

Robotic Surgery, Human Fallibility, and the Politics of Care

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Communication Studies.

Chapel Hill  
2009

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## ABSTRACT

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Robotic Surgery, Human Fallibility, and the Politics of Care  
(Under the direction of Della Pollock)

“Robotic Surgery, Human Fallibility, and the Politics of Care” leverages the methods and theoretical paradigms of performance, visual, and new media studies to explore the contradictions, aspirations, and failures of modern technologized medicine. In particular, I consider the use of robots in the operating rooms of a large research hospital. “University Hospital” illuminates a contemporary articulation of human bodies and robotic technology that focuses and amplifies existing and emergent tensions and contradictions in modern medicine’s investment in providing both care and cure. Intuitive Surgical, Inc.’s *da Vinci Surgical System* provides a “platform” for this exploration, both as a concrete, material, and particular assemblage of hardware, software and human wetware, and as a technology that offers a specific and perhaps more productive vantage point—a modest step stool—for understanding the contemporary politics of surgical pedagogy and practice. I locate the *dVSS* in a broader context of ambivalence that surgeons experience with regard to the manual practices of their craft, an ambivalence amplified by the increasing sophistication and automation of surgical tools and the changing ontologies of surgical practice. The surgical interface of the *dVSS* prosthetically enhances—as well as displaces and replaces—embodied surgical skill. At a time when all facets of medical care grapple with the problem of medical error, I outline an emergent sensibility of machinic virtuosity, articulated to both human and robotic surgical practice alike, geared toward addressing and overcoming the perceived pitfalls of human fallibility. Rather than simply enacting a technological dehumanization of medicine, robotic surgery suggests a more complicated terrain where the nature of the human and the machine bleed into each other. What I term the “becoming machine” of the surgeon and the “becoming surgeon” of the medical device occurs on the cutting edge of the robot-surgeon interface. The implications of this emergent medical sensibility are far from clear or unilateral. In closing, I reflect on the

uncertain impact of the ideal of machinic virtuosity on the politics of care. This reflection considers software and machine ethics alongside medicine's aspiration to manage contingency according to the "procedurality" of medical and surgical protocols.

## DEDICATION

To Melissa and Noah, without whose boundless care-taking, support, and love  
nothing that follows would be possible.

Words fail . . .

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INTRODUCTION

It is often said that contemporary US medical care is increasingly technologized. Indeed, the everyday practice of Western medicine immediately brings to mind an array of technologies and technological devices, from the ubiquitous digital thermometer to the most sophisticated high definition magnetic resonance imaging system. This has not always been the case.<sup>1</sup> As medical historian Stanley Reiser points out, medicine in the 17th and 18th centuries was characterized by an anti-technological ethos, “deeply held convictions that encountering patients with technology was inappropriate -- that tools were reserved for action in the common trades and the specialities of medicine of lower station such as surgery. The physician was to observe and question patients to gain diagnostic knowledge, not to poke and probe their bodies.” (1993: 262-263). In this medical epistemology, a patient’s self-narration of her or his corporeal experience was the key medical evidence, to be modestly supplemented by the doctor’s own sense data (precisely modest, as social norms demanded that examination be conducted at a polite distance from the patient).

Physicians of the early nineteenth century, eager to shore up their professional authority, granted less and less authority to patient narratives, however. Coupled with the rise of the clinic and the growing emphasis on physical examination as a source of diagnostic evidence, Victorian doctors came to value the information their own senses provided over the stories told by their patients. As Reiser points out, “the result was a diminution in the doctor’s attention to the subjective, experience-centred account of illness by the patient, and turning to the evidence of illness the doctor could acquire directly through the senses” (1993: 264).

Physicians of this era articulated their concern about the value of patient narrative in terms of

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<sup>1</sup> Astute scholars of media technology might argue, rightly, that medicine has always been technologized, so to say that medicine is increasingly technologized, a statement of quantity, should instead be recast in terms of quality. In other words, it would be more precise to say that the specificity of medicine-specific technics has changed, but not the fundamental technicity of medicine. I will return to consider this argument later in relation to a discussion on the technicity of care.

an emergent scientific emphasis on the value of objectivity in producing truth. In this epistemology, diagnostic evidence required detached observation and empirical verifiability. Moreover, diagnosis in this moment valued -- and indeed required -- the *autopsis of the autonomous expert*, the physician *seeing for himself*, rather than the physician reliant upon the "reportorial skill, memory and veracity of patients", (Reiser, 1993: 264). In other words, the expertise and authority of the physician was cultivated through a sensibility of autonomy from the patient. The net effect of this emergent epistemology was to render a patient's narrative suspect in its subjectivity, unreliable and subject to distortions of overemphasis and omission.

This emphasis on skilled autoptic observation by the physician aligns with the mid-19th century development of technologies designed to augment, enhance and refine the physician's sensory powers. Sterne (2003) offers the the stethoscope as a paradigmatic example, a technology that both augmented the aural capabilities of the physician *and* displaced his ear from direct contact with the patient's body. The virtue of the stethoscope was that it amplified and differentiated sound in a manner superior to "immediate auscultation" allowing the ear of the physician to develop a virtuosity of diagnostic discernment, reading the subtleties of the body's sounds. Ironically, then, the movement away from dependence on a patient's narrative gives way to a new and relatively uncritical dependence upon technology as sensory prostheses. Seeing or perceiving *for oneself* in this moment becomes intimately linked to seeing or perceiving *through* a technological device. Yet, the autoptic epistemology of early modern medicine comes up against tensions in its increasing reliance on the technical. How autonomous is the privileged "self" when the seeing for oneself that undergirds the importance of the physical examination acquires a dependence on technical mediation?

Certainly, this blurring of the self-other distinction in the doctor-stethoscope articulation yielded a certain epistemological uncertainty, but Reiser and Sterne offer different, but mutually constitutive views on how this uncertainty was stabilized. For Sterne (2003), a new understanding of perception emerged alongside the rise of the stethoscope, one that emphasized the autonomy of each of the senses and made them pliable and amenable to techniques and technologies that further isolated and optimized their operation. Sterne articulates the logic by which the technical supplementation of human audition, far from

destabilizing the evidentiary status of data collected by the ear-stethoscope apparatus, instead buttressed it. He writes:

A simple instrument marks and helps solidify a whole medical epistemology of mediation . . . In order to get the truest possible sense data (reception), for the doctor to *really* listen, hearing must be separated from the other senses. Once so separated, hearing can be supplemented by techniques and technologies especially designed for it. As the ear comes to be conceived as a technology, an apparatus to register a piece of the vibrating world inside doctors' heads, the ear becomes particularly amenable to other technologies. (Sterne, 2003: 110-111).

In sum, the technically-assisted isolation and intensification of the ear-as-technology enabled it to register truth free from a certain kind of *bias*, the aberrant noise of other sense modalities that impinge upon "true listening." In a complementary fashion, Reiser (1993) outlines how the perceived autonomy and *non*-human nature of the technological device instead stabilized diagnostic evidence. Non-subjects, technological devices came to be seen as *objective*. Machine-produced and, crucially, self-registering, the data produced by these devices was seen as uninfluenced by human concerns, human fallibility, or human fatigue (Reiser, 1993: 266). The self-registering technological device thereby supplemented, displaced (and some would argue replaced) the physician's own unaided sensory apparatus as the ground of diagnostic evidence. In place of the hand as a temperature sensor, the thermometer yields an information equivalent in terms of a numerical representation. The doctor's "new" technologies generate copious volumes of information about the body's current state of health with a precision unheard of in the past. No one would dispute, for example, that the latest MRI systems produce *in vivo* anatomical images of the human body with a contrast, clarity and accuracy that far exceeds that of earlier techniques.<sup>2</sup> In the biomedical model, the overriding goal of medical care is *cure*,

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<sup>2</sup> Of course, even the best diagnostic technologies carry with them a certain degree of epistemological uncertainty about whether they in fact reveal what they purport to reveal. X-rays, CT scans and MR images draw their evidentiary status based upon the logic of photographic truth, an epistemological grounding that persists despite the fact that the materiality medical images register is of a much more convoluted nature than the trace of light rays bouncing off the surface of an object in the photographic image. MR images, for example, are visual models, visualizations, constructed by graphically re-presenting numerical data that registers the differential radio-frequency gradients of energy released by the body's hydrogen protons when subjected to strong magnetic fields. MR images are indexical signs, yes, but of an entirely different order than the photographic. Even more striking, perhaps, is how epistemologies of photographic truth persist in the medical imaging realm, a domain where algorithmic digital image *manipulation* is the norm. See Cohn (2007) for insights on the "play" involved in manipulating a medical image to reveal what radiologists and physicians want to be able to see.

which today means access to the best technologies, whether they are diagnostic, interventional or therapeutic.

Technology rests uneasily in relation to our concepts of “good medical care.” What constitutes good medical care? Is it access to the best technologies, be they diagnostic, interventional, or therapeutic? In other words, is care synonymous with the pursuit of cure, no matter the cost? Different domains of medicine yield different answers. The overriding goal of the biomedical model is cure. This is particularly true in surgical medicine, where getting the best care is often seen as simply a function of the technical competence of the surgeon (dexterity, judgement) and access to the best facilities, technologies and techniques. Surgeons are stereotypically infamous for their *lack of care*, of bedside manner, often forgiven by the patient who jokes “I don’t care if my surgeon’s an asshole, as long as he can cut straight!” Palliative medicine, on the other hand, suggests that in the absence of the possibility of cure, medical care involves a much more holistic *caring-for* the patient, as well as for his or her family. Indeed, palliative care is associated with the *withdrawal* of the techniques and technologies of treatment or cure, and the amplifying of the care of the body, mind and spirit with the goal of relieving suffering, improving quality of life (often at life’s end), and reinforcing affective and relational ties. Clearly these latter concepts of care exist in a relation of exteriority, and often outright opposition to the technical.

## Scene

On the last day of my observations in the operating rooms of University Hospital, Glenn, the third year Urology resident, claps me on the back as I tie my surgical mask. “We’re going to be kickin’ it old skool today!” he exclaims. We push through the heavy door and enter OR 8, its usual buzz of activity and amiable banter heightened several octaves by the anticipation of a rather challenging case. “We’ll be doing a radical nephrectomy for a big, nasty cancer,” Dr. Sierra, the attending surgeon, had explained to me earlier in the day. “You should stick around for the case. It’s going to be open, not like the robotic prostates you’ve been observing us do every week. They’ve become pretty routine. But we just don’t see cancer like this every day.” Unlike the majority of cases conducted by University Hospital’s urological surgical service, this would not be “keyhole” surgery. “Keyhole surgery” gets its name from the five or six half-inch

incisions made in the patients abdomen, just wide enough to allow the insertion of an endoscope, long slender laparoscopic surgical tools and similarly engineered teleoperative robotic instruments into the patient's otherwise closed abdominal cavity. This open nephrectomy procedure, however, required a large 10-inch incision, large enough for the surgeons to get their hands—sometimes three or four hands—inside the patient to remove safely a kidney entirely engulfed in cancer. For residents trained extensively on laparoscopic and robotic surgical techniques, the chance to ratchet up the learning curve on traditional open surgical techniques—“kickin’ it old skool”—was, ironically, a relative novelty.

The patient, identified on a whiteboard propped against the wall by name (“Carlos Santiago”), age (“59”), weight (“78kg”), drug allergies (“N/A”) and procedure (“Left Rad Nx”), was already under anesthesia. (“Induction” is the medical term, as if it were an honor to be there on the table, on par with joining a learned society.) One member of the anesthesia team puts in a central line, spattering a bit of blood on her gloves in the process. Micah, promoted to chief resident just the day before, stands over in the corner in front of the PACS system.<sup>3</sup> As the circulating nurse clicks through the patient's CT images, Micah whistles. “Come here, guys. You've gotta see this.” He gestures toward the LCD screen as Glenn and I draw closer, making room for the 4th year medical student who had also scrubbed in as part of his surgical rotation. “See that? The tumor spreads over the midline. It's even pressing against his aorta.” “Yeah,” we all respond, even I. Months of observing pedagogical practices in the OR have rubbed off in unanticipated ways, leaving me with a reasonable level of confidence that I recognize what I see on the screen.

“This could be a bloody case. The tumor's so vascular. Good thing they embolized it earlier.” Glenn turns to the medical student and explains that with tumors like these, they try to cut off its blood supply prior to the surgery by a catheter-delivered injection of alcohol U.S.P., an attempt to “dry it out a bit.”

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<sup>3</sup> PACS is an acronym for Picture Archiving and Communication System, which stores and manages all the diagnostic imaging records for University Hospital. Any scan (CT, X-Ray, MRI) can be called up by a patient's medical record number. See Saunders (2006) for a consideration of the impact of PACS on visual apprenticeship in the radiological CT suite.

We turn to the patient, now fully anesthetized. The residents and medical student move to the patient's side. I take up my usual position above the patient's left shoulder, near the suction canisters that will collect any blood lost during the procedure. Since the canisters tend to be a bit too visceral (literally!) for my taste, I edge as close as I can into the anesthesiologist's domain at the patient's head, careful not to get in the way. But soon I have to move as an endoscopic echocardiogram and a medical device called a "BRAT" are wheeled into the OR. I have no idea what the BRAT either is or does, but I make a note to ask at a less chaotic time. I step out in the hall and pause for a moment on my way to the door that enters on the opposite side of OR 8. In my observation notebook I scribble "Verging on chaos in here. 2 residents, 1 attending, 1 med student, 3 from anesthesiology, 3 nurses (scrub, circulating, student) + 1 BRAT (?) technician. + Me." That's a lot of people to cram into a small operating room.

I reenter the OR and stand now above the patient's right shoulder, out of anesthesia's way but with a view partially obstructed by the IV hanger. Glenn, joking about no longer being at the bottom of the "surgical food chain", gives the medical student "the opportunity" to catheterize the patient. He supervises the medical student's clumsy attempts at inserting a catheter and then swabs the patient's abdomen with betadine. Together, they position the sterile drapes. All that remains visible of the patient is the sterile field. Blue drapes frame a rectangle that extends from the pubic symphysis of the patient's pelvis to just above the xiphoid process of his sternum.

Glenn casually runs his double-gloved hand over the word "YES," written in large bold black letters on the left side of the patient's abdomen, a not-so-subtle reminder that it's the left kidney, and not the right, that is the focus of today's operation. The chief resident steps in with a black sterile marker. He traces an inverted "V" just below the patient's ribline, its apex just a few finger widths below the patient's xiphoid process. "What's this incision called?" Dr. Sierra, the attending surgeon, pimps the medical student.<sup>4</sup> "A bilateral subcostal incision, or chevron," the medical student answers quickly, with only a slight upward inflection of voice betraying his outward confidence.

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<sup>4</sup> "Pimping" is slang in medical school contexts for situations in which a senior physician, usually the attending, spontaneously and thoroughly quizzes a medical student on the particularities of a procedure, drug interaction, anatomical structure or other element of medical practice.

“Excuse me, **but where are you gonna be!?**” the circulating nurse suddenly bellows in my ear. The surgical field may be the attending surgeon’s domain, but the rest of the OR is hers. “Out of *your* way, that’s for sure,” I counter, blushing a bit behind my mask. I step out of the way and quickly scan the room for another location to observe the surgery. Unlike a robotic procedure, where a video endoscope transmits the surgeon’s privileged viewpoint to three LCD screens in the OR, this open procedure offers no televisual immediacy, no telepresence. Seeing *something* is going to require being *somewhere* where I can see. I circle a wide berth around the scrub nurse’s sterile instrument trays and stand between the patient’s feet and the *da Vinci* surgical robot, which, not needed for this procedure, is pushed up against the wall as far as it will go. I know I’m still standing in the circulating nurse’s path, but by stepping up on the robot’s stabilizing base, I can both allow her to pass without interference and gain a better vantage point on the surgery. “Should I be standing on this?” I wonder, but no one seems to notice that I’m using the \$1.2 million *Da Vinci® Surgical System* as a stepstool.

“Alright, people. Can we do a time out? People? Listen up! Let’s do a time out.” The circulating nurse waits for everyone to give her his or her attention. “Alright. This patient is Carlos Santiago, a male with no known allergies. The scheduled procedure is a left radical nephrectomy. Does everyone agree?” “Yes,” the OR team responds in unison. Dr. Sierra directs, “Let’s get started, then.” He stands on the patient’s left side, with Glenn and the medical student lined up along the patient’s flank beside him. Micah and Anissa, the scrub nurse, stand on the other side of the patient. Dr. Sierra holds out his hand and without a word, Anissa places the scalpel in his palm. “Care to do the honors?” Dr. Sierra queries the medical student. Glenn and the medical student switch places. Carefully taking the scalpel in hand, the medical student moves the blade toward the black line he’s supposed to incise. “Smooth and deliberate” advises Dr. Sierra.

“Incision at 14:05.”

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*Photo courtesy of Intuitive Surgical, Inc., 2009*

This dissertation is a cultural study of robot-assisted surgical technologies, an emergent apparatus of “minimally invasive” surgical techniques being woven into the fabric of everyday life—at least the everyday life of the surgical suites of major medical institutions across the country, including University Hospital, where I observed. Such techniques have become the standard of care for many surgical procedures and, with the FDA approval in 2000 of Intuitive Surgical’s robot-assisted *da Vinci*® Surgical System (*dVSS*), they are increasingly performed via televisual and telehaptic robotic mediation. Intuitive Surgical, Inc. is the industry leader in robotic surgical systems, reporting as of December 31, 2008 an installed base of 1,111 *da Vinci*® Surgical Systems: 825 in the United States, 194 in Europe, and 92 in the rest of the world (Canada, China, India, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, Saudi Arabia, Qatar, Australia, Venezuela, Brazil, Argentina, Mexico, Puerto Rico and Russia).<sup>5</sup> Hackensack University Medical Center is the single institution with the highest number of systems (5), and over 110 hospitals own more than one system. Since its first FDA approval, Intuitive Surgical has garnered FDA clearance for the use of its products in laparoscopy, thoracoscopy, prostatectomy, cardiomy, urology, gynecology, pediatric and revascularization

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<sup>5</sup> Figures from Intuitive Surgical’s Q1 2009 Investor Presentation.

procedures. The company estimates that over 136,000 *da Vinci*-assisted surgical procedures were performed in 2008, an increase of approximately 60% from 2007.<sup>6</sup>

The increasing ubiquity of these techniques has led some surgeons to declare an emergent “paradigm shift” in surgical practice:

Substantial improvements in the art and science of surgery were made over the 150 years since the introduction of antiseptic techniques by Lister, including improved anesthetic agents, antibiotics, surgical nutrition, and organ transplantation, in which the basic tools and techniques remained basically unchanged. The core task of “surgery,” that is, “cutting and sewing,” with hand instruments and direct visualization of and contact with the organ or tissue has remained the same. However, during the last quarter of the 20th century, and especially during the last decade, there has been a paradigm shift in the methods for performance of surgery. (Mack, 2001: 568)

It is, perhaps, at best too early (and at worst, futile) to “diagnose the new” as indicative of a fundamental paradigm shift in medicine.<sup>7</sup> And yet I will argue that, as the scene I have recounted above suggests, these emerging technologies do transform specific relations in the context of surgical intervention. Specifically, they reconfigure the relationship of bodies to machines, images, and particular formations of medical knowledge, as well as to other bodies. The *da Vinci Surgical System* will serve as a concrete site for interrogating these new modes of surgical practice. At issue are complex technical mediations of vision and touch, which have been aggregated into procedures and protocols of control, cutting, manipulation, dissection and suturing.

In particular, I focus on the everyday practice of using Intuitive Surgical’s *dVSS* for conducting and teaching robot-assisted urologic and gyn-oncologic surgery at a major U.S. teaching hospital (“University Hospital”). It is my contention that the introduction of robots into surgical practice exacerbates existing tensions within the surgical profession, such as the surgeon’s ambivalent relation to the manual aspects of surgical craft, the increasing strictures on the surgeon’s professional autonomy in an era of managed care and corporate medicine, and the

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<sup>6</sup> Of these 136,000 procedures, over 72,000 were *da Vinci*® prostatectomy procedures (approximately 50%). Intuitive Surgical expects that the prostatectomies to continue to be a product driver, but expect prostatectomies to be a decreasing percentage of the array of robotic procedures as the *dVSS* repertoire expands. *da Vinci*® hysterectomies, for example, more than doubled from 2007 to 2008, to approximately 33,000 annual procedures.

<sup>7</sup> Modernity certainly has a pernicious ability to incorporate and appropriate the new into its logic and structure.

displacement of the surgeon's expertise, authority and judgment in the face of proliferating loci of medical knowledge production and exchange. Here I am thinking particularly of the array of web-based corporate, educational and "patient-driven" social networking websites available to patients and their families. Furthermore, surgical robots are emerging at a cultural moment when the problem of medical error is receiving significant professional and public scrutiny. In a context increasingly geared toward addressing the problem of error, the promise of robots (in the cultural imaginary, at least) to transcend the limitations of the human articulates, inflects and amplifies attempts to manage contingency and risk by technical means. "To err is human," after all. As I will argue, the *dVSS* participates in an emergent socio-technical apparatus of discipline and control in the practice and pedagogy of surgical medicine.

Throughout the project, I maintain a dual sense of the ***practice of medicine*** as both a performative-interventionist and a pedagogical enterprise. By focusing on robotics as new media technologies in the context of the teaching hospital, I operationalize both of these senses of practice. Practicing surgery in this perspective becomes a compound protocol of surgeons learning to perform with robots. Furthermore, my analysis conveys the attending set of ambivalences and contradictions that follow from this pedagogical enterprise of producing surgeons. This pedagogy may be largely focused on the teaching of *procedure* — surgical skills — but it still takes place in the context of providing patient *care*. Ultimately, the questions motivating this dissertation are these: What is the nature of robotic surgery? And, if robotic surgery is a procedural technology of ever-more effective yet "non-invasive" seeing, knowing and intervening on the human body, what are its implications for the politics of care in contemporary techno-medicine?

## The Million Dollar Step Stool

It may seem odd to begin a dissertation on the impact of robotic surgery by relating a story where the robot is merely a bit player, a million-dollar technology reduced to a step stool in the corner of the OR. Why might this be a fitting choice after all? First, I want to acknowledge at the outset the limited and partial nature of my study. Even at University Hospital, where robot-assisted procedures constitute a major component of urologic and gynecologic surgical services, they do not exhaust the surgeon's procedural repertoire.

Laparoscopic and, to a lesser extent, open procedures still constitute a significant percentage of these surgeons' workloads. In such procedures, the *dVSS* is more impediment than enabling apparatus, because its sheer size consumes a large footprint in an already crowded operating space. Simply put, I don't want to overstate the impact of robotic surgery on care; although important, it is only one vector in a complex field of forces constituting the present and shaping the future of medicine.

The surgeons with whom I worked are actively involved in expanding the repertoire of procedures performed using the *dVSS*. While I am certain that open and laparoscopic procedures will not disappear from surgical practice in these domains, I do maintain that the rapid adoption of the *dVSS* in urology, gynecology and gyn-oncology, together with its growing use in cardiothoracic, pediatric, and general surgery suggests a trajectory toward a robotic territorialization of broad domains of surgical practice. Further--and this demarcates another significant limit of my study--surgical intervention constitutes only one facet in the "continuum of patient care" at University Hospital. My ethnographic observations are limited to the space of the operating room and the various apparatuses of surgical care deployed there. My focus in this study is on surgeons and their practices in relation to robotic surgical technologies. I had very little contact with patients (at least as conscious subjects); their understandings of and perspectives on these new surgical technologies in relation to the politics of care are thus notably absent from consideration.

At another level, figuring the *dVSS* as a stepstool is an invitation to understand technology according to Ian Bogost's and Nick Montfort's analytic of the "platform." According to Bogost & Montfort (2008), in computing, a platform is:

the hardware and software framework that supports other programs . . . A platform in its purest form is an abstraction, simply a standard or specification. To be used by people and to take part in our culture directly, a platform must manifest itself materially. This can be done in the chips, casings, peripherals, and other components that make up the hardware of a physical computer system. A platform may also include an operating system. It is often useful to see a programming language or environment on top of an operating system as a platform, too. Whatever the programmer takes for granted when developing, and whatever, from another side, the user is required to have working in order to use particular software, is the platform. In general, platforms are layered —

from hardware through operating system and into other software layers — and they relate to modular components, such as optional controllers and cards. (176)

For me, this notion of a platform provides a useful framework for thinking about the media specificity of the *dVSS*. The *dVSS* is, quite literally, an operating system upon and through which particular surgical procedures are carried out. Articulating the differential specificity of this particular surgical platform involves drilling down through the components that form the material substrate of technologically enabled surgical practice, with the goal of understanding how the matter of a particular technological assemblage matters: how “the hardware and software of platforms influences, facilitates, or constrains particular forms of computational expression”, and, I would add, computationally-mediated agency (Bogost & Montfort, 2008: 177). As outlined on the website for the Platform Studies book series (<http://www.platformstudies.com/>), an attention to technology as platform “investigates the relationships between the hardware and the software design of computing systems and the creative works produced on those systems.” It, in other words, a complex question of attending to a technology’s material affordances and constraints. In part, then, this dissertation explores the specificities of the *dVSS* as a platform of hardware and software, the specificity of which has implications for the “creative work” of surgical practice. I hope to expand on this notion of platform by foregrounding the materiality of the body. As such, human “wetware” and its articulations to the hardware and software of the robotic surgical system are crucial. Insofar as the *dVSS* operates by tightly coupling bodies and machines, the question of its material effects is intimately tied to the materiality of the human body and the capacities and constraints the body brings to the human-machine interface. It’s not even sufficient to speak of “the” body; an expert surgeon seated at the *dVSS*’ controls is an entirely different apparatus than an amateur like me using the robot as a platform upon which to stand. By expanding the web of platform affordances and constraints to include the specificities of “wetware” (i.e. the surgeon-body or the patient-body), I pursue a nuanced analysis of the productivity of the *dVSS* as socio-technical apparatus. In attending to the specificities of human wetware, however, I recognize the pitfalls: first, the tendency to reify the human, as if biology exists outside history and the social. And second, the tendency to think of the human only in opposition to

technology. A helpful *via media* regards the human as fundamentally constituted in and by relations with the technological.

To view the robot as a step stool is to signal how pedagogy in the operating room always and already involves the assumption of a proper vantage point. In the surgical theater, like all forms of theater, being able to see for oneself is paramount, as this early twentieth-century image of surgeons crowding to learn new techniques from the pioneering neurosurgeon Harvey Cushing powerfully illustrates. Hirschauer describes how “location in relation to the operating area corresponds to the surgical hierarchy; those in places 'with restricted visibility' have no say, those with the best view do” (1991: 294). In the ORs of University Hospital, surgical residents have the privilege of positioning themselves for the best view. Usually, this is either next to or across from the attending



*Photo courtesy of the American Association of Neurological Surgeons, Rolling Meadows, IL, 2009  
(Photographer: Richard U. Light, MD)*

surgeon as s/he works in the sterile surgical field. Medical students, on the other hand, must jockey for position to look over the shoulder of the attending or a resident. As a PhD student in Communications, I was an anomaly in this hierarchy of vantage points; clearly I fell outside the social hierarchy of the typical operating room. The circulating nurses, who manage the spatial distribution of observers in the OR, didn't know what to do with me. However, the success of my ethnographic observations hinged upon my own ability to see. This meant that I, too, spent a great deal of time attempting to find my own vantage points from the periphery. As will become clear, the *dVSS* figures as a means to transcend the limited human capacities of the surgeon. This is exemplified in Intuitive Surgical's trademarked byline “Taking Surgical Precision and Technique Beyond the Limits of the Human Hand®.” In foregrounding the *dVSS* as a step-stool in the opening pages of this dissertation, I finally want to highlight the ways in which I, too, used the *dVSS* in an embodied (always embodied) attempt to transcend the limits of both my particular body and my relative outsider status in the OR. Even when functioning as a “mere”

step stool, a technology of augmenting height, the *dVSS* gave me a place to stand—figuratively and literally—in the contemporary OR. Without question, this afforded me a particular and sometimes privileged perspective on robotically-enhanced surgical medicine, and allowed me to see things I otherwise might not have seen.

## Visuality & Performativity in Surgical Pedagogy

Whether interfaced with robotic technologies or not, the practice and teaching of surgery crucially depends on visuality and performativity. One theme that I trace in this dissertation is their entwining. Surgeons often refer aphoristically to the teaching of surgical procedure as “See one, do one, teach one,” a particularly tight circuit of vision, performance-as-doing, and re-performance-as-display. The practices of teaching surgical procedure in the operating theater are thus medicine-specific forms of performative show and tell that demonstrate, through gesture and narration, the precise manual practices that constitute surgical technique. Teaching surgical procedure requires making visible the practices of the surgical eye as well as the hand, and so surgical pedagogy involves what Mitchell (2002) calls the “performance of showing seeing,” where the “objects” of an attending surgeon’s show-and-tell performance are the practices of surgical visuality.<sup>8</sup> In other words, the training of the surgical apprentice relies upon modes of visuality that are decidedly synesthetic, embodied, and, as recent work in cognitive neuroscience has argued, *enacted*.

On one level, this domain could be described as the domain of “know-how,” where both practice and visuality are integral. Stefan Hirschauer suggests that the anatomical knowledge required of successfully navigating particular bodies in a surgical procedure emerges out of a circuit or feedback loop of the enskillment of vision and the manual practices of cutting. He writes,

'Knowing about' these regions of the body, which grows out of acquiring an anatomical view in surgical practice, combines the anatomical knowing that of the visible, and the anatomical knowing how of making something visible. Knowledge and skill are tied to each other. On the one hand, the knowledge emerges out of dissection; on the other hand, it structures dissection as an instruction for viewing and cutting. (Hirschauer, 1991: 310)

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<sup>8</sup> Jackson (2005) uses Mitchell’s precise phrasing to launch a reflection on the “parallels, discontinuities and enmeshments between performance studies and visual culture studies” (164)

To put it another way, contemporary surgical pedagogy relies heavily on medicine's modern investment in **autopsis**. With the concept of *autopsis* I intend to signal both autopsy proper — the “opening up of a few bodies” that Foucault describes as the founding moment of modern medicine — but also autopsy as a particular apparatus of perception, of seeing, of knowing that constitutes the productivity of the medical gaze. As Saunders (2008) points out, *autopsis* involves not only a “seeing for oneself”, but also a “saying what one has seen” (17). *Autopsis* is thus a particular and historical configuration of perception and knowledge and the articulation/transmission of that knowledge. Seeing and saying are not co-extensive and the veracity of either may be contested. But it is through adopting a particular apparatus of autopsy, I contend, that surgeons “acquire a body.” As employed by Bruno Latour (2004), “acquiring a body” connotes the taking on or developing of the skilled sensorium. These trained habits of perception differentiate and individuate the surgeon-body as an expert or “articulate” and, I would add, articulated, subject (Latour, 2004: 209). Insofar as *autopsis* is also a “self-seeing,” seeing oneself as a surgeon involves literal *incorporation*, i.e. the naturalizing of certain modes of embodied comportment, a complex making-habitual of perceptual, kinetic and epistemic formations.

## **(New) Media & Medicine**

When interfaced with robotic technologies, these questions of performativity and visibility assume the additional problematic of technological mediation. The *dVSS* introduces a technological assemblage between the surgeon and the patient. The surgeon no longer looks directly into the patient. Her gaze is mediated by the *dVSS*' InSite® Vision System, a binocular form of endoscopic video camera that, when processed according to an image registration and display algorithm, produces a 3D video representation of the patient's interior. The surgeon no longer stands at the side of the patient, but sits at a console on the other side of the room. The surgeon no longer feels the patient's tissues with his hands —sensations of texture, temperature, and hardness are lost to sight. The sound of cutting tissue is oddly dislocated and muffled in comparison to open surgery. But the smell of tissue vaporized by the electrocautery remains. Consequently, in building upon the theoretical resources and insights from performance studies and visual studies, I would also characterize this dissertation as contributing to a deeper understanding of the interrelationships between *new media and*

*medicine*. There has been much important work in this vein, perhaps best exemplified in the edited volume Cultural Sutures: Medicine and Media (Friedman, 2004). Much of this work, however, confines itself to the analysis of the representation of medicine in various media (print, television, cinema, etc).<sup>9</sup> My approach is different in that I want to move beyond the question of the representation of medicine in the media into an engagement with the entwining materialities of media and medicine as *platform practices*.

At least three theoretical vectors help to map this domain. The first is McLuhan's claim that all media are prosthetic mediations – extensions and amputations – of the human sensorium, a controversial theory that nonetheless calls attention to the manner in which media and medicine possess a common terrain of operation: reworking the materiality of human bodies.<sup>10</sup> The second vector involves the claim that new media (commonly associated with the digital) and medicine (commonly associated with the biological) are becoming promiscuous with their material substrates. As Mitchell (2007) points out, contemporary “new media” encompasses both the informatics of digitality and the wetware of biomedicine. Similarly, contemporary medicine produces and operates on bodies that are both “flesh and blood” and “bits and bytes.” In other words, as Waldby (2000), Lenoir (2004) and others have argued, medicine increasingly deploys digital images and simulations as “operative images” that represent (signify as well as stand-in for) their “analog” flesh and blood counterparts. At the same time, bioscience increasingly conceives of the cognitive and biological processes of human wetware in terms of information, communication, computation and (genetic) code. Finally, I argue that both medicine and new media share a common concern with the question of mediation. While this may seem obvious in the case of new media (media are precisely that which mediate), it is also true, as Lenoir (2004) notes, that “surgery demands an interface.”

The issue of mediation in medicine is not new, of course. I read, for example, Stanley Reiser's seminal Medicine and the Reign of Technology in precisely these terms, as a history of

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<sup>9</sup> A notable exception in that volume is Lenoir (2004).

<sup>10</sup> See McLuhan (1994). To return to McLuhan is, of course a controversial move within cultural studies, given Williams' influential critique that McLuhan aestheticizes, abstracts and de-socializes media technologies. For Williams' critique, see his important Television: Technology and Cultural Form (Williams, 2003). Kember (2006) suggests that the influence of Williams' critique of McLuhan within cultural studies has significantly limited the field's ability to adequately deal with techno science.

changing spatial, temporal, and technical mediations in the dynamic field of technique, perception, knowledge and intervention that constituted medical practice from the 17th century to the 1970s. Reiser adeptly illustrates how medical technologies signal different modalities of the doctor-patient interface, and consequently introduce into the history of medicine configurations of (and anxieties about) changing spatial, temporal and technical mediations. For example, Reiser outlines how, in the 17th and 18th centuries, physicians' reliance on patient self-narration of symptoms as sufficient medical evidence enabled a postal system of telemedical diagnosis and treatment, medical practice mediated by mail. Changing configurations of what constitutes modern medical evidence, as well as new technologies and techniques, such as pathological anatomy, the protocols of the physical examination, and even the spatial arrangement of the hospital, produced a different configuration, one "dependent upon the geographic proximity of doctors to each other, to patients, and to the implements of technology" (Reiser, 1978: 197).

A shift toward greater physical immediacy between patients, doctors and technologies did not erase mediation as a problematic in medicine, however. For Reiser, the issue of mediation shifts at this historical moment from one of *spatial* mediation to *technical* mediation of the physician's sensory apparatus by a myriad of monitoring, diagnostic and visualization technologies. Historically, this mediation was embodied in two forms, augmentation and displacement. Jonathan Sterne (2002), for instance, discusses how the invention of the stethoscope augmented the aural capacities of the physician by inserting a mediating technology, a hollow tube, between the physician's ear and the patient's chest. He argues that the stethoscope prompted the emergence of a medicine-specific form of media technics: techniques of "mediate auscultation" (as opposed to "immediate" auscultation – the physician's ear on patient's body). Sterne outlines how these techniques and technologies of mediation remobilized and reconfigured the physician's senses in the name of, and in relation to, reason. In Sterne's analysis, the stethoscope involved both a reworking of the materiality of the patient and the sensory apparatus of the physician, who became, ideally, a virtuoso at identifying the auditory signs of vital "flow" and "pathology." In these cases, the physician was, in a sense, made super-human by prosthetic sensory media technology.

Other technologies displaced and replaced the physician's unaided sensory apparatus. For instance, in his essay "Technology and the Senses in Twentieth Century Medicine," Reiser cites how the now-mundane technologies of the thermometer, the X-ray and the electrocardiograph supplanted the physician's sense of touch in the reading of subtle gradations of a patient's temperature, or the audile/tactile sense involved in determining if a bone was broken (crepitus) or if a pulse exhibited subtle deviations from the norm. In their place, these technologies offered numeric (a temperature reading in degrees Fahrenheit), pictorial (an x-ray image) and graphical (an EKG tape) representations that, within the context of an emerging scientific rationality that valued objectivity, standardization and reproducibility, were seen as far superior to the merely subjective and potentially biased "sense data" gathered by the unaided physician. As Reiser puts it, in relation to this "self-registering" evidence, "the doctors and their senses were found wanting" (1993: 267). These developments, interestingly, did not reduce the relative power of doctors within the social hierarchies of medicine, even though these technologies did introduce a form of "deskilling" into medical practice. As both Reiser (1993) and Sandelowski (2000) point out, the skill involved in medical practice was dissociated from practices of medical observation and re-articulated onto practices of diagnostic interpretation. The dissociation of medical observation from the body of the physician was ultimately recuperated by a two-fold renegotiation of the "proper domain" of the physician vis a vis other medical personnel, such as nurses.

Reiser's and Sterne's work helps us trace the emergence of medicine-specific forms of modern media technics. Reiser's analysis leaves off in the mid-1970s, however, just at the point of emergence of the then-new technologies of telecommunications and computation that are central to the tele-robotic operation of surgical systems like the dVSS. I envision my own project, then, as an extension of Reiser's analysis into the contemporary moment. What are the effects of "new media in medicine" at this particular juncture? New media yield new modes of mediation, and, in turn, different configurations of embodied power/knowledge in medicine.

Interestingly, for example, we are witnessing a return (and growing acceptance) of the spatial mediation of care enabled by tele-videoconferencing technologies. In fact, California-based InTouch Health markets the RP-7® Robot, a so-called “rounding robot” that allows a physician to conduct rounds remotely (see image at right). This return of spatial mediation, however, does not abandon an investment in proximity as a component of care, but instead refigures relations of proximity to allow for “virtual” or “remote presence.” Again, this technology figures as an augmentation or empowerment of the physician. As InTouch Health states on their website, <http://www.intouchhealth.com>:



Photo courtesy of InTouch Health, 2009

Remote Presence is the ability to project yourself from one location to another to hear, see, talk and move around as though you were there. Using telecommunications and mobile robotic technology, a physician can visit more often with patients and hospital staff. With the impending aging demographic crisis, Remote Presence plays a key ‘force multiplying’ role enabling the healthcare work force to meet the ever increasing demands of the healthcare system.

InTouch surrogates human presence with a mechanized platform. The machine becomes a doctor who performs care “as if” he—the flesh and blood doctor—were there. The performative dis/placement of the physician answers a metaphysics of person-centered presence with technologically reproduced multiplicities of person-like presences.

Alongside the resurgence of technologies that mediate medical care spatially are technologies that threaten to displace and perhaps replace not just medical observation but *medical interpretation*. Let me pursue, for example, Reiser’s example of the electrocardiograph. If technologies like the electrocardiograph “made it possible to separate the act of receiving medical data from the act of interpreting it,” then contemporary innovations in electrocardiography suggest that the cognitive labor of interpreting medical data might be soon be displaced from the *domain propre* of the contemporary doctor. Atul Gawande, for example, tells of research conducted in Sweden to gauge the ability of artificial intelligence software to perform against a human expert in the interpretation of EKGs, a study Gawande calls “the

medical world's version of the Deep Blue chess match" (2002: 35). Lars Edenbrandt, an MD/PhD with expertise in artificial intelligence, developed a computer system to learn to identify EKGs whose electrical signatures indicated a heart attack. Gawande continues:

[T]he machine grew expert at reading even the most equivocal of EKGs. Then [Edenbrandt] approached [Dr. Hans] Ohlin, one of the top cardiologists in Sweden and a man who ordinarily read as many as ten thousand EKGs a year. Edenbrandt selected two thousand two hundred and forty EKGs from hospital files to test both of them on, of which exactly half, eleven hundred and twenty, were confirmed to show heart attacks. With little fanfare, the results were published in the fall of 1997. Ohlin correctly picked up six hundred and twenty. The computer picked up seven hundred and thirty-eight. Machine beat man by 20 percent" (2002: 37)

Since that study was published in 1997, Edenbrandt's research group has expanded its research to include "decision support systems" to aid physicians in the interpretation of diagnostic images such as CT images, arguably much more complex in nature than a EKG. This dissertation explores, in part, a parallel set of mediated displacements in surgery brought about by the dVSS. As surgical technique becomes more and more mediated, and potentially automated through robotic technologies, surgeons tend to disavow their manual practice and suggest that their real domain propre is what they refer to as "surgical judgment," a notion that I will take up later in the dissertation.

### **New Media: A Disclaimer**

For me, differential determinations of the distinctiveness of "new media" bear an additional danger when the distinctiveness is articulated according to a (binary) logic of new versus old, a binary that often tends to fetishize "the new." Much can be said about this tendency – it can be located in a modernist logic of difference; or in a capitalist logic of "planned obsolescence" that drives ever faster the pace of contemporary commodity consumption, or in a contemporary "forgetting of history." Pursuing these lines of critique, some scholars, such as Carolyn Marvin and Lisa Gitelman, relativize contemporary claims about the radical novelty of the new (media) through historical work that considers "when old [media] technologies were new" (Marvin, 1990; Gitelman, 2006). Their work historicizes taken-for-granted "old media" by attention to the moments of their emergence as new media technologies, when their "location" in culture and networks of communication and power were neither as stable nor as naturalized as they

might seem to be today, when dominant and pre-existing fantasies about the possibilities of the new media hold much sway in contouring their actualization. As a consequence, the purported radical “newness” of contemporary new media (whether utopic or dystopic) gets blunted. This happens through the re-presentation of similar fantasies and fears that accompanied the emergence of older, now-taken-for-granted technologies such as the telephone.

Further, such work displaces the tendency in media studies – new media and old – to position media technologies as the engine of history. As Acland puts it:

In fact, I would go so far as to suggest that few phrases have been evacuated of meaning, and have outlived their critical usefulness, faster than “new media.” If there is a reigning myth of media, it is that technological change necessarily involves the “new” and consists solely of rupture from the past. It ignores the way the dynamics of culture bump along unevenly, dragging the familiar into novel contexts. (2007: xix).

For the purposes of this dissertation, then, I want to highlight how the new/old binary tends to over-amplify the effectivity of “new media” in determining the contemporary moment (not to mention the future). This dichotomy diminishes and sometimes erases the continued effectivity of older media still operating in the contemporary context, as well as other social and economic forces.

Rather than “new media” I would prefer to use the term “emergent media” to describe innovation in media form and technology. [Here I am following Williams (1973) and more recently Acland (2007).] Accordingly, this approach acknowledges the fact that dominant and residual media are still “in effect”, exerting effectivity in the present, in the contemporary context, alongside vectors of newly emergent media, even as the rhetoric of “new media” asserts their obsolescence. With his notion of the “emergent,” Williams sought to convey “that new meanings and values, new practices, new significances and experiences are constantly being created” (1973). On the other hand, “the residual, by definition, has been effectively formed in the past, but it is still active in the cultural process, not only and often not at all as an element of the past, but as an effective element of the present” (Williams, 1977: 122). As Acland points out, Williams’ “categories of the residual and emergent . . . act as prefiguring formations for the not yet fully dominant” (2007: xx). In this way, I hope to bear witness to the

pressure of both the residual and the emergent as forming the condition of possibility for the contemporary moment. I do so while keeping open the question of future articulations (rather than subsuming transformation under a teleology of the “new”). I intend this to be a materialist approach to media – understanding how we, in our media(ted) practices, make history, under conditions not of our own making. Acland describes this conceptual framework as “a materialist process, wherein ever-shifting social conditions arise from ever-present preexisting ones, as well as opportunities for struggle” (2007: xxi). As such, emergent media can’t be thought in isolation from dominant and residual media, nor other emergent, dominant and residual lines of force that constitute a particular context.

To put it succinctly, my interest in this dissertation is in the materiality of media practices in medicine, some of which are residual, some dominant, others that are emergent or “new.” Even emergent technologies are assemblages of both innovative and “old” devices, of “new” as well as dominant and residual ways of seeing, of conflicting modes of spectatorship, and remediations of dominant media forms. In fact, I’m not even interested in media *per se*, but in media-in-relation, within relations of power; within configurations of technologies, bodies, knowledges and institutions, or what Foucault might call an “apparatus.” As always, we find ourselves *in media res*. Despite these reservations, however, I continue to use the term “new media” in part because, for better or worse, it defines a field and a set of intellectual practices that I want simultaneously to augment and contest.

### **Interdisciplinary Objects: Meaning, Materiality, Anxiety**

In her essay “Performing Show and Tell,” a reflection on the “parallels, discontinuities and enmeshments between performance studies and visual culture studies,” Shannon Jackson suggests that performance and visual studies share a “disciplinary likeness” in their “invocation of a list of expanded objects” of inquiry (2005: 164, 167). If visual studies innovates by expanding the repertoire of relevant objects from fine art to visual culture in all of its contexts of in/visibility, performance studies makes a similar move, opening its aperture to let in everything from the proscenium-staged theater event to carnival to performance in everyday life. As Jackson aptly notes, however, this expansion is wrought with anxiety. For example, Jackson cites the anxiety of supplementarity, the anxiety that the incorporation of an expanded set of objects

will “never be benignly additive but always anxiously substitutive” (2005: 166). Jackson also points out that an expanded disciplinary field incites anxieties about the expertise required to engage, using the tools of one’s own discipline, with the objects “proper” to another field of study. She writes that:

While visual scholars worry about the appropriateness of studying baseball cards or wonder whether their colleagues really know enough about bio-imaging to think anything worth saying, parallel scholars in theater and performance worry about the prospects of someone who studies the ‘performance of picnics’ and wonder if their colleagues really know enough about ‘the performance of surgical practice’ to say anything worth hearing.” (Jackson, 2005: 167).

Insofar as my project engages both medical imaging technologies and the performance of surgical practice, I risk a double indictment, double anxiety. What do I, as someone who hails from a Department of Communication Studies, have to say that’s worth hearing about the emergence of robotics in surgical practice and pedagogy? I experienced anxiety acutely every time I described my research interests within the space of the OR. If, as I noted earlier, the circulating nurses literally didn’t know where to place me within the physical configuration of bodies in the OR, I struggled throughout my observations to position my research within the conceptual and discursive space of medicine. When describing my research project to the medical students who often observed next to me, I’d explain “I’m part anthropologist, part computer scientist.” This was usually met with silence, or worse, “oh, I took an anthropology class in college once.” Positioning my research in relation to the data-driven context of evidence-based medicine was even more difficult. “How would you quantify that?” was a question too often posed to me by the attending surgeons and more experienced surgical residents, at times suspiciously, at others amusedly. My expressed interest in understanding how the dVSS functions to shift configurations of expertise among surgeons was translated into “Oh, so you’re interested in the surgical learning curve. We’ve done some studies of that; I can get you the data. It’s about 50 procedures.”

The ways in which I was articulated in the operating room suggest that disciplinary identifications are a means of (perhaps) falsely purifying entangled domains of practice. What utility does my analytic bring to the life and death practices in the operating room? Am I simply

adding an anthropological overlay — about the social and cultural meaning of robotics in the lifeworld of the OR — to the “real work” of medicine, critical work that deals in blood and guts, the visceral materiality of the body? I argue that cultural work is critical work that traverses the material as well as the semiotic, that this kind of research matters to the material work medicine does. In The Body Multiple: Ontology in Medical Practice, Anne-Marie Mol questions the fundamental distinctions upon which these anxieties hinge, distinctions between meaning and materiality, between the social and the body. She wonders about a critical practice that not only “interprets reality” but has the “power to mark physical reality:” (2002: 11). She suggests that this power was ceded to the sciences in the 1950s, through the founding work of medical sociologists like Talcott Parsons. For Mol,

relating to [Parsons'] work allows someone fifty years later to discover how the social sciences established their rights to speak about health care and sickness in the 1950s—and at the same time how they set limits on this right. They turned the domain of the social into what they were competent to speak about. In this way, the social sciences delineated an object of their own and granted biomedicine the exclusive right to talk about the body and its diseases. (2002: 13).

The disciplinary division between the social and medical sciences was predicated on an empirical positivism borrowed from and shared with the natural sciences, by which the material object was distanced from the subject-scholar or practitioner in what has become a classic subject-object relation. This relation is of course exacerbated by the renewed materiality or object-ness of the mediated/remediated body.

Contemporary medical futurists such as Dr. Richard Satava claim that medicine is no longer about blood and guts, but about bits and bytes. For someone trained in Communication Studies, such an assertion would seem to position medicine firmly as an “object” of my home discipline: medicine as media, as communication, as information. I align myself, however, with an array of communication and cultural studies scholars who hold fast to the embodied nature of digital experience and the materialities of information, communication and computation. As such, this dissertation still seeks to traverse and to trace the semiotic and the material across crisscrossing circuits of blood and guts, bits and bytes, informatics and practices of care.

## Sites of Inquiry I - Robotic Surgery at University Hospital

Le bloc opératoire en est le cœur ; c'est la scène d'un théâtre qui me fascine et m'attire ; c'est le lieu le plus mystérieux, la scène de mes peurs et de mes fantasmes ; une zone protégée que seuls les initiés ont le droit de pénétrer ; c'est le territoire des chirurgiens, une tribu arrogante et secrète, des guérisseurs qui retardent la mort et rendent à la vie.<sup>11</sup>

— Benoît Rossel, *Le Théâtre des Opérations* (2008)

“University Hospital” is a prestigious teaching hospital, with a strong reputation nationally and internationally for its leading-edge care and exceptional medical school. University Hospital owns 2 of Intuitive Surgical's platforms, a first generation *dVSS* with an accessory 4th arm, and a second-generation HD “S” model. As part of my research for this dissertation, I spent close to six months observing the use of the *dVSS* on the hospital's urology and gyn-oncology surgical services. In all, I observed 38 surgical procedures. The majority of them were robot-assisted radical prostatectomies and hysterectomies but my observations also included robotic-assisted pyeloplasty and partial nephrectomy. I also observed non-robotic procedures — both open (radical nephrectomy, uterine fibroid removal, as well as a colostomy reversal) and traditional laparoscopic (radical hysterectomy) — in order to better understand the differential specificity of these particular surgical practices.

Gaining research access to the operating suite, one of University Hospital's most restricted areas, was no easy task. Beyond the usual IRB approvals, a 7-page legal contract was drawn up by University Hospital's legal counsel, establishing between my home academic department and University Hospital's Department of Urology a six-month “educational preceptorship,” a recognized mode of supervised practical experience and training within the medical sphere. I provided documentation that I had obtained the required immunizations and that I had successfully completed University Hospital's online HIPAA training. An attending urology surgeon agreed to serve as my preceptor. Once fully vetted by the hospital administration, it was largely through this surgeon's goodwill and guidance that I was able to conduct my ethnographic research. Introduced to the protocols that one must traverse to enter University Hospital's restricted areas — protocols that I in many ways transgressed — I obtained my own

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<sup>11</sup> Translation: “The operating block is [the hospital's] heart; it is a theater that fascinates and attracts me; it is the most mysterious place, the stage of my fears and of my fantasies; a restricted area that only the initiated may enter; it is the territory of surgeons, an arrogant and secretive tribe, healers who delay death and bring back life.”

set of University Hospital's green surgical scrubs and made use of the physicians' locker rooms, even had a permanent locker assigned to me, with a nameplate that read "Dr. Olsen" (my name misspelled, I joked, so that being called "doctor" couldn't go to my head). And yet once these conditions of access were met, my movement in the hospital was relatively unfettered. I received the Urology surgical schedules on a weekly basis via email, and was able to come and go as I pleased. Indeed, I found that the aura of restriction, of the OR as bounded space, was largely just that. University Hospital's main suite of operating rooms sits off a main hallway and can be entered through a door that does not require swipe-card authorization for access. I found that with a pair of green scrubs and an ID (any ID, actually) attached to one's scrubshirt pocket functioned as a passport to the most of the hospital, so long as you acted like you knew where you were going. In fact, I was never able to work out obtaining card-swipe authorization to the women's and children's OR, where the gyn-oncological procedures were conducted using the more advanced *dVSS*, the S model. But if I paced the hall outside the OR suite for 30 seconds or so, I could slip in behind the relatively constant flow of traffic in and out of the main door.

Not that my movements were completely unbounded; fluid movement required adopting the quotidian habits particular to the OR. These habits are both socially and spatially structured. Fox (1997) suggests that the spatial organization of the OR, its "physical boundaries and barriers enable, and help to constitute, a regime of sterility which organize sets of movements through the surgical spaces: movements of bodies, staff and instruments" (650). Different spaces have different regimes of sterility. As one moves about from the general environs of the OR, into the OR itself, and approaches the "sterile field" that surrounds the patient during a surgical procedure, one's mobility is marked by increasing constrictions on comportment that correspond to the increasing requirements of asepsis in each space. Fox (1997) calls these structured mobilities "circuits of hygiene" and suggests that patients, surgical staff and instruments all travel within different, but intersecting circuits. No one ever entered the suite of operating rooms except in scrubs and a surgical cap (or in the "bunny suit" reserved for visitors who came in their street clothes). Entering the operating room itself required a sterile mask, of course, even if it was just held in place rather than tied on. And the

nursing staff quickly checked the identity of anyone they did not recognize, and recorded the name and position of everyone observing in the OR.

The OR is both a bounded space *and* a space of flow. As Moreira notes:

Our familiarity with the operating room as a bounded space is in tension with our knowledge that its activities depend on resources organised outside this space: electricity, sterilised materials, radiographic prints, technological and medical standards, etc. How are we to think about the relationships between the operating room and the other locales on which it depends, between this locale and the 'global' on which it depends or in which it is included? And how can we describe the relationships between these different types of spatial relations? (Moreira, 2004: 53)

Accordingly, it is a space of and in tension, between public and private, between the sacred and the profane, and, crucial for my purposes, between the professional and the popular. While the surgeons I observed relentlessly maintained that the robot was simply a new surgical tool, it was clear that the circulation of "the robotic" preceded and exceeded the sterile instrumentalism of the surgical profession. Flows of popular culture co-mingled amidst "circuits of hygiene." These flows varied in intensity, but one afternoon in the OR was saturated with popular and professional figurations of the robotic. We waited for pathology reports to come back on some tissue excised during a radical prostatectomy. The focus of attention in the OR dispersed from the procedure into several side conversations. The senior resident at the Surgeon's Console sang along with the mix of tunes pouring out of the always-present iPod. At one point she exclaimed, "Hey! Look everybody! I'm doing 'the robot!'" The Endowrist instruments did a pop and lock on the LCD display, suspended above the patient's prostate. Everyone laughed. Conversation shifted to a debate between the attending surgeon and the medical student *du jour* about whether or not the latest summer action flick was worth the price of admission. The film was *Iron Man*, whose main character, a billionaire genius engineer, creates a mechanized suit to save his own life, later perfecting the robotic exoskeleton to assume the superhero persona Iron Man. No one caught my ironic glance up at the imposing robotic arms stretched out over the patient. Conversation halted abruptly when the OR telephone rang with the verdict from the pathology lab: no evidence of cancer in the biopsy. Relieved, the surgical team re-aggregated their focus on the task at hand. The iPod speaker volume was turned back down, but not before I registered the song that had just begun to play.

“More Human Than Human.” I scribbled it down in my observation notebook, only later recalling that the band White Zombie titled their single based on a line from the 1982 cyborg classic *Blade Runner*.

### **Sites of Inquiry II - Intuitive Surgical, Inc.**

Intuitive Surgical, Inc designs, manufactures and markets the *dVSS*. The company’s signature product can traced back to the Stanford Research Institute, later known as SRI International. SRI was created in 1946 by the Trustees of Stanford University as a non-profit scientific research institute to promote technical and commercial innovation on the West Coast. Its major activities have centered around conducting government, commercial and private foundation-sponsored R&D, which often produce “strategic partnerships” and spin off for-profit companies. SRI also licenses the technologies it develops through its R&D activities. In the 1960s, SRI was home to Douglas Engelbart’s lab, the Augmentation Research Center; a team of researchers led by Engelbart that developed many of the constituent technologies of the personal computer, including hypertext, the bitmapped screen and, notably, the computer mouse. In 1970 SRI became independent from Stanford University and was legally established as a California Non-Profit Benefit Corporation. From 1966 to 1972, SRI’s Artificial Intelligence Center developed Shakey, the first robot capable of sensing its environment and autonomously navigating its own course.<sup>12</sup>

In the mid-1980s, SRI, under contract to the U.S. Army in the mid-1980s and later funded by the National Institute of Health, developed the tele-robotic surgical prototype on which the *dVSS* is based. The goal of this initial prototype was to explore the feasibility of distance tele-surgery: would it be possible to perform remote telesurgery by leveraging robotics and satellite telecommunications to conduct surgical procedures on the battlefield while keeping the surgeon hundreds of miles from harm’s way? In addition to military interests, SRI also actively demonstrated this early prototype to various venture capitalists and medical administrators, hoping to illustrate the potential for tele-surgery in the emerging field of tele-medicine. Telesurgery, SRI argued, might allow a single specialist - a master surgeon - to operate in many different operating rooms around the country or around the world, in a single day,

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<sup>12</sup> It is ironic that the research that would eventually lead to the *dVSS*, which eliminates human hand tremor, would be called “Shakey.”

without having to travel. The biggest obstacle to this version of telesurgery proved to be the disorienting time lag that network latency introduces into the circuit between a surgeon's hand motions, the remote robotic arm movements, and the video transmission of those motions back to the surgeons. As a consequence, SRI's marketing efforts of their tele-surgical prototype were largely unsuccessful.<sup>13</sup>

However, Dr. Frederic Moll, cofounder of several medical device companies that have focused on innovations in laparoscopy, took interest in the prototype for a different reason. According to Moll, "What got me excited wasn't the remote-surgery aspect . . . but the way the system eliminated the need for a hand to be directly connected to a surgeon's instruments. It offered new ways of solving the challenges in minimally invasive techniques" (Ditlea, 2000). In November 1995, Moll, John Freund (a Harvard MD/MBA) and electrical engineer and ultrasound device entrepreneur Robert Younge founded Intuitive Surgical Devices, Inc., after Freund successfully negotiated and entered into a licensing option agreement with SRI on September 12, 1995. The licensing agreement between Intuitive Surgical and SRI was signed in December of 1995 and granted Intuitive Surgical licensed access to "certain patent rights and know-how regarding Telepresence Surgical Technology" owned by SRI (Intuitive Surgical - SRI License Agreement).

Intuitive Surgical received FDA approval for the *dVSS* to assist with surgery in 1997. This initial approval allowed the *dVSS* to be used in conjunction with only a limited set of non-sharp instruments - blunt dissectors, retractors, stabilizers — and its endoscopic camera system. This was referred to as an approval to use the *dVSS* to "assist" in surgical procedures. In 2000, however, the FDA cleared the *dVSS* to perform laparoscopic procedures, authorizing scissors, scalpels, forceps, needle holders, clip applicators and electrocautery instruments so that the system could be used for the additional indications of grasping, cutting, electrocautery and suturing. In

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<sup>13</sup> SRI continues research in the area of tele-surgery, most notably in conjunction with the TraumaPod project. SRI and the University of Washington's BioRobotics Lab are co-PIs on this jointly funded DARPA/TATRC initiative, which also includes partnerships with General Dynamics Robotic Systems, the Oak Ridge National Laboratory, the University of Texas, the University of Maryland and Robotic Surgical Tech, Inc. The goal of the project is to create a mobile robotic surgery platform. SRI's major contribution is the M7 surgical robot, a several-generation descendent of the original SRI prototype, which recently conducted the first "acceleration compensated" medical procedure in zero gravity and has been able to overcome network latency issues successfully enough to perform telesurgery over 1,200 miles of the public Internet. The TraumaPod also includes Penelope, a robotic surgical scrub nurse, and a machine vision system (TraumaPod MVS) designed to count surgical supplies, both developed by Robotic Systems & Technologies, Inc.

other words, the *dVSS* was cleared to perform the array of manual practices that constitute the craft of surgery. The *dVSS* has since been approved for an array of surgical procedures in urology, gynecology, cardiothoracic and general surgery.

Since going public in 2000, Intuitive Surgical has become a revenue-generating powerhouse. In 2008 its revenues increased to \$875 million, up 46% from 2007 after three consecutive years of 60%+ growth for the company. According to its latest financial reports to its investors, reflecting all four quarters of 2008, Intuitive Surgical's operating profit was \$311 million, up 50% from 2007. Its current cash assets are estimated at \$902 million. Intuitive Surgical describes its business model as "essentially a 'razor/razor blade' operation. Initially, we sell and install the *da Vinci* Surgical System into new customer accounts. Once systems are sold into customer accounts, we generate recurring revenue as our customers use the system to perform surgery and, in the process, buy and consume our EndoWrist instrument and accessory products. We also generate recurring revenue from system service" (Intuitive Surgical - Investor FAQ). The average sale price of Intuitive Surgical's "razor," the *dVSS*, is \$1.34 million and the most feature-rich systems "retail" for \$1.7 million. Thus, the sale of "razors" has generated \$455 million in revenue as of Q4 2008. In terms of "razor blades," each surgical procedure generates revenue of \$1,300 - \$2,200, the per-procedure cost of Intuitive Surgical's patented EndoWrist instruments, which have a life cycle of only 10 procedures, enforced by a microchip that prevents use after the procedure limit is reached (and conveniently ensures that only Intuitive Surgical-manufactured instruments can be used). The sale of "razor blades" has generated \$293 million in revenue as of Q4, 2008. Finally, the company's two-tiered service plans cost hospitals on average \$140,000 per *dVSS* annually, generating \$127 million in revenue in 2008.

Intuitive Surgical's FDA clearances provide it with a virtual monopoly in the field of surgical robotics, and the company possesses exclusive rights to over 600 patents. Total investments in intellectual property during the year ended December 31, 2008 were \$43.5 million (Intuitive Surgical - Annual Report 2008). As a consequence, the company places a premium on intellectual property. According to the company's Code of Business Conduct and Ethics, "Protection of ISI's intellectual property — including its patents, trade secrets, copyrights, trademarks, scientific and technical knowledge — is essential to maintaining our competitive advantage. The intellectual property you generate while doing your job contributes to ISI's

strength, and you have a duty to protect these valuable assets from misuse and unauthorized disclosure” (5). At Intuitive Surgical, knowledge = property = surplus value. I highlight this facet of Intuitive Surgical’s business operations here to underscore how central the commodification and privatization of knowledge is to the company’s success, an issue that I take up later with regard to the production of embodied surgical knowledge in the contemporary teaching hospital and how the *dVSS*, potentially at least, intervenes on the surgeon’s “ownership” of her or his knowledge and skills.

During the course of my research, I interacted with Intuitive Surgical on a number of different levels. Their official website, <http://www.intuitivesurgical.com> provided a wealth of information and insight on how the company positions its product across several different audiences, from patients to surgeons to hospital administrators to current and potential investors. From this website I was able to access Intuitive Surgical’s annual reports as well as PDFs of PowerPoint presentations made to investors on a quarterly basis. Intuitive Surgical’s main website also linked to several minisites that focused on promoting to patients the *dVSS* in relation to particular procedures (<http://www.davincisurgery.com>, <http://www.davinciprostectomy.com>, and <http://www.davincihysterectomy.com>). I also interacted on several occasions with a field representative for Intuitive Surgical who worked closely with the surgeons at University Hospital. Ravitch (1987) suggests that the presence of sales personnel in the OR poses issues for surgical authority and potentially challenges surgical expertise. He writes

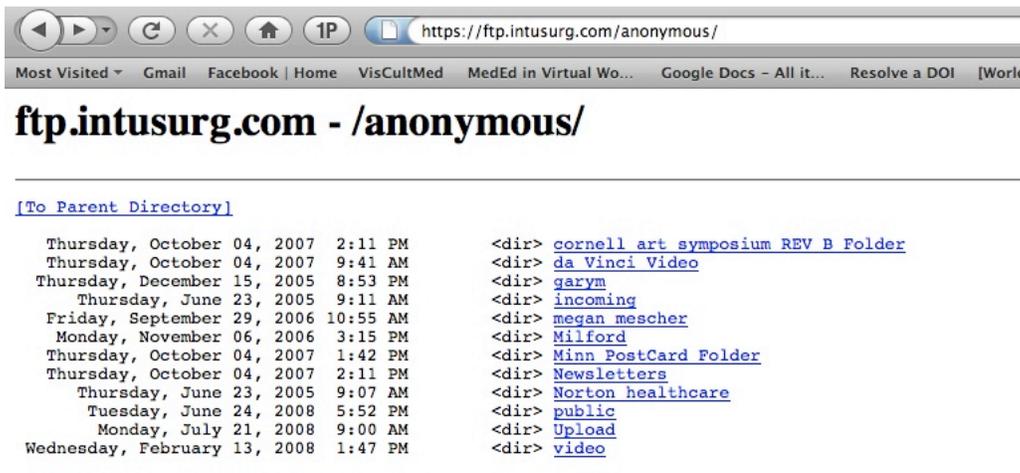
The role of the company representative is the one most often questioned when [the company’s] device is one to be used in the operating room . . . The surgeon cannot turn an intrinsic portion of his operation over to a mechanic versed in the use of a device, much though he would appropriately benefit from advice from such a source as to the manner in which the device itself is operated, i.e., turned on or off, made to cut more or less rapidly, perhaps the angle at which it is to be held” (Ravitch, 1987: 133).

However, I did not see this interaction as anything but a collegial partnership, which suggests that contemporary surgery, reliant as it is on technical devices, requires understanding surgical expertise as necessarily distributed, a condition that often results in tight corporate-medical (and in the case of University Hospital -university) enmeshment. The Intuitive Surgical field

representative provided me with several promotional and educational flyers and CD-ROMs that were geared toward surgical professionals and provided comprehensive descriptions and video demonstrations of procedures conducted with the *dVSS*. Finally, I was able to receive from Intuitive Surgical's Applied Research Group information on the *dVSS*' Application Programming Interface, or API, which provides, through proprietary means, access to the data streams produced by the *dVSS* while it is being used to perform surgical procedures.

Crucially, and perhaps controversially, my research also draws upon materials downloaded from Intuitive Surgical's WebDAV server. I encountered this publicly available website during the course of my internet research. While I can't recall my original search string, the site is currently still available through a Google search ("intuitive surgical ftp"). Web-based Distributed Authoring and Versioning, or WebDAV, is an extension of the Hypertext Transfer Protocol (http) that allows users to both read file from (as in traditional web browsing) and write files to a web server. As such, it is similar to the older, and perhaps more familiar File Transfer Protocol (FTP). Like FTP servers, WebDAV-enabled servers are typically used to facilitate the distribution of digital files (images, documents, videos) from a central computer over the internet. Authorized users can access the WEBdav server using a "client" that enables them to both upload and download files. Occasionally, WebDAV servers allow for users to access (read and/or read & write) files on the server "anonymously" (e.g. without requiring authorization). This is the case with Intuitive Surgical's server. I've been reticent to inquire about the intended functionality of this file server, as I'm not entirely certain that Intuitive Surgical is aware that its contents are openly available to the public; it has been a rich archive the access to which I don't want to lose. It may be that Intuitive Surgical is aware that these files are publicly available, or it may be that the systems administrators responsible for the server feel that "security through obscurity" outweighs the hassle of enforcing authentication and having to assign usernames and passwords for access. The materials available on the site include product videos, product sell sheets, high resolution images, and marketing materials, as well as 3D models of the *dVSS* and its instruments. Some material, such as ISI's highly-polished marketing collateral, is clearly intended for the public, albeit perhaps not through this media channel. Other material is clearly intended for ISI's sales force, such as a document that provides a script to be delivered while surgeons "test drive" the *dVSS* at professional meetings. Still other material is clearly in draft form, such

as training materials being developed in conjunction with practicing surgeons (including surgeons at University Hospital). Occasionally, a file will be placed on the server that seemingly bears no relation to ISI at all. For example, for a time the site hosted a video clip from the animated television comedy *The Family Guy*. In fact, I've verified that the public is able to upload their own files to this server, which is clearly not a security "best practice," causing me to dream a bit about perpetrating a bit of performative multimedia mischief, such as uploading a poignant clip or two from the 2004 film *I Robot*.



If one locus of my research, the operating room, can be productively described as a heterotopia, so can Intuitive Surgical's WebDAV site. Arguably, the WebDAV site functions as "a counter site . . . in which the real sites" — such as the highly-polished official Intuitive Surgical websites — "are simultaneously represented, contested, and inverted" (1986: 24). Further, as Foucault notes, heterotopias "are outside of all places, even though it may be possible to indicate their location in reality" (1986: 24). To me, this sense of a real yet thoroughly "other" space characterizes well the nature of ISI's online archive. It is real, mirroring ISI's utopic corporate self-representation, while yet "hiding in the light," publicly accessible but thoroughly obscure without serendipitous bit of Google jockeying.

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## THE DA VINCI® SURGICAL SYSTEM: MATERIALIZING TECHNOLOGY, MEDICINE AND CARE

This dissertation focuses on the *da Vinci*® *Surgical System* as a concrete site for thinking through questions about the media specificity of medical technology and the technicity of care. Moreover, I focus on the *dVSS in a particular context*, the urology and gyn-oncology surgical suites of University Hospital. This is necessary, I argue, because these issues cannot be explored in the abstract. Too much discourse about technology tends to elide important differences between technologies, the specificities of their affordances, and the differential affectivities of their articulation with other entities: humans, other technologies, the physical environment, and so on. A similar tendency to gloss over specificity can be found in the medical humanities, which often treat medicine as a singular and unitary discursive formation. Instead, I see contemporary biomedicine as a complex and disjunctive set of discourses and disciplines, each of which differentially addresses the human body, and *practices different ontologies* (Mol, 2002). Medicine, care and technology — and in particular the question of care's relation to medical technology, the politics of medical care's technics — must therefore be evaluated in concrete material contexts, in reference to sets of specific material practices and technologies. Care is an embodied, material practice, not an abstract ethic.<sup>1</sup> Medicine, too, practices its epistemologies and ontologies in material ways, through materially embodied enactments of care and cure. Its techniques are increasingly rationalized into the logic of the protocol. While

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<sup>1</sup> I'm particularly drawn to Maurice Hamington's notion of "embodied care", which he defines as an approach to social relations "that shifts ethical consideration to context, relationships, and affective knowledge in a manner that can be fully understood only if its embodied dimension is recognized" (2003: 32). Drawing on the work of Merleau-Ponty, Hamington brings the centrality of the body into theories of the ethical, arguing that care manifests in embodied habits, material practices that emerge from embodied knowledge of the self and other; not an abstract other; but a concrete, particular other. While embodied care has for Hamington, "a telos of well-being or the flourishing of embodied creatures," the "processes and practices of care are as important as the good." In other words, it's the embodied, performative nature of care that necessitates grounding care in concrete relations, contexts and practices.

I will at times speak of technology and medicine in the abstract, my desire is to keep my analysis materially grounded, specific and concrete.

Two risks attend this articulation of the differential specificity of the *dVSS*. Weber points out one important danger: “The attempt to work out the differential specificity of the medium—to get at what distinguishes it from other media—runs the risk of transforming, albeit unawares, a differential determination into a positive and universal essence” (1996: 109). In order to introduce the *techne* of the *dVSS* system, I begin with a relatively straightforward account of its material specificity. The second risk derives from the fact that this accounting is an interpretive and potentially endless task. As Hayles notes:

“The physical attributes constituting any artifact are potentially infinite; in a digital computer, for example, they include the polymers used to fabricate the case, the rare earth elements used to make the phosphors in the CRT screen, the palladium used for the power cord prongs, and so forth. From this infinite array a technotext will select a few to foreground and work into its thematic concerns. Materiality thus emerges from interactions between physical properties and a work’s artistic strategies. For this reason, materiality cannot be specified in advance, as if it pre-existed the specificity of the work. An emergent property, materiality depends on how the work mobilizes its resources as a physical artifact as well as the user’s interactions with the work and the interpretive strategies she develops—strategies that include physical manipulations as well as conceptual frameworks. In the broadest sense, materiality emerges from the dynamic interplay between the richness of a physically robust world and human intelligence as it crafts this physicality to create meaning.” (Hayles 2002: 32-33)

In context, Hayles is talking about “technotexts,” digital literature that explicitly engages with the material conditions of its expression. Following her argument nonetheless, I want to suggest that any engagement with materiality entails critical mobilization. Materiality is a dynamic interplay between specification and interpretation.

My point of interpretive mobility is governed by two primary methodological frameworks. The first, as I indicate in my introduction, is ethnographic observation. In order to understand the *dVSS in situ* and in relation to the material practices of surgery, access to the ORs at University Hospital has been key. I am not a surgeon myself, so understanding the *dVSS* in the professional culture of surgery, its “lifeworld”, is a critical mode of grounding my claims. It yields

a sense of the technology-in-use, how the *dVSS* gets practiced with, within and against a pre-existing field of surgical and pedagogical practices. Or again, how it produces new objects, affects and effects by bending the trajectories and structures of power and relationality already operative in the contemporary operating room. Consequently, I must tell the story of the *dVSS* from a position of being in material/corporeal articulation with emerging practices—practices of repetition that, in their performance, nonetheless remain unstable and so open to critique and change.

Secondly, I bring to this project a certain “technical expertise” that leverages my own “making sense” of the socio-technical components of the *dVSS*. Having spent the last 10 years working on developing technologies and technological practices that can serve and transform the arts and humanities, this dissertation follows the implications of the *dVSS* as technical assemblage “all the way to the metal” (Kirschenbaum, 2008). In other words, I take specificity and materiality in my analysis literally, and work to reconstruct the technical mechanisms of the *dVSS*’ black box.

Pursuing media specificity of a platform in this manner may tend toward technological determinism. I do want to maintain some sense that technology isn’t just what we do with it. Attention to the materiality of technology must acknowledge its “thing-ness” apart from human use value. This proposition resonates with Gilbert Simondon’s (1958) attempts to articulate a *mechanology*, even as the very terms of differential specificity between human and technology collapse as they interface in increasingly complex ways. Where possible, however, I try to highlight the *relationality* of the system, how its ontology is a function both of its articulation to human actors, as well as the techniques of my own interpretive practices. Part of my analysis then might be characterized as an attempt to balance, perhaps precariously, both vectors that make up the interface of *somatechnics*, “a newly coined term used to highlight the inextricability of soma and techne, of the body (as a culturally intelligible construct) and the techniques (dispositifs and ‘hard technologies’) in and through which bodies are formed and transformed.”<sup>2</sup> Following Richardson (2003), my analysis “underscores simultaneously the equipmental and corporeal — the technosomatic — specificity of seeing and knowing” that is

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<sup>2</sup> See <http://www.somatechnics.mq.edu.au/>

always relational, but articulated by and through the material conditions that shape or “do” these relations (22).

## What is the *dVSS*?

What is the da Vinci Surgical System? Intuitive Surgical, Inc’s website offers this enticing description, portraying the surgical robot as:

...an advanced surgical system that we believe represents a new generation of surgery—the third generation. We believe that this new generation of surgery, which we call Intuitive surgery, is a revolutionary advance similar in scope to the previous two generations of surgery—open surgery and minimally invasive surgery, or MIS. Our da Vinci Surgical System consists of a surgeon’s console, a patient-side cart, a high performance vision system and proprietary “wristed” instruments. By placing computer-enhanced technology between the surgeon and patient, we believe that our system enables surgeons to perform better surgery in a manner never before experienced. The da Vinci Surgical System seamlessly translates the surgeon’s natural hand movements on instrument controls at a console into corresponding micro-movements of instruments positioned inside the patient through small puncture incisions, or ports. Our da Vinci Surgical System provides the surgeon with the intuitive control, range of motion, fine tissue manipulation capability and 3-D visualization characteristic of open surgery, while simultaneously allowing the surgeon to work through the small ports of MIS. (Intuitive Surgical - Investor FAQ)



*Photo courtesy of Intuitive Surgical, Inc., 2009*

This description can be parsed in several ways. First, Intuitive Surgical describes the *dVSS* as the (r)evolutionary advanced offspring of the “previous two generations of surgery,” open and MIS, a prodigy that carries forward the best elements of the previous generations. Second, it defines the *dVSS* as a set of hardware components — a surgeon’s console, a patient-side cart — that map in some fashion to the key elements of the human surgeon’s body: eyes and hands, in particular.<sup>3</sup> Third, ISI defines the *dVSS* as a prosthetic enhancement of the capabilities of the human surgeon in that it enables better precision, better control, greater freedom of movement, and better visualization of the surgical field, all of which yield, in the end, better surgery. Importantly, this prosthetic enhancement, as a product of computational mediation—by placing a computer between surgeon and patient—is, nonetheless, a *seamless* translation. It effectively dispels any notion that slippage occurs any moment of translation as re-presentation (e.g. “Ceci n’est pas une pipe”), or that the tight coupling of human and machine might produce something *other*. In the rest of this chapter, then, I consider these different vectors defining the *dVSS*: a (r)evolution of the surgical interface; a set of components, and a seamless translation of the surgeon’s intention into robotic action, of the surgeon’s eyes and hands into the surgical field.

## The “(R)evolution” of the Surgical Interface

ISI positions the *dVSS* as the next evolution of the surgical paradigm. The story of the “evolution” of surgery is usually told by marking a progressive series of technical “revolutions”: the ability to control hemorrhage through cautery and ligature; the ability to control pain through anesthesia; the ability to control infection through aseptic technique. Not only did each of these innovations radically improve the prognosis of the surgical patient, they also transformed the subjectivity and embodied skills required of the surgeon. For example, prior to the introduction of anesthesia, even minor procedures required adopting a disposition of grim if not sadistic virtuosity, teeth-gritting speed and desperate economies of efficiency:

A complete mastery of the craft was essential—a sureness, a boldness, and a fearlessness, with complete control of the instruments used, were especially

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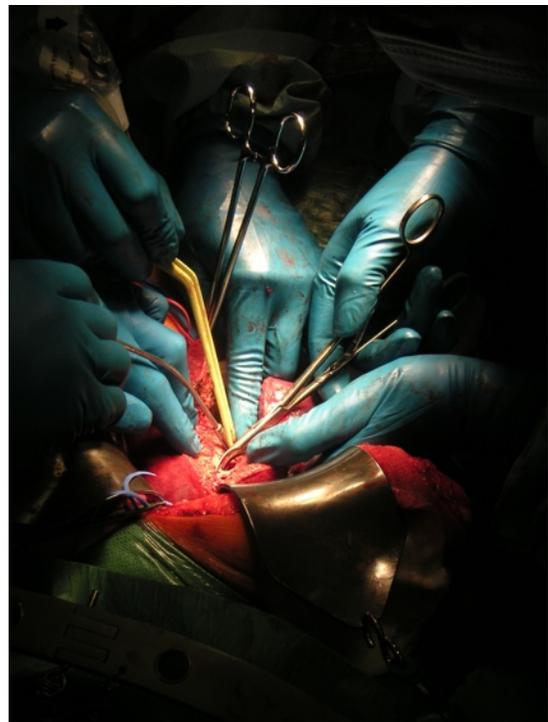
<sup>3</sup> Hirschauer (1991) describes how the practices of “scrubbing in” effectively reduce the surgeon-body to its most instrumental elements, eyes and hands. Not only is the patient immobilized and reduced to the “operating field” through practices of draping, the surgeon’s body is “visually reduced to the light gloves and the region of the eyes” and immobilized as well by the requirements of aseptic technique (Hirschauer, 1991: 285).

necessary, for we can imagine the difficulties due to the movements of the patient and too often the disturbing effect of his moans and cries. (Thomas, 1919: 804)

Surgery here figures as barbarous acts of non-anesthetized torture that more often than not resulted in the patient's death, either from uncontrolled bleeding or the onset of systemic infection. Certainly the introduction of these new techniques "humanized" surgery, as the act of surgery could be performed with less trauma and with a brighter post-operative prognosis. Not surprisingly, narratives of revolution and progress continue to frame innovations at the surgical interface.

## Open Surgery

Within the evolutionary logic of surgical innovation, "in the beginning" were the large incisions of open surgery. Open surgery is so named because it involves opening up the body in often dramatic ways to gain direct access to the surgical field. This mode of surgical practice is predicated on direct, unmediated visual and tactile *contact* between the surgeon and the patient. Large incisions allow the surgeon to look directly into the surgical field, to see and touch *autoptically* the targeted anatomy. Or to put it another way, in the absence of techniques and technologies of prosthetically telemediating these senses, surgery's fundamental reliance on the senses of touch and vision *requires* large, open incisions.



*Image courtesy of Benoît Rossel*

Source: *Le Théâtre des Opérations*, a film by Benoît Rossel. Produced by Pierre-André Thiébaud — PCT cinéma Télévision (Switzerland)

Hirschauer describes open surgery as a strategic "occupation of the patient body":

The surgeon-body extends itself into the flesh: with fingers, clamps, suction tubes and cutting instruments. One layer after the other is removed, camp is pitched, and the expedition continues. Layers of skin and tissue obstructing the

view are cut through and spread apart. Operating becomes a sequence of looking and cutting, of manipulations providing visibility for further manipulations. One must see to cut, and one cuts to see more. Furthermore, organs are shifted for the sake of increased visibility; retractors spread the wound apart, gauze pushes organs aside, sleeves help to shift organs out of the wound. (1991: 299-300)

This particular configuration of the surgical gaze has its roots in the epistemologies of the body inaugurated by pathological anatomy. The emergent techniques of anatomy, Bichat's "opening up a few bodies," produced a body amenable to the operational gaze of the surgeon—a spatial body composed of solids and surfaces, the body proper to anatomical mapping, the localization of disease to lesion—and set the conditions of intelligibility for surgical intervention as a mode of remediating pathology. Foucault calls this mode of visibility the "anatomy-clinical glance" that, in kinship with the clinical gaze, formed the basis of modern medical perception.<sup>4</sup> Unlike the clinical gaze, which Foucault links to aural perception, the glance involves a haptics, a

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<sup>4</sup> Foucault's notion of the "medical gaze" is often taken to be unity. But in fact Foucault identifies two medical gazes in his cartography of medical perception in the 19th century. The first modality is the clinical, observing gaze: "The observing gaze refrains from intervening: it is silent and gestureless. Observation leaves things as they are; there is nothing hidden to it in what is given" (Foucault, 1994: 107). This gaze implies "an open field, and its essential activity is of the successive order of reading; it records and totalizes; it gradually reconstitutes immanent organizations" (Foucault, 1994: 121). The clinical gaze is thus an open, scanning, ever-vigilant surveillant gaze. Over time, however, Foucault argues that "the anatomy-clinical glance became suzerain over the clinical gaze" (1994: 4). "The clinical eye discovers a kinship with a new sense that prescribes its norm and epistemological structure; this is no longer the ear straining to catch a language [symptoms], but the index finger palpating the depths. Hence that metaphor of 'touch' (le tact) by which doctors will ceaselessly define their glance." (Foucault, 1994: 122). Pathological anatomy and clinical observation thus formed a mutually validating and constituting alliance.

In Foucault's analysis itself, then, I find reason to question any unitary conceptualization of the medical gaze. Instead, there are medical gazes, particular configurations of knowledge/power whose particularity, in a given context, can't be glossed over. The clinical gaze, once articulated in a particular apparatus, becomes something else in its relation to other elements in the apparatus, and can be literally refigured over time. If the techniques of anatomy, Bichat's "opening up a few bodies", produced bodies amenable to the anatomy-clinical gaze—a spatial body composed of solids and surfaces, the body proper to anatomical mapping, the localization of disease to lesion—then the techniques of the cinema, as a graphic practice, produced bodies amenable to the "vivifying physiological gaze"—a processual, temporal body. These gazes are differently constituted and different in their effects. If the anatomy-clinical glance was a gaze of bodily surfaces, Cartwright writes that the physiological gaze "regarded the body in terms of its living functions and processes, and its practitioners devised methods and techniques to facilitate a temporal, dynamic vision of the body in motion" (1995: 11).

Media technologies are crucial here – the "new media" of the cinema in Cartwright's analysis was crucial to the physiological inflection of the medical apparatus. Other technological mediations in the medical apparatus produce differently inflected medical gazes. Note that I suggest that the medical gaze Michel Foucault describes is contextually and historically *situated*. He theorizes how bodies came to be "objectified" in a particular domain, at a particular time: the clinical teaching hospital in the 19th century. Too often, Foucault's notion of the medical gaze gets abstracted from the particular context from which Foucault articulated its formation, applied a-historically or mobilized too fluidly across contexts. In other words, Foucault's notion gets deployed unproblematically as a description of the politics of visibility, power and knowledge in medicine without doing the work of articulating how "the medical gaze" constitutes and gets constituted by other contexts, the contemporary clinic, for example, or domains of medical practice not defined by the clinical apparatus.

materializing tactility: “this is no longer the ear straining to catch a language [symptoms], but the index finger palpating the depths. Hence that metaphor of ‘touch’ (le tact) by which doctors will ceaselessly define their glance.” (Foucault, 1994: 122)

Foucault elaborates that the anatomo-clinical glance thus “plunges into the space that it has given itself the task of traversing . . . In anatomo-clinical experience, the medical eye must see the illness spread before it, horizontally and vertically in graded depth, as it penetrates the body, as it advances into its bulk, as it circumvents or lifts its masses, as it descends into its depths” (1994: 136). Implicit in Foucault’s description is how this medical glance both enacts and depends upon manipulation, on an exploratory or expositional *doing* that creates the space of visibility that the glance then “traverses.”<sup>5</sup>

In open surgery, hands are as important as eyes. The sensory “resolution” of the hand far exceeds that of the eye. The hand, for example, can pick out nanoscale variation on a surface that the eye perceives as undifferentiated and smooth. The hand can sense the differentials in tissue viscosity and tensile strength that escape the eye. Further, the hand can see more by virtue of its capacities for tinkering with the properties of tissue, further enabling the perception of subtle gradients of difference. As Hirschauer elaborates:

Bare hands can, for example, make something out and then stretch some tissue to make it more transparent, or they identify nerves by way of their tensile strength. ‘Blunt’ dissection involves stretching, tearing or shifting tissue with one’s fingers, during ‘sharp’ dissection hands serve as holders for the scalpel, scissors or the electric cauterizer. Vessels, skin, tissue and bones are tackled differently depending on the way in which they resist: the skin is treated with the scalpel, the yellow layer of fat and the peritoneum with scissors, muscles with the cauterizer. (1991: 300)

The practice of open surgery is thus sensorily rich and nuanced. The work of the skilled surgeon in an open procedure resembles that of skilled craftsmen, cutting across skills associated with the carpenter, tailor, and butcher (Hirschauer, 1991: 300). As a skilled craft,

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<sup>5</sup> The French “regard” can be translated as both gaze and glance. It is unclear why Sheridan chose to translate “le regard anatomo-clinique” as the anatomo-clinical *glance*. Casey (1999) provides an interesting meditation on the “striking” tactility of the glance that aligns it with medical practices of incision. He writes: “The glance lacerates; not only does it strike, as we signify in speaking of a ‘glancing blow,’ but it also *cuts* . . . Glance-work thus proves to be lance-work. This latter is not to be confused with the separation-work of the intellect that neatly divides space and time into punctiform points and instants . . . Instead, the glance opens tiny tears in the continuous cloth of duration as well as minuscule faults in the surfaces of things, places, and people.” (Casey, 1999: 92-93)

competent execution of a procedure requires of the practicing surgeon a deep and embodied knowledge of the “stuff” of his or her craft. This is knowledge inscribed in hands and finger-tips, skin and muscles, the mnemonics of muscle memory. Learning to practice open surgery involves a rich pedagogy of the senses, and accrues to the sentient body an intimate knowledge of the human body—the color and consistency of tissues, their shape and texture, their temperature, resiliency or fragility. Zetka (2003) refers to this knowledge as “tactile intelligence” (11). A surgeon learns as well to master her tools—the scalpel, scissors, needle and cautery—not only how they “fit” in her hand, but how they interact between hand and the visceral raw material of the surgeon’s art.



*A Bookwalter™ Retractor - ©2009 Codman & Shurtleff, Inc. All Rights Reserved  
BOOKWALTER is a registered trademark of Codman & Shurtleff, Inc.*

The large incision is not the final accomplishment of surgical visibility, however. Its realization is both tenuous and temporary, and must be re-performed many times during an operation. Maintaining the visual integrity of the surgical field can be described as both hard work and *hand* work, by which hands struggle to hold organs in place or out of place, to staunch the blood that always threatens to occlude a clear view of the targeted anatomy, by seepage or torrent. As Hirschauer notes, the almost constant flow of blood is both an obstacle and a “sign of life” within the surgical lifeworld, initiating all manner of non-visual perceptions — e.g., warm and sticky sensations, the specific odor of blood and the stench of the cautery, the

gurgle of the suction (Hirschauer, 1991: 299). Organs slip from grasp, flopping back over the surgical site. A bleeder obscures the contours of anatomy under a wash of red. Retractors stabilize the surgical field, but at the cost of inflicting greater trauma on the body, forcing skin, muscle and connective tissue to stretch to maximum limits. I recall the first open surgery I observed on Dr. Kinema's surgical service. The procedure began with a 5-inch incision, vertically across the patient's navel. But the surgeons used a Bookwalter™ Retractor (pictured above) to force it open to twice that size, by ratcheting retractor spatulas against a rigid steel frame.

### Laparoscopic Surgery: The “Minimally Invasive” Revolution

Laparoscopy “revolutionized” surgery by replacing the long incisions of open surgery with smaller, albeit more numerous, “keyhole” cuts. Instead of a long incision and flesh held back by hands and steel retractors, several small incisions are made in the abdominal wall, which is then inflated with CO<sub>2</sub> gas. Long, rigid, thin instruments are then passed through trocars that hold these small incisions open and into the inflated abdominal cavity. Surgeons visualize the operating field tele-visually, by means of a fiber-optic video camera called a laparoscope or endoscope. A television screen displays a 2-dimensional video feed from the endoscope. The surgeon's eyes and hands are thus extended prosthetically into the patient with minimal trauma.



*Image courtesy of Intuitive Surgical, Inc., 2009*

Often referred to as “band-aid” surgery, the smaller incisions heal much more quickly than the incision required for open surgery, lending to the characterization of contemporary laparoscopic surgery as “minimally invasive.” As endoscopic surgery became the standard of care for many surgical procedures in the 1990s, cultural critics raised important reservations

about the degree to which such practices were truly “minimally-invasive.” Instead, they stressed the continuities with well-established discourses of Enlightenment and the hegemony of the surgeon-subject. Largely perceived as a masculine, voyeuristic, even colonizing form of spectatorship, these critiques of the “endoscopic gaze” emerge out of a feminist critique of invasive visuality, exemplified in the work of Ella Shohat (1998), Christina Lammer (2002), and, most recently, José Van Dijck (2005). As Lisa Cartwright summarizes such arguments,

The imaging of the body’s interior space in medicine and science has suggested to some scholars a narrative of Western advancement characterized by technology’s prosthetic augmentation of the sensory powers already built in, as it were, to the scientific observer’s body. This argument suggests that devices designed to visualize physiological processes in effect enhanced researchers perceptual powers, extending the observer’s epistemological domain into previously uncharted territories—an Enlightenment project that continues in today’s medical imaging technologies. (1995: 23)

Importantly, these scholars challenge us to see that in our contemporary context, the interior of the human body emerges as an important terrain of political struggle. N. Katherine Hayles has argued, for example, that the extension of new techniques of scientific visualization into cyberspace and the “endospaces” of the body offer up both cyberspace and the bodily interior as “areas newly available for colonization” (Hayles, 1993: 185). Ella Shohat perhaps expresses it most emphatically, however, in the following claim: “in an era when X-ray, ultrasound, and video laparoscopy have thoroughly charted the *terra incognita* of bones, chromosomes, and reproductive organs, feminist critique cannot afford to surrender the interior body to the curtained authority of the medical office” (Shohat, 1998: 240)

I find the work of these theorists important for a number of reasons. First, they assert that the social doesn’t end at the surface of the skin, but rather extends into bodily interiors as well.<sup>6</sup> Their interventions counter the tendency within medical practice to strip bodies of their social significations, reducing them to “mere” biophysical objects (an ideology often referred to

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<sup>6</sup> I discuss the significance of Probyn’s (1996) “sociology of the skin” in the next chapter. For Probyn, the image of “stretching the skin” beyond the individual figures prominently in what she calls a politics of “outside belonging.” In other words, rather than conceive of skin as a boundary that encapsulates discrete individuals, Probyn seeks to articulate a sociality of skin, the skin of the social that extends outward from the external limits of the individual body. Insofar as I have an affinity with Probyn’s ethics of belonging, I therefore read attempts to think the social beneath the skin in a similar spirit. Consequently, I have difficulty with feminist critiques that are predicated upon supposed violations associated with permeating the skin-as-boundary.

as “instrumental realism”).<sup>7</sup> To put it another way, they resist the tendency within surgical practice for bodies to become subject to what Michael Taussig calls “phantom objectivity”—a reduction to biological and physical ‘thingness’ in a manner that masks bodies (and bodily interiors) as sites and relay points in a network of social relations (Taussig, 1992: 84). Against a medicine that treats bodily interiors as an asocial, apolitical terrain, whose perception can be ascertained independent of social codes of reading, these scholars render visible the complex politics of race, class and gender that striate the body’s viscera. Furthermore, these scholars raise important questions about the politics of spectatorship in medical practice. If both medicine and media involve interfaces, and if those interfaces are increasingly converging around the (computer) screen, then bringing critical insights from media studies (such as the spectator’s gendered gaze) to bear on media practices in medicine seems an important critical move. Additionally, these critical analyses ask important questions about the materiality of optical and surgical interventions. As Lammer (2002) points out, even though contemporary minimally-invasive procedures reduce invasiveness in terms of requiring smaller (horizontal) cuts, the (vertical) optical and tactile penetration into the body seems no more “minimally invasive” than open surgery. Finally, these critiques raise serious reservations about epistemologies built upon Enlightenment-inspired ideologies of visibility and transparency.

Keeping these important critiques in mind, my analysis however focuses on the flip side of the discourses of enhancement and extension that accompany the endoscopic gaze. Yes, laparoscopic technologies are media(ted) extensions of the human sensorium. Yet every such sensorial extension is also an “amputation”, one that instigates a consequent re-ordering of “sense ratios” and disrupts the regimes of skill associated with open-incision procedures (McLuhan, 1994: 45). Prosthetic extension consists of displacement and distancing as much as it involves enhancement and extension. In his book, *Surgeons and the Scope*, James Zetka provides insight into some of these displacements. He writes,

“The contrast between the laparoscopic and the open-incision cases is pointed. A strange thing happens when the intra-abdominal image is projected on the television monitors: Reality is inverted. The larger-than-life image projected onto the television screen replaces the focus of the body as the focus of attention. This images becomes the real, while the patient’s body serves as a

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<sup>7</sup> For a medical humanities defense of instrumental reason in surgical and imaging practices, see Belling (1998).

mere base from which the surgeon and her assistants manipulate their lever-like instruments. The surgeon did not look directly at the tissue she was working on inside the body. Her hands were not in the picture that was projected onto the screen; they were hovering above the abdomen and guiding instruments that protruded from the puncture ports. Everything was done at a distance.” (Zetka, 2003: 15)

The laparoscopic image on the screen displaces the body of the patient; surgeons seemingly operate on the image, and the patient’s body tends to disappear from conscious acknowledgment. This displacement is often seen as *the* salient issue when considering the ethics and politics of the endoscopic gaze from the point of view of the patient and the politics of recognition. But when considered according to the craft- or labor-politics of the surgical profession, the disappearance of the patient from consciousness is not the only or the essential factor. This disappearance co-exists alongside several other operations that the telemediated prosthetics of laparoscopy performs on the skilled open surgeon’s embodied “tactile intelligence.” First, laparoscopy flattens the display of the surgical field into two-dimensional televisuality, eliminating depth perception and truncating the surgeon’s ability to judge distance in the surgical field. Second, the surgeon’s sense of touch is severely attenuated; sensations transmitted through the laparoscopic tool handles in no way approximate the rich sensations received by the hand in open surgery. The resistance of tissue to the probing intervention of the instrument is felt, but radically diminished by the fulcrum physics of the rigid laparoscopic tools. And these instruments cannot transmit temperature, texture, viscosity — all the detailed qualities constitute the surgeon’s tacit knowledge of the body, of “seeing with” the hand. Finally, laparoscopy inverts several of the habitual embodied relations upon which the open-incision surgeon relies upon for action orientation. One manipulates here, but sees the action over there, on the screen, as in video game consoles like the Wii and Playstation that make use of a television screen and remote controllers. Laparoscopy turns inside out the body’s habitual understanding of intention and action. The fulcrum physics of traditional laparoscopic instrumentation inverts the relationship between hand movement and instrument tip. To move the tip of an instrument upward, the hand grasping the instrument must be moved downward, and vice versa. This, coupled with the 2D view of the surgical field, makes intervening on anatomy an extremely difficult and non-intuitive endeavor.

Making matters even more complicated, the laparoscopic surgeon seldom controls the orientation of the endoscope. Instead, a surgical assistant holds and maneuvers the endoscope based on explicit verbal commands and by intuiting the scopic orientation desired by the surgeon. The assistant and the camera become, in effect, the surgeon's eyes.<sup>8</sup> This simple displacement sunders the coupling of optical and the kinesthetic senses that constitute the "natural" human visual system. More often than not, the eyes and the hands are out of sync, and cannot be fully re-aligned. A skilled surgical assistant, of course, learns to anticipate and approximate the line of sight desired by the operating surgeon holding the instrument handles, but even among skilled surgical teams this separation is never ultimately overcome. And if the surgery requires a spatial reconfiguration of the surgical team, such as the surgeons trading places to afford one or the other a better view or to enable a better surgical approach, orientation gets *un-done*. As described by an ob/gyn surgeon quoted in Zetka (2003):

"You are looking at a screen and transferring [cognitively] what you are doing with your hands to what's on the screen . . . You know, it is hard. I mean you don't know where you are. Once you've oriented yourself and have that all worked out . . . now if you move to a different side of the table, everything has just changed again and you have to retrain your brain." (21)

Weber suggests that this dis-orientation constitutes a key element of the differential specificity of the television medium. Weber argues that televisuality "*transports vision as such and sets it immediately before the viewer*" (1996: 116). In a sense, Weber's argument is a version of the mediation-as-alienation argument, except that Weber articulates it according to both the medium specificity of television *and/in* its relation to embodied human perception. Television doesn't dis-embodiment as much as *split* embodiment, creating syncopations in our sense of emplacement *here*. He suggests that not only does the televisual augment the viewer's capacity for sight, "it involves a transmission or transportation of vision itself. The televisual spectator can see things from places — and hence, from perspectives and points of view (and it is not trivial that these are often more than one) — where his or her body is not (and often

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<sup>8</sup> Becoming the eyes of the surgeon has a coercive quality to it. Operating surgeons can get quite angry if a surgical assistant or resident shifts position during the procedure. In my interview with a gyn-oncology resident, this became, quite literally, painfully clear; as she described how for many laparoscopic procedures she must stand, perfectly still, often in an awkward and twisted position that gives the operating surgeon "proper exposure." Laparoscopic surgery can resemble a deadly serious version of games like Twister (in this case, the awkward positions can be held for hours) or Simon Says (in this case, the "players" try to interpret and faithfully reproduce the movements that "surgeon says.>").

never can be) situated” (Weber, 1996: 116). This makes vision relatively independent of the limits of embodied situatedness and does so by cutting the sutures that map bodily orientation to visual perspective. As Weber succinctly puts it, “television *overcomes* distance and separation . . . only because it also *becomes* separation” (1996: 116).

### The “Next” Revolution: Emergent Surgical Paradigms

Continuing the logic of medical (r)evolution, Intuitive Surgical’s website positions its technology at the bleeding edge: “In the late 1990s, another evolutionary stage in the development of surgical technique was achieved with the application of robotics to surgical technology. At the forefront of this new era, Intuitive Surgical introduced the da Vinci® Surgical System” (Intuitive Surgical - Robotic-Assisted Surgery). Proponents of the robotic surgical paradigm now recast laparoscopy as a mere “intermediary” technology on the way to the robotics revolution. Satava, for example, describes laparoscopy as a “revolution from the past,” a “transition technology” that “will recede in importance as newer modalities come forward” (2001: 1408). Narratives of progress in late modern medicine tend to recast “old” technological revolutions as roadside attractions along a historical highway of ever-advancing innovation. Implicit in the evolutionary narrative is a teleology of “species improvement,” such that each successive generation retains the traits best suited to its survival, while other, less adaptive traits wither away. As I will articulate later in this chapter, ISI positions the *dVSS* platform as remediating the limits of the laparoscopic revolution without abandoning the “minimally invasive” affordances of tele-mediated vision and manipulation. Indeed, the



*Laparoendoscopic Single-Site Surgery*

“minimally invasive revolution” continues. For example, Laparoendoscopic Single-Site Surgery (LESS) reduces the number of “keyholes” cut into the abdominal cavity to a single incision at the navel. Endoscopic camera and laparoscopic instruments enter the body through this single point, as the image on the left indicates. Natural Orifice Transluminal Endoscopy claims to eliminate the surgical incision altogether; surgeons enter the body

instead through one of its “natural” access points: the nose, mouth, anus or vagina. Since any

cutting used to access a surgical site takes place from *already inside* the body, NOTES is thus often referred to as “incision-less” surgery. Some new surgical apparatuses leverage principles of interventional radiology in order to do away with incisions altogether; these can accurately be described as non-invasive surgical procedures. For example, the Cyberknife® Robotic Radiosurgery System treats cancerous and non-cancerous tumors anywhere in the body by precisely delivering beams of high-dose radiation. If “going under the knife” is a euphemism for surgery, it no longer obtains in these new surgical paradigms. Cyberknife, for example, retools the surgeon’s scalpel as an artist’s paintbrush: “The CyberKnife System can essentially “paint” the tumor with radiation allowing it to precisely deliver treatment to the tumor alone, sparing surrounding healthy tissue” (Cyberknife: How is the Cyberknife Unique?, n.d.). Even more remarkable than Cyberknife’s severing of the link between surgery and razor-sharp steel, emergent techniques that leverage bioengineering foreshadow an even greater disruption of the ontologies of surgical practice. Satava & Wolf (2003) name these practices “biosurgery.” Satava (2007) suggests that instead of operating at the macro-level of gross anatomy, these surgical techniques will be “implemented at the cellular and molecular levels—changing the basic biology (and possibly DNA itself) without changing the anatomy but inducing the repair at a biologic level” (160).

I cite these examples not to suggest that they constitute a singular vector of change sweeping over surgical practice. Open-incision and laparoscopic techniques will continue to be practiced for some time to come. I outline them here to provide a context for the discussion that follows, which focuses on the material media specificity of the *dVSS* platform. Each of these surgical apparatuses — the *dVSS*, LESS, NOTES, Cyberknife and biosurgery — transform surgical practices in different ways and refigure relations between surgeons and patients, between surgeons and their sensory apparatus, between surgeons and the authority or autonomy of their labor practices in diverse and divergent directions. Addressing all of these technologies in a comparative manner falls outside the scope of this dissertation (although I perceive the need to consider them in future work).

## Three Components

To this point, I've said surprisingly little about the *dVSS* itself. The goal of this section is to describe the key components that make up the *dVSS*, to convey a sense of the technology as a mobile, shifting set of practices or interfaces, and to proliferate the connectivities that constitute the *dVSS* as an interfacial technology assemblage. The "System Overview" section of the 2007 Da Vinci S Surgical System User's Manual lists the main hardware components of the *dVSS*: "the Surgeon Console; the Patient Cart, which is designed to hold the EndoWrist® Instruments, and the Vision Cart." Taken together, these three components comprise key elements of the *dVSS* platform. The Da Vinci S User's Manual represents these components de-contextualized, and, importantly, dis-embodied of both surgeon and patient, two undeniably constitutive elements of the *dVSS* as an apparatus. The goal of this chapter is to re-articulate a "manual eye's view" of the surgical system. This will necessitate prying open some of the systemic opacity that a traditional user's manual might leave intact, in the name of clarity, or intellectual property.

To consider the *dVSS* beyond the manual eye's view of its three components is metaphorically to dissect its surface anatomy, opening up these surfaces to reveal new ones. It is to tease out finer structures, making new technical surfaces and objects visible. Surgical imagery is particularly apt in relation to the articulation of the media specificity of the *dVSS*. Hirschauer describes the surgical practice of dissection as something that materializes or makes visible:

Dissection, which is the precision work of making objects visible, is at the same time classifying work. The flesh is dense and compact, stuck together and impenetrable. First, one has to identify something in a crevice opening up, in the depths of a wound or on a bloody surface. During the search for a spermatic duct, someone utters 'I can't see anything', and an assistant is told, 'now, this is the transversus perinei profundus'. In the case of microsurgery, this identifying work can take hours, in which whitish and red cords are identified as particular nerves and vessels and lifted out of their bloody surroundings by slings and numbered clamps.' (1991: 300-301)

In other words, dissection is a cut that structures the conditions of possibility for seeability and sayability within surgical practice; further, dissection "cuts across" the discursive and non-discursive, creating new visibilities and intelligibilities.

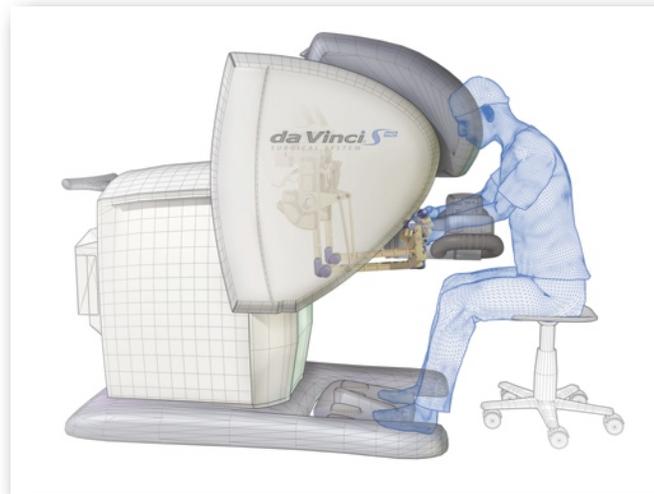
Hirschauer goes on to suggest, however; that these new visibilities are instrumentalized or territorialized according to the abstract machine of the anatomical atlas. He writes that, as dissection proceeds, “[a]nother film seems to be spread out on the patient-body like an overlay: the anatomic film. Dissection aims to present organs in the isolating style of an anatomic atlas. The drawings show neatly separated organs; in the patient-body this state must first be produced by isolating them with the knife” (1991: 301). In other words, anatomically-driven dissection and specification is an attempt to recreate the body according to its own image, its image as represented in the anatomical drawing. It proceeds by restructuring the territory to look like the map, sculpting the patient’s tissue in such ways as to resemble the anatomical atlas. It also might be said to effect a certain violence on the patient’s body, molding it into an externally-imposed regime of intelligibility.

By contrast the surgeons I observed seemed to pursue a different mode of expository dissection. To be sure, its goal was visibility and intelligibility; the surgeons had to cut to see and to see to cut, both of which required recognizing, at least provisionally, what they were seeing and cutting. Ultimately, for example, their goal was to expose the bladder neck in its differential specificity from its surrounding tissues. And yet more often than not, the practices of exposition seemed much inflected by the practice of the craft. I mean the sense that surgeon and knife don’t so much impose a form as *elicit one* from the patient’s body, which exerts its own singular material resistances and fluidities in anticipation and in response to the surgeon’s efforts to shape it. Surgical residents were repeatedly encouraged to “follow the plane as long as it’s giving it up,” not so much cutting as tracing along an interface, spreading apart the involuted surfaces that constituted it. This intervention in turn opened up new surfaces, constituted new objects, and so on.

As I work through the three main components of the *dVSS*, then, I play with both modes of expository dissection; on the one hand, I anatomize the *dVSS* apparatus according to its anatomical atlas, the Da Vinci S User Manual. Consequently, my descriptions work through the components of the *dVSS* in a rather objectified manner. Occasionally, however, I find a plane or interface to follow as long as it’s giving it up (perhaps all the way down to the metal); my analysis complicates and reconstitutes the User’s Manual, opening up new planes of analysis, and new modes of understanding the *dVSS* that exceed the instrumental logics of the Manual.

## Component I: Surgeon's Console

The **Surgeon's Console** is the primary interface of the surgeon to the surgical system and it technically mediates the operating surgeon's relation to the patient. This relationship is fundamentally *tele-somatic*, in that it involves both an embodied relation with the *dVSS* as technical apparatus and an experience with televisual and telehaptic space (Richardson, 2003). As illustrated by the image at right, the Surgeon's Console allows the surgeon to operate while "comfortably seated at an ergonomic console" which offers a 3-dimensional image display of the surgical field and access to hand-operated master controllers and foot-operated pedals (2008 Annual Report).<sup>9</sup> The master controllers and pedals provide the means for the surgeon to control the surgical instruments and endoscope within the patient.



*Image courtesy of Intuitive Surgical, Inc., 2009*

To operate, the surgeon places her or his head in the console's viewport; in fact, the System requires that the surgeon's head be in the viewport at all times. Any looking up or away from the viewport locks the surgeon's instruments, part of the *dVSS*' failsafe design. In this way, the *dVSS* requires a tight coupling of the surgeon to the console. No one can operate without forging the proper bodily orientation to the apparatus.<sup>10</sup> The viewport is the surgeon's visual interface with the *dVSS*, and provides a content-rich view of the surgical field:

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<sup>9</sup> Comfort and ergonomics here are relative to other surgical practices, such as open and laparoscopic procedures which involve standing for long intervals, often while holding awkward body postures.

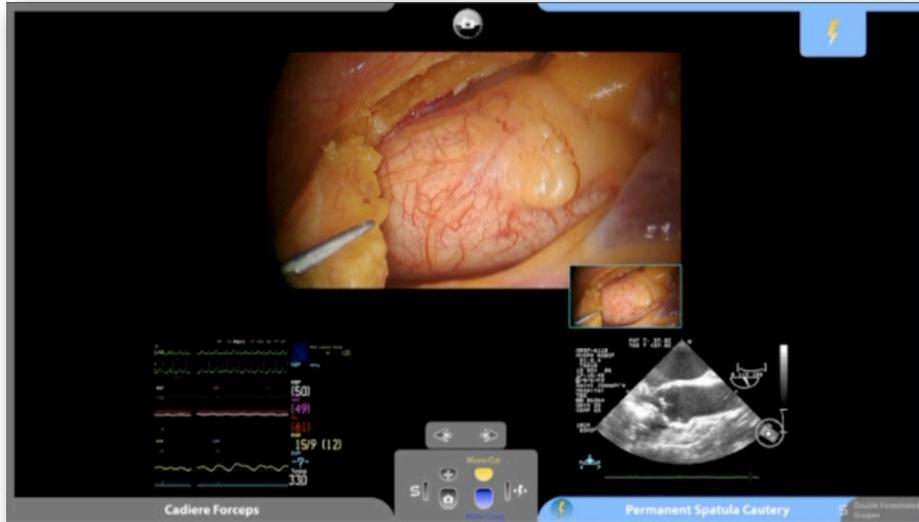
<sup>10</sup> This also implies a different kind of yoking - of surgeon to a corporation.

When the endoscope is activated, the stereo viewer's integrated left and right video channels provide the operator with continuous 3D video, virtually extending the eyes of the operator into the surgical field. The view port also displays messages and icons which convey status of the da Vinci S System to the Surgeon Console operator. (Manual, 2007: 1-6)



Photo courtesy of Intuitive Surgical, Inc., 2009

The surgeon can view the 3D image in “full-screen mode” or can choose to swap to “TilePro™ mode,” which displays the 3D image along with up to two auxiliary images of “patient critical” information, such as a CT scan of the surgical anatomy.<sup>11</sup> Icons and text messages are overlaid on the video to provide extended information to the surgeon. In this way, the dVSS' InSite Vision System can toggle between an immediate and hypermediate televisuality.



Hypermediated TilePro™ View  
Image courtesy of Intuitive Surgical, Inc., 2009

With head firmly in viewport and eyes fixed on the InsiteVision display, the surgeon then grasps each master controller with index finger and thumb. In a gesture reminiscent of a

<sup>11</sup> “Or a procedure manual” as was often joked at University Hospital.

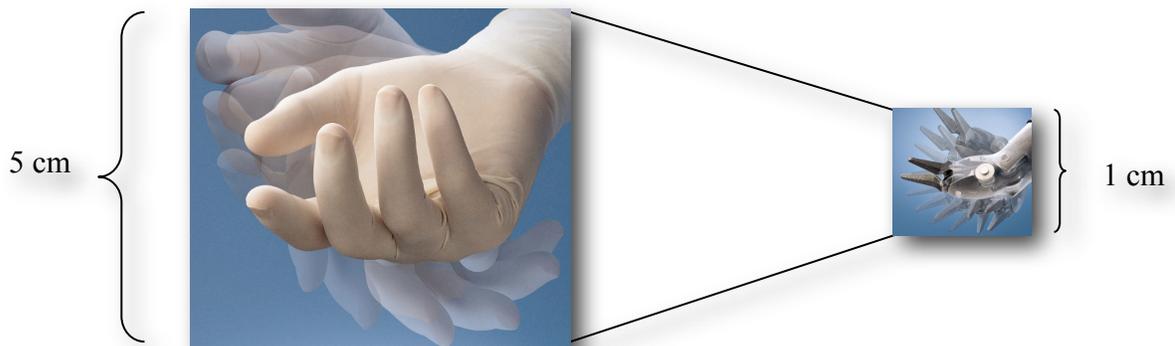
conductor calling an orchestra to attention, bringing the thumb and index finger together activates the instruments.

Once activated, the instruments mimic the motions of the operator's hands: "These movements are precisely and seamlessly replicated at the Patient Cart, thereby virtually extending the operator's hands into the surgical field" (Manual, 2007: 1-5).



*Photo courtesy of Intuitive Surgical, Inc., 2009*

The master controllers (often referred to simply as "masters") consist of two main parts, the "orientation platform" and the "positioning arm." Manipulating the orientation platform rotates the instrument tips and opens and closes the grips of the instruments. Manipulating the positioning arm with gestures like reaching and pulling move the instruments in 3-dimensions in the surgical field. These "positioning movements" can be scaled to according to three hand-to-instrument ratios, depending on the precision required for a particular task or at a particular magnification: 2:1 (normal), 3:1 (fine) and 5:1 (ultrafine):



*Image courtesy of Intuitive Surgical, Inc., 2009*

Setting this ratio gears down the surgeon's movements to match the magnified space in which s/he operates. So, for example, with the scale set to 3:1, movement of the surgeon's hand at the master controller 6 mm to the right only moves the surgical instruments 2 mm to the right.

Finally, the Surgeon's Console's "foot switch panel" affords the surgeon a foot-activated interface to control the *dVSS*. In the center of the foot switch panel is a rocker bar that controls the endoscopic camera's focus (+/-). The right-hand foot switches are labelled "BI" and "MONO" and are used



*Photo courtesy of Intuitive Surgical, Inc., 2009*

to apply bipolar and monopolar cautery control through instruments equipped for the delivery of electro-thermal energy to cauterize, score, and/or incise tissues. Bipolar cautery involves the passing of high-frequency electrical energy through tissue from one electrode to another. In the case of the Maryland Bipolar Forceps, for example, the two "electrodes" are the two toothed grasping surfaces of the forceps which compress and vaporize tissue held between them. In monopolar cautery, cautery and scoring of tissue occurs at the point of contact between a single electrode and the patient's tissue. In monopolar, the patient's body acts as a ground. The Maryland Bipolar Forceps are often used to deliver monopolar energy, with the two toothed grasping surfaces closed together to form an instrument tip that is pressed against tissue (usually a "bleeder") and energy is applied. The bipolar pedal has a different textured "feel" under the foot to help surgeon's distinguish between the two pedals. Most surgeons I observed removed their shoes and operated in their stockinged feet.

The two pedals on the left side of the foot switch panel are labelled "CLUTCH" and "CAMERA." These two pedals allows the surgeon to control the patient side cart's four arms with only two master controllers. Tapping the CLUTCH allows the surgeon to change which arm each controller manipulates. Swapping robotic arms is signaled by the message "Swapping" on the surgical display and an audible tone. Depressing and holding down the

CLUTCH footswitch delinks the master controllers from control of the instruments and “floats the Masters in space” (Manual, 9-9) This process “locks” the surgical instruments in place while allowing the surgeon to reposition the master controllers freely in relation to them. One way to describe the function of the CLUTCH is by analogy to lifting and repositioning a computer mouse. Lifting the mouse allows you to move it freely in space without moving the cursor. Once the mouse is put back down on a surface, its control of the cursor resumes. In terms of the computer, this technique becomes useful when the limits of screen space and physical space fail to align, such as when a mouse runs out of space on a mousepad before it reaches the edge of a display interface. Lifting and repositioning the mouse creates a new set point for the orientation of the mouse to the screen, a new mapping relation between hand and cursor. In a similar fashion, engaging the CLUTCH allows the surgeon to reorient the relation between controller and instrument, in order to assume a more comfortable position, attempt a different approach at a targeted anatomy, or in the event that the masters run out of working space. When the CLUTCH pedal is released, the masters resume control of the surgical instruments.

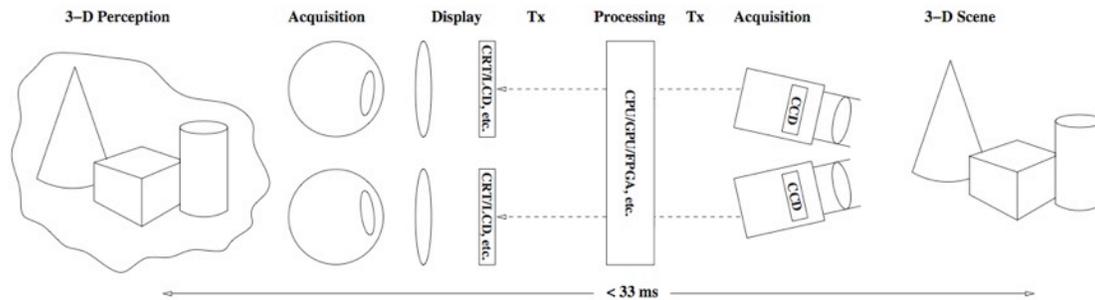
By pressing and holding down the CAMERA pedal, the surgeon disarticulates the master controllers from the surgical instruments and re-articulates them to control the endoscopic camera arm. Moving the endoscope in 3D space requires moving *both* hands in unison. In the *dVSS* training session I attended, the instructor suggested that we think about it like reading a newspaper with both hands, pulling it closer to you to read the fine print and pushing it away to scan the paper’s headlines. The *dVSS* Manual describes it terms of manipulating an image, as if you were holding a photograph:

In this mode, the Surgeon Console operator uses both masters at once to zoom in or zoom out, pan from side to side, or rotate. To zoom in, pull the image toward you by moving the masters toward your eyes. To rotate the image clockwise, rotate the two masters together clockwise, like a steering wheel. When the pedal is released, the masters will resume control of the instruments. (9-9)

Given the centrality of pedals in the performance of robot-assisted surgery, images and references to the foot switch panel are notably absent from promotional materials. In a way, this is not surprising, given how the foot gets overlooked in modern discourses of virtuosity,

which prefer to speak of the precise dexterity of the hand.<sup>12</sup> And yet, as French prehistorian Andre Leroi-Gourhan argues, if the technicity of the hand defined the evolutionary specificity of the human, the freeing of the hands for gesture and tool-use relies upon the foot bearing the “foundational” responsibility for bipedal human locomotion (1993).

## Component II: Vision Cart



Source: (Shevlin et al, 2007: 92)

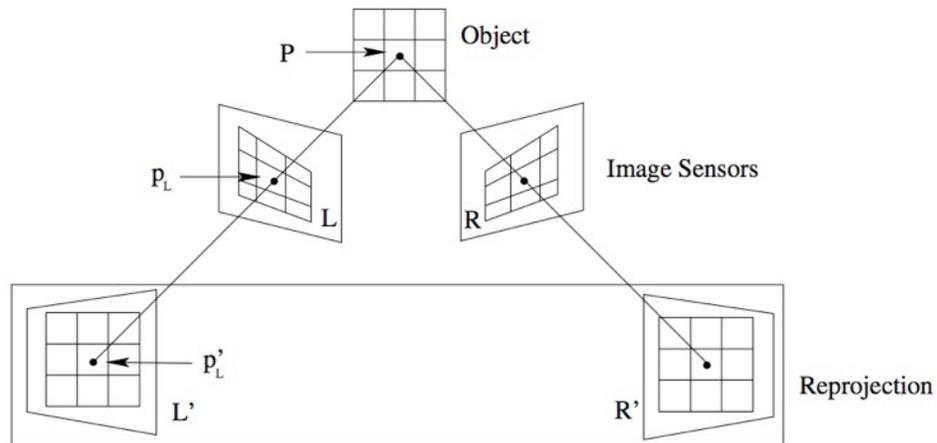
Continuing the “Manual’s eye” view of the platform, the second component of the *dVSS* is the **Vision Cart**. The Vision Cart houses the *dVSS* platform’s endoscopic image illumination and processing hardware. Properly speaking, the InSite Vision System spans all three components of the *dVSS*: A centrally located robotic arm on the Patient Cart holds the InSite’s dual channel endoscope (production) that traverses fiber optic, HDMI and computational pathways through the Vision Cart (transmission) to the 3D display at the Surgeon’s Console (reception). In an effort to continue the narrative conceit of re-constituting the User Manual, however, I consider the entire vision system here under the heading “Vision Cart.”

<sup>12</sup> Much more can be said about the importance of the foot in understanding the gender politics of automating skilled labor. Indeed, if surgery is defined in some sense by skilled practices of sewing, it is both interesting and troubling to place the automation of surgery alongside the gendered labor politics of the contemporary. The old Singer sewing machine was powered by a foot pedal, and defined a significant part of the relationship of the female body to the labor practices of piecework. Further, as Andrew Ross points out, “today, the sewing machine’s foot pedal is still very much in business, no longer competing with steam power, of course, but with the CPU (Central Processing Unit of the computer), which, at the higher end of garment production, is used to govern computer assisted design, ensuring fast turnaround and just-in-time supplies for the volatile seasonal trade in fashion lines” (Ross, 2002: 101). Their sewing skills decidedly undervalued, women still constitute the majority of sweatshop labor and therefore stand most to lose from the automation of their skilled craftwork (Ross, 1997: 15).



*da Vinci InSite Vision System 12mm 3D HD Endoscope  
Photo courtesy of Intuitive Surgical, Inc., 2009*

Fiber optics illuminate the surgical field with bright, white, Xenon light (the same bulb technology in contemporary automobile headlights). Light bounces around the surgical field, glancing off glistening anatomy and into the dual lenses of the robotic endoscope, a dual channel model with lenses offset at a ratio roughly equivalent the offset of the eyes in the human binocular vision system, positioned with focal points that overlap but don't fully coincide. Non-identical right and left images of the surgical site are transmitted through a series of lenses in each scope channel until the photons of the image acquired by the scope reach the InSite Vision System's 3D Camera Head. The Camera Head contains two HD cameras, one for each scope channel. The HD cameras themselves are 3CCD cameras, so photons reaching the cameras are first separated into red, green and blue wavelengths of light by a prism. The prism directs each color to the 2-dimensional capacitor array on one of three separate charge-coupled devices (CCDs) which converts the different intensities of light into voltage differentials, which are digitally sampled and transmitted to the Camera Control Units on the Vision Cart itself. Light becomes a voltage differential sampled into a digital data-stream. The Camera Control Units apply algorithms that adjust gain and control brightness; they balance contrast and color saturation. And, importantly, the CCU's correct for keystone distortion. Regular users of data-video projectors are familiar with this phenomenon, which can be thought of as a highly technicized form of "parallax error." To be precise, keystone distortion is the horizontal and vertical disparity that result from a rectangular plane being projected off-center in the X or Z axis (assuming a right-hand coordinate system). It occurs because the computational generation of 3-dimensionality from a 2D image requires that the CCD image sensor hardware be positioned at an angle oblique to the endoscope shaft. Because of the material constraints of the video apparatus, the "raw" image data has to be computationally re-sampled, re-projected, and then the reprojection rectified (inversely mapped) back onto the "original" image in real time, as illustrated in the diagram below:



Source: (Shevlin et al, 2007: 94)

This computational matrix confounds the relationship between reality and its representation in terms of the “reality effect” of the image. The “original” image both reflects and distorts reality, requiring a computationally intense restoration of perspectival realism in the data-image stream.<sup>13</sup> Once the data-image is geometrically corrected, it is relayed to a Video Signal Distribution board that hypermediates the data-image, applying system messages as textual and graphic overlays before sending the image to the pair of monitors at the Surgeon’s Console. These finally display the data-image as image. The “restoration” of depth perception to the surgeon’s endoscopic gaze relies therefore on a dizzying array of physical and computational mediations, translations and transformations. This “accomplishment” of 3D laparoscopic vision also depends upon the specificity of human wetware. A human observer “adapts their eyes’ convergence angle to minimise horizontal disparity at a fixated object, and so achieves a single view with depth perception enhanced by stereopsis” (Shevlin et al, 2007: 93). This is not machine vision, where the human observer need not figure into the perceptual loops, but rather a prosthetics of vision accomplished in and through the articulation of hardware, software and wetware.

The InSite Vision System consequently refigures the surgeon’s gaze in a manner quite distinct from the traditional endoscopic gaze. It reroutes the penetration of autoptic viewing

<sup>13</sup> Shevlin et al (2007) suggest that a relatively low resolution (512x512 pixel) stereo image pair requires over 10 million calculations *per video frame*. Calculated on a per pixel basis, “the reprojection requires 6 multiplications, 6 additions and 2 divisions per rectified pixel and bilinear interpolation adds 4 multiplications and 2 additions” (Shevlin et al, 2007: 95).

through a circuitous system of fiber optics and video processing units that expands and shapes the surgeon's own optical system. Magnified and digitally enhanced, the InSite Vision System provides the surgeon's eyes with vision, a vision of real reality, but a reality that has been really worked over. The *dVSS* thus shifts problems identified with medical imaging onto those of the mediation of vision. It changes not only the nature of *what-is-seen* but also of *seeing-what-is*. The patient as seen through or with the *dVSS* platform returns to the surgeon's gaze as a dispersed "field" of spectatorship that cannot be entered without prosthetic support.

### Component III: Patient-Side Cart

The **Patient Cart** is the "sharp end" of the *dVSS* apparatus, described in the Manual as the "operative component" of the *dVSS*. This core element of the *dVSS* is composed of several subcomponents. First, the cart is supported by a



*Photo courtesy of Intuitive Surgical, Inc., 2009*

motorized base used to position or "drive" the patient cart in place for an operation. The base supports robotic arms, four in the case of the "S" model, and three in the case of the standard model, although the standard model can be upgraded with a fourth arm. At the top of the cart is an LCD display, which displays a two dimensional rendering of what the operating surgeon sees in 3D at the Console's Insite viewport. In the "S" model, this display is touch-sensitive and allows the surgeon at the patient side cart to draw on the screen with digital ink, which appears simultaneously in the operating surgeon's viewport. This feature, called "remote telestration," affords a mode of visual communication and pedagogy within the apparatus. Attending surgeons use this feature to highlight, for example, an anatomical structure when the surgical resident is unsure of what he or she is looking at, or to trace a visual path for the surgical resident to follow when dissecting tissue. Thus, the process of "remote telestration" offers one

way in which gesture finds its way into the tele-mediated circuits of exchange through which apprenticeship on the *dVSS* proceeds.

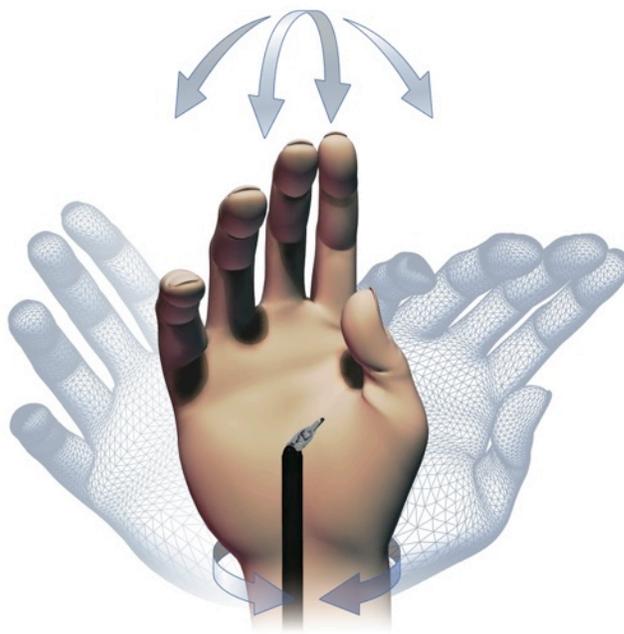


*Telestration: The attending surgeon traces a path for the resident to cut along.  
Image courtesy of Intuitive Surgical, Inc., 2009*

The function of the Patient Cart's robotic arms is to hold the System's endoscopic camera and Intuitive Surgical's proprietary Endowrist® surgical instruments. The Endowrist® instruments are one of the centerpieces of the surgical platform and form the basis of ISI's claim to exceptionalism, that the *dVSS* platform is "Taking Surgery Beyond the Limits of the Human Hand™". Traditional laparoscopic instruments are rigid and provide only four degrees of freedom in their movement within the surgical field; the surgeons I shadowed likened them to operating with chopsticks. Endowrist® instruments, on the other hand, are "wristed" near the instrument tip, affording surgeons with greater range of motion and increased dexterity: 7 degrees of freedom, 90 degrees of articulation, and 540 degrees of rotation. ISI positions them as both "like" (modeled after) and "unlike" (superior to) the human hand, as illustrated in this description taken from the company's website:

Intuitive Surgical's exclusive *EndoWrist* Instruments are designed to provide surgeons with natural dexterity and full range of motion for precise operation through tiny incisions. Modeled after the human wrist, *EndoWrist* Instruments can offer an even greater range of motion than the human hand. They truly allow the *da Vinci*® System to take surgical precision and technique beyond the limits of the human hand. Similar to human tendons, an *EndoWrist* Instrument's internal cables provide maximum responsiveness, allowing rapid and precise suturing, dissection and tissue manipulation. The wrist-like movement, responsiveness and robotic control afforded by the *da Vinci* System and its exclusive *EndoWrist* Instruments provide surgeons fluid ambidexterity and unparalleled precision. (Intuitive Surgical - Endowrist Instruments)

Intuitive Surgical's promotional materials go to great lengths to **suture** the relationship between the Endowrist® instruments and the surgeon's hand — emphasizing their similarity — while simultaneously positioning the former as a superior materialization of the latter. This is illustrated by the representational strategies deployed in the images below.

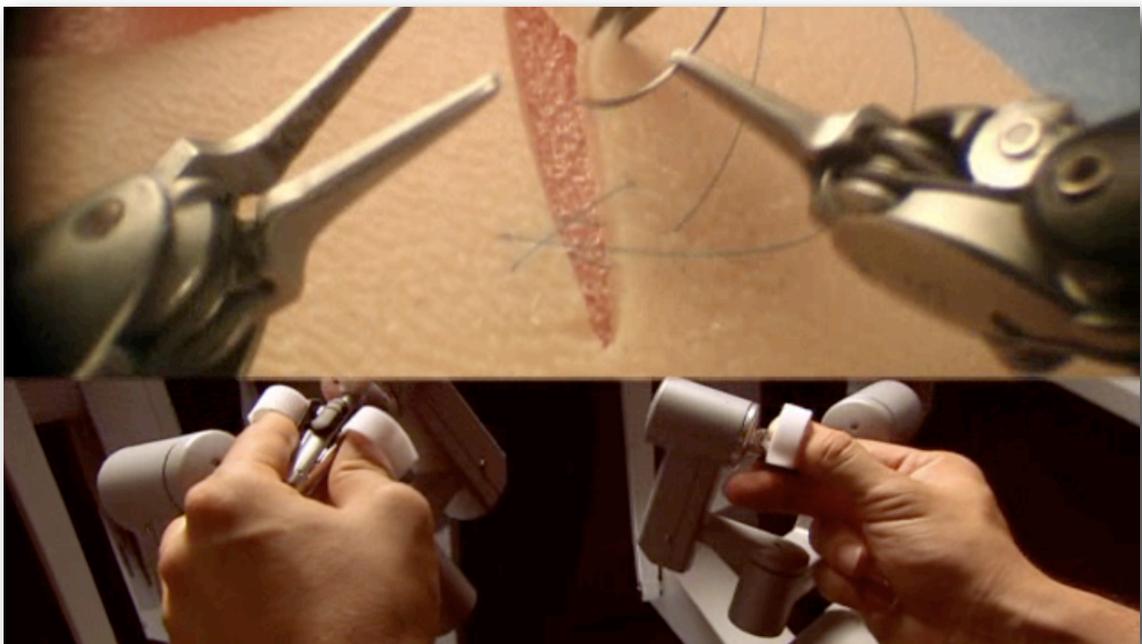


*Images courtesy of Intuitive Surgical, Inc., 2009*

The image at left superimposes the instrument and the hand in order to highlight their likeness. Significantly, however, the hand represented is not a photograph of a particular human hand. Instead, the Endowrist instrument is made to coincide with the stylized image of a perfected (and endlessly perfectible) digital simulation of the hand. The image at the right juxtaposes the

Endowrist instrument with the gloved hand of a surgeon, but the greater number of after-images that halo around the Endowrist images are intended to signal the superior mobility of the instrument's greater range of motion.

Finally, explicit in the design of the *dVSS* is a mechanism that both foregrounds and mitigates against another limitation of the human hand. Specifically, the human hand tends to exhibit a "natural" or "physiological tremor" that oscillates at approximately 8 - 12 Hz not despite but rather *because of* the biomechanics of steadying the motion of the hand (Eible & Koller, 1990). In the interstices between hand and instrument, the *dVSS* interjects a computational algorithm that actively rejects *as noise* the wetware specificity of the human hand: "An adaptive disturbance rejection scheme cancels the surgeon's natural hand tremors and enables greater accuracy in the placement of the microinstruments, with less danger to neighboring tissue and less blood loss" (Lilly, 2005). Due to this filtering mechanism, the Endowrist® instruments function with greater precision and control than the hands that manipulate them. In rhetoric if not in fact, Endowrist instruments exceed the hands that made them.



*Image courtesy of Intuitive Surgical, Inc., 2009*

## Command and Control: Master/Slave Robotics

In industry terms the *dVSS* is considered a "master-slave" system.<sup>14</sup> This designation means that the robotic end effecters (the *dVSS* arms and Endowrist® instruments) only accept and respond to commands initiated from the "master console", the surgeon's console controls. To convey a sense of seamlessness at the articulation of master to slave, ISI's promotional video materials almost always include video footage that portrays the Endowrist® instruments and the surgeon's hands at the master controllers in split-screen and in perfect synchronicity: You move, it moves. At the crux of this representational strategy is the issue of command and control, and the video sequences are intended to convey how perfectly the *dVSS* follows or replicates the hand motions of the surgeon at its controls. Online FAQs about robotic surgery recite the reassurance that the da Vinci robot is "under the direct control" of the operating surgeon and cannot operate autonomously. ISI's FAQ webpage also declares that "At no time does the surgeon...program/command the system to perform any maneuver on its own/ outside of the surgeon's direct, real-time control" (Intuitive Surgical - Frequently Asked Questions). While watching a procedure with the corporate representative from Intuitive Surgical responsible for the University Hospital account, he leaned over and whispered, "The da Vinci's not really a robot; it can't do anything on its own. It only does what the surgeon does. While it could be imbued with artificial intelligence, we intentionally keep it dumb, for safety's

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<sup>14</sup> Anna Everett cautions against the persistent rhetorical deployment of the master/slave hierarchy in conceptualizing technological dependency loops within the digital public sphere. She describes a quotidian scene re-iterated thousands of times each day, with every boot and re-boot of a PC:

In powering up my PC, I am confronted with DOS-based text that gives me pause... "Pri. Master Disk, Pri. Slave Disk, Sec. Master, Sec. Slave." Programmed here is a virtual hierarchy organizing my computer's software operations. Given the nature of my subject matter, it might not be surprising that I am perpetually taken aback by the programmed boot-up language informing me that my access to the cyber frontier indeed is predicated upon a digitally configured "master/ slave" relationship. (Everett, 2002: 125)

While Everett sees in these deployments "no racial affront or intentionality," I want to highlight here the way in which the etymology of the term robot carries a structure of human oppression within it. The Czech playwright Karel Čapek is said to have coined and popularized the term "robot" in his science fiction play *R.U.R.* (Rossum's Universal Robots), which premiered in 1921 (Ewing et al, 2004; Moran, 2007). In Czech, the term *robota* implies "forced labor," and importantly, Čapek's robots weren't machines. Instead, they were bioengineered humanoid organisms, human-like, but reduced to the "bare life" necessary for the provision of cheap, reliable and reproducible labor. In the play, Harry Domin, R.U.R.'s general manager, describes the ingenuity of the company's namesake and founder: "Young Rossum invented a worker with the minimum amount of requirements. He had to simplify him. He rejected everything that did not contribute directly to the progress of work—everything that makes man more expensive. In fact, he rejected man and made the Robot" (Čapek, 1921).

sake.” Dr. Ornstein, surgeon and assistant professor of urology at UC Irvine’s Medical Center soothes against fears “that the robot will take over. There’s no intelligence involved. The robot won’t work on its own. It is an extension of the surgeon’s arms and eyes” (Young, 2007).

Ironically, all of this incessant re-iteration and re-affirmation of surgeon control over robot docility may unwind the stability that ISI seeks to maintain. As Heidegger notes, “the will to mastery becomes all the more urgent the more technology threatens to slip from human control” (1977: 5) Intuitive Surgical’s efforts to figure the Endowrist® instruments as mimetic of and yet superior to the human hand co-exist precariously alongside the company’s equally emphatic assertions that these robotic end effectors remain completely, and ineluctably, under human control. Put simply, how can the robot be both superior *and* subordinate to the human? Taken together these representations suturing the hand-instrument relation pursue incommensurate ends. The Endowrist® instruments are positioned as “more human than human,” as the perfection and supercession of the human, their dexterity exceeding that of the human, measured according to “degrees of freedom.” And yet the same hand/instrument articulation is called upon to do the work of concretizing the command and control that the surgeon exerts over the robot. The split screen video representation dramatizes the hand/Endowrist® relationship as one of mimicry in the context of subordination may [following Bhabha (2004)] function as a relation of instability and ambivalence. While not wanting to gloss over crucial differences between colonial discourse and the technocratic context at hand, Bhabha’s analysis nonetheless seems apposite. The *dVSS* platform performs as a “slave” system that nonetheless mimics (and indeed surpasses) the surgeon-as-master. It seems to participate in

a discursive process by which the excess or slippage produced by the *ambivalence* of mimicry (almost the same, *but not quite*) does not merely ‘rupture’ the [master/slave] discourse, but becomes transformed into an uncertainty which fixes the colonial subject [robot] as a ‘partial presence.’ By partial, I mean both ‘incomplete’ and ‘virtual.’ It is as if the very emergence of the ‘colonial’ [discourse of ‘command and control’] is dependent for its representation upon some strategic limitation or prohibition within the authoritative discourse itself. (Bhabha, 2004: 123) [additions mine].

It could be said that the representational strategy articulating the relationship between surgeon and robot “depends upon a proliferation of inappropriate objects that ensure its

strategic failure, so that mimicry is at once resemblance and threat” (Bhabha, 2004: 123). Like the colonial Other produced by the “civilizing” practices of colonial rule (“not quite/not white”), ISI’s representational strategies of mimicry produce a complex matrix of embrace and disavowal that destabilizes the very ground of (human/nonhuman) difference that it depends. The *dVSS* in this context functions as both resemblance and threat, both of which hinge upon the disconcerting displacements of the “not quite”: Not Human/More Human Than Human.

Even if one rejects the discursive ambivalence of mimicry and the import of a marketing strategy, a brief consideration of the *dVSS* platform’s architecture, a return to its media specificity, suggests that as much as the surgeon controls the robot, *the robot also controls itself* through a series of fail-safe mechanisms and watchdog feedback loops. Together with the careful surgeon at the controls, a nested series of “fail safe” mechanisms actively and passively preclude opportunities for autonomous action on the part of the robot. Some of these are under the control of the surgeon, such as the pressing the “EMERGENCY STOP” button at the Surgeon’s Console (Manual, A-6). But for the most part, system safety and stability is monitored and enforced by System itself. As the User Manual points out, “when a fault occurs, the system will make a determination on whether the fault is recoverable or non-recoverable” and then will pursue the appropriate action, locking the Patient Cart’s robotic arms, sounding an alarm, and posting an error message on the Console Viewport with instructions for how the surgeon should proceed (A-2). At no point does the surgeon intervene in this process, except the appearance of control the system affords by allowing the surgeon to press the “fault-override” button. In the event of “Non-Recoverable Faults,” the *dVSS* has to be restarted, allowing the robot to “regain control” of itself so that it can *give over* control to the surgeon. Complete malfunctions of the system result in a complete loss of control over the *dVSS*, and require that the surgical team rely on “dVSTAT,” the *da Vinci*® Surgery Technical Assistance Team, which provides a live technical support engineer within 30 seconds of placing a service call during regular business hours. Furthermore, research is underway that effectively reverses the power relations of command and control on the platform. This research explores and tests the feasibility of mechanisms (“virtual fixtures”) by which surgical robots can restrict the surgeon’s movements to a pre-defined surgical field, with the rest of the patient’s anatomy designated as a “no-fly



zone” (see, e.g. Abbott & Okamura, 2003; Kapoor et al, 2005) In this sense, the *dVSS* prevents the surgeon from harming the patient (and indeed protects the surgeon from himself!).

In the command and control architecture that sutures the surgeon to robot, issues of authority, autonomy and automation fold into each other. I will come back to this complex articulation in the next chapter as I discuss how it plays out in relation to the becoming-robot of the surgeon and the becoming-surgeon of the robot. For now, I simply mark the slippages and disjunctures that emerge when attempts are made both to suture the interface between surgeon and robot and yet to render the robot as Other, as a docile body for the exercise of mastery and control. In what follows, I continue to pursue the trope of ambivalence, through the surgical platform’s interplay of distance and immersion and the paradoxical haptic productivity of error.

## Distance

Within the space of the typical OR, the Surgeon’s Console is positioned approximately 6 - 8 feet from the patient and Patient Cart, outside of the sterile surgical field. This dissociation of the Surgeon’s Console from the sterile field theoretically enables the *dVSS* to be used as a tele-surgical instrument, the surgeon and the patient geographically dispersed. Intuitive Surgical’s website suggests that they are not interested in developing telesurgical applications at this time, even though they were the driving force behind the DARPA-funded SRI research from which ISI emerged. According to the ISI website:

**Q. Is this telesurgery? Can you operate over long distances?**

**A. The *da Vinci* Surgical System can theoretically be used to operate over long distances. This capability, however, is not the primary focus of the company and thus is not available with the current *da Vinci* Surgical System.**

<http://www.intuitivesurgical.com/products/faq/index.aspx#4>

This is a bit equivocal on Intuitive Surgical’s part. ISI insists that the *dVSS* is not for telesurgery, even though all of the development was conducted under DARPA funding for telesurgical applications that would allow surgical procedures to be conducted under hostile conditions (e.g. a battlefield) without placing the surgeon in harm’s way. In fact, ISI avoids the claim that the *dVSS* constitutes telesurgery because it lost a patent infringement case to Brookhill-Wilk I,

LLC (“Brookhill”) in 2003. This case hinged upon the definition of “remote.” The litigation began in 2000 when Brookhill brought a patent infringement lawsuit against Intuitive Surgical, claiming that the dVSS infringed upon claim 10 of U.S. Patent No. 5,217,003 (“the ‘003 patent”). This patent established intellectual property rights over any surgical system that transmitted televisual images to and received tele-manipulation commands from “a remote location beyond a range of direct manual contact” with the patient’s body. Since the dVSS platform involves, potentially at least, positioning the Surgeon’s Console at a distance from the patient, it would seem that ISI was clearly infringing on the ‘003 patent. Brookhill contended that their patent applied to any technological mediation that extended “beyond an arm’s length from the patient.” However, Intuitive Surgical successfully argued in US District Court that this specification of “remote location” meant “a location outside the operating room.” A US Federal Court of Appeals overturned the District Court’s decision, and Brookhill settled with Intuitive Surgical for a one-time fee of \$2.6 million. In return, Brookhill granted unrestricted, perpetual and exclusive license to practice any of the Brookhill-Wilk Patent rights.<sup>15</sup>

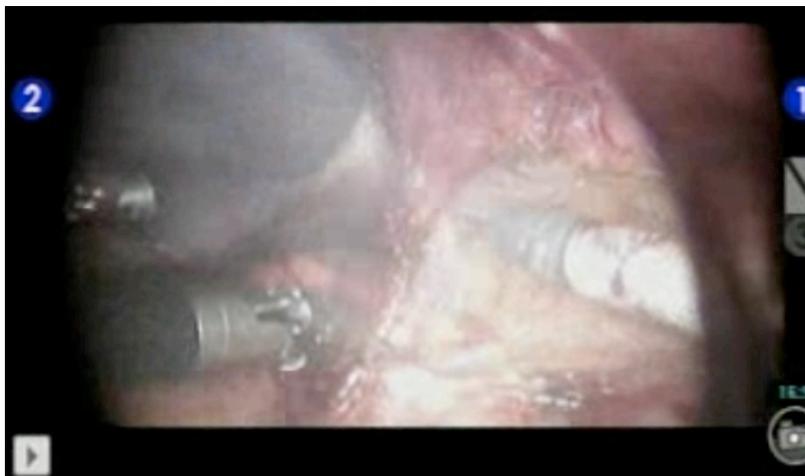
Legal maneuvering aside, this is not mere semantic play. Beyond this explicit ambivalence about distance, there are the implications for the changing practice of physical contact in the context of care. The telemediated distance that the dVSS introduces — the surgeon no longer at the patient’s side, but 6-8 feet away—puts the patient literally out of reach and out of touch, and confounds notions of care based upon physical intimacy and phenomenologies of touch. From the surgeon’s phenomenological perspective, this new distance from patient is often experienced as disconcerting, especially for the veteran surgeon. Dr. Sierra, for example, expressed a certain alienation from the patient, which he described as a both a loss of connection and control. As he put it,

*I don’t know how I’d describe it . . . a loss of connection, maybe . . . I’m really most comfortable when I’m at the patient’s side. I feel like I’m more in control of the situation, particularly if something goes wrong. [Laughs] I guess I’m more comfortable being the conductor than the first violin.*

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<sup>15</sup> As McLean & Torrance (2008) point out, this “loss” was a major victory for Intuitive Surgical, affording them the freedom “to operate in the cybersurgery market exclusively, unencumbered by further patent liability. By contrast, anyone who attempts to enter the market with any surgical instrument that allows the a surgeon to stand away from the operating table must now be prepared to defend itself in a patent infringement lawsuit” (6).

Notably, Dr. Sierra recoups his place in the surgical hierarchy by refiguring the spatial position of the operating surgeon's assistant from an assistive to directorial role. Another example: When I entered the OR on the first day of my observations, I was immediately positioned as a spectator to other spectators, as somebody watching somebody play a video game. The patient's body was completely *elsewhere*. We all watched the surgery play out on the screen, watched the operating surgeon *play* on the screen. Like teenagers playing Nintendo, the spectators praised certain actions — “Nice move” — and one of the more experienced “gameplayers,” the attending surgeon, directed the play: “No, you want to move over there. That's it, now cut.” And yet the cool and seamless layering of sights and screens was occasionally interrupted by sounds and smells that dis-located the “gameplay” from the screen back to the patient's body laying just within my peripheral vision, off to the right. We saw the tissue parting under the scissor blades on the screen, but heard the sharp “clip” sound from under the drapes, where the real tissue was removed. We watched the boil of blood at the tip of the cautery as the surgeon took care of a bleeder; smoke briefly occluded our view on the screen. But the sound of the sizzle and its pungent smell emanated from somewhere less localized. These odd dislocations comprise the excess of the patient body within the corporeal space that the *dVSS* materializes. On the one hand, the *dVSS* enacts both the cut and the cautery and provides a high definition visualization of each. On the other hand, the snip and sizzle, not to mention the stench, are the traces of a body otherwise forgotten in its technical suspension or supercession. Technology thus both evokes and effaces the body, generating a shuttling back-and-forth of “visibilities” across the visual, aural and olfactory registers.



*Smoke from cauterized tissue occludes the view of a radical nephrectomy*

Accordingly, the *dVSS* embodies an ambi-valence of intimacy and distance, technological “high” culture and “natural” care, rational and so-called intuitive systems of interaction. The operating experience is a highly technically mediated interface with the patient’s body. The surgeons with whom I interacted, however, repeatedly insisted that this interface was both “intuitive” and “natural”, especially insofar as the technologies engaged reproduced or mimicked the eye-, hand- and instrument-orientation of open surgery. Unlike traditional laparoscopic surgery, which flattens the display of the surgical field into two-dimensional televisuality, the Surgeon Console’s InSite Vision System restores depth to the televisual image. Further, if the fulcrum physics of traditional laparoscopic instrumentation inverts the relationship between hand movement and instrument tip (in laparoscopy, to move the tip of an instrument upward, the hand grasping the instrument must be moved downward), the *dVSS* re-inverts the orientation of hand to instrument, thereby restoring “natural” motion. Finally, as the images below attempt to convey, when seen through the *dVSS* stereoscopic viewer, the instrument tips appear to align with the surgeon’s hands at the controls, increasing the sense that the



*Images courtesy of Intuitive Surgical, Inc., 2009*

instruments are virtual extensions of the operator’s hands.<sup>16</sup> This realignment remedies how the specificity of the now-traditional laparoscopic apparatus “decouples” surgeons’ “oculo-

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<sup>16</sup> For a complementary perspective on how this cognitive phenomena of suturing what is seen and what is experienced as “my body,” see contemporary work on “mirror-box” therapy and “If I Were You: Perceptual Illusion of Body-Swapping” (Petkova & Ehrsson, 2008)

vestibular axis for visual orientation from their haptic-proprioceptive axis for manipulating” (Satava, 1998: 142). I move my hands here but see the instruments move over there, on the screen. This requires a differently skilled body than open or robotic surgery, akin to the most “non-immersive” video game play. Working in this way, *dVSS* corrects for a technologically-imposed disability. If MIS laparoscopes disengage the “proper” orientation of the body, then the *dVSS* platform restores it.

### Immersion

The *dVSS* repairs the very distance upon which it depends. It goes further yet to provide an immersive experience, the feeling of being truly “inside” the patient. As I noted to myself, the *dVSS* provides:

*the experience of virtual reality but it's not virtual reality. It's real — real reality. The quality of the image, while HD, is not such that I am looking at an open procedure. You still have the sense that this is a mediated, somewhat constructed image. But you soon fall into an immersion in that space and the docs talk about feeling like they're really inside the body. The tendency of all the surgeons is to zoom in closer and closer and closer, particularly the novice surgeons.*

As a complementary practice, the more experienced surgeons tend to recommend resisting the zoom, the play of visual movement in and out. In one instance, Dr. Sierra charged the resident performing the surgery: “Don't move your eyes. Keep the camera where it is right now.” I asked him later why. As a result of the tendency to zoom in closer and closer, he said that one loses a sense of spatiality, the perception of both scale and depth. Dr. Sierra also noted that the “stable vantage point has a kind of efficiency to it, if you can find a point from which to operate comfortably without having to constantly shift the camera around.” By “efficiency,” Dr. Sierra intended to signal how “staying put” functioned as a means of economizing motion, eliminating “unnecessary” movements to speed up the pace of a procedure. But equally implicit in this disciplining vision to “stay put” is the presumed efficiency of Cartesian perspectivalism in mastering the bodily interior and seeing “into” interior truths.

### Prosthetics of Human Encounter

It is not surprising that ISI's promotional materials often picture the *dVSS* in an anthropomorphized form, such as in the image of the Patient Cart below. The way in which

the platform is posed positions the TilePro LCD display as head, with the robot arms extending from the “torso” supported by the motorized base which protrudes forward like a pair of feet:



**da Vinci**  
SURGICAL SYSTEM

*Taking surgical precision beyond the limits of the human hand™*

Intuitive Surgical Inc. supports the use of the da Vinci System as an effective tool for minimally invasive surgery. Individual outcomes may vary. © 2009 Intuitive Surgical, Inc. All rights reserved. Intuitive Surgical, the da Vinci System, and Endowrist are trademarks or registered trademarks of Intuitive Surgical, Inc. All other trademarks are the property of their respective owners.

*Courtesy of Intuitive Surgical, Inc., 2009*

By media extension, the dVSS performs a prosthesis of human encounter. As ISI indicates, “the da Vinci S HD Surgical System integrates 3D HD endoscopy and state-of-the-art robotic technology to virtually extend the surgeon’s eyes and hands into the surgical field” (<http://intuitivesurgical.com/products/davincissurgicalsystem/index.aspx>). Accordingly, the system at once removes the surgeon from direct contact with the patient and superattenuates his or her connection to “the surgical field,” i.e. the patient’s body. The prosthesis of human encounter depends upon a structural homology to the body of the surgeon. The dVSS becomes an “information system” with eyes (3D endoscope), hands (Endowrist® instruments and even a brain with the “computational capacity of 7 decent laptops. . . and the operating code stretches beyond 1.4M lines” (“Da Vinci S robot II,,” 2009, February 10). In addition to the ambivalence

of mimicry; then, this (often anthropomorphized) structural formation produces a dual dynamic of distance and immersion.

## Touch

Thus far, I've laid out how the *dVSS* emerges within a discourse of surgical (r)evolution, one that involves both an augmentation of the surgeon's faculties and a reduction in trauma on the patient's body. But as McLuhan notes, any media extension of the sensorium often involves an amputation, and so within the historical trajectory of open to laparoscopic surgery, a story of loss of sensory plenitude is latent. Vision becomes reduced to the two-dimensional video screen image. Touch is severely attenuated; the haptic feedback experienced through the laparoscopic tool handles in no way approximates the rich sensations received by the hand in open surgery. The resistance of tissue to the probing intervention of the instrument is felt, but radically diminished by the fulcrum physics of the rigid laparoscopic tools. And these instruments cannot transmit temperature, texture, viscosity — all the detailed qualities that once constituted the surgeon's tacit knowledge of the body.

The innovation of the *dVSS* is that it restores visual depth perception and realigns the surgeon's visual and the motor axis. It does this by operationalizing a structural homology between the system and the human body. From the point of view of the surgeon, eyes and hands are brought back into "proper" alignment. The dual-camera endoscope and related image processing unit both mimics and capitalizes on the human binocular vision system, producing the effective perception of dimensionality and depth in the televisual endoscopic image. As a result, the surgeon experiences a certain immersion in the patient's body, aided by the "intuitive" nature of the *dVSS* surgeon console interface. Unlike the laparoscopic apparatus, eyes and hands align with the "point-of-view" perspective of the surgeon, creating the experience that the robot's Endowrist instruments are the surgeon's hands, and that the surgeon is peering directly into the patient's abdomen, even though in physical space neither eyes/endoscope nor hands/instruments align at all. This experience of distance is not fully sublimated by the *dVSS* interface, in part because the surgeon's perceptual system does not fully merge with the *dVSS* interface. Surgeons still hear the sounds from physical space, sounds directionally spatialized in ways not consonant with the *dVSS*' "intuitive" eye/hand alignment: I

cut here, in front of my eyes, but hear the cut somewhere over there. I cauterize here, but hear the sizzle over there; the smell takes longer to reach my nose than in an open procedure, further spatializing the sensory distance between surgeon and patient. The material configuration of the mediating technologies comprising the *dVSS* thus raise the dual dynamic of, and tension between, immersion and distance. This dynamic tension is a question of the interface, the mutual articulation of bodies and machines on which I will focus greater attention in Chapter 3. For now, I want to consider the interface as a question of touch; specifically, touch as a ground of caring practice.

Both touch and aurality can be related to humanist figurations of care. For example, “really listening” to patients—to their narration of symptoms, fears and aspirations—is often cited as technique that conveys that a doctor “really cares” about her or his patients. The performance of active listening, of course, does not apply in relation to care in an intra-operative surgical context, except in the cases of conscious neurosurgery and minor procedures not involving anesthetic. But the tactile sense of caring, of attending to and with a “human touch” does apply in this context. Surgery can be associated with acts of violence; a sentient body would experience unbearable pain under the surgeon’s knife. But surgeons such as Richard Karl are cognizant of the tactile facets of caring-for that accompany the controlled trauma of surgery. In his memoir *Across the Red Line: Stories from the Surgical Life*, Karl writes: “We irrigate the abdomen with warm saline. We are very gentle, lest we disrupt some other nonhealing tissue and make him worse. These are acts of surgical tenderness” (2002, 63). On a list of “acts of surgical tenderness” I would also include a surgeon’s “taking care” during the opening and closing a surgical incision to create as small a wound as possible, tracing a cut that can be closed with minimal and inconspicuous scarring. For example, in one open operation I observed, to correct for post-operative complications following a robotic procedure, the attending surgeon made the decision to close the operation himself, a task usually relegated to the surgical residents. His motivation for doing so was, I think, driven by a certain guilt that the failure of his initial operation had resulted in an emergency surgery, where care could NOT be taken in making the first cut, resulting in a large slash across the patient’s navel. In opening, the surgeon had removed much of the discolored scar tissue. And in closing her incision, Dr. Kinema decided to forgo the much quicker but more imprecise stapler and instead chose to manually

sew her incision closed, even using finer gauge sutures than he would normally use to close. The choice of suture meant that even greater care had to be taken, more stitches thrown, but ultimately resulting in a much cleaner, tighter closed incision and a minimal, and perhaps eventually imperceptible scar. Finally, I would include a whole myriad of unconscious and conscious acts that resist the reduction of the patient to mere object on the operating table. While the patient's chest, for example, is often used as a "tray" for holding instruments during a procedure, I also observed surgeons gently squeezing their patient's arm, or shoulder; etc. Through these forms of tactility, at least two forms of care are practiced: the affective show of concern for another human being, and the guarding against harm or leaving an ugly trace of surgical violence.

My argument is not that touch is somehow inherently caring or care-giving. Touch, like speech, can be violent and violating. But I do maintain that *caring* touch requires a certain modicum of tactility, requires enacting an experience of multi-sensory embodied connectivity between interlocutors. In this sense, the *dVSS* is positioned ambiguously in relation to caring touch in the surgical context. On the one hand, the precision of the Endowrist instruments do create the conditions of possibility for greater care-taking within an operation, of sparing precious nerve tissue in a prostatectomy for example, tissue crucial for maintaining continence and sexual function post-operatively. On the other, its cold steel robotic arms and toothed and bladed instruments are the antithesis of what we tend to think of as instruments capable of conveying caring tactility.

Contemporary researchers actively pursue the integration of a richer sense of haptics into the interface of the *dVSS* and other telemediated surgical platforms (see, e.g. Culjat et al, 2008; Reiley et al, 2008; Okamura, 2006). I make no claim here about whether these efforts will succeed or fail. If, as I maintain, care on the tactile register requires a multimodal and embodied experience of the other, I hope that they will. What interests me here are what resources for caring tactility the *dVSS* platform affords, and by what mechanisms a rudimentary sense of tactility emerges from its interface with the surgeon. While Lenoir (2002) suggests that the *dVSS* incorporates the PHANTOM force feedback system, this is not the case. At this point in time, the *dVSS* lacks *any* engineered haptic mechanism that would allow surgeons to experience even the basic forces that the robotic arms exert on the patient's tissues during an operation.

Because of this lack, tissues can be more easily damaged by an inattentive or novice surgeon. Tying sutures tightly without breaking them is one of the more difficult tasks for a novice *da Vinci* surgeon to master:

ISI claims—and my own experience on the *dVSS* confirms—that the *dVSS* platform is not entirely devoid of a haptic, tactile experience. The surgeon at the console does experience a limited haptic sensation when instrument arms collide or when manipulating tissues in the surgical field. If not explicitly engineered into the system, on what mechanisms, then, does this haptic sensibility depend? In part, haptic experience on the *dVSS* platform depends upon the role the human visual system contributes to our sense of touch. ISI refers to this sense of tactility as “haptic visuality” (or, occasionally, “visual tactility”) to capture the way in which seeing something happen on the *dVSS* display gets experienced, substitutively or synesthetically, by the surgeon’s hands at the master controllers (Hagen et al, 2008; Bethea et al, 2005). Simply put, the hands experience what the eyes see. On one level this adds further credence to the multimodal sensory knowledge that a surgeon brings to her craft, knowledge that gets carried in the muscle memory of the skilled and experienced surgeon. When tying off a suture, for example, surgeons do not sense the force they exert on the Vycril suture based on proprioception and touch alone; subtle visual cues also provide feedback on how much tighter a suture can be cinched. This knowledge is made explicit in the training of surgeons on the *dVSS*. Dr. Sierra, for example, instructed a student frustrated about breaking yet another suture that he would eventually learn to see the tensile limits of the suture through such visual cues as the blanching of tissue or the glisten of moisture that beads up on a length of suture as it is pulled taut. As David Rosa (ISI’s senior marketing director) puts it, “You make up for the loss of sense of touch with what you’re seeing with your eyes . . . how far tissue is stretching, if it’s blanching, how far you’re pulling your instruments apart if you’re tensioning a suture” (Cleaveland, 2005).

Phenomenology also asserts the entwinement of the visual and the tactile in shaping our experience, as does Roland Barthes’ theorization of the punctum, the “prick” of the photograph, and Laura Marks exploration of haptic visuality in the cinema, how certain modes of video invite the viewer to see haptically: “the eyes themselves function like organs of touch” (Marks, 2002: 2). Certain strands of cognitive neuroscience also suggest strong ties

between the human visual system and embodied experience.<sup>17</sup> For example, Alva Noe (2004) argues against the primacy of the “retinal image” model of visual perception, where the eye’s function is analogous to a camera and the only “data” for vision is the image which the retina records. Instead, Noe posits that vision involves *enactment*, a much more kinesthetic and synesthetic mode of perception based on the anticipation (and memory) of touch, of whole-body interaction and exploration with objects in the world that unfolds over duration, instead of the photographic “instant”.

Even more interesting for my purposes, however, is the manner in which the limited haptics of the *dVSS* result from *error that is not a malfunction*; namely, the productive excess of the complex cybernetic feedback system behind the master-slave relation so crucial to the media-specificity of the *dVSS* platform. As noted earlier, ISI suggests that the master-slave relation is one of “seamless translation” between the movements of the surgeon and the movements by the robotic arms controlling the Endowrist® instruments. Cleaveland (2005) interviewed Bill Nowlin, ISI’s director of software systems, on the issue of haptics on the *dVSS* platform.

Cleaveland writes:

The da Vinci system does provide some force feedback, derived from the error signals in the position loops. “I would describe it as a variant of bilateral force reflection,” says Nowlin, “and what that means is that the error produced between desired and actual at the patient-side manipulator is used to generate a feedback signal that the master and, therefore, the surgeon feels.” This is not true force feedback, he points out, for a simple reason: “If that were completely linear and if its scale factor were one, if its gain were one, then that would be true force feedback. It would also violate Bode’s theorem and a few other things and would be unstable.” (2005)

As I will attempt to outline, this disjuncture between desired and actual is not dysfunction; to the contrary, the primacy of error motors the robot body as much as it generates tactility within the system. Without knowing for certain the precise mechanism by which the *dVSS*’s positioning feedback loops generate haptics through error — the technology remains largely blackboxed — I can outline the contours of this process by extrapolating from some of the patents that ISI has taken out on robotic surgical technologies. Patents protect knowledge as

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<sup>17</sup> I’m also aware of studies that leverage neuroimaging techniques to dramatize how simply visualizing something — in the “mind’s eye” or even on television — activates the same neuropathways as would be activated if someone were *actually doing* the same thing.

intellectual property not by black boxing knowledge, but instead by elaborately defining and specifying it. Patent claims *stake a claim* on knowledge as a property that can be defended from infringement. They define the contours and boundaries of that property. They are therefore useful tools in understanding the media specificity of complex technical objects. In this section, then, I draw upon two ISI patents: “US 6,722,053 B2: Aspects of a Control System of a Minimally Invasive Surgical Apparatus” and “WO 2007/111749 A2: Method for Handling an Operating Command Exceeding A Medical Device State Limitation in a Medical Robotic System.”

As I outlined earlier, the *dVSS* is a master-slave robotic system. Ideally, the robot's end effectors do not move except as initiated by the master controllers at the surgeon's console. In the logic of robotic engineering, the perfect master-slave system is one that achieves perfect mimesis between master and slave, where the surgeon's actions are seamlessly reproduced by the end-effectors, without excess or loss, except for the *active cancellation* of that which is deemed expendable from or excessive to the movements being reproduced, such as human hand tremor. As Hansen Medical describes it in relation to their Sensei surgical robot, “You Move, It Moves.” I see ISI's often repeated assertions of the seamlessness of the master-slave translation as an effort to sublimate the instability that *translation* inserts into systems of exchange, be they semiotic, computational or electro-mechanical. The movement of the hands at the master-controllers does not translate into a one-to-one correspondence of movement at the end-effector in the surgical field. Nor is the system designed to do so. Instead, on a superficial level, it both *scales* the motion reproduced (according to a specified ratio) and filters motion that occurs at the same frequency as human hand tremor. One might still imagine that translation according to a mechanics of simple mechanical gearing, but this is not the case. The interface between master and slave in this robotic system is *computationally-derived* as much as its *mechanically-driven*.

To elaborate, there are some elements of the master-slave relation that adhere to the physics of the direct application of physical force. One might say the master-slave logic of the laparoscopic apparatus is mechanically-driven: Force applied to the handle-end of the laparoscopic surgical tool is directly translated into force exerted at the sharp end of the tool, albeit in an inverse direction (downward force on the handle results in upward force at the

instrument tip). The ratio between force applied and force delivered is a function of how deeply the laparoscopic tool is inserted into the patient's abdomen. (Think of the fulcrum effect of a see-saw. If the fulcrum of the see-saw is exactly centered, then force delivered on one end should match force exerted at the other.<sup>18</sup> The closer the fulcrum is to one end of the see-saw, the greater the force differential produced.) Force-translation is also a function of the material properties of the laparoscopic shaft (e.g. how stiff or flexible the instrument shaft is will also affect the force-translation ratio).

But the *dVSS* also introduces *computationally-derived* forces into the master-slave interface that complicate the master-slave logic exponentially. The mechanical linkages of the laparoscopic system--the rigid shaft of the laparoscopic tool--break down at the fiber-optic, informatic interface that connects the Surgeon's Console to the Patient Cart. The physics of force move through spaces of simulation and back again. The seamless translation of surgeon movement into end-effector action proceeds through a complex of computational algorithms, as indicated by the block diagram below:

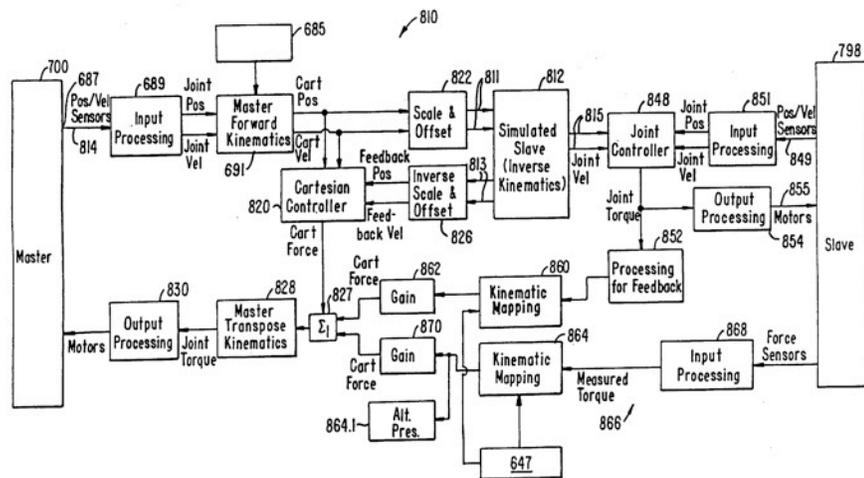


FIG. 14.

<sup>18</sup> Not accounting for the counter-force of gravity.

Parsing through dense patent language is difficult at best, but allow me to outline several key operational logics in this diagram. First, the movement of the master controllers does not drive the slave end-effectors. Instead, this movement is “captured” by an array of position and velocity sensors (814) in the joints of the master control hardware apparatus. The relative position of the various segments of robot arms is measured at their joints at a sampling rate of 1300 Hz (1300 times per second). Each of these measurements is a numerical value that represents a position in *joint space* at a particular moment in time. It is important to appreciate that the position represented in joint space is not a Cartesian coordinate system. Rather, it is *translated* into Cartesian space by the application of forward kinematics algorithms (691). Kinematic velocity, too, is a product of computation, derived by measuring the degree and rate of change in the joint space position values. As noted in my discussion of the Surgeon’s Console at the beginning of this chapter, these velocities and relative position values are both scaled down (according to the scale factor set by the surgeon) and filtered (to eliminate the oscillations of physiological tremor). What these computational procedures produce is a simulated or virtual *model* of the manipulations desired of the slaved end effectors (812). Control is exerted at this virtual domain on the “simulated desired”, ensuring that the position and velocity values desired do not exceed preset tolerance levels. If they do, they are processed accordingly to bring them back into an acceptable range. This controlled desired simulation is then translated from *Cartesian space back to joint space* through inverse kinematics, producing a tolerance-delimited simulated model of the desired joint positions and velocities.

Crucially, this desired model does not directly drive the end-effectors, either. Note the symmetry of the block diagram. Just as sensors at the master controller capture the position and velocity of the surgeon’s manipulations, identical sensors in the joints at the end effector are capturing the movement of the end-effector, again producing a representation of end-effector kinematics in *joint space*. The slave joint controller (848) then compares the actual joint position and velocity measurements as computed from the end-effector sensors against the simulated desired joint positions and velocities. The difference between the “simulated desired” and the “actual” is, functionally, positional error quantified numerically, as a deviation from zero.

It is finally this quantification of error that then drives the slave end-effectors. Rather than being driven “to” a position in Cartesian space, the actuator motors in the end-effectors are driven with a torque geared to reduce the error differentials between desired and actual in joint space to zero. This proceeds via a feedback loop in the upper right corner of the block diagram, 1300 times per second. Joint controller (848) outputs the disjuncture between desired and actual to an output processor (854) that drives the motors in an attempt to reduce that disjuncture to zero. This results in actual displacement of the end-effector in Cartesian space, a displacement which is sensed at the joints in the end-effectors (849) and processed (851) to create a new representation of actual end effector position and velocities in joint space. This new actual is fed to the joint controller (848) where it is compared against the “simulated desired” model again. The feedback loop repeats itself until the positional error is reduced to zero, whereby the “state” of the slave end-effector and the master controller coincide. Of course, the system is much more dynamic than this explanation conveys, for the “simulated desired” model is refreshed at 1300 Hz as well.

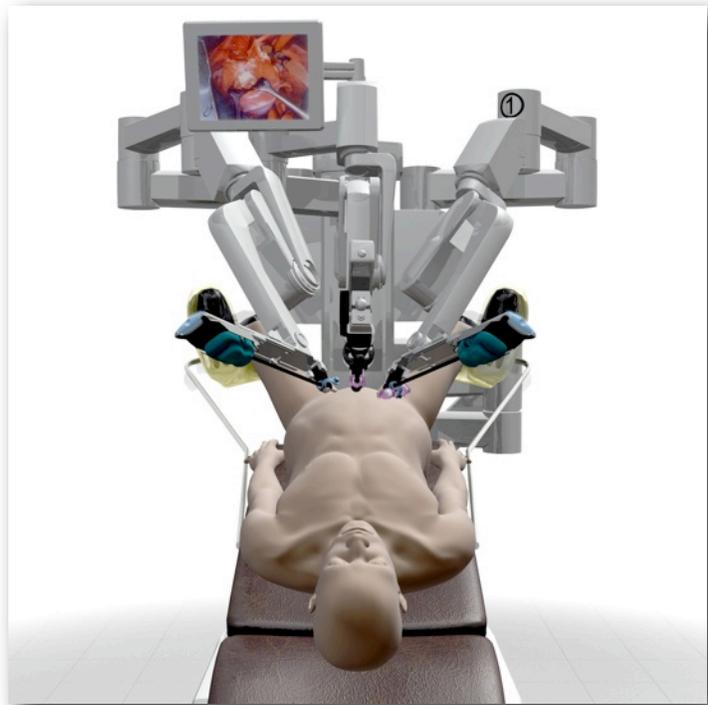
So how, then, does error produce haptics within this configuration? Haptic feedback is not simply a function of calculating the force by which the patient’s tissues “push back” against the robotic end-effector, and then translating that into actuation in the joint space of the master controller. The force exerted by instrument collision with patient tissue does get picked up by the force sensors at the slave end-effector, as indicated by the lower-right of the block diagram (868). But the production of torque that drives the slave actuators to approximate the “desired” also produces force that must be taken into account when analyzing the data from the force sensors. In overly simplified terms, the motor-induced force needs to be subtracted from the tissue-induced force in order to generate semi-meaningful force-feedback data. But even this force-feedback data does not drive the haptic output at the master controller alone. Instead, the *dVSS* platform also generates force feedback that is a function of the degree to which the movements of the surgeon at the console exceed the pre-delimited tolerance limits that are calculated in the virtual domain of the simulated slave (812). Haptics, then, is error-driven and is as much an experience of reflexivity— of recoiling from a preset *dVSS* tolerance limit— as it is a “virtual” experience of the elasticity and density of human tissues encountered by the Endowrist® instruments.

In essence, then, the entire system that drives both the end-effector actuators to perform the tele-surgical operations and the limited haptics experienced by the surgeon at the master controller emerge out of disjunctures in a virtual matrix that measures *desire against limit*, the *desired against the actual*, productively. Consequently, the limited haptics produced by the dVSS platform is either a compensatory one that channels yet another mode of embodiment through the visual register (haptic visuality), or, where it does engage tactility and proprioception, it does so according to a complex logic of productive error. Therefore, the condition of possibility for caring touch on this surgical platform, limited as it may be, emerges out of the *productivity of error and the necessity of the limit*. The vexed relationship between care, fallibility and error is something I return to in the context of the next chapter, where I discuss the “becoming robot of the surgeon” as a figure of both machinic virtuosity and degraded alienation. Error makes a reappearance as the purported “other” of machine virtue, leading discourses of patient safety in contemporary medicine to conflate safe medical care with the mitigation of error, if not its elimination.

— 3 —  
THINKING (AT) THE INTERFACE

### Docking the Robot

Docking the robot creates a tight and material coupling between human and machine in the operating rooms at University Hospital. Once the patient is anesthetized, catheterized, prepped and draped, the operating table is tilted back into a “Trendelenburg position,” the patient’s feet higher than his head. The patient’s legs are also spread apart to accommodate the Patient Side cart, whose sterile-plastic-draped and crab-like form is parked unceremoniously along the OR’s back wall.



*Image courtesy of Intuitive Surgical, Inc., 2009*

The docking procedure begins with first incision, the surgeons creating one 12 millimeter and four or five 8-millimeter incisions precisely mapped out with a centimeter ruler on the patient’s abdomen. The “extra” incisions allow the assisting surgeon to insert the “sucker” (suction) and/or a traditional laparoscopic forceps into the surgical field. Each of the incisions is intended for a trocar, a plastic cannula or “port” which will serve as a pathway for the dVSS’ Endowrist® instruments to slide smoothly into the body cavity without damaging the patient’s abdominal wall. The first trocar is inserted in the incision directly above the navel. This trocar, a bit larger than the others, will hold the 12 mm endoscopic camera. It has a special

collar through which a pneumatic tube will supply the CO<sub>2</sub> necessary to inflate the abdominal cavity. The insertion of the first trocar carries the greatest risk of damage to the abdominal organs; it is inserted “blind”, without the benefit of endoscopic visualization. Surgeons proceed by touch, first enlarging the incision with a scalpel and their fingers, pulling up on the patient’s abdomen while twisting the trocar deeper into place with careful but deliberate force. Surgeons then feel their way forward, seeking the “give” that signals the trocar’s successful progression through the peritoneum. Once this first trocar is inserted, the patient’s abdominal cavity is inflated with CO<sub>2</sub> and the endoscopic camera is inserted into the abdomen, giving the surgical team their first view of the surgical field, a glistening terrain of pink intestines, bladder and yellow visceral fat underneath the smooth dome of the peritoneum’s serous tissue.

The surgeon’s first visualization task is to ensure that no underlying organs were damaged by the blind insertion of the trocar. Once the integrity of the insertion is ascertained, the endoscope is maneuvered to provide a “view from below” while the surgical team inserts the remaining trocars into the abdominal cavity. As each trocar is twisted into place, the endoscope shows first the trocar’s tip stretching against the resistive peritoneal membrane. It blanches white, and then the trocar’s tip ruptures through. These trocar insertions are constitutive of the bodily penetrations required of “minimally invasive” surgery. While in fact these incisions exact very little trauma, the stubborn manner by which the body’s tissues resist penetration by the trocar is remarkable to watch. The moment of rupture is both anticipated and carnographic.

Once the trocars are in place, the circulating nurse “drives” the *dVSS* Patient Cart into position between the patient’s legs. While the *dVSS*-as-automobile is a trope that recurs across many different contexts within the course of an operation, the docking procedure tends to elicit the most references to car culture. Maneuvering the refrigerator-sized Patient Cart into place is surprisingly difficult. Proper position is crucial to ensuring that the robot’s arms can move through their full range of motion without collision or other encumbrance. And the final location—“close, but not too close . . . a little to the left, now back up a bit”—can make or break the proper angles of approach for a particular procedure, in this case a robotically-assisted radical prostatectomy. Painfully banal “car jokes” abound: “*Hey, you’re pretty good at that! But can I trust you to parallel park my [insert model of ridiculously expensive car here]?*” “*Look out, you almost backed over Grandma!*” “*Watch out everybody, student driver!*” “*Vroom, vroom,*

vroooooooooom, vroooooooooom”... Once positioned, brakes are applied to hold the cart firmly in place. Neither cart nor patient can move once the docking process is complete. As one surgeon put it, “in a tug of war with the robot, the patient will lose every time.”



**WARNING: Once the *da Vinci S* System is positioned, cannulae are placed in the patient and Patient Cart arms are attached to the cannulae, the surgical table MUST NOT BE MOVED in any way. Serious injury could result.**

*Source: da Vinci S User Manual*

With the Patient Cart parked, the surgical team manually extends each robot arm over its respective trocar. The camera lens is cleaned off and inserted first, interlocking with the camera arm. The rest of the trocars and arms articulate with the snap of a latch. Finally, the appropriate Endowrist® instruments are snapped into place. A LED flashes while a microchip in Endowrist® instrument housing communicates with the Patient Cart, both revealing the instrument’s identity (as a fenestrated Maryland bipolar, for example) and verifying that it has not yet exceeded its limited lifespan (usually 10 procedures). Once properly vetted, the “sharp end” of the instrument descends, noiselessly, into the surgical field. A blue LED light on each robotic arm indicates that the *dVSS* is ready to accept the operating surgeon’s control.

\* \* \* \*

This scene foregrounds a myriad of layered and interlocking interfaces, the most obvious being the dramatization of a critical coupling of human and machine, the mutual articulation of patient to robot through the process of docking. Docking is the moment that an operation becomes robotically-assisted; it serves as a token for the essential confusion of human and mechanical (re)production that such a coupling initializes. The scene ends in the expectation that the surgeon will take control, and appropriate the patient/robot apparatus to intervene on the patient’s prostate cancer. Taking control, however, requires that the surgeon, too, interface with the robot. As with docking, the surgeon seated at the controls must assume the proper body-orientation *vis a vis* the robot in order to “make” the apparatus function.<sup>1</sup> At this point, he/she is also effectively “docked,” raising the twin specters of the becoming-robot of the

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<sup>1</sup> As the concluding analysis of the last chapter dramatically illustrated, the seamless translation of surgeon’s gesture to Endowrist® instrument, of “making them move,” cannot be conceived as control in any simple or straightforward manner.

surgeon and the becoming-surgeon of the robot. In this chapter, I want to confront the machine/flesh synchronization that occurs at both “ends” of the operational system and the problem/promise of the interface it suggests. The multi-layered mediation of the relationship between the surgeon and patient raises the basic question: how does the *dVSS* system focus and specify the interface? This question in turn raises one that is much larger: what does or can it mean then to perform “care” at the interface? How does focusing life at the porous border of body and machine implicate care? As I proceed to elaborate the nature of the interface, even to the extent that the complex computational system that “drives” the *dVSS* embeds the kind of error we usually identify with human practice otherwise perfected by machines, I want to insist upon the inadequacy of the liberal humanist fallback on care as a matter of uniquely human, unmediated affect and touch. The triumphalist technological fantasy that care would improve with the elimination of human imperfection is also an illusion. Beyond the dualism of human-vs.-machine, and the regressive claims to one-or-the-other to which it is prone, I also want to suggest that it is precisely at the sometimes attenuated articulations of human and hardware that new possibilities for care emerge. This will be the primary focus of my concluding chapter. For now I want to show just how prominently and multiply “interfaced” the *dVSS* is, and then to dramatize the intensive enmeshment of doctor/machine/patient within a matrix of authority, automaticity, and the automaton. How does the machine complement or compromise the authority of the surgeon? How does his/her authority, as secured in and around the *dVSS*, change or challenge norms of care? In other words, I want to think *from* and *at* the interface about possibilities for care. First however, I must pursue the primary focus of this chapter: to display the intensity of the interface within a matrix of authority, automaticity, and the automaton, the intensive, medial networks in which patient and surgeons meet.

## **What is an Interface?**

What is an interface? The IEEE Standard Computer Dictionary provides this definition:

A boundary across which two systems communicate. An interface might be a hardware connector used to link to other devices, or it might be a convention used to allow communication between two software systems. Often there is some intermediate component between the two systems which connects their interfaces together.”

Central to discussions of interface is an *articulation* that is at the same time a *communication between systems*, between hardware components, between software components, or between hardware and software. Often, this articulation is made to enable joint *operation* of the interfaced devices. Complicating this further, the term can also be used to specify a *mediating* device that connects other interfaces. Interfaces layer upon interfaces, making the notion itself difficult to parse in the concrete. This is particularly true of complex technologies like the dVSS. On one level, the device itself is an interface in the sense of being a mediating component between two interfaces: the surgeon's tools and the patient's skin. And yet it itself is comprised of numerous interfaces that translate, for example, mechanical motion of the master manipulators into digital information processed computationally and then output at another interface that translates the digital information into the mechanical motion of the surgical end effectors.

In relation to technology, the contemporary meaning of the term is usually deployed to mark the *site* and *methods* of interaction between humans and technological devices. Human-computer interaction, therefore, takes place at the "user interface." As I type this, I rely on the user interfaces of screen, keyboard and mouse to interact with my laptop to co-produce this text. As Steven Johnson explains, an interface is not a transparent, passive connector or conduit for interaction:

What exactly is an interface anyway? In its simplest sense, the word refers to software that shapes the interaction between user and computer. The interface serves as a kind of translator, mediating between the two parties, making one sensible to the other. In other words, the relationship governed by the interface is a *semantic* one, characterized by meaning and expression rather than physical force. [emphasis in original] (1997: 14)

Johnson's definition, however, tends to reduce thinking at the interface to a question of meaning production and negotiation - which is not surprising, since his focus is on software and not hardware, where the former is often thought of strictly in terms of symbol manipulation. Hardware interfaces do exert physical force. Furthermore, Johnson's understanding of language as semantics does not address the complexities of power/knowledge, the articulation of the seeable and the sayable according to what Foucault calls a diagram of power or what Deleuze refers to as an "abstract machine." If software is a language, it is a peculiar one, marked less by

meaning production than by what Ian Bogost (2007) calls *procedurality*. The point of writing software is to execute as much as it is to represent. Seen from this perspective, software becomes a materially performative medium: “When media become things, we enter a world of operability, a world not of interpretation but of navigation. We do not ‘read’ them so much as ‘do’ them (‘Just Do It’), or do with them” (Lash & Lury, 2007: 8). Bogost (2007) makes the stronger claim that procedurality not only defines software’s mode of operation, but that “procedures found the logics that structure behavior in all cases... when we do things, we do them according to some logic, and that logic constitutes a process in the general sense of the word” (7, emphasis in original). My intention in invoking procedurality or operability is to signal how medicine’s use of these terms creeps into the context of the computational interface and, conversely, how medical care is increasingly proceduralized. I also want to reinforce the fact that interfaces mediate on more than the level of the semantic, the plane of meaning. The interface is a zone of articulation for affect (in the sense of the capacity to affect and to be affected) between bodies, be they human, electro-mechanical or code (Hansen, 2006). The interface of hardware, software and human wetware both enables and constrains action, what humans and computers can do together, in the doing that the interface performs. This is particularly true for the *dVSS*. As a surgical platform, an apparatus of hardware and software, the *dVSS*’ interface enables and constrains expression, which in this case is gesture and action, the surgical operation.

A genealogy of the term “interface” underscores this broader emphasis on affectivity. The OED indicates that the term “interface” first emerged in the 1880s, and denoted “a surface lying between two portions of matter or space, and forming their common boundary” (Interface, *n.*, 1989). The first known use of the term is attributed to Bottomley (1882): “The term *interface* denotes a face of separation, plane or curved, between two contiguous portions of the same substance” (Interface, *n.*, 1989). Interestingly, this early (and quite abstract) use of the term interface suggests a Deleuzian processual metaphysics of the fold. Here interface does not presuppose a boundary between different substances (identities) that express difference derivatively in their coming together. Instead, this definition of interface asserts the ontological priority of difference, the processual productivity of interfacing as an

engine of subjectivation and individuation, fundamental to the production of knowledge, subjectivity and agency.

The next entries in the OED date from the early 1960s discourses of systems, information, communication and media theory. Here an interface is a “means or place of interaction between two systems, organizations, etc.; a meeting-point or common ground between two parties, systems, or disciplines.” In his 1962 *The Gutenberg Galaxy*, Marshall McLuhan, for example, describes the “meeting of medieval pluralism and modern homogeneity and mechanism” as the Renaissance “interface” (141). He elaborates,

An age in rapid transition is one which exists on the frontier between two cultures and between conflicting technologies. Every moment of its consciousness is an act of translation of each of these cultures into another. Today we live on the frontier between five centuries of mechanism and the new electronics, between the homogenous and the simultaneous. It is painful but fruitful. The sixteenth century Renaissance was an age on the frontier between two thousand years of alphabetic and manuscript culture, on the one hand, and the new mechanism of repeatability and quantification, on the other. (McLuhan, 1962: 141).

In these terms, the interface is the “contact zone” between what Foucault might call two positivities or epistemes, or what cultural studies might describe as the friction between the residual, the dominant and the emergent. Importantly, then, the interface is a space of communication as well as miscommunication, of translation as well as agonistic difference. The interface is more than the meeting of different ideas or ideologies; it is also the meeting of different knowledge/power formations, systems of governmentality and, quite literally, protocol.

The interface presents itself as a system of communication and the point of mediation and connection between communication systems. This includes, for example, disparate transportation systems. As Carey (1989) reminds us, in the 19th century “the movement of goods and people and the movement of information were seen as essentially identical processes and both were described by the common noun ‘communication’” (15). Accordingly, the OED stipulates one definition of the interface as the nodes and relays between *systems* of communication, such as buses, trains, subways, or in contemporary terms, networks and circuits: “The advantages of high-speed transport were piddled away at the nodes or

interfaces: from bus to train, train to train, city terminal to airport terminal, check-in counter to loading gate, and so on.” (Interface, *n.*, 1989). Because these interfaces were sites of translation and exchange, possessing disparate and perhaps asynchronous temporalities, *the interface should also be seen as a site of loss* and all the anxiety that loss evokes. Translation is never seamless. For instance, re-presentation across different linguistic or graphical registers confronts both excess and loss. The translation conveys both more than one means and less, and sometimes something completely unintended. The same can be said for networks and systems of exchange — luggage and letters misplaced in transit; data packets dropped due network latency; the transmission of authority lessened along a chain of command, etc.

This is particularly clear in another early deployment of the term—this one found in Albert Battersby’s 1967 contribution to the literature on “operations research,” the foundations of which have been traced to Charles Babbage.<sup>2</sup> Network Analysis for Planning and Scheduling elaborates techniques for visualizing and optimizing the execution of complex projects by leveraging network theory. In developing the post-war technique of “critical path analysis,” Battersby asserts that “events should be established at stages where the work passes from one

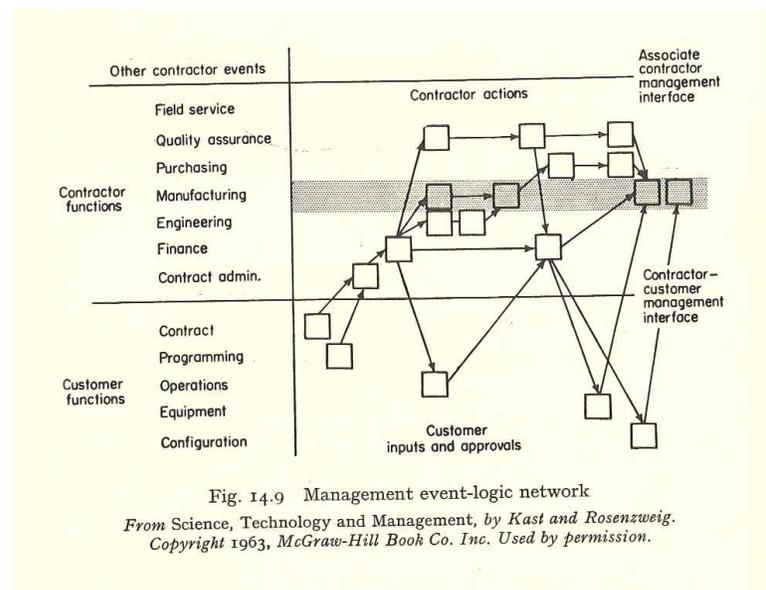


Fig. 14.9 Management event-logic network  
 From Science, Technology and Management, by Kast and Rosenzweig.  
 Copyright 1963, McGraw-Hill Book Co. Inc. Used by permission.

<sup>2</sup> Lewis (2007) explicitly makes a case that Babbage should be recognized as a pioneer in the field of operations management. Lewis links Babbage’s attempts at building his “Difference Engine” (an automatic, mechanical calculator designed to tabulate polynomial functions: in essence, Babbage created plans for an early mechanical computer) to the study of optimizing mechanical and mental processes as algorithms. Babbage’s analysis of the sorting, pricing and distribution operations on the postal industry also inspired Sir Rowland Hill to develop the English “Uniform Penny Post” in the 1840s.

department to another; these stages are known as interfaces" (1967, 116). Battersby uses the graphic above to illustrate the interfaces between different functions in an organizational network. Later in the same text, Battersby refers to interfaces as divisions between zones of authority: "The divisions between zones are called 'interfaces' and they are important in that any arrow (including dummies) which crosses an interface means that responsibility is being transferred" (1967: 246). Because the interface in this discourse functions as the hand-off between nodes in a bureaucratic process, these interfaces were subject to intense scrutiny and administrative control to minimize inefficiency and other modes of organizational "loss."<sup>3</sup> The interface is the point at which authority and responsibility are both specified and transferred, displaced or even usurped. *The interface is thus a site of control, given the inherent or perhaps the inevitability of failure.* It contains and conditions the power necessary to fuel given systems, attempting to enforce and maintain certain relations and directionalities of exchange.

Discourses of computational loss and failure are particularly powerful today, dependent as many of us are on computers as prosthetics of memory, as means of expression and communication. From the PC's notorious "Blue Screen of Death" to the important email memo that never arrives, from jittery streaming video webcasts to the corrupt Microsoft Word term paper one neglected to back up, computational interfaces are haunted by always imminent breakdown in a manner than mimics their bureaucratic predecessors.

Computers are not flawless. Errors typically occur at the juncture between analog and digital states, such as when a drive's magnetoresistive head assigns binary symbolic value to the voltage differentials it has registered, or when an e-mail message is reconstituted from independent data packets moving across the TCP/IP layer of the Internet, itself dependent on fiber-optic cables and other hardwired technologies. All forms of modern digital technology incorporate hyper-redundant error-checking routines that serve to sustain an illusion of immateriality by detecting error and correcting it, reviving the quality of the signal, like old-fashioned telegraph relays, such that any degradation suffered during a subsequent interval of transmission will not fall beyond whatever tolerances of symbolic integrity exist past which the original value of the signal (or identity of the symbol) cannot be reconstituted. (Kirschenbaum, 2008: 294).

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<sup>3</sup> In contemporary medicine, the "hand-off" between shifts of medical personal is one such "interface." Research aimed at addressing "the problem of error" in contemporary medicine often cites this moment as a critical juncture in the continuity of patient care, particularly susceptible to inefficiencies and miscommunication.

At the crux of even the highest performance computational interface lurks the threat of error; of a system fault — Abort? Retry? Fail? While the illusion of error-free virtuosity structures our perception of the technological, the reality is that the performativity of any signal passed through the interface—call this its effectivity—relies on constant resuscitation (i.e., whenever the signal risks falling outside of the tolerances of “data integrity”). Von Neumann (1951) makes this observation as well early on in the history of computer science: digital computers produce “no error whatever” only “as long as the operation of each component produces only fluctuations within its preassigned tolerance limits” (294).

The computational concept of the interface is germane to this dissertation because the “paradigm shift” that robot-assisted surgery represents hinges upon the *interposing of a computer* between the surgeon and the instruments operating on the patient’s tissues. The fact that the interface between surgeon and patient is computational is not incidental; computational interfaces, like all interfaces, have an *orientation*.<sup>4</sup> I argue that understanding the interface in these terms is key to understanding the *politics* of the dVSS: the computational interface orientation of the DVSS sets the conditions of possibility for various “futures” in relation to the automation of surgical practice and the knowledge politics of embodied skill. It also articulates a generalized terrain for considering the mediality of these politics. Let me turn, then, to two distinct ways in which the term “interface” is used in relation to computers and computation, first by considering the notion of the computational interface as “skin” and second by a longer engagement with the specialized discourse of computer science and the use of the term “interface” within the framework of Object-Oriented Programming (OOP).

### **Graphical User Interface as Skin**

The graphical user interface (GUI) of a software or hardware assemblage is often called its “skin”. The term “skin” is usually invoked to describe the surface appearance of the interface, and it is often counterposed to the underlying system. PROSKIN (<http://www.proskin.org>), a

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<sup>4</sup> Ahmed (2006) reminds us that bodies and objects become oriented to each other through the specificity of their interfaces, which can be shaped by both the physical materiality of the objects themselves, as well as their social materiality. Her analysis centers on the “philosopher’s table” in shaping the queer orientation of phenomenology. The table is both a physical and a social object; it is a place where one gathers, but also marks the gendering of spaces of domesticity.

research project focused on methods to more effectively customize and personalize the GUI skin of a wide range of technologies, explains the concept in this way:

A skin is considered to be the appearance of the user interface, including graphic, haptic, and/or aural patterns...Skins are used typically to change the "look and feel" of the interface components, often a cosmetic change alone (i.e. the colours change or a background image is applied, but the interface components remain unaffected in location, attribute or function). (quoted in Starioleski, 2008: 35)

Skins in this sense are often interchangeable with themes, such the ability to customize the look and aesthetic feel of the Mozilla Firefox web browser by downloading and "applying" an add-on theme: <https://addons.mozilla.org/en-US/firefox/browse/type:2> In the context of current best practices of web design, the skin of the website — its graphical design and layout — should ideally be completely separated from the site's content, its "data." Following these web standards means coding the web page's aesthetics in a separate CSS (Cascading Style Sheet) file, that is then linked to the XHTML content. Different stylesheets (skins) can be applied to a single XHTML content page. The website CSS Zen Garden vividly illustrates the diverse ways that CSS can skin a single HTML file (<http://www.csszengarden.com/>).

This notion of interface as skin seems fundamentally opposed a platform approach to technology. How so? The platform approach is interested as much in the underlying code of software as it is in its GUI, as much with the affordances of a particular chipset as it is with the industrial design of the computer chassis. What is the relation between the interface and the platform? Is the skin "that which overlays," a mere surface? Vernacular uses of the term "computer interface" tend think of it as a particular type of skin, as superficial exterior or epidermal film, as a mode of expression that overlays or merely presents a technologically determinative "core." This enveloping skin is identified with appearance (the canvas or screen upon which meaning is visually inscribed). It metaphorically excludes the porousness of corporeal skin and its tenderness; it's capacity to be pierced, cut, and variously to bleed, seep and weep (Probyn, 1996; Ahmed & Stacey, 2001). Scholars who imagine the cinematic or television screen as permeable skin on the other hand characterize it as a passage, a scene of appearances playing out the fantasy of moving between the interiority and the exteriority of the televisual hardware, on rays of light, or pixels if you will. The image of climbing into or out

of the TV screen as if it were window is consistently entrancing, precisely because it dramatizes or promises the fantasy of transgressing a boundary. The solidity of the CRT, LCD or plasma screen becomes permeable.

I find it productive to conflate platform and interface, or rather to assert their fundamental inseparability (like two sides of the same piece of paper; different and differentiable, *this and that*, but profoundly dependent upon one another -- in other words, interfacing). Imagining a "platform-interface" interface in this way renders current approaches to new media and medicine inadequate. As Wendy Chun (2006) explains, these approaches are marked by a gap or division through which interfaces might be constructed. Chun writes,

to exaggerate slightly, the screen divides new media studies into these two fields. Visual culture studies stem from the Anglo-speaking academy and generally treats the interface, or representations of the interface, as the medium. The second approach, media archaeology, although inspired by Marshall McLuhan and Foucault, is mainly Germanic (most specifically, it emerges from the "Sophienstraße" departments of Humboldt University in Berlin). Taking as its ground zero McLuhan's mantras of "the medium is the message" and "the content of a medium is always another medium," media archaeology concentrates on the machine and often ignores the screen's content. Archaeological studies critique visual culture studies' conflation of interface with medium and representation with actuality; visual culture studies critique the archaeologists' technological determinism and blindness to content and the media industry. (2006, 17)

Enfolding the semiotics of the screen and the technologies of their (re)production puts screen and technological "guts" on the same ontological plane. What would it mean to "do" media studies in this way? I suggest that Alt's elucidation of the "object orientation" of contemporary computation points the way, both through his methodology (he attends to the computer-as-medium and also gets into the "guts" of code) and his conclusions (that object orientation and computational mediality exist on the same plane, as different perspectives—"this and that"—on what is fundamentally the same phenomenon).

### **The "Object Orientation" of the Interface**

In his forthcoming essay "Objects of Our Affection," Casey Alt seeks to understand how and when computation "became a medium" (2). It is often forgotten that the word "computer" originally referred to human workers who performed numerical calculations. And

as Alt points out, it was this notion of calculation that defined both the material practice of computing as well as its relation to the Enlightenment project of engineering freedom:

In the beginning there was the Calculating Machine. Whether that of Pascal, Leibniz, or Babbage, the Calculating Machine represented the ultimate Enlightenment dream. It was the fullest material expression of humanity's most rarified process of rationality: an autonomous, mechanical device that could automatically compute mathematical solutions. It was the promise of an engineering miracle that would liberate our creative minds and active bodies from the sedentary tedium of complicated numerical tasks. Perhaps no one despaired of this problem more than Charles Babbage, who, in considering the mathematical labor required in compiling and verifying various astronomical tables in the early 19th century, uttered his legendary lamentation: "I wish to God these calculations had been executed by steam!"

However, as Alt then proceeds to point out, our contemporary sensibility about computers treats them as *media*, not calculators. In profound ways, computers both enable and shape our access to the world; they mediate. So how, then, did the computer make this leap from "machines that calculate" to "machines that mediate"? It could be claimed that the adoption of the graphical user interface—a screen technology that both presents and frames a "virtual world" produced by computer graphics—fueled this shift. Certainly the emergence of television (and the much longer history of the desire for *televisuality*, of using media technologies to overcome mediations of time and space) precedes and shapes the early development of the computer's visual interface.<sup>5</sup> Insofar as television was conceived of as a "window on the world", so too the provisioning of computers with a graphical user interface harnessed a similar sense of mediation, perhaps most evident in the emergence of "windows" as the dominant metaphor for that interface (Spigel, 1992; Friedberg, 2006).

Alt's brilliant analysis takes a different tack, one more in line with taking seriously the material specificity of the computational *platform*. This allows him to articulate both the genealogy and the stakes of the emergence of computation-as-medium. Alt's central thesis is that "computation became a medium when the concepts of medium and interface were implicitly embedded in computation at the material level of the programming language itself," an event Alt attributes to the emergence of the object-oriented programming paradigm

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<sup>5</sup> Importantly, Margaret Morse (1998) articulates how the use of computer graphics on television, in turn, shaped our contemporary notions of televisual space as well as influenced emergent notions of "virtual reality."

(forthcoming: 2). Alt cites several systems that prefigure the object-oriented programming paradigm, such as the programming approach used to develop Stephen Russell's 1962 computer game *Spacewar!*, Ivan Sutherland's 1963 graphics application *Sketchpad*, and the creation of the simulation programming language SIMULA-67 by Norwegians Kristen Nygaard and Ole-Johan Dahl in 1967 (forthcoming: 5-6).

It is the work of Alan Kay, however, that motors Alt's argument, particularly Kay's work with the Learning Research Group at Xerox's Palo Alto Research Center (PARC). As part of his efforts to create the first laptop computer, the Dynabook, Kay developed the first properly object-oriented programming language, Smalltalk-72. Importantly, as Alt points out, the *material* level of the programming language of Smalltalk is not simply the symbolic, the realm of software, but necessarily includes hardware as well.<sup>6</sup> As computer scientist Tim Rentsch wrote,

More than a programming language, Smalltalk is a complete programming environment, all of which reflects the object oriented philosophy... Smalltalk may be thought of as comprised of four pieces, viz., a programming language kernel, a programming paradigm, a programming system, and a user interface model... Thus the user interface is built on the programming system, which is built following the programming paradigm and using the programming language kernel... Although I have represented the pieces as separate and independent, they are not, really. In fact, they are inseparable and very interdependent. Not only could each piece itself not exist in a vacuum, the design for each piece influenced the design for all the other pieces, i.e., each design could not exist in a vacuum. (Rentsch, 1982: 52; quoted in Alt, forthcoming: 11)

Rentsch's comments suggest that object-orientation in the Smalltalk programming paradigm is not just a language, but an entire *environment*, a total platform.

Alt ambitiously argues that the emergence of OOP should be read not simply as a conceptual shift useful for thinking about computation in a new way, as mediated communication instead of calculation. Instead, his claim is that OOP enacts a shift in the historical formation of computability itself, at the level of its operations, its code. In his words,

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<sup>6</sup>This is arguably the case for all software. In his essay, "There is No Software," Friedrich Kittler argues that "software does not exist as a machine-independent faculty" (2005). For Kittler, whose materialist approach to media informs this dissertation, this is because "All code operations, despite their metaphoric faculties such as 'call' or 'return', come down to absolutely local string manipulations and that is, I am afraid, to signifiers of voltage differences."

object-orientation is not merely a way of thinking about computation that just happens to lend itself to viewing computation as a medium, rather object-orientation is the medialization of computation. That is, it is both historically and conceptually impossible to conceive object-orientation and computational mediality apart from each other, as they are in fact only different perspectives on the same phenomenon. (forthcoming: 2)

Alt then proceeds to outline the contours—to conduct an *archaeology*—of the “abstract machine” of *object-orientation*. Before proceeding, however, Alt first describes the act of programming under the paradigms of low-level *machine* and *assembly* languages as well as later, “third-generation” *procedural programming* paradigms that preceded OOP but still continue to co-exist alongside it. I gloss over them quickly here.

Programming in machine and assembly languages is, Alt tells us, a process of *delineation*. In this paradigm, the task of the programmer is to break down into steps the operations necessary to complete a particular computational task, and then “order these operations into a linear, flat, stepwise list of instructions for the processor to execute ” (forthcoming: 15). The process of delineation thus requires the programmer to translate “a macro-level task into a linear list of every single processor operation required to achieve the desired result”, conceptually to “*think through the processor*, to anticipate its logic at the most granular level” (forthcoming: 15). The *procedural programming* paradigm introduced a shift in the conception of programming from a process of delineation to a process of organization. Alt explains that “whereas delineation consists of creating linear sequences of instructions for the processor, organization privileges human readability and an economy of instructions over linear literalness” (forthcoming: 16). In procedural programming, functionally-related or commonly repeated lines of code are grouped together to form a single block of code, which is alternately referred to as a procedure, subroutine, or function. This block was assigned a human-readable name so that the coder could re-execute the entire block of code simply by “calling” its name at any point in the code. Procedural coding thus introduces a hierarchy of control into the conceptual space of programming. The “master” program calls the subroutines, which take control over the processor, execute, and then return control the master program. While much more compact than low-level programming, the form of the procedural program is still a line: “execution of the program remains the same since control jumps back and forth to different

points in the line as different procedures and control statement loops are executed in order to reproduce the original list of linear instructions” (Alt, forthcoming: 17).

In contradistinction to the procedurality of the line, the “encapsulation of objects” characterizes the conceptual space of OOP. Object Oriented Programming is organized around “objects” and “classes” rather than actions or operations. What do these terms denote? A **class** is an abstract definition of a computational entity, a definition which includes all of its characteristics (attributes or properties) and all of the things it can do (methods or operations). For example, the class “scalpel” consists of the traits shared by all scalpels: sharpness, hardness, blade shape, length, circumference, grip shape, and so on. It also consists of all the things a scalpel can be called upon to do, such as slice or perforate. An **object** is an *instance* of the class, instantiated at run-time. One could say that a class’s only existence *as such* is as an object. So, using class “scalpel” as an example, the object “10 blade scalpel” is instantiated only when the piece of software is run. This object consists of both the data that makes this a *particular* instance of the class (e.g. surgically-sharp 440C stainless steel, pencil grip, blade curved along the cutting edge with flat back) and the capacity to perform all the operations of the class (in this case, cutting and perforating). Cultural critics might find it useful to think of the instantiation of objects at run-time in terms of the turning, the performative subjectification that occurs with the interpellative hail. Objects *become* when they are called.

If, as I have discussed, previous programming paradigms viewed a “program” as the linear execution or control of the processor from one line of software code to the next, then OOP turns this definition inside out. OOP proliferates the program, multiplies the lines of code that *co-operate* (and, by extension, the loci of control within these multiple spaces of operability). In the place of a line, OOP opens a conceptual *plane* in which objects are instantiated and interact. The single line of code becomes multi-threaded, a parallel architecture. Alt explains that OOP “sunders the cohesiveness of the program into a number of independent entities whose interactions emerge to approximate the end goals of the program” (forthcoming: 18).

Objects in OOP are thus said to be “encapsulated;” they are self-contained and their properties and operations are hidden from each other. In simple terms, OOP objects are

black-boxed. Objects do not “know” the particularities of another object’s properties or its methods, except as these are explicitly *exposed* by that object. The definition (specification) of an object’s exposure is called an **interface** — properties and abilities are exposed at the interface according to the specifications defined by the object. For Alt, this exposure signals the mediality of computation by inserting the concept of interface at the very level of its code. As Alt conveys, “an object’s interface is a public face for the object that describes which of the object’s internal methods may be requested by another object, the necessary format for making each request, and the sort of message (if any) the requesting object should expect in response to the requesting message” (forthcoming: 24). At the macro-level, the computer interface enables and shapes our access to the world. Computers mediate. Even at the micro-level of the computational object, interfaces are equally crucial in enabling and shaping an object’s access to and interactions with other objects.

How do objects interact in OOP? They send messages. They communicate. Again, the communication is shaped by means exposed at the interface. Using another surgical tool as an example, one can imagine a computational object “Ravitch stapler” that exposes its ability to staple tissue, designated here as “staple( )”.<sup>7</sup> The method “staple( )” is available at the object’s interface. It is therefore, in the Heideggerian sense, “ready at hand.” The surgeon-object may, by sending the proper request [e.g., SqueezeHandle(“Ravitch Stapler”, “transverse colon”)], call upon the object to implement its method staple() on the property “transverse colon.” The surgeon-object cannot call a method that the stapler-object hasn’t exposed. Non-exposed methods are both private and protected. But if an object receives a properly formatted

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<sup>7</sup> More precisely, the method is exposed, but exactly how that method is implemented is not. For example, the subroutines that constitute the method “staple( )” may themselves be hidden, black-boxed. The surgeon-object need not worry about them in order to implement the staple ( ) method.

```
staple ( ) {  
    advance single staple into staple driver chamber ( );  
    fire driver ( );  
    crimp ( );  
    reset staple driver ( );  
    return staple;  
}
```

Practically speaking, this means that the methods and properties contained within the method staple( ) can be changed without having to re-write any segments of the code that call upon it. The ability to staple may be made much more efficient or effective but the surgeon still “calls” it with the same message, staple ( ). In this way, objects both hide internals and present functionality through their interface.

message from another object, the sending object can expect the receiving object to perform accordingly: perform an operation, return certain data, message other objects, and so on.

Because of the “normative” nature of inter-object communication in OOP, the interface is commonly referred to as a social contract. It is a promise to the other objects in the program that it will implement its interface *as specified*. An interface defines no actual functionality itself; instead, it exposes the functionality of the object of which it is an interface. It acts as a contract to other users (objects themselves), a sort of *guarantee* that the object in fact implements the methods defined by its interface. This is not to say that there is no error or system failure in OOP. Interfaces can be poorly defined. Messages can be malformed. Objects return unexpected data or the wrong data types. Properties can be unintentionally exposed. The “social contract” of the OOP interface, like all contracts, can be broken. Some contracts can be broken without too much impact; software acts buggy, but doesn’t freeze up. Other contracts when broken force the user to resort to CTRL-ALT-DELETE or to reboot the system entirely.

Let me thematize and reiterate some key elements of the conceptual space of OOP outlined thus far. First, in OOP, objects are the proliferation of programs, self-contained computers in the sense of calculation, bundled with their data. Second, objects are encapsulated; this encapsulation produces an interior and an exterior to objects. Alt suggests that this gives objects a kind of “subjectivity,” which I would characterize as an after-effect of the individuation of encapsulation. In any case, from the point of view of other objects, interiority is irrelevant. Objects don’t “care” about what goes on inside other objects. Third, objects are known only through their interfaces: the messages they send (communication) and the methods they implement (practices). An object’s “identity,” then, is thoroughly performative from the point of view of other objects. Computational objects communicate and interact in a mediate fashion, through their interfaces, through the methods they expose that materially set the terms for communication and the shape of action. Finally, interfaces function as a sort of systemic social contract, a public declaration of obligation to other objects within the same computational space. Importantly, Alt suggests that this social space extends to the human as well. Object orientation, through the concept of the interface, subsumes computer users themselves. Alt elaborates:

interface is also the means by which the concept of the human user enters the program. Just as interfaces dictate possible interactions among objects, they similarly proscribe possible interactions between objects and human users. As a result, users are made to inhabit the space and medium of the other objects and are treated as objects themselves. (forthcoming: 25).

Interfaces, then, bring forth the mediality of the human and invite its participation in broader circuits of mediality. “In creating the possibility for computational mediality, object-orientation opens the rigid, linear logic of serial computation onto the brute messiness of the world” and extends an invitation to “the entire breadth of lived experiences” (forthcoming: 27).

To summarize, in OOP the interface exposes the methods of an object, placing it in interface-mediated communication with other objects, the mediality of computation that is nonetheless a seemingly ethical space. Remarkably, the interface in OOP resembles Agamben’s theorization of the ethical opened up or exposed by the gesture: “The gesture is an exhibition of a mediality: it is the process of making a *means* visible as such. It allows the emergence of being-in-a-medium of human beings and thus opens the ethical dimension for them” (Agamben, 2000: 58). The exhibition of mediality not only opens up the ethical, but opens onto the political. For Agamben, “politics is the sphere of pure means,” the space of means *as such*, means without end(s) (2000: 59). Alt, however, concludes his essay with a much different meditation on the ways in which the human user gets incorporated into the logic of object orientation. For Alt, far from opening the political, object orientation ultimately forecloses on the possibilities that computational mediality opens up. Instead, it invites the entire world into its “self-fulfilling, self-reinforcing feedback loop” (forthcoming: 27). The turn that Alt’s argument takes at the end of his essay is sharp enough to cause whiplash, and I’m not entirely certain I understand its contours. Alt’s critique seems to hinge upon a linkage of object orientation to the legacies of cybernetics, which, he contends, are less about addressing problems in the world than about “creating a believable simulation” (forthcoming: 27). Object orientation “proves” itself by being able to illustrate how more and more of the world can be modeled (represented?) according to the logic of object orientation itself. He puts it emphatically when he writes:

the only way to increase the validity of an object-oriented simulation is to model more and more of the world as object-oriented. As such, object-

orientation is as much about recasting our entire view of the universe as *exclusively object-oriented* as it is about using object-orientation to “solve” certain problems in the lived world. (Alt, forthcoming: 27).

Here Alt’s and Agamben’s understanding of the ethical/political dimensions of the medial, of the interface diverge. Unlike Agamben’s means without end(s), Alt seems to take issue with the particular ends that he sees object orientation pursuing — a self-referential feedback loop rather than using computation to solve pressing problems in the world. My hunch is that Agamben’s figure of “means without end(s)” will prove useful as I pursue a richer mode of understanding the politics of care. For now, I simply want to highlight what happens when Alt brings the human into interface with object-orientation: the articulation of human and the platform of object orientation results in a rather apocalyptic implosion, a future vision of hyperreal simulation that ultimately alienates us from lived experience, and the messiness of the world. In philosophical terms, OOP achieves agency, but excludes contingency. Within its logic, the mutual constitution of human and machine results in an ever-constricting disciplinary productivity that (re)produces itself, endlessly.

### **On the specter of the mutual articulation of bodies and machines**

The specter of the becoming-machine of the human and the becoming-human of the machine is a common theme in both science fiction and public discourse about contemporary technoculture. As the line between the human and the machine becomes more and more blurry, what will become of *us*? And, equally, what will *they* do to us? The *dVSS* is just one node in a much broader field of the techno-human, although I would argue that the hopes and anxieties that accompany it share a continuity with the affects structuring that broader field. Our contemporary moment is one of ubiquitous and crucial body/technology articulations.<sup>8</sup> Much of the cultural criticism that has been written about the intensity of the contemporary moment falls into three loose and overlapping categories, each of which elevates the body/technology interface as a crucial site of inquiry. The first category highlights the *tight coupling* of humans & technology in the contemporary moment. Here I would place much of the work

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<sup>8</sup>To describe the contemporary moment in such a manner does not, however, necessarily claim exceptionalism for the present—the history of media technologies, for example, suggests that the ubiquity of body/technology articulations is “always already new,” that technology has always defined the limits of the human/body, that, in fact, the human should be theorized according to an “originary technicity” (see, e.g. Hansen, 2006).

that follows from Haraway's deployment of the notion of the cyborg, as well as various takes on the manner in which contemporary bodies experience the world as mediated through technologies of the screen, and even various riffs on posthuman prosthetics and augmented reality. The second category highlights the increasing sense that "nature" (of which human bodies are a part) can be *produced (and reproduced) through technical means*. Here I would place work on new reproductive and cloning technologies (see, e.g. the work of Sarah Franklin and Charis Thompson), tissue economies and biocapital (see, e.g. the work by Kaushik Sunder Rajan as well as Cathy Waldby and Rob Mitchell) as well as work on virtual reality that makes the synthetic production of environments its central problem. The third category highlights the notion that the *human body is itself a technology*. Work in this domain collapses (or examines, post-facto, the purported collapse of the distinction between) bodies and machines, bodies and code. Here I would locate work that focuses on emerging definitions of life based on models of computation or informatics (Kate Hayles), contemporary cognitive neuroscience and AI research, and perhaps even much of the theoretical work that deploys Deleuzian machinic logics, chosen perhaps for their descriptive power in charting contemporary configurations of power and knowledge, relations that often/always involve bodies and technologies. This triple typology is, of course, a radical simplification, but I offer it as a framing mechanism for what follows, a detour through theory that explores the general problematic of the mediated interface in the more specific context of the mutual articulation of bodies and technologies. If my central problematic is how to think about care in the context of contemporary technomedicine, where care is often positioned as an irreducibly human capability, this detour will hopefully provide a theoretical frame for understanding both the becoming-robot of the surgeon and the becoming-surgeon of the robot and present a foundation on which to consider the technicity of care in the concluding chapter:

This detour will proceed through the work of three authors: Don Ihde's (2002) Bodies in Technology) Lisa Cartwright's (1995) Screening the Body: Tracing Medicine's Visual Culture, and Catherine Waldby's (2000) The Visible Human Project: Informatic Bodies and Posthuman Medicine. I have selected these three authors because their respective work touches on a common domain of inquiry -- bodies and/in the practice of medical-scientific imaging

technologies.<sup>9</sup> As I move through this analysis, I want to foreground what each theorist offers in terms of making more precise the nature of the human/machine interface. Furthermore, I want to consider the degree to which each of these authors open up or foreclose on the project of engaging with the politics and ethics of the human/machine interface immanently, *at* and *from* that interface. I find it useful to provide a brief precis of my analysis here, to better focus the more detailed explication that follows. Ihde (2002) offers the important observation that when discussing humans and technologies, the analytic primitive needs to be the body-technology relation, an approach which complicates our understanding of the prosthetic by adhering to a principle of symmetry: the human/technology articulation not only prosthetically extends human capabilities but it also extends the “reach” of the technical into our experience of what it means to be human. Ihde, however, stabilizes the potentialities of this en-folding by suggesting that, in the end, technology needs to answer to the experiential frame of the “human invariant.” In other words, after arguing that the human and the technical cannot be thought of independently from their interfacing, Ihde introduces an extra-interface human, one that moreover is not or has not been radically transformed by technicity itself. Cartwright (1995), on the other hand, deftly argues that material ontologies of “the human” proceed from the immanence of the human/technology interface. Like Ihde’s, Cartwright works from the analytical primitive of the human/technology relation. However, rather than working from a phenomenological perspective, what Ihde calls the human experience of itself as a body-in-technology, Cartwright focuses on the ontological productivity of the interface. In simple terms, the human can only be articulated *as such* at and through its interfacing with technologies. Cartwright, however, sees the human/technology interface as primarily a disciplinary one that connects up with larger cultural projects to discipline the social body that ultimately collapse the human into the implosive rationality of technoscientific systems that privilege measurement and objectivity, an argument remarkably similar to Alt’s above. Finally, in my analysis of Waldby (2000) I highlight her particular version of the productivity of the human/technology interface, for which she draws from Heidegger’s notion that both nature and technology possess *techne*, in the sense of a “bringing-forth,” but that modern technology’s

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<sup>9</sup> As Annemarie Mol points out, the intellectual technique of “relating to the literature” is neither a straightforward nor innocent practice (2002: 2-26). It is itself a production of particular bodies—disciplines, authorities, domains of expertise, and objects of knowledge.

particular mode of “bringing-forth” is to render the world as a “standing reserve” or use value. Waldby, however, reads Heidegger against the grain of his critique of technology, to articulate an ongoing biotechnogenesis of the human/machine. Through this process, new human/technology interfaces put the putative stability of the human at risk, but do so with the promise of opening up the future to “unforeseen possibilities for new modes of embodiment, translation, extension, supplementation and loss” (Waldby, 2000: 49).<sup>10</sup> Waldby ultimately points the way, I argue, to a research agenda that seeks to construct “a modest cartography of our present” (Rose, 2007: 5). According to Rose, a cartography of our present “would not so much seek to destabilize the present by pointing to its contingency, but to destabilize the future by recognizing its openness. That is to say, in demonstrating that no single future is written in our present, it might fortify our abilities, in part through thought itself, to intervene in that present, and so to shape something of the future that we might inhabit.” (2007: 5). Following my detour through theory, then, I return to the *dVSS* to map the ways in which the surgeon and the robot, in their becoming-together at the interface, disrupt configurations of authority and autonomy and open up several possible futures for thinking about the automatic.

### **Embodiment and/in Technology**

I will begin my discussion of different conceptions of the body/technology interface with a focus on Don Ihde’s *Bodies in Technology*. As we shall see, Ihde’s phenomenology circumscribes his conceptual framework, and places certain epistemological valences on his conception. Ihde focuses on a particular relation between bodies and technologies – relations of embodiment, or more precisely, our sense that “we are bodies *in* technologies” [italics mine] (2002: 138). Ihde opens his book with the suggestion that our experience of embodiment proceeds according to three senses. The first body-sense, which Ihde calls “body one” involves the phenomenological sense that “we are our body,” that our bodies provide us with a sense (literally, *through sensation*) of “our motile, perceptual and emotive being-in-the-world” (2002: xi). Ihde’s body one is the active, perceiving being-a-body from which we experience the world around us. Body one is “both preconceptual and precultural, and without this sense of body,

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<sup>10</sup>That this biotechnogenesis is ongoing might open up some affinities between Waldby and Agamben, insofar as both seem to suggest that the opening of the political, of future possibility, is without end(s).

there is no experience at all" (2002: 17).<sup>11</sup> In a way, Ihde is trying to capture some sense of the biological body here – the specificity of the human sensory apparatus, including proprioception and a sense of the organic sensory capabilities of the flesh.

Ihde's "body two" is our experience of our bodies in "a social and cultural sense" (2002: xi). To illustrate this sense of embodiment, Ihde cites the variability across cultures of what body parts are experienced as erotic zones (2002: xi). Later he discusses "skilled" perception in another attempt to describe our sense of body two, such as the ability of an archeologist to spot a fossil where others may simply perceive rocks (2002: 39). The experience of body two inflects or overlays the experience of body one with socially/culturally inflected perception. Body two also resonates with what Ihde calls a "Foucaultian framework": "Foucault's body is thoroughly a cultural body . . . The body objectified by the medical gaze in the clinic, the body of the condemned in the regicide, and the subjection of bodies within all forms of discipline are culturally constructed bodies" (Ihde, 2002: 17). Following Foucault, we might consider this sense of embodiment technological as well – the sense of embodiment one has as worked/ worked over by social technologies. But Ihde takes care to indicate only "echoes" of this body in his notion of body two, for "to follow an almost total body two direction" is not his project: "I shall not go that way" (2002: 70). Instead he wants to keep both body one and body two in operation, for they both underline "situatedness" in particular ways (where "situatedness" is, for Ihde, rigorously asserted as situatedness *in a phenomenological lifeworld*). Ihde finds the work of Iris Young exemplary in its mutual recognition of body one and body two. He cites her "Throwing Like a Girl," "On Pregnant Subjectivity," and "Breasted Being" as a "model development" that recognizes that "[b]odily motion, pregnancy and breasts are real in both bodily-physical senses and the sociocultural senses that situate these phenomena" (2002: 70). Ihde refuses to collapse one body into the other, while recognizing their entanglement.

Ihde suggests, then, that there is a third dimension of experience, a "body three" that traverses the experience of body one and body two with the "dimension of the technological

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<sup>11</sup> It is unclear whether Ihde would also consider body one "pre-technological." He says that the experience of the body in technology, what Ihde calls body three, traverses both body one and body two, suggesting to me that for Ihde, the primordial experience of body one has resonances with Hansen's notion of the "originary technicity" of embodiment, for we do, in fact, experience our bodies in a technological relationship (our hands as tools, for example, or even language as tool).

(2002: xi). This is the sense of embodiment most relevant to the discussion at hand, although I would argue that technicity informs bodies one and two (see above and footnote XX) and may, in fact, be inseparable from them in practice. Body three is “the relation of experiencing something in the world through an artifact, a technology” (2002: xi). Ihde stresses that body three is *relational* (and, I would add, *mediational*); body three inheres in the experience of relationality, of being a body in [relation with] technology, a relation that transforms both the body and the technological artifact. In fact, Ihde argues that the aspect of relationality is the smallest unit of analysis one should engage when considering bodies-in-technologies. Drawing upon his 1990 Technology and the Lifeworld, Ihde uses his refutation of the NRA’s claim that “Guns don’t kill people; people kill people” to illustrate that, once *in-relation* one can no longer speak of technologies-in-themselves, nor of bodies-in-themselves. One can instead only speak of the human-gun relation-in-itself in relation to other technological artifacts, other bodies. In such an account, “where the primitive unit is the human-technology relation, it becomes obvious that the relations of human-gun (a human with a gun) to another object or another human is very different from the human without a gun” (Ihde, 1990, cited in Ihde, 2002: 93). In a way, then, Ihde’s focus shifts here from the embodiment of a body to the embodiment of an assemblage – the experience of the relationality of bodies-in-technologies. For Ihde, this relationality has several important dimensions (I will discuss three), and yet, as I hopefully will make clear, all hinge upon Ihde’s primary identification of bodies with embodiment, and his focus on our experience of body three.

First, the embodiment of body three is the experience of the *extension of the here-body*.<sup>12</sup> In other words, a primary experience of body three, of our bodies in technology, is the way in which a technology extends our body’s sensorium (our vision, our touch, even our proprioception) “through” a particular technology. A telescope extends our organic capacities for vision; a blind person’s cane extends her reach and her sense of touch; a hammer extends both one’s sense of touch as well as one’s proprioceptive sense. “The very materiality of the

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<sup>12</sup> Ihde makes a distinction between two other experiences of our body – our embodied here-body, and our quasi-disembodied image-body. To illustrate the difference, he speaks of a classroom exercise where students are asked to describe the experience of jumping out of a plane. Those that speak of the here-body experience describe the stomach-tightening of the fall, the wind on their face, etc. Those that speak of the image-body experience describe a plane, a body exiting the plane, falling, etc. Ihde asserts the primacy of the here-body and its full plenary sensation as the norm which makes the experience of the image-body possible.

technology allows this extendability (sic)" (Ihde, 2002: 7). In other words, Ihde asserts, extendibility is not generalized; it is specified by the limits and possibilities of the materiality of a technology.

Second, this extension is also only a quasi-extension. Technology does not extend the full plenitude of our perception, the full bodily sensory awareness that constitutes our engagement with the world. Ihde explains, for example that "the hardness—but not the coldness—of the nail is experienced through the hammer; the multidimensional 'click' of the sidewalk cement and its textured resistance is felt through the cane, but not its grayness" (2002: 7). We must use the rest of our sensorium to "fill in" aspects of the experience not provided through the technical extension (Ihde, 2002: 7).<sup>13</sup> Here, it seems, Ihde is advancing a version of McLuhan's theory of the relationship between the body and the media: media technologies are extensions of the human sensorium, but every such sensorial extension is also an "amputation", one that instigates a consequent re-ordering of "sense ratios" (McLuhan, 1994: 45). And yet Ihde's not so confident in the ability of a technology to truly "abstract" a single sense to the exclusion of others. He calls the ability of a body-technology artifact to effect this abstraction a "quasi-illusion" (2002: 38). It may be, as Ihde discusses at length in his chapters on "Visualism in Science" and "Perceptual Reasoning," that the sciences have a tendency, a "cultural habit," to "produce, display, and reiterate what counts for evidence in visual form," to reduce the perception of "truth" to the plane of the visual, a "forgetfulness of the plenary or whole-body perception that Husserl called the forgetfulness of science" (2002: 37; 54). But this does not mean that science has effected an amputation or reduction in perception per se. While the "forgetfulness of science" may have led Husserl to differentiate the abstractness of science from the "fullness" of the lifeworld, Ihde points out that in making such a distinction, Husserl "forgets" that "a technologically embodied science never leaves the lifeworld" (2002: xvi). Ihde uses therapeutic medicine as a means to recuperate Husserl's forgetting. Even amidst the ocularcentricity of modern medicine, Ihde points out that "the examination of a living patient is undertaken by a whole series of hands-on practices . . . one can say that therapeutic medicine, in practice, did not forget or abandon the lifeworld plenary-bodily mode of engaged knowledge" (2002: 57). Even in experiencing body three, the body in [relation to]

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<sup>13</sup> Ihde's observation here adds further credence to the 'haptic visibility' surgeons experience at the dVSS viewport.

a particular technology, our experience of body one and body two exceed the ability of body three to fully exhaust, cancel out, determine or otherwise delimit our embodiment of the lifeworld. So in one sense, the supposed suppression of situated embodiment is simply a Cartesian “god trick.”

A third key aspect of Ihde’s conception of the how bodies and technologies are mutually constituted can be found in his inflection of science studies’ foregrounding of the “symmetry” of human and non-human actants in the concluding paragraphs of his text. After repeating that body three, technical embodiment, is a “relation between the human and the technologies employed”, he remarks on three aspects of this relation. First, he writes, “all human-technology relations are two-way relations. Insofar as I use or employ a technology, I am used by and employed by that technology as well” (2002: 137). Here Ihde acknowledges a basic symmetry – one must afford agency and effectivity to human and non-human actants. Second, in asserting this basic symmetry, Ihde grants technology’s agency over us, over our human bodies. Ihde writes, “bodies, our bodies, adapt to different kinds of technologies and technological contexts” (2002: 138). Put simply: We adapt to our machines.<sup>14</sup> Following from this, Ihde outlines the third aspect of human technology relations: “the technologies must adapt to us. A scientific instrument that did not or could not translate what it comes in contact with back into humanly understandable or perceivable range would be worthless. It would lack the anthropological invariant that points to the implied limits of the machines we build and use.” (2002: 138). To understand what Ihde means, let me take a few moments to detail how he reads the history of imaging technologies in science. Certainly, for Ihde, this history is a history of the extension of sight into new realms. For many authors, however, this extension ultimately displaces the scientific observer as the ground of knowledge – at some point the certainty of “seeing for oneself” gives way to epistemological instability and anxiety. The extension of perception ultimately cedes to the displacement of perception, from human to machine. The human is no longer the arbiter of perceptual evidence. Cartwright, we shall see, makes much of the destabilization of the observer in technical mediation of perception. It is telling, then, that Ihde doesn’t see this displacement as a cause for anxiety, as evidence of epistemological unmooring. He certainly acknowledges that, with particular technologies,

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<sup>14</sup> Here I might highlight another affinity with McLuhan: “We become what we behold.”

perception ceases to be technologically extended and instead becomes technologically constituted. Imaging moves “beyond ordinary visual capacities” and becomes “second sight imaging,” employing everything from “the infrared and ultraviolet ranges of the optical spectrum” to invisible “gamma to radio waves”, translating these invisible traces into datasets that are in turn translated into false-color, algorithmically-manipulated, enhanced visualizations (2002: 47).<sup>15</sup> And yet, Ihde remains unflustered.

Why? Because Ihde maintains that all forms of technological embodiment must ultimately answer to what he variably refers to as the “human invariant,” the “anthropomorphic invariant,” the “anthropological invariant.” This human invariant both limits the extent of our possible adaptation to technology (we adapt, but only as far as our biology allows) and determines the directionality and terms of technology’s adaptation to us (which Ihde identifies as a horizon of translatability – the ability of a particular technology to translate its perceptual extensions back into the “human perceptual range” (2002: 138).] Ihde’s “human invariant” is this: all forms of technical embodiment have “the necessity for there to be a bodily perceiver” (2002: 48).<sup>16</sup> Science, for example, may have moved from “direct bodily perceiving” to “translated and technoconstituted imaging” and yet “with, through, and among these instruments, the scientist also always remains a bodily perceiver—that is, the reflexive retroreferent of scientific activity” (2002: 48). Thus, for Ihde the danger is not in the desire to see more, to extend vision into new realms. Nor is there danger in the fact that this extension of perception proceeds through layer upon layer of technical mediation. Instead, for Ihde the key danger is the desire for “pure transparency,” to escape the “limitations of the material” – bodily and technological materiality (2002: 13-14).

In summary, then, Ihde develops a keen sense of technological embodiment that is multiple, experienced as relations of perceptual extension. Bodies and technologies have two-way effects – we are transformed by technologies and technologies are transformed by us ... but

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<sup>15</sup> For a fantastic description of all the translations, filters, enhancements, calibration – in short, all the work – that goes into producing PET images as evidence in contemporary medicine, see Dumit (2004).

<sup>16</sup> Virilio (1994), notably, is not convinced of the anthropomorphic invariant, and instead expresses concern about “the possibility of achieving *sightless vision* whereby the video camera would be controlled by a computer” (59). Accordingly, Virilio warns “we are moving from a civilization of the image to a civilization of optics. This leaves open the possibility of an ‘optical correction’ of the world—the reconstruction of perception according to the machine. The machines themselves have become opticians. This is an unprecedented event.” (2005)

within limits: the limits of the materiality of technology, and the materiality of the body's sensory apparatus.

### **Productive Bodies / Disciplined Bodies – Bodies, Technologies and Power**

Lisa Cartwright's conception of the body/technology interface in Screening the Body: Tracing Medicine's Visual Culture departs in significant ways from Ihde's conception. As I've already alluded, Cartwright and Ihde differ significantly on their interpretation of the historical trajectory of visualization technologies in science and medicine. Cartwright explicitly condemns as complicit with the "Enlightenment" project narratives such as Ihde's, where technical embodiment is characterized as augmentation and extension:

The imaging of the body's interior space in medicine and science has suggested to some scholars a narrative of Western advancement characterized by technology's prosthetic augmentation of the sensory powers already built in, as it were, to the scientific observer's body. This argument suggests that devices designed to visualize physiological processes in effect enhanced researchers perceptual powers, extending the observer's epistemological domain into previously uncharted territories—an Enlightenment project that continues in today's medical imaging technologies. (1995: 23)

I can note in Cartwright's skepticism toward "sensory powers already built in, as it were" to the body we have a radical departure from Ihde's three bodies. Ihde would say that Cartwright takes the way he chose not to go – toward an interrogation of what he would call Body Two. But, as I hope I will make clear, Cartwright's conception is no mere "social construction" – in her conception, technologies are productive of materiality.

Cartwright's project interrogates the deployment of cinematography as a laboratory technology and its consequent entanglement in the emergence of physiology as a discipline in the late 19th and early 20th centuries. For Cartwright, the cinematic apparatus, along with other graphical techniques of observation and experimental control in the early physiology lab, articulated the conditions of possibility for physiology's constitution of its object of knowledge – "life itself."<sup>17</sup> As Cartwright explains in her introduction, the cinematic apparatus was a "crucial

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<sup>17</sup> It is important to point out that in contemporary terms, physiology refers both to the mechanical, physical and biochemical functions of the human body, and to their study. One can read *Screening the Body* as a cartography of the specific practices that maps the co-emergence, the tight co-extension of the body and its study along the lines of *The Birth of the Clinic* as well as the body and its discipline in *Discipline and Punish*.

instrument in the emergence of a distinctly modernist mode of representation in Western scientific and public culture—a mode geared to the temporal and spatial decomposition and reconfiguration of bodies as dynamic fields of action in need of regulation and control” (1995: xi).

Cartwright explicitly articulates her project as an extension of Foucault’s work in the The Birth of the Clinic. Cartwright transports Foucault’s project from the domain of pathological anatomy (where bodies are technically produced as objects of knowledge -- through techniques of the corpse - as spatialized entities, the “body itself”<sup>18</sup> as a opaque volume, where disease is, potentially at least, localizable and mappable) into the domain of physiology. In this domain, Cartwright’s focus is on the technical productivities of cinematograph, where “the cinema was used as a technique to rejuvenate pathological anatomy’s object of study, the corpse, rendering life an elusive and seductive object of scientific conquest” (xiii).<sup>19</sup> To put it another way, if the techniques of anatomy, Bichat’s “opening up a few bodies”, produced bodies amenable to the clinical gaze—a spatial body composed of solids and surfaces, the body proper to anatomical mapping, the localization of disease to lesion—then the techniques of the cinema, as a graphic practice, produced bodies amenable to the “vivifying physiological gaze”—a processual, temporal body. Cartwright writes that physiology “regarded the body in terms of its living functions and processes, and its practitioners devised methods and techniques to facilitate a temporal, dynamic vision of the body in motion” (1995: 11).

Already in my description of Cartwright’s project, I hope one can see the clear outlines of her version of the “mutual constitution” of bodies and technologies. For Cartwright, technologies are practices that render bodies intelligible according to their systems of inscription. This inscription should not be seen, however, as merely a representation of the real. Instead, this technical inscription is a material practice, with material effects. Cinema is a

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<sup>18</sup> Foucault writes that the medical gaze “plunges into the space that it has given itself the task of traversing . . . In anatomo-clinical experience, the medical eye must see the illness spread before it, horizontally and vertically in graded depth, as it penetrates the body, as it advances into its bulk, as it circumvents or lifts its masses, as it descends into its depths” (1994: 136). In other words, the anatomo-clinical gaze produces “the body itself” in the very techniques of autopsy, “the very space of the organism” (Foucault, 1994: 136; 191).

<sup>19</sup> Cartwright’s use of the term “rendering” is key: rendering affords to the technological apparatus the ability to both interpret and produce an object in the world (render as in “giving a rendition of”) and to produce a field of effects, enact a disciplining of the object produced (as in “to render a person immobile”, for example, or in a more Foucaultian sense, to “render a body productive and efficient”).

temporal, graphic inscription practice that doesn't just render visible pre-existing biological processes, but instead produces processual bodies in the act of writing them.<sup>20</sup> If early 20th century physiologic laboratory techniques are materially implicated in the incorporation (embodiment or formation) of the very bodies they purport to produce knowledge of, it is perhaps a function of the experimental set-up required to render "life itself" perceptible. If anatomy produced body-knowledge through the "techniques of the corpse", designed to open up bodies to visual perception, physiology had to pursue more oblique means. "Life itself" – the processual body – was not amenable to direct sensory perception. Physiological principles weren't visible in the corpse. At best they were made visible through the induction of various forms of "rigor mortis" on the living body – as in Bernard's "experiments in destruction," where he severed the two principle nerves of the face, one by one, thereby, or so he thought, allowing their respective life functions to "present themselves in circumstances or conditions in which nature does not show them" (Bernard, quoted in Cartwright, 1995: 27). However, as Cartwright argues, "what is ultimately shown is nothing more than an absence, a body stripped of its capacity to perform the function in question" (1995: 27). Consequently, physiology's object could be apprehended only through a technical, instrumental triangulation. As Marey put it, "we are constantly obliged to use apparatuses in order to analyze things" (Dagnognet, quoted in Cartwright, 1995: 24). In other words, in order to "present" life for analysis, bodies and the instruments used to analyze them had to be articulated tightly together. Here one could read Cartwright's experimental setup alongside Ihde's discussion of the human-gun – except Cartwright's focus is on the productivity of the coupling, and not on its experience. Cartwright cites the invasive methodology of the horse heartbeat studies conducted by Marey and Chaveau in the late 1870's. In order to render the workings of the movement of blood by the heart, Marey and Cheveau setup a heart-ampoule-kymograph relation. Air-filled ampoules were inserted directly into the beating heart of a living horse, and the ampoules were coupled with a kymograph, which graphed the pressure changes in each chamber. Here we have the horizon of translation that Ihde references, but for Cartwright, the important issue is not so

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<sup>20</sup> In a similar manner, Alan Sekula and John Tagg have identified how static photography functioned in the 19th century in attempts to render criminality into a stable characteristic of deviant bodies, somehow inhering in body morphology.

much the translation but the interpenetrating body-technology coupling needed to even initiate it. As she elaborates,

This experiment marks a dual shift in methodology: a shift toward movement as a characteristic state of the body, and a shift toward implanting a technology of observation directly into the body studied—a technique that joins technology and the living body rather than using technology to sacrifice the body for the sake of analysis. Marey and Chaveau had devised an apparatus in which the technology and the life form it interrogated were made into a generative and interdependent system. As the horse's body motored the inscription device, so the kymographic inscription reconfigured the conception of the living body from within, rendering it an ordered living system—a system best represented by graphical, temporal forms like the calibrated kymographic line or the incremental cinematic image, for example. (Cartwright, 1995: 24-25)

Cartwright's emphasis is not so much on the translation effected by the interface, but on the interface itself, the coupling of bodies and technologies to produce particular visibilities and regularities. (As I argue in what follows, this use of the Foucaultian language of disciplinarity is intentional.)

If experimental cinematographic technologies are productive of particular bodies in Cartwright's analysis, the mode of their operation is not simply on the individual body. The mutual constitution of bodies and technologies is social as well as individual.<sup>21</sup> The bleed between laboratory and popular cultures is ever-present in Cartwright's work. Throughout her text Cartwright is careful to connect laboratory control over "life itself" with larger cultural projects to discipline the social body, projects that exceed a particular technological apparatus (Foucault would call these more abstract configurations of discipline "diagrams of power"). As Deleuze notes, commenting on Foucault's *Discipline & Punish*, "machines are social before being technical. Or rather, there is a human technology which exists before a material technology. No doubt the latter develops its effects within a whole social field; but in order for it to even be possible, the tools or material machines have to be chosen first of all by a diagram and taken up by assemblages" (1998: 39). Cartwright thus argues that cinematographic techniques in the lab functioned in the service of a broader cultural apparatus of discipline, a social

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<sup>21</sup> If this is a position similar to Ihde's, it is an involuted one. Certainly for Ihde the individual body is also the social body, but the valence is quite different here, inflected not with the experience of embodiment, but the experience of being subjected to embodiment. "Insofar as there is experience, it is experience suffered or wrought upon human bodies" (Ihde, 2002: 17).

technology geared toward disciplining both individual bodies as well as populations into what Foucault calls “subjected and practiced bodies, ‘docile’ bodies. Discipline increases the forces of the body (in economic terms of utility) and diminishes these same forces (in political terms of obedience) . . . [D]isciplinary coercion establishes in the body the constricting link between an increased aptitude and an increased domination” (Foucault, 1979: 138). For example, in Cartwright’s discussion of Marey’s chronophotographic motion studies of the human body, she points out that technologies intended to inscribe the movements of the individual body are geared at the same time toward the social body. The analysis of the individual body is meant to have productive effects on the social body, increased but controlled “aptitudes.” She writes that Marey’s chronophotography “functioned as a disciplinary technique, then, insofar as it facilitated the establishment of a productive dynamic economy of the body. By theorizing the physiological forces that drove the body to move, think and act, Marey contributed to the determination of a more efficient rate of locomotion, or a more effective use of the limbs in the military, in industry, and in athletics” (1995, 37).

In establishing this “productive dynamic economy of the body”, these disciplinary techniques of the body incorporate not only the observed body, but the body of the observer as well. Recall that physiology was self-conscious of the need for instrumental intervention in order to render its object to perception. Experimentation required intervention – unlike observation, it had to intervene in nature in order for nature to present itself. Experimentation necessarily moves “beyond noninvasive observation. Touching is no longer a neutral intermediary between physician/experimenter and body/object; touch constitutes ‘action on the body’ insofar as it alters the object it investigates” (Cartwright, 1995: 28). In other words, the terms of experimentation required that the body of the observer intervene upon the phenomena studied and not just observe it. Much like the “technically constituted perception” discussed in relation to Ihde, here we have another opportunity for epistemological anxiety. This anxiety is created not by the displacement of perception from human to technology, but rather by the slippage between “nature presenting itself” but “only by experimental intervention,” the intervention of the observer. Here, the scientific observer is not Ihde’s “human invariant” that grounds technical mediation in the “necessity of a human observer.” Far from invariant, in Cartwright’s conception the technical observer is that one more variable to be disciplined and

controlled, managed in order to optimize the “monitoring, regulating and ultimately building ‘life’ in the modernist culture of Western medical science” (Cartwright, 1995: xi).

Consequently, if there are limits in this conceptualization, the limits are not imposed by the materiality of the human body, nor the materiality of technology as Ihde’s conception would have it. While Cartwright wants to argue that the materiality of the living body itself resisted and disrupted the experimental apparatus as a dynamic force “that eluded and reflexively disciplined the gaze of the technical observer;” ultimately her argument locates resistance not in the materiality of the living body, but in the implosive rationality of the system itself (1995: 39). Indeed, as her discussion of François-Franck’s “graphocinematographic apparatus” suggests—with its involution of techniques of calibration dispersing agency throughout the “heterogeneous elements of the apparatus . . . the kymograph, the clock, and the film image, as well as the bodies of the observer and the observed”—that the apparatus eventually gets entangled in the logic of its own disciplinary regime (Cartwright, 1995: 43).

In sum, and in contrast to Ihde’s body-technology relation mutually conditioned by the limits of materiality, Cartwright’s conception offers us a diagram of power-knowledge, of bodies and technologies tightly coupled and mutually disciplining/disciplined in an ever-constricting formation of disciplined productivity.

### **En-Framing the Body – Informatic Bodies and Posthuman Spectacle**

If Ihde’s sense of the mutual constitution of bodies and technologies revolved around embodiment, and Cartwright’s conception hinged upon the materiality of disciplinary incorporation, in The Visible Human Project: Informatic Bodies and Posthuman Medicine, Catherine Waldby’s conception of the body/technology interface emerges through Heidegger’s notion of “en-framing:”

As she begins her discussion of en-framing, Waldby makes two observations about contemporary biomedicine. First, she enumerates all the clinical, surgical, hospital and laboratory techniques that “indicate the extent which the computer screen has become the dominant way first-world medicine frames its object”: endoscopic surgery, computer modeling, telemedicine, MRI, and so on (2000: 25). Second, Waldby notes the prevalent

framing of the body's molecular organization as a cybernetic system: "This proposition has been articulated in molecular biology, immunology, endocrinology and other medical disciplines which understand the body as a network of informational systems, working through code, signal, transcription, interference, noise, and the execution of programmes" (Waldby: 25). For Waldby, both of these modes of framing provide biomedicine with powerful and productive techniques for instrumentalizing matter (into economies of biovalue, which I will discuss later). In order to better capture the active, productive process of instrumentalizing matter to yield "a profit of knowledge", Waldby thus shifts her terms – from framing to Heidegger's en-framing (ge-stell).

In brief, Heidegger's "en-framing describes a particular way of producing technical objects, of bringing objects forth into presence" (Waldby, 2000: 27). For Heidegger, all technology is "a mode of bringing forth" (1977: 13). *Techné*, the root of technology, implies not simply the application of techniques, but also a poetic productivity, a *poiesis*. This poetic mode of *techné* is a mode of "making present of things which is not limited to technical production but extends to the auto-productivity of living beings and to artistic production" (Waldby, 2000: 28). In other words, Heidegger identifies in nature a fundamental technicity, the auto-*poiesis* of nature, nature's *techné*; it is the mode by which nature (humans included) reproduces itself by an open bringing-forth. This open bringing-forth nonetheless constitutes relationships according to a sort of ethical economy, of responsibility and indebtedness. As Weber (1996) points out, *poiesis* "designates a relationship of being-due-to. This in turn involves not merely a private or negative relation: to be "due to" is to appear; to be brought into play thanks to something else" (63).

According to Heidegger, modern technology still participates in the mode proper to technology, the mode of "bringing-forth," but with a particular inflection that proceeds according to a radically different economy than *poiesis*:

The revealing that holds sway throughout modern technology does not unfold into a bringing-forth in the sense of *poiesis*. The revealing that rules in modern technology is a challenging which puts to nature the unreasonable demand that it supply energy that can be extracted and stored as such. (Heidegger, 1977: 14)

In other words, for Heidegger, the en-framing of modern technology is an emplacement, a setting aside of nature as a form of “standing-reserve,” as potential “use value.” Instead of traditional technics which bring-forth in the sense of revelation, modern technics is “a driving or goading forth: ex-ploiting, ex-tracting, ex-pelling, in-citing . . . an extracting of that which henceforth only counts as raw material” (Weber, 1996: 69). As Waldby writes, under this conception “the operation of modern technology is to order the world as use value and immediate resource to make it knowable and accessible, ready to hand, through such ordering” (2000: 29). [I’ll note here in passing the similarities between the Heideggerian account of modern technicity and the Foucaultian account of modern disciplinary power.]

Waldby’s own conception of the mutual constitution of bodies and technologies exhibits an ambivalent relationship to the negative valence in Heidegger’s concept of en-framing. On the one hand, she reads biotechnology’s “gearing of the material order of living matter” and biomedicine’s particular instrumentalization of bodies as a project of en-framing, a technics that sets aside a standing-reserve of what Waldby calls “‘biovalue’, a surplus value of vitality and instrumental knowledge which can be placed at the disposal of the human subject” (2000: 19). She locates the Visible Human Project within the long history of en-framing technics in biomedicine, where economies of sacrifice yield profits of biovalue. “This surplus value is produced through setting up certain kinds of hierarchies in which marginal forms of vitality – the foetal, the cadaverous and extracted tissue, as well as the bodies and body parts of the socially marginalized – are transformed into technologies to aid in the intensification of vitality for other living things” (2000: 19). In the Visible Human Project, the cadaverous bodies of the socially marginalized – the male criminal body of Joseph Jernigan and the anonymous female body – are instrumentalized (sacrificed, indeed obliterated) in order to produce supposedly normative human anatomical archives for the advancement of medical care. On the other hand, she suggests that she wants to read Heidegger’s notion of technics “against the grain of its apparently anti-technological biases” (2000: 19). Against a simplistic version of modern technics which rests on a “simple expropriation of a given nature,” the instrumentalization of raw material, Waldby wants technics to signify “the open-ended participation of the natural world in technology” (2000: 19). Rather than seeing biotechnology, for example, as an expropriation of nature, Waldby suggests that “biotechnology could, in

general, be considered a mode of instrumental 'address', an exploratory form of intervention which is also an invitation, soliciting an active compliance from the productive capacities of living matter. Biotechnology seeks to instrumentalize the already instrumental capacities of living entities along particular lines" (2000: 19). To be sure, Waldby would concur that technics always involves what Heidegger calls the "destining of revealing", or what we might call, relating back to Cartwright, a disciplining of nature's technics (1977: 25). And yet Waldby wants to defend the openness, "the contingency of technics, its driven and ongoing nature, and the incalculability of its consequences" (2000: 49). She continues with a powerful statement of her position, and I quote her at length:

[A]ny transformation in technologic, particularly biotechnologic, will risk the putative stability of the human and send it out of phase, into non-coincidence with the existing terms of its naturalisation. New bodies of technique produce new forms of commensurability, new calibrating networks, which in turn lend themselves to particular ways of materially gearing the world. Shifts in forms of calibration change the trajectories of technics in which the human takes place, the operational conditions of its production and reproduction. They open it up to unforeseen possibilities for new modes of embodiment and translation, extension, supplementation and loss. Transformations in repertoires of technique introduce discontinuities and open-ended forms of instability in the material conditions which locate the human, shifting the terms of its enablement and disablement. The human is hence a category and status in a constant play of discontinuous mutation and provisional restabilisation, which must work with whatever field of technics is present. (Waldby, 2000: 49)

Here we have a vision of "mutual constitution" occurring in a dynamic field of forces, technics materially addressing living matter according to particular directionalities of productivity, sometimes in phase, and sometimes out of phase with the existing terms of "nature", the already instrumentalized capacities of living matter ("itself" a shifting field). Each new technology, each new attempt at material gearing of the world produces stabilities and displacements, unforeseen possibilities and new forms of agency, and new forms of control.

If each technology attempts to instrumentalize already instrumental capacities along particular lines, Waldby then proceeds to map residual, dominant and emergent technicities (while she doesn't use those terms, the movement is implicit in her text – from the manner in which the body is instrumentalized in the anatomical atlas to the archival data practices of the Visible Human Project to meditations on emerging forms of virtual surgery). At every point,

Waldby articulates what she calls the “media specificities” of medicine. For example, in her chapter “Theaters of Violence,” Waldby explores the “differential specificity” of the Virtual Human Project as “a transformation of the material possibilities of the anatomical body inaugurated by a move from the book to the screen” (2000: 59).<sup>22</sup> She considers how the material technicity of the book form of the anatomical atlas “allowed medical knowledge to take form...but in a particular way, the form enabled by the particular conditions of possibility presented by the book” (2000: 70). She also engages with the Visible Human Project as a different media specificity, a different technics, that yields different instrumentalizations, imposes different directionalities on the “bringing-forth” of the human, and opens the space of different performativities for bodies: volumetric rendering, point of view animation and morphability and digital photorealism all open up a performative space for the Virtual Human to function not as model but as surrogate object for modern medical practices (2000: 70-78). As a surrogate, the figures of the Virtual Human Project open up “certain kinds of possibilities for surgical navigation and transformation of living bodies” (Waldby, 2000, 21). Accordingly, Waldby speculates in an open-ended way about possible biomedical futures that emerge in the instabilities these figures both represent and perform: actual/virtual, living/dead, flesh/data, an uncanny—yet ongoing—biotechnogenesis.

What Waldby offers is an analytic through which to see the *dVSS* one version of ongoing biotechnogenesis. The bio-techno creative process (a *poesis* of new human/technology interfaces) puts the putative stability of the human at risk, but do so with the promise of opening up the future to “unforeseen possibilities for new modes of embodiment, translation, extension, supplementation and loss” (Waldby, 2000: 49).<sup>23</sup> Waldby ultimately points the way, I argue, to a research agenda that seeks to construct “a modest cartography of our present” (Rose, 2007: 5). I now return to the *dVSS* with the aim of a modest cartography of the peculiar “present” it embodies: the ways in which the surgeon and the robot, in their becoming-together at the interface, disrupt configurations of authority and autonomy that open up onto several possible futures for thinking about the automatic.

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<sup>22</sup> Waldby draws on Weber (1996) for this notion of differential specificity.

<sup>23</sup> That this biotechnogenesis is ongoing might open up some affinities between Waldby and Agamben, insofar as both seem to suggest that the opening of the political, of future possibility, is without end(s).

The *dVSS* is a particularly powerful apparatus within contemporary surgical medicine because it invokes the specter of robotic automation, the slippage of a human domain of practice into the machinic, and all the blurring and sublimation that happens in that movement, which I describe as the *becoming-machine* of the surgeon and the *becoming-surgeon* of the machine. The *dVSS* embodies and enables the practice of technical rationality in what has been historically been seen as a fundamentally craft practice, the “art” of surgery. This robotic apparatuses amplifies existing tensions in surgical practice, between care and cure, between cognitive and manual work, between art and science. The *dVSS* forges new articulations between humans and machines in this professional domain, and raises both the specter and the dream of automation and the overcoming of human fallibility through technical means.

### **Interface Exigencies: The Surgical “Demand” for an Interface**

In his essay “The Virtual Surgeon: Operating on the Data in an Age of Medialization,” Timothy Lenoir makes the observation that because the “surgeon is on the outside” and the “targeted anatomy is on the inside,” surgery “demands an interface” (2002: 37). At a moment when the verb *interface* has been generalized to reference *any* connecting, bringing together, or meeting, the claim that surgery demands an interface seems like a commonsense and rather banal observation. Certainly surgery involves the interface of doctor to patient, of outside to inside, of scalpel to anatomy. So what difference does it make to think of surgery as/at an interface? First of all, the concept of the interface puts the question of mediation front and center. More specifically, it focuses the question of *movement* at the interface: movement inside and outside the body and the inscription and exscription that attends that movement. The exscriptive movement marks where bodily interiors are written outwards onto a myriad of screens and other interfaces. The inscriptive movement marks where bodily interiors are written into with discourses of biomedical progress and the encounter with and crossing of “new frontiers.” Again, Lenoir claims that “surgery *demands* an interface” (emphasis mine). It's interesting to me that he characterizes the subject-object relation between surgery and interface with the verb “demands.” His intention is to outline the practical problematics of a surgeon being outside and anatomy being inside - a chasm that needs to be practically bridged or mediated for surgical intervention to happen at all. But in contemporary surgery, the demand for an interface can be conceptualized in at least three other senses as well. First,

surgery demands an interface in the sense of having an ethical obligation to use as "minimally invasive" surgical techniques as possible in order to minimize bodily trauma, speed recovery and minimize infection risk. Second, these new surgical techniques create a context that demands—in the sense being *exigent*—a re-consideration of the nature of the ontology of surgery in the face of changing practice parameters. And third, insofar as emergent surgical interfaces suggest an increasing abstraction of the patient into an "information equivalent", the surgical interface seems to demand a re-engagement with the question of care, the interface-as-connection with the patient *qua* human being. I'll note here as well a fourth sense of demand, demand in terms of the logic of the capitalism. "Surgeons love their toys" is an oft-quoted euphemism, and it is interesting to consider the manner in which surgery creates a demand for ever-innovating interfaces, in order to provide "cutting edge" surgical care. Morris-Suzuki (1984) also claims that an industry re-tooling itself for automation sees an emphasis on never-ending innovation for the production of surplus value, which she calls the "perpetual innovation economy" (114). Additionally, the use of a particular interface in the training of surgical residents creates a market for that interface. For example, at University Hospital urology residents perform radical prostatectomies using the *dVSS* on a daily basis, whereas open or traditional laparoscopic procedures are a much rarer occurrence. The residency program literally produces *da Vinci surgeons*, surgeons for whom the practice of surgery is dependent upon access to Intuitive Surgical's product. Accordingly, pedagogy is complicit with the production of a particular demand for consumption, complicit in creating a demand for Intuitive Surgical's products.

The pedagogy of the *dVSS* projects a surgical authority that is no longer linked to expertise *per se* but is haunted by "automaticity" dispersed across the apparatus and yet managed within the relatively stable hierarchy of the OR. The surgeon's authority persists at the interface, understood in this chapter broadly in these five ways:

1. Interfaces differentiate entities, but even early notions of the interface recognized on a conceptual level how the interface produces difference as much as it marks the coming together of two previously distinct entities. This observation is important for my purposes, insofar as I think that dealing with the politics of authority and care in contemporary medicine needs to work at and from the interface, with an understanding that the human has

an originary technicity, that the human emerges in the exteriorization of the tool, the earliest of which is language.

2. Interfaces enable joint operation, but at the expense of autonomy. If the human/tool relation is the proper analytic for grappling with technological interfaces, then the prosthetic enhancement of surgical practice that the surgeon/dVSS apparatus enables transforms the autonomy of both surgeon and robot. The surgeon and robot, in their interfacing, are both becoming-robot<>becoming-surgeon in complex and contradictory ways.

3. Authority and the specificity of the interface are linked. Interfaces are sites where authority is exercised, transferred, transformed and undermined. Increasingly, it is also at the surgical interface where the surgeon is held accountable, particularly in the context of increased public surveillance of “error in medicine.”

4. Relatedly, interfaces are site of communications, both informatic and material. And the site of organizational and communication breakdown. Importantly, contemporary computational interfaces also informate; they produce data about what transpires at the interface.

5. Finally, interfaces are not neutral, but make demands. The “exposure” of the interface in OOP suggests a broader terrain of obligation and responsibility that the interface opens up. The surgical interface is no exception: institutional, economic, ethical and political demands play out at the dVSS surgical interface.

For the rest of this chapter, I want to consider the dVSS interface in relation to some of these themes. As the scene that opens this chapter evokes, the human/technology articulation of the dVSS is a dual articulation that might be illustrated as follows:

*patient <> dVSS <> surgeon*

For the sake of clarity, and because my research interlocutors were surgeons and other medical professionals, I’m going to focus on the right-hand articulation, the surgeon robot interface. I begin by describing the way several key and interrelated terms structure some of the tensions in contemporary medicine, surgical practice in particular, and then consider in turn how the

interfacing of dVSS and surgeon amplifies or complicates these tensions, as well as creates new ones: authority, autonomy, automaticity and automation.

### **The Skilled Surgeon - Autonomy Lost? Between authority, automaticity and automation**

In his important book, The Social Transformation of American Medicine, Paul Starr traces the rise of medicine's professional sovereignty. He explores how the medical profession transformed historically from the nineteenth century where "the medical profession was generally weak, divided, insecure in its status and its income, unable to control entry into practice or to raise the standards of medical education" to the twentieth, where doctors became "a powerful, prestigious and wealthy profession [that] succeeded in shaping the basic organization and financial structure of American medicine" (Starr, 1982: 8-9). Importantly, Starr's study historicizes the elite status of the medical profession, inviting the recognition that medicine's social and scientific authority and autonomy are historical accomplishments that could have been otherwise. In other words, Starr conducts what Nikolas Rose calls an "genealogy of the present," an attempt to destabilize the present by illustrating its contingency (Rose, 2007: 4).

One of Starr's main arguments is that the power and prestige enjoyed by the medical profession at the present moment is indeed contingent, and perhaps on the wane. He writes in his concluding chapter, "The Coming of the Corporation," that "[i]n the twentieth century, medicine has been the heroic exception that sustained the waning tradition of independent professionalism... But the exception may now be brought in line with the governing rule. Unless there is a radical turnabout in economic conditions and American politics, the last decades of the twentieth century are likely to be a time of diminishing resources and autonomy for many physicians, voluntary hospitals, and medical schools" (Starr, 1982: 420-421).

Since Starr wrote of the coming corporatization of medicine over 25 years ago, we might ask if indeed the system of medicine in America has slipped from physician control, "as power has moved away from the organized profession toward complexes of medical schools and hospitals, financing and regulatory agencies, health insurance companies, prepaid health plans, and health care chains, conglomerates, holding companies, and other corporations" (1982: 8). The answer, of course, as with all such conjecture, is that Starr's predictions have been realized

unevenly, and in contradictory ways, according to social, economic and technical forces that he did not and could not anticipate.<sup>24</sup> For example, his prediction that a doctor “surplus” would introduce a “zero-sum game” of competition where “the gains of one physician, or group of physicians, will have to come at the expense of other physicians or other providers” has simply not emerged (Starr, 1982: 421-425).<sup>25</sup> While the reasons are complex and outside the scope of this dissertation, far from facing a surplus, contemporary medicine, and surgery in particular, seems to be facing a shortage of personnel, and facilities for them to train, particularly at the residency level, which would seem to shore up the power of the profession according to an economics of scarcity. The role of the internet, on the other hand, was completely unanticipated by Starr and has a radical effect on the relative authority of physicians in governing patient access to and mastery of medical knowledge outside of the physician-patient dyad..

In other words, what I am arguing is that the sovereignty of the physician is still very much in question, and in flux, and my goal in this section is to understand how, and in what directions, the dVSS is mediating upon the surgical profession’s authority and autonomy. Ironically, Starr opened his book by remarking on how the medical profession has served historically as a remarkable counter-example to the argument that increasing technology within a profession results in a decrease of professional autonomy (1982: 16). Not so with other artisans through history, the most commonly-cited example being the impact the Jacquard Loom exacted on the skilled textile weaving profession. Automating technology such as the Jacquard Loom is often associated with the following impact: The technology displaces the highly skilled worker, usurping his/her tactile intelligence. The highly skilled work can be replaced by cheaper, unskilled labor; as a whole, the profession is “deskilled.” The skilled artisan is not necessarily unemployed. Her or his skill in creating textiles might allow movement into management, the planning department, whereby her or his expertise is used to create new textile designs for the machine to execute.

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<sup>24</sup> Starr himself acknowledges the openness of the future as he closes his book: “But a trend is not necessarily fate. Images of the future are usually only caricatures of the present. Perhaps this picture of the future of medical care will also prove to be a caricature. Whether it does depends on choices that Americans still have to make” (1982: 449).

<sup>25</sup> For an analysis of the contemporary employment outlook for physicians and surgeons, see Cooper (2008) and Cuschieri (2003).

It is unclear whether or not the dVSS and technologies like it will become medicine's jacquard loom. It a fun prospect to argue: *Surgery is not automated.* Yes, but several trajectories point the way. Any monkey can do it, after all. *Yes, but even if the manual practices of surgery could automated, don't forget that "a skillfully performed operation is 75% decision-making and 25% dexterity" (Darzi, 1999: 887).* You'd still need a human surgeon to supervise, right, to make those crucial decisions? I guess. There's pressure to cut costs, though, so maybe the total number of surgeons will at least be cut back. A single surgeon, for example, might oversee an entire surgical ward of autonomous dVSS robots. *That might be good, actually, since there's going to be a shortage of surgeons. In any case, I'm not worried, because it's my surgical judgment that matters, and they can't automate that! Right? Right?!*

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Shands, University of Florida publicized an event promoting a demonstration and test drive of the dVSS to its staff of surgeons with the flyer pictured above left. The declaration “The Robot Is In!” and an anthropomorphized picture of the Patient Side Cart figure prominently at the top. The human surgeon was notably absent. Scripps Mercy Hospital announced the hospital's acquisition of a dVSS with a different marketing strategy. Punning on the surgical platform's name, *da Vinci*, Scripps Mercy's advertisement suggested that because its surgeons “have joined forces with another genius — *da Vinci*®” that their “state-of-the-art program brings patients the best of everything—the amazing precision of robotics, the expertise of

experienced surgeons and the compassionate care that's synonymous with Scripps Mercy Hospital." When I asked Dr. Kinema about this advertising strategy, he scoffed. "That's just billboard medicine. They use the robot to attract patients to their hospital. But do they even use it?<sup>26</sup> . . . I want to make my own commercial someday." Kinema is an amazingly talented amateur filmmaker in his spare time. He gestured with his hands, roughly sketching a television screen.

Picture this: The commercial opens with a pair of janitors in a dimly lit basement, sweeping the floor. As they sweep, the broom of one of them—the new guy—bumps up against this hulking object in the corner, which is draped in a white sheet. The sheet shifts a bit, revealing a robotic arm and some cobwebs. The new guy recoils. "What the heck is that?", he asks. "Oh that?" his colleague snorts. "That's one of them *da Vinci* robots. The hospital bought that about four years ago. Haven't used it since." Then the screen fades to the University Hospital logo, and a voice booms, "University Hospital. We actually use our robot."

A central theme that stands out from my observations as University Hospital is the degree to which the surgeons saw the emerging technology as a displacement of their authority as providers of medical care and possessors of medical knowledge and surgical skill. The surgeons I interviewed all relayed stories about how the *dVSS* figured more prominently than their reputation in terms of attracting patients to have their prostate cancer treated at University Hospital. During one of the first interviews I conducted with Dr. Sierra, he explained why University Hospital purchased its first robot. University Hospital's main competitor in the area had bought one the year before, and they were getting all the referrals. Patient load at University Hospital was dropping off. *"Turns out, people were asking their primary care doc for a referral for the robot whenever their PSA test results came back high. I mean, they might not even need surgery and here they are asking for the robot! But you know what? When we bought our robot, things evened out again. I guess it's okay; it gets them in the door and they have the benefit of my experience and judgment in terms of their treatment course. Most of the time they don't need surgery."*

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<sup>26</sup> Dr. Kinema's reaction was not a critique of the particular institutions referenced above. As Kinema is well aware, the University of Florida and Scripps Mercy's Minimally Invasive Robotic Surgery Program are in fact very active centers for the practice of robotically-assisted surgery in the United States. Instead, he was reacting strongly to the general *advertising strategy* of foregrounding robotic hardware to promote a surgical center.

Dr. Azmeer, a senior gyn-oncology fellow, described how her patients were often disappointed when she told them that they'd be having a traditional laparoscopic instead of robotic hysterectomy. "When they say that, I tell them 'Hey, you need to trust my judgment!'" It did not surprise me, then, when the *dVSS* proved to be a controversial issue during an early morning Grand Rounds at University Hospital. Dr. Sierra had just finished presenting on the progress in establishing robotic surgery on the Urology surgical service. His focus had been on patient outcomes as the metric by which to measure the success of the program. A question came from the second row of the audience, someone clearly senior among the surgical staff:

*Question: "Is it true that the technology is driving more prostatectomies, perhaps unnecessarily?"*

*Dr. Sierra: Well, my income is not dependent on volume, which is a good thing [laughs] because I actually spend more time talking people out of surgery, in favor of watchful waiting. That's the most complex part of our job, that kind of diagnostic art. But I am seeing a change in referral patterns. More patients are coming here from across the state. I imagine that's because we have the robot. I expect that once these things become more ubiquitous we'll see referrals more grounded in more traditional factors like surgeon expertise and the prestige of the hospital.*

The *dVSS* redirects patient flows away from the "traditional" bases for deciding on a surgeon: a surgeon with "good hands and good judgment," preferably in a hospital with good reputation (Zetka, 2003: 12).<sup>27</sup> It functions within contemporary surgical medicine as an affective force, not only claiming patient attention and desire, but also displacing the surgeon as the main attraction. The desire for the robot is seen by these doctors as an affront to their authority. It puts in question their expertise as arbiters of who must go under the knife and who need not, eliminating its apparent transparency as a defining "good."

Second, the high costs of the *dVSS* means that the contemporary surgeon is bound in new ways to the hospital as an administrative entity. A surgeon's autonomy hinges upon her or his

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<sup>27</sup> Zetka (2003) offers this elaboration on what constitutes good judgment and good hands in the context of surgery:

Surgical judgment develops in response to the existential difficulties inherent in working with varied and unpredictable anatomy. It denotes a type of wisdom that is acquired over time through direct experience. This attribute is the core skill that is most highly valued in the surgical culture. Surgical judgment is what separates good surgeons from poor ones. Good hands are the action counterpart to surgical judgment. The concept denotes working wisely in a treatment modality that demands quickness, instantaneous responses to contingencies, and manual dexterity. (12)

relative mobility in relation to any particular hospital administration. The reliance of the surgeon on the *dVSS*, and by extension the resources of a hospital to provide one, mean that the surgeon is institutionally bound and diminished. Of course, surgeons are generally institutionally bound to the hospital; unless they have their own clinics they require access to the high tech operating rooms and expensive diagnostic equipment that only a large corporate hospital can provide. But by entering into interface with the *dVSS*, by becoming *da Vinci* surgeons in the sense that access to the robot is required to practice their craft, the *dVSS* makes institutional affiliation all the more a matter of emplacement since the number of hospitals possessing even one *dVSS* represents less than 15% of available hospital employers.<sup>28</sup> He/she is at best the supplement to technical edifice, that positions him/her far removed from the country doctor who had little prestige but whose “little black bag” afforded a great deal of autonomy and mobility. The question of surgeon autonomy takes on additional significance in the context of academic medicine. If, as Bousquet observes, “the new realities of managed education strongly correspond to the better-understood realities of managed care,” then the autonomy of academic faculty operating in a teaching hospital is doubly-bound, by managed care and managed education (2003: 233). Further, when asked why they chose University Hospital for their Urology residency, every single resident I interviewed said “the robot.” It wasn’t the prestige of the attending surgeons who would mentor them, nor the prestige of the institution itself. The robot was the primary affective force in shaping student desire in the market of surgical residencies. Residency experience on the robot was seen, unequivocally, as the ticket to secure future employment, a shortcut in the pursuit of upward mobility.

## Automobility

Given how authority, autonomy and their diminishment intimately connect with issues of mobility and immobility, I am reminded of a moment in the scene that opened this chapter: the

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<sup>28</sup> The career autonomy of the surgeon is marked by its mobility, or at least the potential for mobility if the surgeon chooses: “Like the university professor, the full-time staff member of the medical school and the teaching hospital tends to have a national or even international ‘clientele’: while his “practice” depends upon holding a position in an organization, his career tends to be one of high mobility, moving from one organization to another.” (Freidson, 1970: 113). Freidson (1970) might be wrong to equate autonomy with mobility, however, at least in relation to the contemporary university faculty. As the current proliferation of adjunct faculty in the contemporary University suggests, the enforced autonomy of casualization can be equally problematic; adjuncts operate under the sort of perpetual and enforced mobility that marks the casual worker, a mobility derived from the fact that the institutions that employ them have no investment in them beyond their labor.

everyday act of docking the robot eliciting a series of references to and jokes about driving and the automobile. Driving the patient cart into place is only one moment in which the figure of the automobile appears at the surgeon/dVSS interface. Intuitive Surgical, for example, structures their demonstrations of the platform at professional meetings around the “test drive,” and even provide a script to their sales force instructing them on how to highlight and demonstrate certain features of the dVSS during these test drives. For example, the suggested method for illustrating the range of motion of the Endowrist® instruments is to ask surgeons seated at the Console to act like they’re starting their car: “I want you to roll your hands around as if you are turning keys in your ignition. Can you see how much range of motion you have with the EndoWrist instruments?” (*da Vinci*® S™ Test Drive Pitch).

“Driving the robot” can be read as a means of taking control in the context of the diminished authority and autonomy described above. It is a means of re-asserting authority and of displaying and exerting expertise. In computer support circles, the exhortation “Let me drive” is often uttered in frustration at the incompetency of the user trying to follow the tech person’s instructions, even if it gets phrased as the more polite: “Do you mind if I drive?” Displacing the user from the keyboard not only allows the computer technician to display his virtuosity in diagnosing and fixing an ailing computer, it reinforces the “incompetency” of the user, who loses the opportunity to learn by doing. In my observations, a frustrated attending surgeon would often take over the controls with a curt “Let me drive!” in order to intervene when a resident was bungling a procedure. Interestingly, in my observations the phrase “why don’t you let me drive?” also functioned in the OR as an ostensible gesture of care, of looking out for the well-being of the doctor, as well as the safety of the patient, as in: “You’ve been operating for 3 hours now, doctor. Why don’t you let me drive now?”

Per the *da Vinci* surgeon’s increasingly immobility *vis a vis* the institution, and her or his loss of authority in cathecting patients, all of these figures of the automobile at the surgeon/robot interface might be productively read in terms of an attempt to operationalize at the interface what Hay & Packer (2004) call “automobility”:

Understood as an expression of auto-mobility, the car is but one kind of assemblage that has become integral to regimes of mobility wherein specific modes of transport are conceived to be a means to self-sufficiency, wherein

self-transport is conceived as a basis for states of freedom and independence, and wherein ideals of self-transport, self-sufficiency, and advanced states of freedom (the fully automatic) bleed into one another. (Hay & Packer, 2004: 212)

The *dVSS* gets figured as a car, I argue, so that the *da Vinci* surgeon can recuperate a sense of self-sufficiency and experience freedom and authority within the space of the OR, even as the surgeon's automobility diminishes without. Critically, Packer (2003) points out that the "freedom" of automobility is a regime of disciplined mobility. The mobile subject that the automobile creates and enables entails new modes of governmentality. Packer reasons that because "governing a mobile society...demands disciplining individuals differently," automobility consequently creates new "lines of articulation between governance, mobility, and the 'safe subject'" (2003: 153). In brief, being a "good citizen" means learning to be a "good driver." Later in this chapter I'll discuss in more detail how the *dVSS* is implicated in broader disciplinary efforts to mitigate "error in medicine," but for now I simply want to make the analogous connection to the automobile that Packer makes possible: the *dVSS*, as an apparatus of automobility, is also governed by discourses of safety and risk.

### **From the Auto-Mobile to the Automatic**

Automobility is a convergence of two modes of agency: autonomy and the automatic. Autonomy means self-governance; its etymology derives from *autos* (self) and *nomos* (rule or law). The meaning of automatic, on the other hand, comes from the etymology of the term "cybernetic," which means "self-steering" or "automatos" which literally means "self willing." The automatic is a precondition for autonomy, but they are not the same. One must have the capacity for automation (the ability to act on one's own accord) as a condition of possibility for autonomy (to self-generate the rules according to which one acts). Autonomy implies a primary indeterminacy that is made determinate or "driven" by the human subject; the automatic is determined, implying self-sufficient mobility, but the inability to follow anything beyond a pre-scripted path. Attewell (1990), drawing on figures from Marx and Harry Bravermann, outlines the following contrast between (autonomous) craft worker and (automatic) machine operator:

a craft worker decides how to accomplish a particular piece of work, chooses the appropriate tools and procedures, and is self-directed in the work. This contrasts with, say, a machine operator, who is told what to do, is given instructions, tools, or procedures on how to do it, and is overseen by management. (441)

Accordingly, the automatic seems to divide into 2 primary figures at opposing poles of value within contemporary surgical practice: the specter of the automaton and the virtuoso of automaticity.

### **The Automaton**

The sense of automation as becoming-automaton is often cast within the narrative of a fall; the surgeon, once a autonomous “hero,” falls from that privileged space of authority and becomes yet another “cog in the machine.” Loss of autonomy means one is *reduced to* the automatic in the sense of becoming-automaton, an alienated sense of becoming-robot. In his memoir, Intern: A Doctor’s Initiation, Sandeep Jauhar writes of being drawn into this sense of automaticity:

By this point in my internship, I had already come to appreciate that there was a fundamental disconnect in the hospital. Good relations with patients weren’t rewarded; efficiency was, which meant focusing on the work at hand, operating with a kind of remote control, in front of computer screens and nursing charts and requisition forms, and on the phone. (2007: 118)

Contemporary paradigms of evidenced-based medicine are often derided as “cookbook medicine,” the blind following of pre-defined protocols, limiting one’s practice to performing only the procedures that managed care allows. The logic of the protocol takes on the unbending tyranny of the line that circumscribes the “low-level” programming languages that I described earlier. Disaffected, care becomes executing one’s “operating instructions,” line by line. This sense of becoming-automaton is also tied to the capitalist restructuring of healthcare, as Cooke et al outline in their “American Medical Education 100 Years After the Flexner Report”:

the harsh, commercial atmosphere of the marketplace has permeated many academic medical centers. Students hear institutional leaders speaking more about “throughput,” “capture of market share,” “units of service,” and the financial “bottom line” than about the prevention and relief of suffering.

Students learn from this culture that health care as a business may threaten medicine as a calling. (2006: 1340)

While the surgeons I interviewed and interacted with never spoke about experiencing this alienation directly, they certainly warned about “factory medicine,” citing a peer institution that owned multiple dVSS platforms, and “all they did, day in, day out, was back-to-back prostatectomies,” the specter of the total automation of the craft shop.

### **Machinic Virtuosity — Automaticity as Virtue**

Some surgeons, however, see machine-like automatism in a different light. Prominent surgeon-author Atul Gawande, for example, advocates the “becoming-machine” of the surgeon. He cites a small medical center outside Toronto, Shouldice Hospital, that has turned hernia repair into factory science. Surgeons at Shouldice do hernia operations and nothing else. As a consequence, each surgeon performs 600-800 hernia repairs a year, more than most surgeons do in a lifetime. As a result, they have cut operating times, cut costs, and reduced the hernia recurrence rate from an average 10-15% of all cases to “an astonishing 1%” (Gawande, 2002: 38). What some surgeons might see as a dystopic vision of mindless automatons in the lock-step of alienated labor, Gawande sees as virtuosity: “To describe one case is to describe them all: I watched three surgeons operate on six patients, and none deviated even a step from their standard protocol...[P]hysicians should be trained to act more like machines” (2002: 39). Gawande is not alone: Automaticity is often defined as *the* goal of surgical skill training. Hirschauer, for example, uses the metaphor of machinic virtuosity to describe a surgical team operating at maximum efficiency: “Alarms signals can be heard whenever a cog in the works of the operating team is out of order and threatens to stop the whole apparatus. Normally, however, the surgeon-body with its rhythmic activity functions like a machine: no words being said, instruments slide into hands snapping shut” (Hirschauer, 1991: 297).

A term coined in the late 1970s, automaticity names a mode of cognition associated with expert virtuosity, a state in which skilled actions become so deeply embedded in the embodied repertoire of the surgeon that the surgeon need not think about the steps involved. S/he simply acts. Hence,

the term “automaticity” refers to the ability to perform a task with little effort and few attentional resources. Highly experienced individuals (experts) can often perform multiple tasks simultaneously with little or no performance decrement, whereas novices often struggle with a new and difficult task, and their performance is severely impaired when they attempt to engage in another task at the same time. (Stefanidis et al, 2008: 211)

Having to stop and think signals incomplete training. “Don’t think, act!” Surgeons are exhorted to go “automatic.” While an intern may need to consult his or her handbook, the master has mastered the skill by virtue of having completely somaticized it. Neurosurgeon Katrina Firlik suggests that, in this sense, even brain surgery isn’t brain surgery: “If you have an expanding blood clot in your head, you want a skilled brain mechanic, and preferably a swift one. You don’t care if your surgeon published a paper in *Science* or *Nature*” (2006: 4). For a neurosurgeon confronted with a bleeding cranial sinus tear, “there’s no role for thinking here... I ask for two things, automatically: a large piece of gel foam and a large cottonoid” (Firlik, 2006: 97). The human surgeon is and is not recovered by automaticity, by their becoming-machine, for so-called mindless automatism shuttles between the specter of alienation and the marker of virtuoso expertise.

### **(Human) Fallibility and Machinic Virtuosity**

Exhibiting automaticity at the *dVSS* interface would seem to be a panacea to human fallibility: the becoming-machine of the surgeon coupled with the already-machine of the robot—perfect procedural precision and the consequent elimination of surgical error:

Western medicine is dominated by a single imperative—the quest for machinelike perfection in the delivery of care. From the first day of medical training, it is clear that errors are unacceptable... When I’m in the operating room, the highest praise I can receive from my fellow surgeons is “You’re a machine, Gawande.” (Gawande, 1998: 149)

As I have already described, ISI emphasizes the *dVSS* as an apparatus that overcomes the limits of the human. It filters out physiological tremor. The “ergonomics” of the Surgeon Console’s interface is intended to mitigate against the encroachment of fatigue. Early on in my research for this dissertation, my son Noah and I happened upon a CBS News Report on surgical error (March 17, 2008). Following the report, Noah observed:

*I know people at hospitals are there to help me, but it makes me scared because they could mess up, I mean, they're only human. They make mistakes. They're not like robots that are programmed, like robots who know how to do everything and know everything they're programmed. People, they can mess up. But robots, they don't get tired.*

The aura of machinic virtuosity is another expression of the affective force of the *dVSS*. It is a fantasy of “seamlessness” and “superhuman” (or in the eyes of my son, “Superhero”) care. But in embodied relation, at the interface of becoming-robot-surgeon, it cannot of course transcend the human. Nor can it transcend error. I've already written about how the productivity of error is built into the very logic of command and control of the *dVSS*. Here, let me discuss how the aura of machinic virtuosity unravels around the question of error.

First, the *dVSS* interface opens up onto the possibility of the technological invention of the accident, or what Virilio calls the “artificial accident” (2007: 15).<sup>29</sup> Virilio's point is that the technological accident proceeds from the process of biotechnogenesis itself. He writes, “there is no *accidentology*, but only a process of fortuitous discovery, *archaeotechnological invention*. To invent the sailing ship . . . is to *invent the shipwreck*. To invent the train is to *invent the rail accident of derailment*” (2007: 10). Following Virilio, we might then say that far from mitigating against error and the accident, the *dVSS* produces the robotically-assisted surgical accident, the unrecoverable system fault. Borden (2007) accounts some of the artificial accidents that occur at the surgeon/robot interface: mechanical failure of wrist and arm; camera error and 3D display blackout, power supply failure, master failure, slave failure and software errors. At the ongoing interface of biotechnogenesis, then, is the creation of entirely new taxonomies of errors, new configurations of failure, new matrices of vulnerability. ISI's *dVSTAT* technical support stands ready to respond to these by telephone helpline, within 30 seconds for US domestic users (but 15 minutes for international users, suggesting that the distribution of catastrophe might become a function of geography).

Another site of “artificial” fallibility is the ways in which both surgeon and *dVSS* get caught up in logics of obsolescence. Like the lifespan of a cutting edge technology like the *dVSS*, “a physician's life is a constant, and losing, battle against obsolescence” (Ravitch, 1987: 125).

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<sup>29</sup>Virilio counterposes the artificial to the natural, not the real. It's not that artificial accidents are fake, but that they are the products of technicity.

Having an “obsolete” system is a site of vulnerability; creation of incompatible software versions or point releases of firmware that no longer go through development cycles to add functionality, maintain security or fix bugs. Fatigue and the “wearing out” of the aging body are as much a product of the last century’s perception of / production of the body according to the laws of thermodynamics and the mechanics of the motor (see, e.g. Rabinbach, 1990).

Third, a paradox exists at the heart of skill and automaticity. Attewell (1990) argues that, from a neo-Weberian perspective, a skilled profession requires the failure of practice to establish skill as such. Attewell describes the logic by which skill

depends on the *absence of an effective technique* or technology to produce the desired outcome. A skilled occupation is one that cannot reliably do what it is called on to do. Work that cannot be carried out effectively every time becomes a resource around which those who are employed at the work build their claims to being especially skilled. (Attewell, 1990: 438)

Even beyond the entanglement of failure in the performativity of skill, recent research on error in surgery suggests that errors occur most often by *expert* surgeons, those who operate most within the mode of the machinic, of automaticity. In other words, the same cognitive mechanisms that are the mark of expertise make the expert, the surgeon with the most naturalized technosoma, the most fallible to error. The ideal behind automaticity is that the surgeon, not having to think about how to throw a stitch, can instead be ready for the contingencies of surgery — the unexpected. Instead, it’s more likely that the surgeon will be distracted. “Off-loading” to lower level processing circuits of the brain the cognitive work of having to concentrate or “think hard” about one’s suturing practice, for example, simply frees up the mind to wander.

### **To Err is Human: The Problem of Error in Medicine**

In 2000, the Institute of Medicine published its landmark report “To Err is Human: Building a Safer Health System,” which placed the “problem of error” firmly in the public consciousness. The report revealed that somewhere between 44,000 and 98,000 deaths occurred each year as a result of medical error. Of these, approximately 12.5%, or between 5,500 and 12,250 deaths, were the result of “surgical adverse events” (Champion et al, 2008: 284). The IOM Report recommended a “systems approach” for mitigating against medical errors. As many

from within and without the medical community have pointed out, this systems discourse raises complicated and entangled issues regarding personal responsibility and individual accountability, particularly when the “system fails.” Moreover, the systems approach exacerbates tensions between traditional protocols of accountability in surgical apprenticeship and practice (such as the M&M conference) and the new “systems” apparatus of error mitigation and risk management. The “To Err is Human” define error as “failure of a planned action to be completed as intended” — an error of execution — or the “use of the wrong plan to achieve an aim” — an error of planning (2000). In 2004, DARPA sponsored a “Conference on Surgical Errors” consensus meeting to further hone the taxonomy of error for surgery-specific practice. The result was a taxonomy that specified both degree (minimal, minor, and major) and type (errors of perception, errors of cognition, and technical error) (Champion et al, 2008: 285-286). More than 50% of surgical errors are said to be technical errors. Champion et al (2008) subdivide technical errors into slips and lapses. Slips are failures caused by distraction, by not being careful, whereas lapses occur when “the necessary knowledge is lacking to solve a problem” (Champion et al, 2008: 286).

My interest in laying out the taxonomy above is not in its accuracy, in its ability to properly name surgical error. Instead, I’m more interested in how this taxonomy creates an expanding yet ever-more-specified environment of risk, of *potential accident*. And how this environment is, in turn, generative of calls not only for surgical skills training, but also for more *objective assessment* of that training. As Packer (2003) puts it, “risk is something to be avoided, while safety is the positivity that organizes conduct.” I argue that risk and the organization of conduct to mitigate it both play out at the interface of the *dVSS* in particular and powerful ways. In concluding this chapter on “thinking (at) the interface,” I want to explore how the *dVSS* participates in these circuits of error specification and regimes of conduct to mitigate them. If the 19th century Scientific Management techniques of Taylor and Gilbreth analyzed the micro-movements of the worker in the name of efficiency, contemporary surgical assessment leverages the same architecture in the name of safety.

## Informating at the Surgical Interface: The *daVinci*® Research Interface

In the last chapter I detailed the complex mechanism by which the *dVSS* “seamlessly translates” the surgeon’s movements into the movements of the robotic arms. Rather than mechanically-driven by the master manipulator, the movements at the slave end effectors are computationally-derived. Crucial to the mediations at the master/slave interface are an array of sensors that sample the positions of each of the joints in the *dVSS*, 1200 times per second. Intuitive Surgical provides another interface into this sensor data, an API (application programming interface) that they have dubbed the *da Vinci*® *research interface*. The *dVSS* surgical interface not only automates, it *informates*:

“What is it, then, that distinguishes information technology from earlier generations of machine technology? As information technology is used to reproduce, extend, and improve upon the process of substituting machines for human agency, it simultaneously accomplishes something quite different. The devices that automate by translating information into action also register data about those automated activities, thus generating new streams of information. (Zuboff, 1988: 9)

In other words, as the *da Vinci* surgeon operates at the console, interacting with the various interfaces that constitute the *dVSS* platform, s/he generates a digital data stream of all the *events* that are enacted at the interface. This data, as procedural input (in Bogost’s sense) not only operates the system, but it serves as a dynamic representation of that system, meta-data on the doing. A record is made of the entire operation from the point of view of the computational interface.

This “recording” is not stored on the *dVSS* platform itself, but streamed in real time from a server on the platform over a standard TCP/IP connection, the same protocol used for communication over the Internet, to a researcher’s computer running client software. The API is an object-oriented interface; data is encapsulated and the API exposes the data-stream in a read-only fashion. The API exposes no *methods* for affecting the data, no means for “remote control” of the robot. Additionally, the granularity of the dataset provided by the API is of much lower resolution than the data streams used in the *dVSS*’ operational algorithms. Whereas we know the sensors in the master controllers and end-effector joints sample kinematic data at 1200 Hz, the API exposes a much lower sampling rate, between 10 - 100Hz, depending on the

data point. It still provides, however, an impressive 192 points of data in each sample. According to the publicly available API documentation, the exposed data “includes the motion of all master and slave manipulators, as well as a number of user console events such as button and pedal activations” (DiMaio & Hasser, 2008: 1). These data points include the angles and angular velocity of each of the master and end effector joints as well as the instrument tip’s pose and translational/rotational velocities, ten to 100 times per second. The system also registers which foot switch pedals are depressed and when. The console even “detects the presence of the surgeon’s head when he/she is looking through the display eyepiece. *Head In* and *Head Out* events are triggered and transmitted by the API server” (DiMaio & Hasser, 2008: 4).

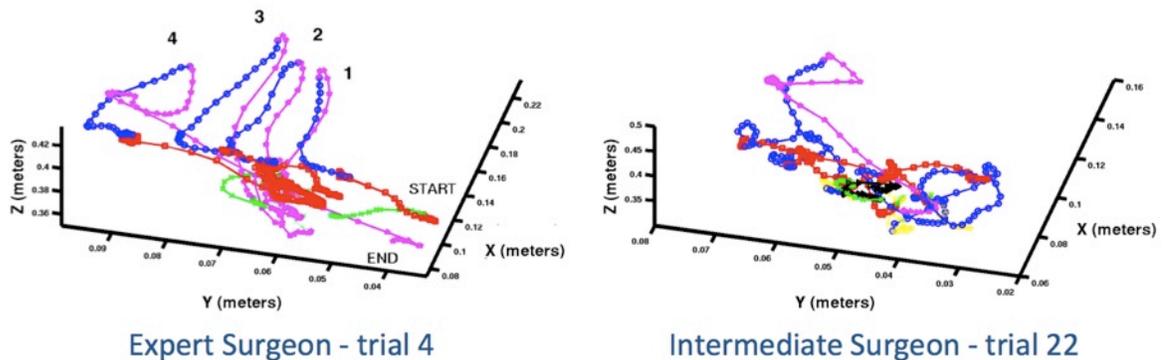
Much like stereochronophotography did for Frank Gilbreth in his studies of surgical motion at the turn of the last century, the *dVSS* API renders surgical craft visible in ways previously inaccessible. Walter Benjamin made this observation about the camera in his often-quoted “The Work of Art in the Age of Mechanical Reproduction:”

Evidently a different nature opens itself to the camera than opens to the naked eye – if only because an unconsciously penetrated space is substituted for a space consciously explored by man. Even if one has a general knowledge of the way people walk, one knows nothing of a person’s posture during the fractional second of a stride. The act of reaching for a lighter or a spoon is familiar routine, yet we hardly know what really goes on between hand and metal, not to mention how this fluctuates with our moods. Here the camera intervenes with the resources of its lowerings and liftings, its interruptions and isolations, its extensions and accelerations, its enlargements and reductions. The camera introduces us to unconscious optics. (1936)

But what are the implications of the *daVinci*® research interface opening up new worlds in this manner? It, too, participates in the biotechnogenesis of the *dVSS*, creating new objects. As does the “storage capacity” of many different media, it renders the skill of the surgeon as an object independent of the body of the surgeon in particular ways. (A simple observation: Both Benjamin’s camera and the *dVSS* API render gesture as digital, just with different sampling rates, different resolutions, and different possibilities for reversibility and playback). This rendering-external of the surgeon’s tacit craft knowledge, the “literalization of skill in an inscription device” marks a potential loss of the surgeon’s labor power (Lenoir, 2002: 43). It places the

surgeon's gesture potentially within the contested realm of intellectual property. Whose "property" is the surgical gesture? The surgeon who "made" the gesture? Or is it the property of Intuitive Surgical, whose robotic platform rendered it as a recordable, storable, transmissible object? Does the *dVSS* interface thus suggest an open source politics of craft?

Second, the dataset of the *dVSS* produces a new taxonomy of surgical skill and surgical error, at the micro-level of the gesture. For example, researchers at Johns Hopkins University are running Hidden Markov models against the *daVinci* API's data stream to automatically recognize the "gesture primitives" of surgical craft. Much like language can be parsed according to phonemes, researchers at JHU foresee the ability to computationally recognize different elements of a surgical procedures, which they call "surgemes." At this point, their research has been used to develop visualizations of different "surgical signatures": novice, intermediate, expert (see image below - The "expert" is marked by clear separation between gestures. The less experienced surgeon makes any number of "unnecessary" movements). Explicit in this research is the development of mechanisms for objective surgical assessment: assessment by and through the *dVSS* interface itself, measuring how a particular surgeon's "signature" deviates from the precisely-separated gestures of an expert.



Two "Surgical Signatures"

Figure courtesy of Gregory D. Hager, Professor of Computer Science, The Johns Hopkins University  
Source: [https://www.cisst.org/wiki2/images/fffa/Hager\\_-\\_LanguageOfSurgery.pptx.pdf](https://www.cisst.org/wiki2/images/fffa/Hager_-_LanguageOfSurgery.pptx.pdf)

As a tool in generating an even more precise profile of risk and error, the *dVSS* interface sets the stage for new positivities for "safety's" intervention. In the context of ever more proliferating environments of risk, *da Vinci* surgeons must perform, or else, giving robotic surgery

a different valence in the “cutting edge” sensibility of contemporary medicine, the drive to always be “state of the art.” Robotic surgical performance seems defined both by virtuoso performativity, and, increasingly precise specifications of error, and the demand to meet not the norm, but the impossible ideal of expert, error-free practice.

— 4 —  
CONCLUSIONS

### Part I: The Becoming Surgeon of the Robot

The notion of a completely autonomous surgical robotic has so far received short shrift in this dissertation, even though I have argued that the *dVSS* interface signals as much the “becoming surgeon of the robot” as it does the “becoming robot of the surgeon.” In part, I am hesitant to speculate on the future of surgical robotics in relation to the automation of surgical craft. It is unclear whether or not robotic engineers will succeed in creating a truly autonomous surgical robot, nor that they will be motivated to do so. But in the more speculative mode of a coda, I want to briefly consider the “becoming surgeon of the robot,” particularly as it sets in motion a range of opposing discourses about humans and machines.

It is the affective force of this figure, the specter of the autonomous surgical robot, that propelled an internet meme that circulated in May of 2006. It was reported that, “for the first time, a robot surgeon in Italy has carried out a long distance heart operation by itself.” When I first came across the story a month or two ago in the archives of the popular technology website Engadget (Blass, 2006), I was both intrigued and alarmed: Was it true? Could it be! If it were true, how had my research missed such a crucial moment in the becoming-surgeon of the robot? But the more I tracked the meme across blogs and newswires, through RSS pingbacks and comment threads, the less and less I cared about the truth-value of the meme. It is, and isn’t true. Instead, the story’s truth mattered less than its *truth-effect* as I realized the range and depth of affects it had mobilized about the (im)possibility of the becoming surgeon of the robot. As it circulated through the blogosphere, the story opened up to public commentary, resulting in a crystallization of many of the themes



I've struck in this dissertation. I present the meme here as a way to see how the affective force of surgery at the robotic interface produces a web of critique in a relatively comic key. The form of the comment thread turns out to be both useful and economical in terms of focusing and amplifying discourse in a condensed frame. Comment threads do not readily lend themselves to extended arguments but rather incite the posting of "discursive gems," compact articulations of the cultural imaginary of the various publics that haunt the internet. As I outline below, these "gems" dramatize many of the issues I raised in the body of my dissertation such as the perceived inflexibility of computational techniques, the conviction that software is inherently rule-bound, linear, and/or procedural and therefore dangerously "automatic." The robo-surgeon recounted in these comment threads is the specter of the automaton. The inflexibility of technique is dramatized at the interface of the robot with the unexpected and contingent, which in turn is both the promise (flexibility) and demise (fallibility) of the human.

### The Meme

On May 18, 2006, the news agency United Press International posted a story to its newswire, reporting that "for the first time, a robot surgeon in Italy has carried out a long-distance heart operation *by itself*" (2006). Dr. Carlo Pappone, head of Arrhythmia and Cardiac Electrophysiology at San Raffaele University in Milan, initiated the surgery from a PC laptop in Boston, where he was presenting to an international congress on arrhythmia. With the click of Pappone's mouse button, the robot then proceeded to perform the surgery at a hospital in Milan, on a 34-year-old patient suffering from atrial fibrillation.<sup>1</sup> Pappone and the heart specialists at the conference monitored the operation via tele-videoconference. The article concluded by suggesting that the robo-surgeon's software reflected the "expertise of several human surgeons" and that the surgical robot "has learned to do the job thanks to experience gathered from operations on 10,000 patients," Pappone said (United Press International, 2006).

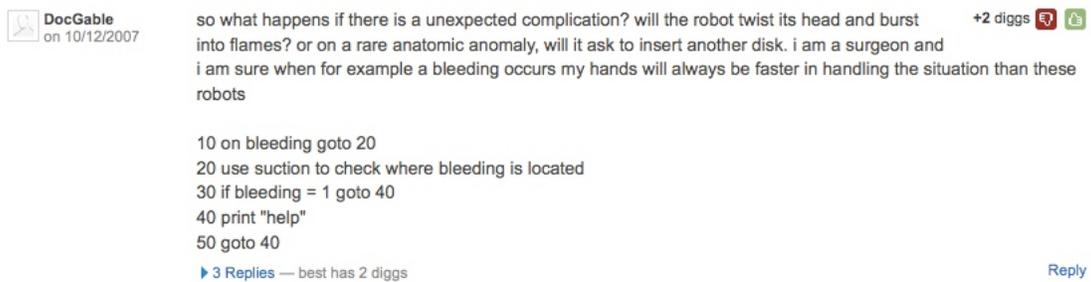
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<sup>1</sup> Atrial fibrillation, or "afib", is a condition in which the electrical impulses that drive the heart muscle to contract rhythmically misfire, resulting in an inefficient, syncopated "quivering" of the heart. While atrial fibrillation is generally asymptomatic, in some patients it may result in chest pain, palpitations or fainting spells. It has also been linked to an increase risk of stroke. A surgical procedure often performed to address atrial fibrillation is called catheter ablation, and requires snaking a catheter through the patient's veins to the left atrium of the heart, where electrodes that can detect electrical activity from inside the heart are used by an electrophysiologist to "map" abnormal electrical activity. The surgeon then inserts another probe into the catheter, which emits radiofrequency energy to ablate or destroy the "localized" abnormal neuro-electrical pathways in the heart tissue itself.

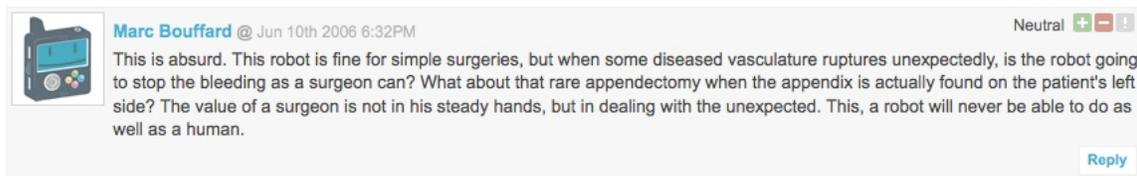
## The Commentary

The story immediately circulated through the blogosphere, and appeared on such prominent websites as engadget.com and digg.com.<sup>2</sup> As I have suggested, the circulation of the meme produced concentrated pockets of commentary and debate, in the form of comment threads on the various blogs and newswires that referenced the story.

Some of these comments retrace familiar territory, commenting on the inflexibility of rule-bound technicity in the face of or even against the messy contingencies of surgical practice. In these comments, the automatic gets figured as a kind of linear procedural logic that locks up at the first sign of complexity and the unexpected:



Similarly, a second kind of response pitted the human against the robot, asserting the superiority of the human, reflecting confidence in what I have previously identified as the surgeon's operative judgment:



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<sup>2</sup> Internet circulation, particularly tied to the blogosphere, is a complicated mix of automated proliferation through RSS feeds and intentional human-driven citation.

 **Samantha** @ Aug 12th 2008 1:07AM Neutral   

Marc Bouffard is right. As surgeons, we don't do procedures as if it's a simple line of steps that works for all complications. Rather we are expected to know what to do just in case something abnormal or unexpected happens. Sure, we are trained to know a lot of procedures but in the end we are expected to adapt and think of a new step to correct something that wasn't taught to us. If being a surgeon is something programmable then anybody can be a surgeon.

Robots will only do what is inputted to them. So when a complication is not in their programming, they don't know what to do. A network of procedures might help but it's still in the surgeon's discretion and experience whether or not it'll work for her case.

You don't become a surgeon because your hands are precise; you become a surgeon because your mind can devise. And your brain can decide what will help save a life.

[Reply](#)

In turn, bloggers pictured the human as fallible, posing human fallibility as irreducible and robotics as infinitely improvable. Adam K., for example, both recognizes the limitation of current instantiations of technology but articulates the dream of technical perfection realized:

 **Adam K** @ May 19th 2006 11:44AM Neutral   

I think its a pretty good idea, after all a surgeon is only human. His fingers could slip, his eyes could blur, all sorts of things. Robots wont have adware or popups so its only focus is the surgery. A lot of what current computers have problems with is programs not working together right. This thing would be designed to work flawlessly. Now if they sold a home surgery kit for Windows Vista, I'd be scared. Even if it did have the latest firmware.

[Reply](#)

Other threads, however, opened up onto different terrain. For example, this thread from Digg (below) opens up important questions regarding robot ethics — to what extent can ethical behavior be engineered into the software and hardware of robots?

	<b>Grimdotdotdot</b> on 10/12/2007	+1 digg  
Doesn't this break the first rule of robotics? (something like 'A robot is not allowed to harm a human?')		
▼ 3 Replies — best has 4 diggs		<a href="#">Reply</a>
	<b>ideasyncrasy</b> on 10/12/2007	+1 digg  
Only if surgery also breaks the Hyppocratic Oath ("Above all, do no harm")		
		<a href="#">Reply</a>

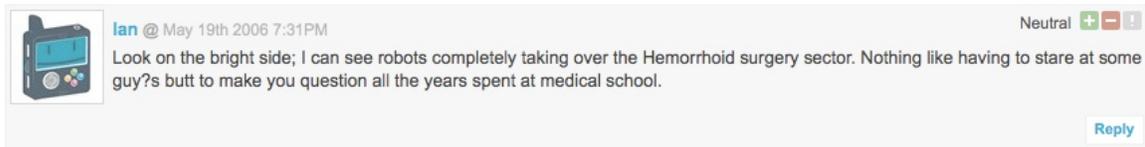
This is a particularly difficult issue for surgical robots in particular; whose tasks involve performing a kind of violence on the patient-body, a controlled trauma, but nonetheless one that seemingly violates Isaac Asimov's "First Law of Robotics:" "A robot may not injure a human being, or, through inaction, allow a human being to come to harm." This comment thread points to the difficult question of how one might program ethics into machines, as Asimov's fictional set of foundational operating instructions encourage us to consider:<sup>3</sup> But the question of machine ethics opens onto human ethics as well, such as the way in which ethical

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<sup>3</sup> For a detailed discussion of Asimov's "Three Rules" in relation to the problem of machine ethics, see Anderson (2008).

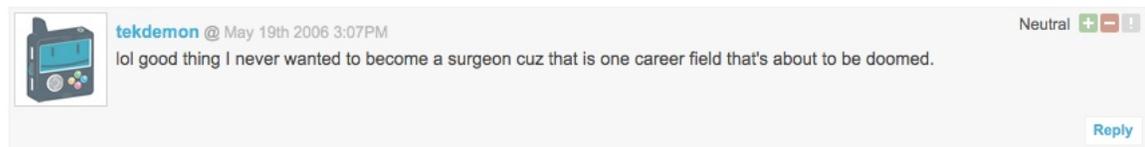
“first principles” still hold sway in medical ethics. For example, a precept commonly taught in medical school is *Primum non nocere* (“First do no harm”).

Still other posts engaged the labor politics of automation. On the one hand, the robot promises to do our dirty work. As “lan” quips:



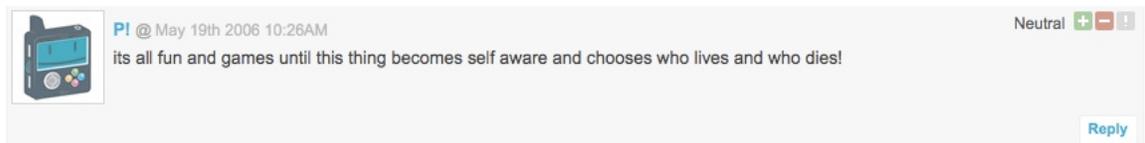
On the other hand, figured as the ultimate in “foreign labor,” the robot threatens to replace us. Advancements in surgical robotics will render surgeons unemployed, if not obsolete.

Commentators “rbvdb” and “tekdaemon” condense this anxiety in their exchange on Engadget:



Even further, some threads braid issues of subjectivity, consciousness, and accountability, and the instabilities that the becoming surgeon of the robot introduces into these relations.

“Cheapside” asks what or who *he* becomes as an effect of uninvited surgical incursion, and who or what might be held responsible for the crime? Finally, “P!” puts the question of displaced judgment and justice concisely:



Through sometimes desperate hyperbole, insistent irony, and parodic allegory, the bloggers declare and domesticate the anxiety at the heart of robotic surgery and the becoming-surgeon of the robot. They open additional questions and raise new, contested issues. Just this short list of comments opens up onto new fields of practice with new ethical and political problematics and possibilities, including the labor politics of automation and of outsourcing, the complex legal and ethical issues of machine and systems accountability, not to mention the inverse question of our ethical responsibility toward sentient machines.

However, far too often the bloggers repeat and elaborate old narratives. Many of the common threads work by positing a kind of exceptionalism to either the robot or the human, rehearsing a conventional antagonism that ignores the work of the interface I've tried to work both through and from throughout this dissertation. The pull of this binary antagonism signals both the difficulty of keeping open the interface and the necessity to continue to strive to do so. At stake is the ability of medical caregivers and patients—in other words, all of us—to engage with the implications of socio-technical change, which promises to only accelerate as more and more of human practice (both manual and cognitive) is augmented with computationally-intensive technologies. We need to be asking new questions, forging new concepts, or we risk replaying the same old stories while technological change proliferates independent of our ability to make sense of it, even as it radically transforms our taken-for-granted “common sense” about what it means to “care” for each other, in medical contexts and beyond.

\* \* \* \*

## **Part II: Care at the Interface**

### **Taking Stock: Focusing the Question**

As I've worked through this dissertation, I have made several major observations and claims. First, I have argued that the relationship between care and technology in medicine is a vexed one. Care and technology are often thought in terms of an opposition: care is what humanizes medicine, puts a "human touch" on the alienating, dehumanizing effects of its creeping techno-rationality. And yet, paradoxically, in formations of contemporary biomedicine the receipt of “quality medical care” is often seen as synonymous with access and acquiescence

to these very same technologies, as physicians and patients alike engage in the dogged pursuit of the best techniques of *cure*. Viewed in terms of an opposition, the politics of care seemingly hinges upon keeping open the possibility of human relationality *in the face of the rationalized technical cure*. The politics of care in this view thus consists of fending off the technical, and defending the human from the encroachment of technology. And yet it seems fair to posit that medicine will continue to be shaped by emergent technologies, and that these will fundamentally alter (in contemporary terms), what it means to care, and, more fundamentally, what it means to be human, to establish relationships defined by “human touch.” Not only is it unreasonable to imagine a future medicine somehow purified of the technical instrumentalization of the human body, it’s equally nostalgic to posit a coherency to “the human” outside of a technological relation. Consequently, I posed in this dissertation a different question: What might it mean to think *at the interface* of care and technology, to consider the technicity of care?

I have argued that to begin to answer that question in a useful way requires focus—understanding the *specificities* of particular human-machine interfaces where care takes place. Technological relations, like relations of care, should not be engaged in the abstract. Consequently, this dissertation is largely a case study based on Intuitive Surgical’s *da Vinci® Surgical System*. I chose this surgeon-robot interface because it dramatizes and focuses the oppositional nature of care and technology outlined above. As a device that telemediates the surgeon’s embodied relation with the patient, it operationalizes the delivery of surgical care through technical means, severing direct contact with the patient and offering instead its interfaced “information equivalent.” In retrospect, I pursued the media specificity of the *dVSS* a bit further than I had anticipated, but by tracing the specificity of the *dVSS* into the complex logics of its command and control systems, my analysis opened up the productivity of error. In contemporary surgical medicine, error is seen as something to be eliminated from both technical apparatuses and systems of care. And yet attention to the media specificity of the *dVSS* and its computational systems illustrates how error figures foundationally in the complex feedback loops by which the *dVSS* platform generates haptics, the sense of embodied tactility in relation to the patient’s body. In other words, error and failure seem as central to the “nature” of robots as it does to “human nature.” If “to err is human,” at the contemporary moment, to

err is also robotic. Furthermore, while not care *per se*, I have argued that haptics are a necessary condition of possibility for caring touch at the robo-surgical interface. What effect on our ability to rethink care in the context of cure might obtain if error and fallibility are considered constituent of both human and machine?

Having just considered the media specificity of the technicity of care *at the interface*, the third chapter of this dissertation focused and further specified the concept “interface.” I engaged the history of the term interface, and thematized it around certain key issues like authority and autonomy, as well as communication and its failure. A focus on the term’s deployment in computational contexts yielded figurations of the interface as porous skin and as the exposure of methods or means that constitute computation’s mediality. I then returned to the *dVSS* platform’s interfacing of human and robot through Waldby’s optic of biotechnogenesis. Waldby’s analytic, I contend, allows us to understand the “becoming-robot of the surgeon” as the *poiesis* of new human/technology interfaces. This ongoing creative process puts the stability of the categories human and machine at risk and out of sync, but does so with the promise of opening up the future to unforeseen possibilities for embodiment. I then began the work of mapping a “modest cartography of the present,” engaging specifically with the different futures that the becoming-robot of the surgeon might be opening up. The becoming-robot of the surgeon raises the promise and the nightmare of the automatic: the virtuosity of the machinic and the alienation of the automaton. The “problem of error” in medicine mobilizes both of these senses of the automatic and yet I suggest again that fallibility — of both human and machine — cannot be overcome. I conclude by returning yet again to an interface, the *da Vinci*® research interface and how it, too, participates in the biotechnogenesis of uncertain objects. These objects raise issues such as the “ownership” of gesture, the proliferation of new taxonomies of surgical skill and error (even at the microlevel of the myo-electric signatures produced by moving the human hand), and finally the potential “reversibility” of the surgical record, a playback that might signal the autonomous “becoming-surgeon of the robot.”

### **The Craft of Care**

What difference does this dissertation make, specifically for care? First, my case study focuses and sharpens the question of the technicity of care and advocates for exploring the

new modes of comportment that thinking about care with and through technology makes possible. I opened this dissertation in the operating rooms at University Hospital, a site of surgical pedagogy. There, I argued, teaching surgical technique depends upon a complex interplay of visibility and performativity, a particularly tight circuit of vision, performance-as-doing, and re-performance-as-display. Surgeons refer to this pedagogical mode as “See one, do one, teach one.” A consideration of the technicity of care affects several dynamics in the teaching OR. For example, it challenges the assumption that partitions “softer” considerations of care from the seemingly instrumental application of technique (particularly techniques of cure). Conceptions of care often play into the human-technology/care-cure division that my dissertation critiques. For example, in his essay, “A History of Caring in Medicine,” physician-scholar Joel Howell (2001) suggests that “care implies *caring*—listening, understanding, empathy, compassion, counseling, and providing emotional support” (77).<sup>4</sup> From this perspective, care represents all the activities that humans can do and machines (currently, at least) can’t. And when doctors and surgeons fail to be caring, they’re often criticized as “acting like a machine.” What my analysis presents, I believe, is a challenge for medical curriculums to interrogate the care/cure distinction, to understand how an attention to care can permeate even the teaching of the most mundane procedure or the most high-tech surgical maneuver. This is not a claim that “machines can care, too” but rather that care is nonetheless operative in and through our relations with technology. My hope is that this dissertation spurs more reflection on what forms care takes in its techno-mediated modalities. In part, in the context of the OR one can understand care at the surgeon-patient interface to center around the cultivation of a sense of *craftsmanship*. Like other craftsmen, surgeons often see the encroachment of technological “assistance” to their work as somehow diminishing of their craftsmanship (even though their work has always already been permeated with tools). However, theorizing care’s technicity suggests that that robotic surgery involves no simple abandonment of craftsmanship, that it is instead continuous with a long tradition of taking care in one’s technical work, a *careful* attention and tactile engagement with precious materiality (the tools, the vulnerable flesh of the patient, etc) and, yes, a *love* of its variability and nuance. Additionally, my own ethnographic

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<sup>4</sup> I would reference here as well Sandelowski’s (2000) explication of the tension between “true” and “technical” nursing and the increased friction that technology places on that tension. Clearly, the care/cure dichotomy connects in significant ways to gendered divisions of labor in medicine, as well as the economic and power relations among different medical professions.

research and interviews with surgeons at University Hospital suggest that they know that the *dVSS* is transforming their experienced relation with patients on the operating table (although they struggle to articulate exactly how) and yet they consistently characterize the *dVSS* as “just another tool.” As I’ve argued, this reductionism to “mere” instrument elides the affectivity of technology in intimate medical contexts and closes down on engagement with the particularities — the problems and possibilities — that new technologies inaugurate. Hopefully, my analysis provides contemporary surgeons with a means to articulate how their relationship with their patients and with their own embodied craft knowledge might be changing, and with what valence. This fluency seems all the more urgent at the contemporary moment, as politicians, corporations, medical professionals and patients alike grapple with imagining new health care systems that overcome the excessive costs and structural inequities of the current system. Understanding how, why and in what way technicity modulates care will be vitally important as proponents of new health care systems attempt to strike a balance between curbing the expenses associated with contemporary technomedicine while at the same time broadening access to the best techniques of care and cure. It is my contention that limits and possibilities of caring technicity should help shape struggles over the ownership and management of medical craft.

Second, and more broadly, I believe my study opens up the question of care to different disciplines, putting pedagogy, craft and discipline at the core of our understandings of care. My own approach to the *dVSS* as case study has attempted to weave together media studies and visual studies, cultural studies and computer science to understand the contexts of care in contemporary medicine. One might argue that my analysis of the command and control architecture of the *dVSS*’ haptics takes me beyond the proper domain of the humanities (or the equally plausible critique that as a humanist, I’m a poorly-equipped interlocutor in the disciplines of AI and robotics). However, I argue that the humanities, as the study of what it means to be human, must extend into territories previously left to scientists, technicians, computer scientists and engineers, for the future articulations of human and machine are going to stretch our capacities—our disciplinary tools and techniques—to make sense of humanity’s possible futures. In a more modest vein, while I’m not certain that my work will cathect such readers, implicit in my engagement with the *dVSS* haptic systems is a hope that robotics engineers might

pursue research agendas that intentionally seek to amplify the conditions of possibility for technologically-mediate care. I've suggested that the productivity of error and haptics might be crucial to such an agenda. What might it mean to build new medical and surgical instruments with an eye toward not only technical efficiency and patient safety, but toward enhancing the capacities for care, for human relationality with and through technology?

Finally, I see this dissertation as contributing to debates about the relation of making and craftsmanship more broadly to what it means to be human, and to humans' ethical and community orientations and obligations to each other and to the environments in which we live. This is manifested in Anne Balsamo's research on the growing importance of "tinkering" in the digital age (e.g. the DIY cultural movement with its emphasis on "thinkering") as well as Richard Sennett's recent calls for a reinvigoration of craftsmanship as a mode of citizenship (Balsamo, 2009; Sennett, 2008). I recently participated in a workshop on the future of the humanities and had the opportunity for extended conversation with the Executive Director of the Penland School of Crafts, Jean McLaughlin. I've long known about Penland; my wife in fact participated in a two week ceramics course at Penland early on in my graduate school years. Located in the Blue Ridge Mountains of North Carolina, the School has been characterized as a "sanctuary for the hand," and as such, has historically pursued a rigorously anti-modern ideology in relation to technology. Not all technology, of course, for crafts as diverse as woodworking and ceramics and bookmaking all rely on technology. But in keeping with its craft orientation, Penland has not only eschewed technologies of automation and mass production, but also media and communication technologies in particular. Opportunities for tele- and computationally mediated experience are seen as, if not antithetical, at least counterproductive to its commitment to engagement, immersion and retreat. However, Penland has recently begun to develop its computational and telecommunications resources. The School now has wireless internet, and many of the studios are equipped with computers to allow students easy access to online exhibitions of other artists work for inspiration. The transformation of photography from a chemical to a digital medium is also propelling Penland to consider the utility of digital labs. What struck me in these conversations were the parallels between the craft workshop and the OR, and the sense that telemediation necessarily alienates the hand from the material. McLaughlin's contributions to the workshop proposed a fundamental

relationship between embodied making and human being, and the need for the humanities to connect theory and practice. In a context seemingly vastly different from the high-tech world of contemporary surgical medicine, I find the flip side of robotic-surgical technique in Penland's passionate preserve of a "traditional" hand-tool-material relation: both craft practices fetishize the hand-tool relation, even as they pursue divergent investments in a technologized future. A future research project might explore how each context opens up the other, particularly in relation to key issues like the politics of touch and its mediation, and the relationship of craft and craftsmanship to care and connectivity.

### **Unfolding Care at the Interface**

What, then, is care at the interface? From the point of the view of biotechnogenesis, the "essence" of care is co-produced and unfolding. Care thus becomes a reality-effect of its performance. It is the image of the practices that precede it. In robot-assisted surgery, those practices are themselves proceduralized within a computational framework that positions the surgeon or "wetware" and the machine or "hardware" in a necessarily interdependent relation. The Object Oriented Programming paradigm accentuates the mode proper of the interface as an exposure or "bringing forth." Fundamentally that "bringing forth" puts the human and the technical into and out of phase with each other in very concrete ways: the triangular tension among the nature of the human, the nature of the technical, and the porous boundary between them sends care into a performative or auto-poetic mode. Following Waldby, this mode makes care a form of production that doesn't appeal to something outside the interface. It is not humanistically referential. *Care is immanent to the processes of biotechnogenesis.* In a way, it is automatic or partakes of automaticity. And yet it is not "boxed in" either. Waldby and others would suggest that to try to answer this question in any kind of final way would be antithetical to the provisionality of the bio-tech interface. Instead, I would rephrase the question: what might it mean to question care *ontogenetically*; that is, to consider care as a question of becoming, of how it *comes to be* (rather than as an ontological question of what care is)? In a sense, the ontological question is also the wrong frame given the embeddedness of error or fallibility in the machinic. "Care" necessarily falls back into the dynamic of failure I articulated at the end of chapter 3. The question "what is care?" requires one to answer it or to fail, as opposed to attending to the systemic productivity of ubiquitous failure and its emergence in

multiple, various, additional interfaces. In this latter sense, care emerges in post-humanist collaborative relation, of which the surgeon-robot assemblage is but one particular instance. Rather than a nostalgia for stability, the vision of care that threads its way through this dissertation leads to an expectation of a certain agonism at that relational interface, where increasing mediations and prosthetic extensions of care don't "sync" with our given notions of what it means to *take care* but are—nonetheless—relations in and through which we must learn to live and love.

## BIBLIOGRAPHY

- Abbott, J. J., Hager, G. D., & Okamura, A. M. (2003). Steady-Hand Teleoperation with Virtual Fixtures. *12th IEEE International Workshop on Robot and Human Interactive Communication (RO-MAN, 2003)*, 145-151. doi: 10.1.1.3.2178.
- Acland, C. R. (2007). Introduction: Residual Media. In C. R. Acland (Ed.), *Residual Media* (pp. xiii-xxvii). Minneapolis: University of Minnesota Press.
- Agamben, G. (2000). *Means without End: Notes on Politics*. Minneapolis: University Of Minnesota Press.
- Ahmed, S. (2006). *Queer Phenomenology: Orientations, Objects, Others*. Durham: Duke University Press.
- Ahmed, S., & Stacey, J. (Eds.). (2001). *Thinking Through the Skin*. New York: Routledge.
- Alt, C. (forthcoming). Objects of Our Affection: How Object-Orientation Made Computation a Medium. In E. Huhtamo & J. Parikka. (Eds.), *Media Archaeologies*. Berkeley: University of California Press.
- Anderson, S. (2008). Asimov's "Three Laws of Robotics" and Machine Metaethics. *AI & Society*, 22(4), 477-493. doi: 10.1007/s00146-007-0094-5.
- Attewell, P. (1990). What is Skill? *Work and Occupations*, 17(4), 422-448. doi: 10.1177/0730888490017004003.
- Balsamo, A. (2009, January 30). Videos and Frameworks for "Tinkering" in a Digital Age. *MacArthur Foundation Spotlight: Blogging the Field of Digital Media & Learning*. Retrieved June 20, 2009, from [http://spotlight.macfound.org/main/entry/anne\\_balsamo\\_tinkering\\_videos/](http://spotlight.macfound.org/main/entry/anne_balsamo_tinkering_videos/).
- Battersby, A. (1967). *Network Analysis For Planning and Scheduling*. London: Macmillan.
- Belling, C. F. (1998). Reading The Operation: Television, Realism, and the Possession of Medical Knowledge. *Literature and Medicine*, 17(1), 1-23.
- Benjamin, Walter. (1936/1968). The Work of Art in the Age of Mechanical Reproduction. In *Illuminations*. New York: Schocken Books.
- Bethea, B. T., Okamura, A., Kitagawa, M., Fitton, T. P., Cattaneo, S. M., Gott, V. L., et al. (2004). Application of Haptic Feedback to Robotic Surgery. *Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A*, 14(3), 191-195. doi: 10.1089/1092642041255441.
- Bhabha, H. (1994). *The Location of Culture*. New York: Routledge.
- Blass, E. (2006, May 19). Robot surgeon performs world's first unassisted operation. *Engadget*. Retrieved May 2, 2009, from <http://www.engadget.com/2006/05/19/robot-surgeon-performs-worlds-first-unassisted-operation/>.

- Bogost, I. (2007). *Persuasive Games: The Expressive Power of Videogames*. Cambridge, MA: MIT Press.
- Bogost, I., & Montfort, N. (2008). New Media as Material Constraint: An Introduction to Platform Studies. In E. Ennis et al. (Eds.) *Electronic Tectonics: Thinking at the Interface* (pp. 176-192). *Proceedings of the First International HASTAC Conference, April 19-21, 2007*. Lulu.com: <http://www.lulu.com/content/2124631/>
- Borden, L. S., Kozlowski, P. M., Porter, C. R., & Corman, J. M. (2007). Mechanical Failure Rate of da Vinci Robotic System. *The Canadian Journal of Urology*, 14(2), 3499-3501.
- Bousquet, M. (2003). *The Politics of Information*. Stanford, CA: AltX Press.
- Čapek, K. (1923). *R.U.R. (Rossum's Universal Robots)*. New York: S. French.
- Carey, J. (1989). *Communication as Culture : Essays on Media and Society*. Boston: Unwin Hyman.
- Cartwright, L. (1995). *Screening the Body: Tracing Medicine's Visual Culture*. Minneapolis: University of Minnesota Press.
- Casey, E. S. (1999). The Time of the Glance: Toward Becoming Otherwise. In E. Grosz (Ed.), *Becomings: Explorations in Time, Memory, and Futures* (pp. 79-97). Ithaca: Cornell University Press.
- Champion, H. R., Meglan, D. A., & Shair, E. K. (2008). Minimizing Surgical Error by Incorporating Objective Assessment into Surgical Education. *Journal of the American College of Surgeons*, 207(2), 284-291. doi: 10.1016/j.jamcollsurg.2008.02.038.
- Chun, W. (2006). *Control and Freedom: Power and Paranoia in the Age of Fiber Optics*. Cambridge MA: MIT Press.
- Cleaveland, P. (2005, November). Operating Room Robotics. *Medical Design Technology*. Retrieved December 24, 2008, from <http://www.mdtmag.com/scripts/ShowPR~PUBCODE~046~ACCT~0000100~ISSUE~0511~RELTYPE~PR~PRODCODE~4730~PRODLETT~B.asp>.
- Cohn, S. (2006). Seeing and Drawing: The Role of Play in Medical Imaging. In C. Grasseni (Ed.), *Skilled Visions: Between Apprenticeship and Standards* (pp. 91-105). New York: Berghahn Books.
- Cooke, M., Irby, D. M., Sullivan, W., & Ludmerer, K. M. (2006). American Medical Education: 100 Years after the Flexner Report. *New England Journal of Medicine*, 355(13), 1339-1344. doi: 10.1056/NEJMr055445.
- Cooper, R. A. (2008). The Coming Era of Too Few Physicians. *Bulletin of the American College of Surgeons*, 93(3), 11-8.

- Culjat, M., King, C., Franco, M., Bisley, J., Grundfest, W., & Dutson, E. (2008). Pneumatic Balloon Actuators for Tactile Feedback in Robotic Surgery. *Industrial Robot: An International Journal*, 35(5), 449 - 455. doi: 10.1108/01439910810893617.
- Cuschieri, A. (2003). Lest We Forget the Surgeon. *Surgical Innovation*, 10(3), 141-148. doi: 10.1177/107155170301000307.
- CyberKnife::How is the CyberKnife Unique? (n.d.). Retrieved May 3, 2009, from <http://www.cyberknife.com/cyberknife-overview/how-unique.aspx>.
- Da Vinci S robot II. (2009, February 10). *SurgRob: Surgical Robotics here and there*. Retrieved May 4, 2009, from <http://surgrob.blogspot.com/2009/02/da-vinci-s-robot-2.html>.
- Darzi, A., Smith, S., & Taffinder, N. (1999). Assessing Operative Skill. *BMJ*, 318(7188), 887-888.
- Deleuze, Gilles. 1988. *Foucault*. Minneapolis, MN: The University of Minnesota Press.
- DiMaio, S., & Hasser, C. (2008, July 22). The da Vinci Research Interface. *MIDAS Journal - Systems and Architectures for Computer Assisted Interventions (MICCAI 2008 Workshop)*. Retrieved April 20, 2009, from <http://hdl.handle.net/1926/1464>.
- Ditlea, S. (2000, November). RoboSurgeons. *Technology Review*. Retrieved December 25, 2008, from <http://www.technologyreview.com/biomedicine/12200/>.
- Dumit, J. (2004). *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton, NJ: Princeton University Press.
- Elble, R., & Koller, W. (1990). *Tremor*. Baltimore: Johns Hopkins University Press.
- Everett, A. (2002). The Revolution Will Be Digitized: Afrocentricity and the Digital Public Sphere. *Social Text*, 20(2\_71), 125-146.
- Ewing, D. R., Pigazzi, A., Wang, Y., & Ballantyne, G. H. (2004). Robots in the Operating Room: The History. *Surgical Innovation*, 11(2), 63-71. doi: 10.1177/107155170401100202.
- Firlik, K. (2006). *Another Day in the Frontal Lobe: A Brain Surgeon Exposes Life on the Inside*. New York: Random House.
- Foucault, M. (1979). *Discipline and Punish: The Birth of the Prison*. New York: Vintage Books.
- Foucault, M. (1986). Of Other Spaces. *diacritics*, 16(1): 22-27.
- Foucault, M. (1994). *The Birth of the Clinic: An Archaeology of Medical Perception*. New York: Vintage Books.
- Fox, N. J. (1997). Space, Sterility and Surgery: Circuits of Hygiene in the Operating Theatre. *Social Science & Medicine*, 45(5), 649-657. doi: 10.1016/S0277-9536(96)00381-4.

- Freidson, E. (1970). *Profession of Medicine: A Study of the Sociology of Applied Knowledge*. New York: Dodd Mead.
- Friedberg, A. (2006). *The Virtual Window: From Alberti to Microsoft*. Cambridge, MA: MIT Press.
- Friedman, L. D. (Ed.). (2004). *Cultural Sutures: Medicine and Media*. Durham, NC: Duke University Press.
- Gawande, A. (1998). When Machines Become Doctors, Will Doctors Become Machines? *Medical Economics*, 75(19), 144, 149-50, 153-5.
- Gawande, A. (2002). *Complications: A Surgeon's Notes on an Imperfect Science*. New York: Picador.
- Gitelman, L. (2006). *Always Already New: Media, History and the Data of Culture*. Cambridge, MA: MIT Press.
- Hagen, M., Meehan, J., Inan, I., & Morel, P. (2008). Visual Clues Act as a Substitute for Haptic Feedback in Robotic Surgery. *Surgical Endoscopy*, 22(6), 1505-1508. doi: 10.1007/s00464-007-9683-0.
- Hansen, M. (2006). *Bodies in Code: Interfaces with Digital Media*. London: Routledge.
- Hay, J., & Packer, J. (2004). Crossing the Media(-n): Auto-mobility, the Transported Self and Technologies of Freedom. In N. Couldry & A. McCarthy (Eds.), *MediaSpace: Place, Scale, and Culture in a Media Age*, (pp. 209-232). New York: Routledge.
- Hayles, N. K. (1993). The Seductions of Cyberspace. In V.A. Conley (Ed.), *Rethinking Technologies*, (pp. 173-190). Minneapolis, MN: The University of Minnesota Press.
- Heidegger, M. (1977). *The Question Concerning Technology and Other Essays*. New York: Harper & Row.
- Hirschauer, S. (1991). The Manufacture of Bodies in Surgery. *Social Studies of Science*, 21(2), 279-319.
- Howell, J.D. (2001). A History of Caring in Medicine. In Cluff, L. E., & Binstock, R. H. (Eds.), *The Lost Art of Caring: A Challenge to Health Professionals, Families, Communities, and Society*, (pp. 77-103). Baltimore: Johns Hopkins University Press.
- Ihde, D. (1991). *Instrumental Realism: The Interface Between Philosophy of Science and Philosophy of Technology*. Bloomington IN: Indiana University Press.
- Ihde, D. (2002). *Bodies in Technology*. Minneapolis: University of Minnesota Press.
- Institute of Medicine. (2000). *To Err Is Human: Building a Safer Health System*. National Academies Press.

- Interface, *n.* (1989). In *The Oxford English Dictionary* (2nd Ed.), OED Online. Retrieved March 22, 2009.
- Intuitive Surgical - Annual Report 2008. (n.d.). Retrieved April 4, 2009, from [http://media.corporate-ir.net/media\\_files/irol/12/122359/2008AnnualReport.pdf](http://media.corporate-ir.net/media_files/irol/12/122359/2008AnnualReport.pdf)
- Intuitive Surgical - daVinci S HD Surgical System. (n.d.). Retrieved March 20, 2009, from <http://www.intuitivesurgical.com/products/davincissurgicalsystem/index.aspx>
- Intuitive Surgical - EndoWrist Instruments. (n.d.). Retrieved May 2, 2009, from [http://www.intuitivesurgical.com/products/endowrist\\_instruments/index.aspx](http://www.intuitivesurgical.com/products/endowrist_instruments/index.aspx).
- Intuitive Surgical - Investor FAQ. (n.d.). Retrieved March 20, 2009, from <http://investor.intuitivesurgical.com/phoenix.zhtml?c=122359&p=irol-faq>
- Intuitive Surgical - Frequently Asked Questions. (n.d.). Retrieved March 20, 2009, from <http://www.intuitivesurgical.com/products/faq/index.aspx>.
- Intuitive Surgical Full Service Plan Features and Benefits. (n.d.) Retrieved April 24, 2009, from [http://www.intuitivesurgical.com/services/servicesupport/ISI\\_Service\\_Plan\\_Features\\_US\\_870031.pdf](http://www.intuitivesurgical.com/services/servicesupport/ISI_Service_Plan_Features_US_870031.pdf)
- Intuitive Surgical Q1 2009 Investor Presentation. (n.d.) Retrieved May 9, 2009, from <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9NTc2OHx0DaGlsZEIEPS0xfrFR5cGU9Mw==&t=1>
- Jackson, S. (2005). Performing Show and Tell: Disciplines of Visual Culture and Performance Studies. *Journal of Visual Culture*, 4(2), 163-177. doi: 10.1177/1470412905055050.
- Jauhar, S. (2008). *Intern: A Doctor's Initiation*. New York: Farrar, Straus and Giroux.
- Johnson, S. (1997). *Interface Culture: How New Technology Transforms the Way We Create and Communicate*. New York: Basic Books.
- Kapoor, A., Li, M., & Taylor, R. H. (2005). Spatial Motion Constraints for Robot Assisted Suturing Using Virtual Fixtures. In *Medical Image Computing and Computer-Assisted Intervention – MICCAI 2005* (pp. 89-96). Retrieved May 4, 2009, from [http://dx.doi.org/10.1007/11566489\\_12](http://dx.doi.org/10.1007/11566489_12).
- Karl, R. (2002). *Across the Red Line: Stories from the Surgical Life*. Philadelphia, PA: Temple University Press.
- Kember, S. (2006). Doing Technoscience as ('New') Media. In J. Curran & D. Morley (Eds.), *Media & Cultural Theory* (pp. 235-249). London: Routledge.
- Kirschenbaum, M. (2008). *Mechanisms: New Media and the Forensic Imagination*. Cambridge, MA: MIT Press.

- Kittler, F. (1995). There is No Software. *CTheory.net*. Retrieved May 8, 2009, from <http://www.ctheory.net/articles.aspx?id=74>.
- Kittler, F. 1999. *Gramophone, Film, Typewriter*. Stanford, CA: Stanford University Press.
- Lammer, C. (2002). Horizontal Cuts & Vertical Penetration: The 'Flesh and Blood' of Image Fabrication in the Operating Theaters of Interventional Radiology. *Cultural Studies*, 16(6), 833-847.
- Latour, B. (2004). How to Talk About the Body? The Normative Dimension of Science Studies. *Body & Society*, 10(2-3), 205-229. doi: 10.1177/1357034X04042943.
- Lenoir, T. (2002). The Virtual Surgeon: Operating on the Data in an Age of Medialization. In P. Thurtle & R. Mitchell (Eds.), *Semiotic Flesh: Information and the Human Body* (pp. 28-47). Seattle: Walter Chapin Simpson Center for the Humanities.
- Lenoir, T. (2004). The Shape of Things to Come: Surgery in the Age of Medialization. In L. D. Friedman (Ed.), *Cultural Sutures: Medicine and Media* (pp. 351-372). Durham, NC: Duke University Press.
- Leroi-Gourhan, A. (1993). *Gesture and Speech*. Cambridge, MA.: MIT Press.
- Lewis, M.A. (2007). Charles Babbage: Reclaiming an Operations Management Pioneer. *Journal of Operations Management*, 25(2), 248-259. doi: 10.1016/j.jom.2006.08.001.
- Lilly, J. (2005, July). Robotics in the Operating Room. *Progressive Engineer*. Retrieved May 3, 2009, from <http://www.progressiveengineer.com/PEWebBackissues2005/PEWeb%2064%20Jul%2005-2/Intuitive.htm>.
- Lotringer, S., & Virilio, P. (2005). *The Accident of Art*. New York: Semiotext(e).
- Mack, M.J. (2001). Minimally Invasive and Robotic Surgery. *JAMA*, 285(5), 568-572.
- Marks, L. 2002. *Touch: Sensuous Theory and Multisensory Media*. Minneapolis, MN: University of Minnesota Press.
- Marvin, C. (1990). *When Old Technologies Were New: Thinking About Electric Communication in the Late Nineteenth Century*. New York: Oxford University Press.
- McLean, T. R., & Torrance, A.W. (2008). Are the Brookhill-Wilk Patents Impediments to Market Growth in Cybersurgery? *The International Journal of Medical Robotics and Computer Assisted Surgery*, 4(1), 3-9. doi: 10.1002/rcs.176.
- McLuhan, M. (1962). *The Gutenberg Galaxy: The Making of Typographic Man*. Toronto: University of Toronto Press.
- McLuhan, M. (1994). *Understanding Media: The Extensions of Man*. Cambridge, MA: MIT Press.

- Mitchell, R. (2007). Vitality, Digitality, and the "Newness" of Media. Presented at *Code: The Twenty-First Annual Conference of the Society for Literature, Science, and the Arts*. Portland, ME: November 1.
- Mitchell, W. (2002). Showing Seeing: A Critique of Visual Culture. *Journal of Visual Culture*, 1(2), 165-181.
- Mol, A. (2002). *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.
- Moran, M. E. (2007). Rossum's Universal Robots: Not the Machines. *Journal of Endourology / Endourological Society*, 21(12), 1399-402. doi: 10.1089/end.2007.0104.
- Moreira, T. (2004). Surgical Monads: A Social Topology of the Operating Room. *Environment and Planning D: Society and Space*, 22(1), 53 – 69. doi: 10.1068/d320t.
- Morris-Suzuki, T. (1984). Robots and Capitalism. *New Left Review*, (147), 109-121.
- Morse, M. (1998). *Virtualities: Television, Media Art, and Cyberculture*. Bloomington, IN: Indiana University Press.
- Noë, A. (2004). *Action in Perception*. Cambridge, MA: MIT Press.
- Okamura, A.M. (2006). Robotics with a Human Touch: Haptics and Medical Applications, *Journal of the Robotics Society of Japan, Special Issue on Women in Robotics*, 24(5), 26-28.
- Packer, J. (2003). Disciplining Mobility: Governing and Safety. In J. Z. Bratich, J. Packer, & C. McCarthy (Eds.), *Foucault, Cultural Studies, and Governmentality* (pp. 135-161). Albany: State University of New York Press.
- Petkova, V. I., & Ehrsson, H. H. (2008). If I Were You: Perceptual Illusion of Body Swapping. *PLoS ONE*, 3(12), e3832. doi: 10.1371/journal.pone.0003832.
- Probyn, E. (1996). *Outside Belongings*. New York: Routledge.
- Rabinbach, A. (1990). *The Human Motor: Energy, Fatigue, and the Origins of Modernity*. New York: BasicBooks.
- Ravitch, M. (1987). *Second Thoughts of a Surgical Curmudgeon*. Chicago: Year Book Medical Publishers.
- Reiley, C. E., Akinbiyi, T., Burschka, D., Chang, D. C., Okamura, A. M., & Yuh, D. D. (2008). Effects of Visual Force Feedback on Robot-Assisted Surgical Task Performance. *The Journal of Thoracic and Cardiovascular Surgery*, 135(1), 196-202. doi: 10.1016/j.jtcvs.2007.08.043.
- Reiser, S. J. (1978). *Medicine and the Reign of Technology*. Cambridge/New York: Cambridge University Press.

- Reiser, S. J. (1993). Technology and the Use of the Senses in Twentieth-Century Medicine. In W. F. Bynum & R. Porter (Eds.), *Medicine and the Five Senses* (pp. 262-273). Cambridge/New York: Cambridge University Press.
- Richardson, I. (2003). *Telebodies & Televisions: Corporeality and Agency in Technoculture*. Ph.D, University of Western Sydney. Retrieved January 10, 2008, from <http://library.uws.edu.au/adt-NUWS/public/adt-NUWS20041101.172222/index.html>.
- Rose, N. (2007). *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*. Princeton, NJ: Princeton University Press.
- Ross, A. (1997). Introduction. In A. Ross (Ed.), *No Sweat: Fashion, Free Trade and the Rights of Garment Workers* (pp. 9-37). New York: Verso.
- Ross, A. (2002). The Uneven Development of Tactics. In A. Kumar (Ed.), *World Bank Literature* (pp. 99-110). Minneapolis: University of Minnesota Press.
- Rossel, B. (2008). *Le Théâtre des Opérations*. Produced by Pierre-André Thiébaud — PCT Cinéma Télévision (Switzerland). <http://www.leteatredesoperations.fr>
- Sandelowski, M. (2000). *Devices & Desires: Gender, Technology, and American Nursing*. Chapel Hill: University of North Carolina Press.
- Satava, R. M. (2001). Information Age Technologies for Surgeons: Overview. *World Journal of Surgery*, 25(11), 1408-1411. doi: 10.1007/s00268-001-0125-1.
- Satava, R. M., & Wolf, R. K. (2003). Disruptive Visions: Biosurgery. *Surgical Endoscopy*, 17(11), 1833-1836. doi: 10.1007/s00464-003-8168-z.
- Satava, R.M. (2007). Adapting to Future Technologies. In R.M. Satava, A. Gaspari, & N. Di Lorenzo (Eds.), *Emerging Technologies in Surgery* (pp. 155-161). Berlin & New York: Springer.
- Satava, R.M. (1998). *Cybersurgery: Advanced Technologies for Surgical Practice*. New York: Wiley-Liss.
- Saunders, B. (2006). CT Suite: Visual Apprenticeship in the Age of the Mechanical Viewbox. In C. Grasseni (Ed.), *Skilled Visions: Between Apprenticeship and Standards* (pp. 145-165). New York: Berghahn Books.
- Saunders, B. (2008). *CT Suite: The Work of Diagnosis in the Age of Noninvasive Cutting*. Durham, NC: Duke University Press.
- Sekula, A. (1986). The Body in the Archive. *October* 39: 1-64.
- Sennett, R. (2008). *The Craftsman*. New Haven: Yale University Press.
- Shevlin, F., McCullagh, B., Eadie, D., Navas-Herreros, M., & Rabaud, C. (2007). Stereoscopic 3-D

Acquisition, Processing, and Display for Telerobotic Applications. In *Advances in Telerobotics* (pp. 91-105). Retrieved March 25, 2009, from [http://dx.doi.org/10.1007/978-3-540-71364-7\\_7](http://dx.doi.org/10.1007/978-3-540-71364-7_7).

Shohat, E. (1998). 'Lasers for Ladies': Endo Discourse and the Inscription of Science. In P. Treichler, L. Cartwright, & C. Penley (Eds.), *The Visible Woman: Imaging Technologies, Gender, and Science* (pp. 240-270). New York: NYU Press.

Simondon, G. (1958/1980). *On the Mode of Existence of Technical Objects*. N. Mellamphy (Trans.). London, ON: University of Western Ontario.

Spigel, L. (1992). *Make Room for TV: Television and the Family Ideal in Postwar America*. Chicago: University of Chicago Press.

Starosielski, N. (2008). Reskinning the Digital Surface: Borders and Immobility at the Interface. In E. Ennis et al. (Eds.) *Electronic Techtonics: Thinking at the Interface* (pp. 34-40). *Proceedings of the First International HASTAC Conference, April 19-21, 2007*. Lulu.com: <http://www.lulu.com/content/2124631/>

Starr, P. (1982). *The Social Transformation of American Medicine*. New York: Basic Books.

Stefanidis, D., Scerbo, M.W., Sechrist, C., Mostafavi, A., & Heniford, B.T. (2008). Do Novices Display Automaticity During Simulator Training? *The American Journal of Surgery*, 195(2), 210-213.

Sterne, J. (2001). Mediate Auscultation, the Stethoscope, and the "Autopsy of the Living": Medicine's Acoustic Culture. *Journal of Medical Humanities*, 22(2), 115-136. doi: 10.1023/A:1009067628620.

Sterne, J. (2003). *The Audible Past: Cultural Origins of Sound Reproduction*. Durham NC: Duke University Press.

Taussig, M. 1992. *The Nervous System*. New York: Routledge.

Thomas, W.T. (1919). An Address on the Evolution of the Surgeon and on his Training: Delivered to the Liverpool Medical Institution. *British Medical Journal*, 2(3077), 803-806.

United Press International. (2006, May 19). Robot Carries Out Operation By Itself. Retrieved May 2, 2009, from <http://www.physorg.com/news67222790.html>.

van Dijck, J. (2001). Bodies Without Borders: The Endoscopic Gaze. *International Journal of Cultural Studies*, 4(2), 219-237.

van Dijck, J. (2005). *The Transparent Body: A Cultural Analysis of Medical Imaging*. Seattle: University of Washington Press.

Virilio, P. (1994). *The Vision Machine*. Bloomington, IN: Indiana University Press.

- Virilio, P. (2007). *The Original Accident*. Cambridge/Malden, MA: Polity.
- Von Neumann, J. (1951/1963). The General and Logical Theory of Automata. In A. Taub (Ed.), *John Von Neumann, Collected Works: Volume 5, Design of Computers, Theory of Automata and Numerical Analysis* (pp. 288-326). New York & Oxford: Pergamon Press.
- Waldby, C. (2000). *The Visible Human Project: Informatic Bodies and Posthuman Medicine*. London/New York: Routledge.
- Weber, S. (1996). *Mass Mediauras: Form, Technics, Media*. (A. Cholodenko, Ed.). Stanford, CA: Stanford University Press.
- Williams, R. (1973). Base and Superstructure in Marxist Theory. *New Left Review*, 82: 3-16.
- Williams, R. (1977). *Marxism and Literature*. New York: Oxford University Press.
- Williams, R. (2003). *Television: Technology and Cultural Form*. London: Routledge.
- Young, O. (2007, April 9). The Surgeon May Never Have to Touch His Patient. *New University*, 40(23). Retrieved January 2, 2009, from [http://www.newu.uci.edu/main/article?slug=the\\_surgeon\\_may\\_never31](http://www.newu.uci.edu/main/article?slug=the_surgeon_may_never31).
- Zetka, J. (2003). *Surgeons and the Scope*. Ithaca, NY: ILR Press.
- Zuboff, S. (1988). *In the Age of the Smart Machine: The Future of Work and Power*. New York: Basic Books.