of wristwatches, neckties, and long sleeves for clinicians. However, the same research found that physicians’ neckties are worn repeatedly and rarely cleaned; making them the perfect substrate to carry bacteria from patient to patient as physicians go about their rounds. Wristwatches, moreover, are susceptible to contamination for the same reasons. In addition, long sleeves were deemed a hindrance to the vital exercise of hand washing. However, C. A. Willis-Owen, et al carried out research in 2009 to examine the effect of the policy on the presence of bacteria on doctors’ hands and concluded that there was no significant difference between the presence of bacteria on the hands of the doctors who were compliant with the policy and those who were not. However, other research has found that what doctors’ wear has an important psychological effect on patients. Subramanian, et al, demonstrated that patients perceive the BBE-compliant uniforms as unhygienic; thus, the patients’ confidence in the doctor may be undermined. What doctors wear can influence a patient’s perception of the clinician, which in turn may influence whether patients follow a doctor’s advice. Format attire has been shown to instill greater confidence and trust in patients. Questions have arisen as to whether a doctor’s clothing can impact the patients’ decision to attend follow-up consultations and consume medicine as prescribed. However, C. A. Willis-Owen, et al, argue that the findings, which led to the legislation are flawed and they recommended that more critical research be done, including an examination of the uniforms and textiles as a source of contamination.

The popularity of the white lab coat has actually decreased significantly since its adoption in the early 1900s. In 1991, studies in the United States indicated that more than 70% of hospital doctors and medical students wore a white coat more than 75% of the time. More recently a 2004 study indicated a large reduction in the number of physicians who choose to wear a white coat at only 13% of the physicians in the study. The studies indicate that the main reasons for this change included infection risk, discomfort, and interference in the physician-patient relationship. In 1991, 294 medical students and physicians in London were asked to explain why they wear the lab coat on the basis of personal priorities. The responses of 25% of respondents stated easy recognition by colleagues and patients followed by 23% stating the need to carry medical instruments, and 15% stated to keep their clothes underneath clean. However, when assessing the results, it is important to note that only 25% of the study population actually wore the white lab coat (92% of the doctors were working in pediatrics and psychiatry). Reasons for not wearing the coat included avoiding a negative impact on patients. Interestingly, research suggests that even with the decline of popularity in wearing the white coat among physicians, it is still desired by many patients. In another study, 56% of patients favored doctors wearing white lab coats. Similar results were obtained during a study of 168 patients from three teaching family medicine clinics in Israel, in which 52% of the patients preferred a physician in a white lab coat because it signaled a trustworthy profession. It is evident that there are inconsistent theories for or against the use of the lab coat, it is clear that there are personal and professional preferences which influence the decision making however if a lab coat is worn, it should function in ways that support both the doctor and patient, offering protection, comfort, and reassurance to both parties.

DESIGN PROCESS

A system such as the medical garment industry has a long and conventional history including multiple stakeholders. The complexity of this system requires cognizance of many disparate perspectives and agendas when approaching the design of a product such as the physician’s lab coat because the garment is a symbol of this system and is therefore deeply embedded in history and meanings determined by the system. In order to work my way through this contextually I used a mind map to arrive at three main topics for exploration and development. In this research I used design thinking to gain a deeper understanding of the subject matter in order to investigate the design of the medical uniform. More specifically, I analyzed problems related to the current uniform and examined the background and history of the physician’s uniform to identify common dominators and factors to be addressed in the redesign of the lab coat.

In this research I used design thinking to gain a deeper understanding of the subject matter in order to investigate the design of the medical uniform. More specifically, I analyzed problems related to the current uniform and examined the background and history of the physician’s uniform to identify common dominators and factors to be addressed in the redesign of the lab coat.

Main Topics of Investigation

- Symbolism
  - meanings and definitions communicated by the product
- Product
  - physicality of the garment
- User
  - physicians
- Hospital
  - systems

Figure 1: Mind map of lab coat stakeholders, VOQGaler, Al Ruayan, Galer (2014)
A question that continually arose as I began to understand more about the role of the doctor’s uniform was: how much change could I make to the lab coat without eroding its benefits to physicians, patients and society as a whole in terms of its status as an internationally recognized symbol? This led me to question why and how the lab coat has become one of the most recognized symbols of medical doctors? I realized that I needed to examine my subject matter in terms that reached beyond materiality to understand the uniform from a more holistic perspective.

The impact of clinical wear symbolism is readily apparent in the physician-patient interaction. The physician-patient relationship is the foundation for all medical care. Research suggests that a patient’s initial consultation plays a fundamental role in the development of this relationship. During this consultation, the patient will develop a first impression of the physician based on a number of factors including the physician’s verbal and non-verbal communication as well as personal attributes such as clothing, accessories, grooming, and cleanliness. As far back as the 400s BC, the ancient Greek physician Hippocrates recommended that doctors should “be clean in person, well dressed, and scented with sweet smelling agents.” Hippocrates’s prescription suggests that how a doctor looks (and smells) has been important at least since the dawn of Occidental medicine.

D. W. Cathwell, MD, wrote the first edition of The Physician Himself, a book to guide doctors in all aspects of their role as physicians entering the medical profession. The first edition of the book was written in 1882 and revised with multiple editions published between 1882 and 1922. Cathwell advised, “Shoe aesthetic cultivation in your office arrangement, and make it look fresh, neat, clean and scientific.” Even at the earliest understanding of the doctor’s profession, it was clear that not only were the physician’s physical appearance and attire important, but also the state of his/her surroundings, each shaping social interaction in a distinctive manner. Multiple factors influence patients’ perception, which promote a relationship of trust between doctor and patient.

The color white has not always been the obvious choice for the lab coat. In fact, doctors didn’t even wear lab coats in the 19th century. The doctor’s dress at that time consisted of formal attire for all clinical activity, including surgery. Doctors attended the sick in their homes, not in an institution. During this period, there was no understanding of the concept of bacteria and its role in the spread of infection. Doctors’ status, as it is today, did not exist prior to the 19th century, when doctors were mostly indistinguishable from other types of healers with their various forms of rituals and dress. To become a doctor was relatively easy; a medical degree could be obtained in a year. Scientists in laboratories wore tan colored lab coats to make dust more visible, and black lab coats were worn in mortuaries as a garment to protect the weaver from various forms of dirt and bodily fluids encountered during certain procedures. It is believed black was used in recognition of the somber nature of the work carried out. Louis Pasteur, the French chemist and microbiologist, proved the germ theory in the mid-1800s, which led Joseph Lister to develop antiseptic methods in surgery, a major scientific development that revolutionized medical care. The white lab coat was introduced into the operating theater to protect the patient from being contaminated by the physician and to protect the physician from being contaminated by the patient while surgery was being performed. Following the discovery and proof of germ theory, a major force in adopting the white coat, which has since become synonymous with the medical profession, was the shift in sick care from home to hospital. This occurred because it became too difficult to create a sterile environment outside the hospital and was impractical to bring the necessary equipment into peoples’ homes. Therefore, hospitals began to adopt the color white for all uniforms related to healing during the early 1900s. During this period, medical schools also adopted a more rigorous and standardized curriculum and physicians became scientific in their practice and dress.
DEVELOPMENT OF HISTORICAL SYMBOLISM

Just as the social function of the physician has evolved over the past century, so has the lab coat. The color white commonly symbolizes cleanliness, purity, and the scientific foundation of the medical profession. Science, with its ability to defy common beliefs and advance the world in ways not previously seen or thought of, became the basis of the medical profession at the turn of the 20th century when the benefits of sanitation and clean water were recognized in conjunction with the introduction of the antiseptic theory.

Dr. Byrad Yyelland, sociologist and Assistant Professor at VCUQatar, explained that a uniform acts on a number of levels. The existence of a uniform implies a group structure. The uniform indicates membership in the group, which represents and embodies the attributes of an organization. The white lab coat therefore acts as a symbol. Admission to a group can be symbolically recognized during ceremonies when the uniform and its accessories are presented to the newly qualified professional. In many professions, these symbols are recognized as an admission to a group, a sign of having proved worthiness to enter the group or rank that goes with the uniform for example the nurse’s pin, the policeman’s shield, army stripes, soldier’s honorary medals, academic robes and lawyer’s wigs. Rituals include the graduation ceremony, which formally acknowledges admission into an elite group and acceptance of what the group stands for. More than 100 medical schools in the US mark the transition from medical student to a qualified physician by holding a white coat ceremony (WCC), a ritual signifying the right of passage into the medical profession. D. W. Blumahagen and others have identified cultural symbols as a form of communication, analogues to spoken words in a natural language. In fact, words are symbols. The word “chair” is not a chair, it is a symbol used to represent a chair during communication. Symbols are developed in congruence with the definitions and meanings held by a social group whether it be a small...
clique or a larger society. As such, symbols express and reaffirm the fundamental belief systems of that group. The white lab coat is symbolically associated with the definition of physician in Western-based medicine and, in fact, is the most frequently used object when representing a physician in a variety of media including advertising and film.

Dr. Ygliband explained that in dramaturgical sociology, one could consider the elements of human interactions as dependent upon time, place, and audience. In the same way language is used in a social setting to define a shared interpretation of reality, the uniform assists the wearer in an actor-like fashion to be seen as a character playing a role and therefore behaving in pre-determined and scripted ways. Symbols such as uniforms also enable others in the society (audience) to understand what they can expect from the actor in that role. In other words, seeing someone wearing a white lab coat in medical setting signals to us that this person is a medical professional, likely a physician, and we can expect certain types of behaviors from that person. In this social drama, the uniform or costume can also express hierarchical relationships amongst the individuals who are interacting. But why have these symbols relating to doctors become so prevalent and powerful?

Symbols are social objects used to represent (or “stand in for,” “take the place of”) whatever people agree they shall represent; holding two fingers in the air stands for victory (or peace, or loyalty to the

Bay Scouts). Symbols are tools for expressing and reaffirming fundamental belief systems of a society. Studies have examined symbols commonly deployed to represent the doctor and have identified four defining objects: the white lab coat, stethoscope, head mirror and black bag. Of all the symbols identified, the white lab coat was found in use most frequently. Importance of the white lab coat as symbol par excellence of doctors can be seen in a variety of media including advertising and film, which often reflect social stereotypes. As far back as the early 1900’s the emerging film industry began to represent physicians as characters of immense power. The doctors eventually achieved a god-like social status as a result of the surgeon’s power to anesthetize the patient and carry out procedures that in any other circumstances would be deemed as violating the body. With this, a message of power and protection emerged and physicians quickly became stereotyped as scientists wearing white coats.

The trend continued on in the 90’s, George Clooney became one of the most popular and recognized actors due to his role as a physician in the popular U.S. medical drama ER. Scrubs and House are two other current popular television series that are aired internationally and portray doctors as central characters. Physician’s characters in television series are usually portrayed wearing a white lab coat worn over their clothes underneath. See Figure 5 and 8

Figure 7 - Ellen Pompeo, TV series Grey’s Anatomy

Figure 8 - Doctor Characters, TV series Grey’s Anatomy
So why is it so important that the doctor be recognized as such by his or her patients? In the article, “The doctor’s white coat,” D. W. Blumahagen explains that the relationship between patient and doctor is “serious and purposeful, not social, casual or random.” A patient must bare himself or herself in front of a doctor in a deeply vulnerable way. This type of situation does not exist in any other form of communication or experience. In many disciplines formal attire is worn for serious business in the same way casual attire is often worn for less serious business or leisure time.

J. P. Kriss, a physician and educator, articulated the need for appropriate physician’ attire in the article “On White Coats and Other Matters”, explaining, “The physician’s dress should convey to even his most anxious patient a sense of seriousness and purpose that helps to provide reassurance and confidence that his or her complaints will be dealt with competently.” Confidence in one’s physician is crucial because the medical process requires patients to share intimate knowledge about themselves in order to receive treatment. This process can also require the patient to bare all or part of the body to the physician and allow the physician to observe, touch, and even cut into the patient’s physical self, all of which are intensely intimate acts. On the other hand, the physician is required to ask questions about intimate topics, observe parts or all of the patient’s body and perform medical procedures upon the patient’s body. All of these acts are profoundly intimate at a physical level, yet must occur while maintaining an emotional distance. This inherently contradictory relationship places both parties into some degree of vulnerability, enhancing the need for a strong feeling of trust.

Merry’s research has highlighted the impact of the white lab coat in terms of patient perception and signification of the lab coat and the reasons for the doctor’s attire, with the lab coat tending to occupy the focus of much discourse. The current lab coat offer in the market is lacking in a number of areas including aesthetic, performance and functionality. There is a significant difference of opinion surrounding the discussion of the physician’s physical appearance. It has been shown that patients may unconsciously evaluate the doctor’s competency and credibility on the basis of how the physician’s physical appearance. A study of parents of children admitted to a pediatric ward of a university teaching hospital in America discovered that they were twice as likely to attribute confidence to doctors in formal clothing compared to doctors in casual dress. In a similar study, 76.3% of the 400 respondents said they preferred the use of a white lab coat. Interestingly, patient trust and confidence were significantly linked to their preference for professional dress. On this very point, Dr. Guy Bisieux, Chief of Pediatrics in St. John Hospital in Qatar reflected on his time teaching trainee doctors and remarked that sometimes they would arrive to class wearing casual jeans and t-shirts. He considered this as inappropriate attire and he felt offending students home to change into more professional clothing that more aptly projected the doctor’s professional image. However, research has also highlighted that there are discrepancies between patients’ perception and signification of the lab coat and the reasons doctors choose to wear or not wear one. Many culturally progressive Western psychiatrists and pediatric doctors, tend not to wear the lab coat, reporting that it inhibits the relationship between patient and doctor because it may intimidate the patient. In this context, doctors often choose to wear pastel coats or normal clothing. Another factor in patient preference for formal attire is age. In a study to assess patients’ preferences, patients over the age of 40 preferred doctors’ formal attire, whereas younger patients were less concerned. Interestingly, the preference for more conservative apparel is age-related for doctors as well as patients. Doctors in more senior positions and over the age of 40 prefer more conservative, traditional dress. However, this trend is a predictable reflection of the normal behavioral shift associated with ageing rather than the specific phenomenon related to the doctors’ appearance. Some studies show that patients actually felt more relaxed where the appearance of physicians than the physicians themselves.

There is a significant difference of opinion surrounding the discussion of the doctor’s attire, with the lab coat tending to occupy the focus of much discourse. The current lab coat offer in the market is lacking in a number of areas including aesthetic, performance and functionality. This inherently contradictory relationship places both parties into some degree of vulnerability, enhancing the need for a strong feeling of trust.

However, as my research strongly suggests, the white lab coat has become a powerful and pervasive symbol of trust in society in general and the medical profession in particular. To further my understanding of trust, I staged a scenario to observe trust in action during my studio class. Intentionally, I avoided grounded theories relating to trust in terms of risk versus gain and the relationship between the principal and the agent. I wanted to examine trust in a new state, in its most basic and primitive form in order to visualize the feeling. The situation needed to be one in which the risk was not too high but also gave me the opportunity to see how the participants would assess risk in a particular situation. There are particular conditions needed for trust to exist.
After brainstorming a number of ideas, I decided upon the classic trust fall that is commonly used as an exercise in team building. Research confirmed that many of the conditions that promote trust include familiarity, understanding, recognition, repetition, and knowledge. In short, people trust what they know. With this in mind, my intention was to engineer a scenario in a way that could eliminate some of the conditions associated with trust as part of the experiment so that I could examine the situation and further understand the human condition in relation to trust.

I designed the scenario in detail with the subjects’ positions clearly marked, cameras poised, and a practice run conducted with Hadeer Omar, a graphic designer who kindly assisted me in setting up, editing the video, and being a volunteer herself. See Figure 14.

Criteria:
- No Instruction
- No Demonstration
- No Discussion
- No Familiarity
- No Prior Knowledge
- No Repetition
I chose seven volunteers, all of whom were female VCUQatar students who wear the Abaya (a black piece of clothing that is commonly worn to hide the clothing underneath). See Figure 19-20. This choice was made to include volunteers of the same sex, of similar status, religious and cultural values. Mixing the sexes in an exercise such as this would not have been appropriate within the Islamic culture. Some of the volunteers already knew each other. In fact, recruiting the volunteers worked better when the two (catcher and faller) were recruited together. This confirmed research that indicates familiarity could promote a sense of trust. Knowing the person who was catching you indeed helped in easing the anxiety of the fall. One volunteer pointedly remarked how she was glad she knew her catcher. In the case of a physician meeting a patient for the first time there is no prior knowledge and makes it even more important that the appropriate conditions exist that help support trust in the relationship including what the physician is wearing.

To capture specific angles and details on camera including facial expressions, gestures and actions, some instruction was required. On the one hand, I had to direct the couple, and on the other, the couple needed to interact naturally by asking questions and discussing things between themselves about how the action would play out and what each would do as part of the act. This interaction also confirmed the theory that having information regarding the situation helps to promote trust amongst participants. It had been my intention to shoot one continuous scene for each couple, but due to the variety of camera shots required, in reality we shot two to three times to get enough footage. Originally, I felt this would make the video look contrived and inauthentic, resulting in the scenario looking rehearsed, but in fact it actually displayed the importance of repetition, one of the main characteristics involved in forming trust. It was clear from talking to the participants that they felt more comfortable assuming the risk with each additional fall. This is evident in the facial expressions of the participants. Another interesting aspect I had not considered was the emotions of the catcher. One volunteer stated she felt far more nervous catching somebody due to the responsibility she felt to the other person, feeling less nervous when she was actually doing the fall herself. See Figure 20. This demonstrates the concept of responsibility and the feelings associated with it are very powerful.

The outcome of the experiment provided first hand knowledge of trust but also insight into the relationship between two people. The scenario, in a way, metaphorically represents the doctor-patient relationship, where the patient trusts the doctor by literally putting themselves in their hands. It begs the question that if the lab coat is used as a symbol to represent trustworthiness, and in so doing acts as a tool to facilitate and reinforce the relationship between patient and doctor, how much can the design be altered and still represent its symbolic meaning or is there something else that can act in the same way?
PRODUCT PRECEDENTS
**INVESTIGATION II**

The classic medical lab coat has existed for over 100 years and has changed very little during that time. The garment appears almost exactly the same as it did when it was first introduced to the medical field in the early 1800s. Many professionals in the clinical setting wear a white lab coat, including nurses, lab technicians, and educators. The coats look very similar, the length being the only significant change. The doctor’s lab coat consists of a number of common features. The color is always white it is usually mid-thigh to knee in length. Student doctors in the USA wear a short coat akin to a blazer. Aesthetically, the silhouette of the garment is similar to the classic tailored, men’s blazer or overcoat. The shape of the collar is a revere in style, which is also synonymous with a men’s formal overcoat or blazer. The collar has a two-piece construction, which is folded back on itself to sit along the neck edge, which aesthetically frames the neck. The coat is single breasted. It has a button down front and is fastened using a classic button through method. The mechanism usually consists consisting of five plastic dyed to match buttons sewn to the base cloth in a single line with equal spacing. The edge of the button is placed so that when it is fastened through the buttonhole, the button secures the two fronts together symmetrically, vertically, and horizontally.

The appearance of lab coats for men and women are almost identical; however, when the coat is fashioned for the male, the front closing has a right side over left side fastening whereas the female version has a left over right fastening. This is a systemic and consistent feature in the construction of all garments with front openings, and sometimes this feature is the only method to identify if the garment is intended for the male or female. However, sometimes the lab coats on offer for doctors are unisex in style. In this case the fastening is constructed as the male closing and the fit of the garment is tailored for a male shaped body, which is more cylindrical thus less fitted and less flattering on a female shape. This exaggerates the ill fitting appearance which in turns makes the lab coat look untidy and unflattering.

In general, lab coats share a similar set of traits, including one chest pocket placed on the left hand side as worn, which serves as a pleatherol for a pen and or a hospital identification badge required by all medical staff. This badge is a source of contamination due to its location, and its potential as a source of contamination due to the frequent handling and thus its susceptibility to contamination, each time it is removed and applied to the garment. There are two larger front pockets on the lower part of the garment to allow the wearer to carry equipment or personal belongings. The garment’s construction process is also the same way as it was in the 1800s, the method of cut and sew creating a garment using two (2D) dimensional textiles that are cut into shapes and sewn together to create a three dimensional (3D) form.

Sleeves of the lab coat are constructed in a set in method, long in length with a single underarm seam. The front panels of the garment are attached to the back by vertical center back seams and shoulder seams. The garment sleeves and body are finished with a stitched hem at the bottom edge using an over-lock stitch and single needle stitch or clean finish hem. The coat has a breast pocket on the lower part of the garment, which is added to provide additional ease when walking.

**The classic process to manufacture a lab coat includes a number of steps:**

1. **Base cloth is woven**
2. **Construction patterns are created**
3. **Pattern pieces are laid on the cloth**
4. **Garment panels are cut**
5. **Panels are sewn together to construct the garment and care labels are sewn into the side seams**
6. **The garment is finished, pressed and packed**
7. **Quality assurance checks happen periodically throughout the production process**

**INVESTIGATION III**

I collected visual references of various types of uniforms, to form a visual dictionary. The images articulate meanings through the aesthetic properties of uniforms. Grouping the imagery by profession I began to identify similar physicality’s, including colors, trim, accessories, shape and style, each adding to the meaning and communicating messages about the person wearing the uniform. Using the storyboards I further analyzed and identified various properties of different uniforms that could also be attributed to the doctors’ profession.

![Figure 22](image22.png)

**Figure 22 Visual storyboard of uniforms**

To gain a greater understanding of uniforms and their associated meanings, I researched uniform aesthetics to examine how symbols are used to create understanding and communicate messages. I collated a list of attributes associated with the doctors’ profession to see how these could be physically represented through the uniform.

**Attributes**

Professional, educated, wise, powerful, competent, trustworthy, hygienic, approachable, clinical, authoritative, empathic, responsible, respectful and precise.

Many professions have qualities that can be productively compared with the medical profession, including the military, clergy, pilot, airhostess, police, educators, superheroes and athletes. To visualize the findings,

![Figure 21](image21.png)

**Figure 21 Visual storyboard of uniforms**
The aim of this investigation is to understand if garment details could be used in an abstracted way to portray similar meanings in a different type of garment. To do this I selected a number of details that could be extracted and used as inspiration for an experiment to examine whether design details alone could provide meaning to a garment. Some features were consistent across multiple groups. Rank, position, authority, power and hierarchy, are often represented by gold braid, epaulettes, gold accessories, special pins, badges, multiple stripes, colored tapes, stars, wings, jewelry, elaborate metallic embroideries and hats. Uniform colors predominately consisted of combinations with black or navy or red and white. Other common styling details included stripes, piping, gold accents, bright color pops, body conscious silhouettes, stitching detail, exaggerated seaming, tapes, technological looking fabrics and quilting. These details were consistent, indicating the likelihood of consistent themes within garments for physicians.
The selected styling details are significant commonalities in a variety of uniforms. Taking these details as a starting point, I began sketching ideas for T-shirts. The first set of sketches appeared obvious and literal so I developed further ideas. In order to understand the meaning of the symbols, I abstracted styling details from traditional uniforms and applied them to white T-shirts to investigate whether the meaning of the details would be understood on another type of garment.

After a period of one week and multiple iterations of the T-shirts, I settled on nine concepts to develop into prototypes taking each detail and deciding on materials, trims, manufacture methods to create the details on the T-shirts.

Using the nine prototypes, I created an installation and invited an audience of VCU Qatar professors, visiting lecturer Alice Twemlowe and VCU Qatar students to attend a focus group to examine the samples and write adjectives they felt described the meaning of the details for each T-shirt. I did not explain the concept or research to the audience prior to the exercise. This installation created an exciting interaction from the participants yet their comments also indicated a strong feeling was one of confusion. The comments heralded a number of adjectives yet these comments did not have the desired effect in terms of symbolic representation as norms for understanding. The meanings I had hoped they would represent had been lost in translation between the base garment and the abstracted details. On the other hand, this experiment extended the data collected through secondary research and helped me understand the importance of context in understanding meaning. A uniform is only part of the whole, for the uniform to have true meaning the environment surrounding it, with the person wearing it and the behavior of that person all contribute to the meaning of the uniform. All of these components must work in tandem to present an image that is understood by society.
Main Themes:

- Professional
- Athletic
- Technological
- Strength
- Powerful
- Authoritative
- Casual
- Rank
- Sterile

**INVESTIGATION V**

Industry standard regulations set by organizations including the Food and Drug Administration (FDA) in the USA and the European Textile Services Association (ETSA) have not mandated the use of antimicrobial or other valuable textile properties that could enhance the performance of medical uniforms making them safer for the medical professional and patient.

As was explained above, the clinical uniform market is saturated with a number of wholesale offers largely motivated by profit; thus, production costs are kept to a minimum. Garments in most cases just meet the rudimentary requirements of health care professionals, which is to clothe them. Little design innovation in terms of function and performance has been applied to these garments, particularly doctor’s uniforms, despite evidence suggesting that medical uniforms play a role in the spread of deadly bacteria. On a functional level in some cases the uniform physically inhibits the wearer and in essence promotes bad behavior.

Ben Favret is CEO of Vestagen, a company that has developed Vestex®, a clinically proven antimicrobial textile for medical uniforms. He explained that studies have shown that the common polyester/cotton cloth used in most medical apparel has been proven to carry and transmit deadly bacteria. In a presentation regarding the new technology he developed, he asked the audience to imagine a doctor walking from patient to patient carrying potentially contaminated uniform, where a doctor who is actually compliant with hand washing unknowingly carries infectious bacteria on his/her clothes, spreading contamination as he/she carries out daily rounds. Yet only a small minority of manufacturers offer anti-microbial or other valuable textile properties that could enhance the performance of medical uniforms making them safer for the medical professional and patient.

Nat Landau is owner of Landau Uniforms, one of the most recognized medical uniform brands in America. He explained that he introduced an antimicrobial offer into his uniform range but found that the technology did not perform consistently during testing and ultimately it proved too risky for him to promote in case of a lawsuit. He considered continuing to use the antimicrobial fabric without promotion but this also proved impractical, as he could not justify the additional cost of the garments to the purchasing companies. As a result, he stopped using the antimicrobial fabric.

Doctor Manel, a psychiatrist at Al Ahli hospital in Doha, explained that she is unhappy with the lab coats provided for her by the hospital. She observed that the fit is not flattering or suitable for her shape, that the lab coat sleeves are too long, the shoulders are too wide and she does not like the fabric. To compensate for these deficiencies she hires a professional tailor to custom make her lab coats, which are specially tailored to fit her. She is not the only doctor in Qatar tailoring her own lab coats. In discussion with a local tailor he commented that he has many doctor clients for whom he tailors lab coats. Interestingly, they provide him with the fabric. I asked to see some and was surprised at the discrepancies in quality ranging from poor quality polyester/cotton blends to 100% polyester. None of these fabrics are antimicrobial.

Further investigation with the Head of Nursing at Aspire Hospital in Qatar revealed that uniform pockets are a major source of contamination. He suggested that uniforms should not have pockets. This would prevent the wearer from putting potentially contaminated objects into the pockets and inadvertently cause bacteria to spread. This logical suggestion may support the drive for eliminating textile contamination by removing an area, which is more likely to harbor bacteria due to its use, but how does this solution match with the clinicians’ need for pockets?

It is clear that the current medical uniform is not fit for purpose on many levels, including health and safety, practicality and comfort. The research shows that there are better alternatives possible, which could be used in uniforms. However, some of the reasons preventing widespread production and use of these alternatives include cost constraints and limiting standards in policy. These constraints have, in essence, stagnated the development of medical uniforms.

Medical professionals often wear lab coats that are ill fitting and appear shabby on the wearer. On recent hospital visits carrying out observational research I was particularly struck by the appearance of clinicians’ lab coats. Many professionals wore coats that did not fit properly, were usually oversized with rolled up baggy sleeves, pockets saged and the collars were crumpled. In the worst cases the fabric had greyish tones from over-use and laundering, although they appeared unhygienic. With this in mind, I realized that both metaphorically and physically one size does not fit all, and one solution will not suit all. Maybe the approach to uniforms should be more bespoke so that each
individual has a lab coat that fits perfectly. The system surrounding the uniform with current mass manufacturing techniques, the procurement process, cost implications and logistics cannot seem facilitate this idea for clinical uniform wearers, yet this is possible in other clothing sectors.

The trend towards individual service and a bespoke offer is available in many clothing sectors. The sports wear industry is usually the first to offer new innovation in many clothing sectors. Nike, Adidas, Reebok and Puma invest millions of dollars annually to technical advancements to the consumer. Sportswear brands such as Nike have developed a side to their business known, have opened up possibilities for manufacturing in a way not seen since the dramatic change that occurred during the industrial revolution. 4 New manufacturing techniques challenge the traditional methods of mass production, enabling products previously unthought-of to be created and manufactured using the digital modeling skills of engineers and designers. Product development is changing at a rapid pace. Technological advancements and investment are key to its success. The fashion industry on the whole still produces clothing in the traditional industrial revolution manner and hence the advancements in manufacturing techniques have to add increased function and performance. In terms of aesthetics, there is considerable evidence to support the elimination of long sleeves. This policy was introduced to reduce pathogen cross-transmission by minimizing patient contact with contaminated, infrequently laundered items, but a blanket approach to sleeve length may not be appropriate in all clinical settings, especially in certain parts of the world. The sports wear industry is usually the first to offer new innovation in many clothing sectors.

Figure 41 Nike speed suit enhances athlete’s performance to run faster than running naked

Recommended Fabric Qualities:

- Crease resistant
- Fluid resistant
- Soil resistant
- Active barrier protective antimicrobial
- Stretch
- Breathable with wicking properties
- Comfortable
- Aesthetically pleasing
- Professional looking
- Withstands commercial laundering
- Non-leaching
- Color fast

Meets international ETSA standards for medical textiles

Problems with the current market offer:

- Unisex lab coat is unflattering on female form
- Oversized ill-fitting lab coat looks sloppy and unprofessional
- Uncomfortable for the wearer
- Restrictive ergonomically
- Sleeve length too long
- Cuff opening too wide
- Body length too long
- Unisex lab coat is unflattering on female form
- Oversized ill-fitting lab coat looks sloppy and unprofessional
- Uncomfortable for the wearer
- Restrictive ergonomically
- Sleeve length too long
- Cuff opening too wide
- Body length too long

Varying fits make it difficult to choose the right size

The medical uniform market is saturated with a number of brands that supply uniforms internationally. Lab coats are offered by all brands. There are many styles on offer, each with subtle variations. The textile used to make the garment can be addressed in a number of ways. The textile used to make the garment can be addressed in a number of ways. The textile used to make the garment can be addressed in a number of ways.
HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

The topic of the doctors’ clothing has become part of a large debate with conflicting ideas on the appropriate attire for the doctor. The lab coat has become the standard for the medical professional. The impact of HAIs in human and financial terms is severe and measurable. In “Adult Hospital Staff with Infections Due to Medical Care 2007,” Jennifer Lucado, et al., indicate that HAIs are a common cause of mortality. In 2002, researchers estimated 17 million cases of HAIs in the USA, resulting in 99,000 deaths. The article highlighted many of the causes of HAIs, focusing on areas related to bloodstream infections caused by devices, grafts, injections or vaccinations. Following that research, evidence-based guidelines were issued for reducing many types of HAIs.10 An investigation, by J. A. Wilson et al., examining the significance of uniforms and uniform policy in the prevention and control of HAIs, states that they found no evidence to support the theory of transfer of microorganisms from uniforms to patients in a clinical environment.10

However, Sabina Fijan et al., reviews the published literature examining the role hospital textiles play in the spread of HAIs on the occurrence of microorganisms on hospital textiles. The body of the reports summarized by Fijan, et al. focus on hospital textiles, particularly hospital uniforms, the customer in often an administrative body or procurement programmers, criteria for assessment. Conclusions of these studies are extremely useful because they indicate that many different areas of the problem need to be addressed, including hygiene policies and procedures, medical equipment and medical textiles, including uniforms and linen, to understand the problems and determine solutions. Consequently, it is highly unlikely that just one method of designing developed in line with advancements in IT where the role of the user is central or that he did not want to create barriers in communicating because of the symbolic hierarchy it represents and that he did not want to create barriers when communicating to his staff or patients. Dr. Brisseau is expected that patient care is the most important part of his job, and being able to communicate in a way that does not overwhelm the patient requires skills to be able to simplify information in an understandable, unimposing and acceptable way.
coats should have short sleeves to decontaminate in the laundry. Doctor Sigalet suggested that all lab coats require physicians to roll up the sleeves before they can wash their hands, thus transferring bacteria and other potentially harmful contaminants from the physician’s pre-washed hands to the sleeves of the lab coat. This was my first experience of interdisciplinary design thinking with a doctor.

In discussion with Doctor David Sigalet, Clinical Chief of Surgery at Sidra hospital, he mentioned that even though hand washing is the primary method of sterilizing the hands, the long sleeves of most lab coats are far too busy to be able to allocate three hours each day to hand washing. We were also discussing whether there was an alternative way to sterilize hands that would take less time. Dr. Brisseau suggested UV light as a possible option. Currently sterilization devices and products harnessing the power of UV light are used in hospitals to sterilize medical equipment thus preventing the spread of bacteria. If the UV light could prove a viable option to replace hand washing, it would eliminate the need for detergent and water, and enable the need for sterile gloves. 

Reviewing some of the designs together we began to discuss some design features in detail, specifically focusing on the lab coat. Dr. Kaura immediately pointed out that a concealed button, a feature designed to hide buttons, would not be suitable for this type of garment. He explained that if a nurse opened the button with blood on her fingers the blood would get trapped in the fabric fold, contaminating the fabric and the design itself. He also explained that this was exactly the type of information we needed at the design development stage of the project that he thought would influence design decisions. He was surprised that we had not talked to the clinical team as part of the design process; however, as has been discussed above, hospital procurement teams often manage the development and management of the lab coat and the main priorities of the purchasing team and very different from the concerns of the user.

Dr. Kaura’s insights highlighted once again how important it is to understand user needs in order to gain an intimate knowledge on the subject matter. I explained to both doctors that I intended to carry out further research and design development on doctors’ uniforms and asked if they would like to participate in the research and design process both responded with a resounding yes.

It has been established that a medical uniform acts on many levels. It provides the wearer with an aesthetic that symbolizes inclusion in a specific social group, often the hierarchical position of the wearer within that group, and is simultaneously a piece of clothing that protects the wearer. We have also seen that the multi-billion dollar clothing industry is constantly evolving as some sectors develop and incorporate advances in technology to enhance clothing performance. This is particularly evident in specialist areas for extreme temperatures and situations, including the military, fire fighters, space travel and sportswear. These sectors apply new technologies to develop and advance materials and garment construction, developing new methods of production to create performance clothing. Merlin Lotti, Nike’s global creative director for the 2012 Olympics, explains how Nike design and engineer sport performance wear place psychology on an equal footing with technological advances when designing sportswear to improve an athlete’s performance.

Undertaking the significance of style for results, Lotti reported that Alpine skier Maria Kirkevåg once told him, “I perform better if I look better.” This brings me to question whether a better-looking uniform might also enhance a physician’s performance? Hajo Adam and Adam Galinski of Northwestern University carried out a study to examine the effect of clothing on cognitive ability. Their research confirmed that when the participants wore a doctor’s lab coat they performed significantly better in cognitive tasks than they did wearing other clothes. In the same study the group was split, both groups were given white lab coats, however, half the group was told it was a painter’s coat and half the group was told it was a doctor’s coat. The volunteers who wore a “doctor’s coat performed better on sustained attention tasks and were better able to discriminate features in nearly similar pages, then those who wore a painter’s coat.”

It is clear that clothing can affect the wearer as much as the viewer as in terms of the doctor-patient relationship. Therefore, if the doctor feels that wearing a lab coat, he will perform better in the same way, an athlete can perform better when he has a suit that is designed specifically for an athletic event. Thinking again of Dr. Brisseau’s comments regarding student doctors’ confidence wearing a lab coat, the evidence strongly indicates that the fabric, style and quality of the lab coat, and any product that plays an important role in the medical and world and to society at large, functioning as a tool on many levels, including enhancing the behavior of the doctor and acting as a signifier to the patient and to society.
DESIGN

To realize the applied outcome of my research I investigated numerous design methodologies before adopting speculative design. Speculative design is an innovative method of design practice described by Dunne and Raby as a method that aims to open up new discussion about existing situations. This method can be used to address wicked problems by creating a space to discuss and debate alternative ways of being. To truly understand the lab coat I have taken a holistic view of the role it plays and the garment embodies. By engaging with the lab coat I have uncovered reveal limitations at every turn which prevent the lab coat from realizing its potential as a better performing, safer and more valuable product. As part of the process I used science fiction prototyping, future scenario building, or future narrative scenarios, all names describe to imagine and envision the future in a new way. This form of prototyping allows the creator to imagine a future reality based on real science and technology by looking at emerging patterns and trends and using them to create a fictional story that has fictional creations embedded in the story. Using the specific method of narrative scenarios I created a fictional story involving characters, in this case I talked about doctors and patients living in a hospital environment. In helping to define the parameters for the products I focused specifically upon the doctor’s lab coat by creating a list of garment properties addressing some of the problems faced by today’s doctors. Solutions to the problems are based on combining emerging technologies, including Nano technology, material science, textile development, communication systems, and IT that will enhance the performance of the doctor’s uniform. I also created mood boards to visualize the aesthetic, feel and concepts behind the scenarios.

The concept proposes new enhanced functions of the uniform that will improve the patient doctor relationship by acting as a tool over and beyond the current symbolic and functional qualities of the existing doctor’s lab coat. In the future narrative the uniform acts as a tool to tell a communication story to the doctor that can be used by the doctor and shared with the patient enabling the doctor to understand not only the complete medical history of the patient but also aspects of patient’s personal life. It is intended to aid communication. It becomes a receptor for digital information and also proposes a solution that uses less of the earth’s most precious natural resource.

The lab coat has the ability to display data and wearables. The information is transmitted wirelessly in an exchange between patient and doctor and when combined with visual and audio communication it creates a new way to communicate electronically, while retaining the simplicity of using body language. The smart technology regulates patients’ vital signs, eliminating the need for hospital gadgets, which harbor dirt and bacteria. Such gadgets are common in many cases HAIs are transmitted through human error such as improper laundering and non-compliance with hygiene policies. In this scenario the uniform is designed to promote better behavior on the part of the doctor by aiding communication that will enhance the doctor-patient relationship and also prompt the doctor to sanitize hands and change the uniform when contaminated.

 Patients’ rooms will be more starker as equipment will not move from room to room, doors will be automatic opening when those authorized to enter are sanitized. All surfaces and textiles used in the patient rooms will be made from easy to clean antimicrobial Nano technologies. Beyond the technical performance of the garment and hospital surroundings, the story also focuses on human behavior. Good design has the ability to positively impact human behavior using engineering, education, communication and monitoring. Research confirms that in many cases HAIs are transmitted through human error such as improper laundering and non-compliance with hygiene policies. In this scenario the uniform is designed to promote better behavior on the part of the doctor by aiding communication that will enhance the doctor-patient relationship and also prompt the doctor to sanitize hands and change the uniform when contaminated.

Figure 42: Medical translation technology

• Wireless non-essential data share
• Smart materials, augmented data visualization
• Patient monitoring in real-time, continuous

Diatex sail, sterilized, technologically connected, data transfer, embedded, smart, clean, transparent

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FUTURE SCENARIO I: DR. WHO?

Scene: Doctor on hospital rounds on a maternity ward.

Characters
Doctor – Male Dr. Tarek Omar
Patient – Pregnant Female Anna Jenkins

Dr. Omar arrives at 7:15am, which is his usual time to begin daily rounds, checking on his patients from the night before. Walking by the nurse’s station, his sleeve flashes, reminding him that he must visit Anna Jenkins this morning. As he pauses to recall the details of this particular patient – he has over 60 patients to attend daily – Dr. Omar raises his arm to view the textile data display showing Anna’s details and photo. These are strong reminders for the physician, serving as a catalyst to jog his memory for even more information. Today he is covering for Dr. Manal and recalls that this patient is 36 weeks pregnant with twins and under observation because the twins’ showed signs of irregular heartbeats during week 35 of the pregnancy. Checking the records, Dr. Omar happily observes that the twins’ vital signs are normal this morning for the third day in a row.

Still scanning Anna’s chart, Dr. Omar sees that this is not her first pregnancy. She has a 5-year-old daughter, who will become big sister to a brother and sister in two weeks’ time following a scheduled Caesarean at 08.00 on April 4th, 2034. What an easy birthday it will be to remember.

Still using the information provided on this cool sleeve visuals, Dr. Omar checks Anna’s pregnancy history right back to 2029 when her daughter Alana was born, seeing that she encountered no previous complications in pregnancy. Happily, the doctor will be able to send Anna home today to spend the last week of her pregnancy getting ready to welcome the new arrivals into their family.

Walking down the corridor to room 08A Dr. Omar’s sleeve flashes again reminding him to sterilize his hands. He extends his hands into the recessed chamber located to the left of the door, where the yellow UV light automatically fills it; his hands and clothing appear yellow with the reflection of light.

As he waits 10 seconds until the light changes to blue, Dr. Omar is reminded of his early days of being a clinician just out of university, when water was still used to sterilize hands, making it almost impossible to adhere to the three minute protocol to clean hands. How did he ever manage to adhere to it? HAIs (Healthcare Associated Infections) are almost unheard of in a clinical setting nowadays, due to the strict implementation of measures to combat infections, which almost crippled medical care in the early part of his career. These measures have improved medical care expediently by eliminating not only HAIs but also many unnecessary hospital visits and stays through the use automated functions, touch-free surfaces, wireless data, tool-free procedures, and virtual care. Now only critical cases enter hospitals. The blue light indicates that his hands and sleeves are sterile and the door opens automatically, allowing Dr. Omar into the patient’s room.

As he walks forward and toward the bed, Dr. Omar greets Anna. The doctor explains the purpose of his visit today as the privacy panel automatically recedes into the wall. Anna is lying with the sheet covering her protruding belly.

This is the first time for Anna to meet Dr. Omar, who is covering for her regular consultant. The doctor asks Anna how she is feeling this morning. Anna squints as the reads the digital display of data on Dr. Omar’s chest. With relief she sees that Dr. Omar is a very experienced physician, having studied and worked internationally. Anna also notes that Dr. Omar is affiliated with a prestigious institution and is a specialist in the treatment of multiple fetus pregnancies, having delivered over 5000 babies during his career.

Dr. Omar glides his hand over the infrared panel to activate the live digital display of Anna’s scan, which appears instantaneously on the shimmering textile surface of the bed sheet, thanks to the CMOS
sensor with its ability to send 3D images of the womb in real time to the data display. The babies bob up and down, totally unaware of this observation. It still makes Dr. Omar smile when he sees the look on a patient’s face as they watch the miracle of life.

Dr. Omar discusses the twins, pointing to each child’s heart, remarking on the normal heartbeat and explaining that everything looks good. Anna’s face relaxes with relief as she hears the news. Dr. Omar asks Anna if Isabelle her daughter is looking forward to having a new brother and sister to look after. Anna smiles thinking what a change it is going to be for her family.

**FUTURE SCENARIO II: DR. WHO?**

Scene: Doctor on hospital rounds on a pediatric ward.

Characters
- **Doctor** – Female Dr. Jane Israr
- **Patient** – 12 year old boy Mustafa

Dr. Israr, preoccupied by an emergency case she attended earlier, starts her rounds. The soft light display at the nurses’ station reception gently fills the space as it reflects on the clean surfaces. She stops and raises her arm to look at the digital display on her sleeve. As it comes into focus, she smiles, seeing the details of her next patient, Mustafa. The young boy’s ankle had been fractured in a fall. The surgery was complicated and lasted 2 hours longer than anticipated. Dr. Israr looks at the date – March 25th 2034 – and thinks how time flies as she notices the surgery was carried out 10 days ago.

Scrolling back through Mustafa’s records she notices that Mustafa was a premature baby who remained in intensive care for 3 weeks post birth but since that time has developed normally with no complications. The test results indicate that everything is clear and she anticipates that he will be sending him home today, after one final observation. As she walks down the corridor to the examination room, she notices that Mustafa has a Labrador dog at home – that will be a good talking point.
The data flashes, reminding her to sterilize her hands. Raising them, she inserts them into the recessed chamber. At once, the light beams a yellow hue before turning blue, indicating that her hands and uniform are sterile. Then her uniform changes color from white to a yellow gradient, which is deemed less intimidating to children. The examination-room door opens automatically where Dr. Israr enters to see Mustafa sitting upright, looking sad.

Dr. Israr walks towards her patient and sits opposite him and at eye level. She begins the conversation by asking how he is feeling. Mustafa explains that he is feeling much better. The doctor swipes her hand over his sleeve and the live scan of the boy’s bone appears on the surface of the textile of the exam gown. Both observe the display. Mustafa is an inquisitive 12 year old, who is not shy about asking questions. In response to his queries, Dr. Israr taps her chest and reveals an animated data display of the bone repair while explaining the details to the child. Mustafa is fascinated as he watches the animation and asks more questions. A picture speaks a thousand words, thinks Dr. Israr, marveling not for the first time at how true the phrase is.

She tells Mustafa that he will be discharged today and asks if he is excited about seeing his dog again, telling him she also has a Labrador named Goldie and asking the name of his dog?

**BACKGROUND TO THE NARRATIVE**

**HAIs**

In an effort to eliminate HAIs, the hospital has ensured that surfaces are flat, so that there are no nooks and crannies in which dirt can lodge, and are easy to clean.

Everything is automated to avoid the need for anyone to touch surfaces.

Hand washing with water has been replaced with UV light to kill bacteria, which also eliminates problems with long sleeves as it sterilizes the cloth too.

All medical equipment is contained in each patient’s room nothing moves from one room to another.

Antimicrobial intelligent textiles are used in the uniform. If contamination occurs, the thread on the fabric surface changes color and the data display indicates contamination.

Doctors don’t carry tools, as the lab coat replaces all the traditional tools needed by a doctor. The coat functions on a totally new level.

The stethoscope is replaced with patient sensors that provide continuous real-time data of the patient’s vital signs and wirelessly transfer the information to the doctor’s digital display.

**Communication**

All data is accessed through digital displays that are either embedded in smart materials or by augmented reality projected on to surfaces within the room.

The textile of the uniform digitally displays patients’ data and records.

The textile surface can change appearance in color and pattern when necessary depending on the circumstances of the interaction.

The lab coat also functions as an information provider for the patient, by displaying the doctor’s credentials and data relating to their health issues.

The bleeper is replaced by the digital signal on the doctor’s uniform.

Via the uniform’s digital display, the doctor replaces the traditional clipboard of patients’ records with digital records. The entire history of the patient can be accessed in one location.

The medical staff badge is replaced with the digital display on the doctor’s chest. This shows not only a name and staff number, but also the credentials of the doctor’s training, experience and success.
DESIGN INNOVATION

The lab coat in the narratives is based on emerging technological advancements not currently commercially available in the market. However, I decided to create a physical prototype to create an aesthetic representation of the design. Using garment technology, this design addresses some issues relating to problems identified in the research. Going back to my roots, I followed the classic fashion design process: researching the most up to date trends in fabrics, textile technology, color, retail, and reviewing the latest catwalk collections from London, New York, Milan and Paris. I collated the research into storyboards visualizing inspiration for styling, silhouettes, details, fabrics, and trims. These combined with the research and list of criteria previously defined (reference page 42) began the iterative process of designing the lab coat by sketching shapes, silhouettes, accessories, construction details and then draping muslin fabric on a mannequin to create 3D forms of the 2D sketches. When I was happy with the shapes I converted these to paper patterns, which were then used to make physical prototypes. The concept design was modified with each new sketch and prototype. The result is a design engineered to accommodate existing production capabilities of clothing manufacturers while utilizing some tried and tested construction techniques used by sportswear and other clothing sectors.

Figure 43: Lab coat toile, calico fabric
Figure 44: Lab coat toile, calico fabric
Figure 45: Lab coat toile, calico fabric
Figure 46: Lab coat toile, calico fabric
Figure 47: Lab coat toile, calico fabric
Figure 48: Lab coat toile, calico fabric

The designed outcome includes streamlined male and female lab coats that have eliminated potentially problematic styling details to reduce contamination touch points including buttons, pockets, flaps, fabric folds, raw edge seams. The garment has minimal paneling also reducing the number of areas to harbor contamination. The design acknowledges the symbolism of the traditional lab coat maintaining an understandable professional look by using garment engineering to create a design that is familiar yet new. The design also has an added elastic detail in the sleeve that helps to keep the sleeve up when hand washing. The final prototypes were made using a local tailor who regularly makes lab coats for a number of doctors he has as customers.
The main challenge of the thesis exhibition was how to communicate a lot of research in a static show, which could engage a live audience in a short amount of time. This required dissecting the research into understandable bites of information to be displayed in a setting complementing the research. To do this I focused on a number of key aspects to highlight:

- Future scenario and narrative of the world and the artifact
- Performance and function of the new lab coat
- Prototypes
- Problems within the healthcare system

The exhibition space was carefully curated to represent a doctor’s examination room. I sourced old medical furniture, bed linen and a number of additional paraphernalia from the medical world to create an installation of a doctor’s examination room. Posters commonly used to communicate information in a doctor’s office were hung on the walls highlighting key aspects of the research. The installation was designed to create a setting that would enhance the exhibition experience by engaging the audience full senses, literally drawing them into the smell, sound and look of medical world.
To communicate the narrative I created a visual in the form of sequential art, which illustrates the story in a simple and explanatory manner. The artwork is also used to create a pamphlet in classic medical style to hand out during the thesis exhibition. The brochure adopts a comic book style illustrating the characters through which the artifact comes alive. The graphics are designed to be informative and provide context to the story in an understandable way.

emphasizing the behaviors of the doctor in the new world. To illustrate the lab coat of the future I utilized video, animation and 3D modeling to virtually create a prototype. The video highlights the lab coat design features promoting the benefits of the new design.
CONCLUSION

Research indicates that the lab coat, a seemingly simple garment, is actually embedded in highly complex social and professional systems that have shaped the resulting product. To change the lab coat requires a multi-faceted approach through many channels including the user, the patient, professional colleagues, society, the producer and the hospital bureaucracy. This requires changes in policy, protocol, testing, standards, specifications, manufacturing, laundering, purchasing and budgets before a new design could be adopted, and even then for these changes to be accepted the concepts would require effective communication to consumer and society. Change is difficult to accept and therefore changing the lab coat radically and in the short term is not feasible. However, it would be achievable through an interdisciplinary approach, engaging all the above-mentioned stakeholders, communicating the possibilities, justifying the costs and quantifying the benefits for change. In addition, education and awareness programs would be necessary to communicate the change and secure the buy-in from all stakeholders by targeting audiences within the medical profession and patient audience by promoting the benefits of the changes. Many medical professionals have stopped wearing the white coat for various reasons including personal preference, perceived symbolism, associated perception with hygiene, physical garment limitations and hospital cutbacks. But not wearing the lab coat has also left a void where the product is still necessary. This thesis presents a concept for doctors’ clothing that builds on the age-old tradition of lab coat with its positive associated meanings and attributes by proposing an alternative that can add value for the doctor and the patient while promoting positive behaviors in the doctor, enhancing the doctor patient relationship and limiting the spread of HAIs.

“"The doctor-patient relationship has been and remains a key stone of care: the medium in which the data are gathered, diagnoses and plans are made, compliance is accomplished, and healing, patient activation and support are provided” 63

Figure 60 Patricia Duignan wearing lab coat prototype

Figure 61 Vestex® technology, polyester/cotton, antimicrobial, medical textile.


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36 Favret, Ben. CEO Vestagen, New York City, NY. Interview, September 2013.

37 Landau, Nat CEO of Landau Medical Uniforms, New York City, NY. Interview, September 2013.

38 Osman, MD. Manal. Consultant Psychiatrist, Al Ahli Hospital, Doha, Qatar. Interview, September 2013.

39 Alkhor, Manager, Albear Tailors, Interview, Doha, Qatar, November 2014

40 Namour, Georges. Head of Nursing Aspetar Orthopedic Sports Medicine Hospital, Doha, Qatar. Interview, December 2012.


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Fig. 34 Professional footballers 1960s, http://www.historicalkits.co.uk
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**i ACRONYMS AND ABBREVIATIONS**

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<td>BBE</td>
<td>Bare Below the Elbow</td>
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<td>HMC</td>
<td>Hamad Medical Corporation</td>
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<td>MRSA</td>
<td>Methicillin-Resistant Staphylococcus Aureus</td>
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**ii DEFINITION OF TERMS**

Doctor – is used when referring to a medical doctor

HAI’s - Hospital Acquired Infections, serious life threatening infections acquired during hospital stays one of the biggest problems facing medical care.

Mind Map - Designers use mind maps to reduce information into key words and images by creating a visual structure, which shows the big picture of the information.

Log Reduction - scientific notation to calculate microorganisms, 5 log is = 99.999% reduction.