Abstract
In this ethnography of a crime laboratory, I explore how criminalists do science in the public eye. In crime labs, criminalists work to discover the scientific “truth” in the evidence and also bring their conclusions into the legal system. Their daily work therefore brings together the institutions of law and science. For instance, the rise of DNA as the gold standard of forensic evidence has produced legal, scientific, and public scrutiny of the other forensic subfields, resulting in “DNA envy” within the forensic science community. DNA envy goes beyond status and jealousy; it has triggered debates about altering analytic and reporting practices. I analyze several such controversies that demonstrate the delicate balancing of epistemological signals and analysts’ values. Doing so shows how interactions of criminalists inside the laboratory, debates within professional societies, arguments in courtrooms, and scientific and public commentary on forensic science intertwine to change the practices of forensic science.
“Forensic evidence that has helped convict thousands of defendants for nearly a century is often the product of shoddy scientific practices that should be upgraded and standardized.” Solomon Moore, *New York Times*, February 5, 2009, p. A1

“Up next, it is the not so scientific world of forensic science… Our country’s forensic sciences ‘have serious problems and we need to overhaul the current structure.’” Ira Flatow, *Science Friday*, February 27, 2009

In February 2009, as I began fieldwork at Western County Crime Lab¹ (a pseudonym), the National Academy of Sciences released a report entitled, ‘*Strengthening Forensic Science in the United States: A Path Forward,*’ (National Research Council 2009) which called into question the scientific validity and standards of forensic science. The report noted that many jurisdictions do not require analyst certification or laboratory accreditation and indicated a lack of both standardized operational procedures and a scientific body of research on the measures, variability, and sources of bias for much of forensic science (National Research Council 2009: S12). Specifically, the report made frequent comparisons of other forensic science disciplines to forensic biology, excluding DNA from the criticisms that many disciplines lack a scientific basis and scientific validity, and suggesting that “with the exception of nuclear DNA analysis, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source” (National Research Council 2009: 7).

The report, and the resulting media attention, gave a strong impression that there was a problem with the scientific practice of forensic science, and generated calls to make forensic science more scientific. However, no scientific practice takes place in a vacuum, but is embedded in complex social structures. The practice of science, whether within the ivory tower, industry, or the government, melds the technical with the social

¹ The laboratory and all individual names are pseudonyms.
and political. For example, Hughes (1998) has shown how the major post WWII advances in science and technology were products of complex, mammoth projects involving revolutions in management and arrangements of multiple systems. Science is a social and political activity, both within its own boundaries as scientists enroll others in their projects (Latour 1987) and downstream, as scientists engage in boundary work to convince non-scientists of the power of their ideas (Gieryn 1999). Science therefore needs to be approached not as a pure independent technique, but as a “social problem” that is inseparable from social issues and social structures (Croissant and Restivo, 1995: 47).

Treating science as a social and organizational practice makes it critical to understand the work, occupations and institutions which structure the experience of its participants (Blumer 1969; Becker 1998). In this manuscript, I explore how public science is done in a context of evolving science, technology, and knowledge. I argue that the NAS report was a catalyzing event that instigated new conditions of possibility for the practice of forensic science, and I chart the activities of a set of forensic science communities in response to its release.

**The differentiation and coproduction of science and knowledge work**

We have become a knowledge economy in which information is considered a key to economic growth (Powell and Snellman 2004). This information revolution has technicized work, creating science, knowledge and technical occupations which require increasingly differentiated knowledge and skills (Barley 1996; Owen-Smith 2001). Science has also gotten ‘big,’ as reflected in increasingly multidisciplinary research laboratories and collaborations (Powell and Owen-Smith 1998, Jasanoff 1992). At the
same time, broad access to information has facilitated widespread availability of science, technical, and medical knowledge outside of universities, laboratories, and research and development facilities.

As science and technical work has permeated the economy, and information has become more available, science has lost some of its unilateral authority. Scientific findings are not only widely covered in the mass media (Chubin and Hackett 1990) but science is conducted in a complex institutional environment comprised of publicly constituted advisory boards and regulatory bodies (Jasanoff 1992, 1990; Hilgartner 2000), public and private foundation oversight (Guice 1998), and industry/university interpenetration (Owen-Smith 2003). While scholars once investigated the “public understanding of science” (Wynne 1995; Shinn and Whitley 1985) as a question of the public’s reception of scientific communication, they now characterize science and society as a “coproduction” in which technical and natural factors and social and political ones are thoroughly interpenetrated (Cooter and Pomfrey 1994; Reardon 2005; Jasanoff 2004; Morning 2008).

Similar dynamics also constitute the field of medicine, where Internet self-diagnosis has become commonplace, patients participate in their own diagnosis (Heritage and Maynard 2006; Rabiharisoa and Callon 2004), and well-informed activist consumers advocate for experimental treatment (Epstein 1995, 1996). In this context, Eyal (2013) notes that the term expertise attained wide usage in the late 1960s, at the same moment as professionals (especially in medicine) began to lose some of their dominance. Moreover, research and development in science and engineering is increasingly relying on public
participation for both detailed technical work and innovative activities (Levina, Fayard and Gkeredakis 2014; Lakhani, Lifshitz-Assaf and Tushman 2013).

Given the interpenetration and coproduction of science and society, some scholars have argued for a widening of our understanding of how we solve science and knowledge problems (Eyal 2013, Collins and Evans 2007). For instance, Eyal (2013) points out that medical problems are not merely fodder for jurisdicitional disputes between competing occupations (Abbott 1988), but are resolved through networks of expertise that link together agents, devices, concepts and institutional and spatial arrangements. He shows that in the wake of deinstitutionalization of mentally retarded children, alternative expertise was mobilized by parents of autistic children, changing and increasing diagnoses and widening treatment of autism.

Eyal’s approach is valuable because it asks what are the conditions of possibility under which a related set of problems and solutions develops, focusing not only on the institutional conditions, but also the political, material, and conceptual conditions that influence the “elaboration of consequential forms of knowledge and expertise” (2013: 899). However, I would argue that in order to understand the unfolding of organizational problems and solutions in an economy where laboratory workers represent the new shopfloor (Owen-Smith 2001), we also need to simultaneously examine the conditions of everyday work.

*Examining the everyday practice of science workers*

As Hughes (1984: 426) notes, accounting for forms of work requires not only the study of the “whole setting” in which work is done, but attention to the boundaries of those worlds and the “development of new definitions growing out of constant social
interaction and change.” Echoing this prescription, Barley and Kunda (2001) and Bechky (2011) suggest grounding our organizational analyses in an understanding of how work is done. Directing attention to the everyday practices of work enables a focus on action, interaction, and meaning.

Specifically, fleshing out Eyal’s notion of networks that assemble expertise with a grounded study of work suggests examining occupational communities to understand their members’ practices and interpretations of their work. Workers share knowledge and create meaning within an occupational milieu (Orr 1996; Bechky 2003a&b; Lave 1988). By looking at practical work activity within occupational communities, we become aware of how structures and interactions are both at play in creating order out of the messiness of organizational life (Becker 1995; Strauss et al 1964).

Moreover, in such communities, identities are built, affiliations cemented, and tastes made, all while the work gets done (Bechky 2011; Bourdieu 1984). Examining the social lives of work communities therefore enables us to uncover the concrete implications of occupational values. These values are intextricably intertwined with the material practices used by members of occupations to solve problems and justify their expertise (Anteby 2010; Fayard, Stigliani and Bechky 2014). Similarly, Galison (1999: 37) argues that science does not have “a strategy of inquiry (an epistemology) followed by a morally-based reception (ethics)” and therefore we should simultaneously embrace the moral, technical and epistemic aspects of science.

In this paper, I adopt such an approach to understand what happened when the rise of DNA as the gold standard of evidence triggered changes in practice across the forensic sciences. I describe how members of different subfields of forensics reacted to
the increasing salience of two epistemological aspects of evidence – visibility and verifiability – and show how these were embedded in their subcommunity values and ideals about judgment and control. Finally, I explore the key aspects of scientific and organizational practice that help differentiate how the effects of evolving knowledge emerged across these subcommunities.

Research context: The field of forensic science

Because forensic science is a field in which applied scientists provide evidence and conclusions for use in the justice system, it is an ideal place to study the implications of the evolution of science, technology and knowledge for public science. Forensics is located at the intersection of science and law, and therefore its practitioners face the pressure of creating hybrid facts that are recognizable and useful in both worlds. Moreover, forensic science was recently under the microscope itself when the public focused its attention on the NAS’s statement that forensics was “shabby” science. In my analysis, I treated this event as a catalyst that instigated new conditions of possibility for the practices of forensic science, following Eyal (2013).

The organizational structure of forensics in the United States is a patchwork quilt of multiple types of criminal justice agencies supervising crime laboratories in different locales. Public crime laboratories include FBI and ATF crime laboratories located throughout the US, state-run Department of Justice laboratories, and laboratories that report to local jurisdictions such as city police departments, Sherriff’s offices, and county District Attorney’s offices. These agencies control the budgets of the laboratories that report to them.2

2 In addition, there are small private forensic laboratories in some states.
The institutional order of forensic science is encapsulated by the motto of one professional organization of criminalists (another term for forensic scientists), “Fiat justitia per scientiam”: justice done through science. Crime laboratories are organizations in which criminalists, science workers with bachelors or masters degrees in biology, chemistry, and forensic science, analyze crime scene evidence and make judgments about what this evidence demonstrates which are used in legal proceedings. Unlike popular television images of the hybrid super-scientists/intrepid investigators shown on CSI or NCIS, forensic scientists rarely go out to crime scenes. They analyze evidence at the bench in the lab, write reports detailing their analyses and drawing conclusions, and testify to these reports in court as expert witnesses. As a part of their regular work, analysts in a crime laboratory interact not only with other forensic scientists, but also with attorneys, police officers and investigators, non-sworn evidence technicians, and judges and juries.

In addition to the system of legal organizations and the labs themselves, the field of forensic science includes universities such as John Jay College of Criminal Justice, George Washington University, UC Davis and others that offer masters degrees in forensic science. Forensic science is served by a number of professional associations, including the American Academy of Forensic Science (AAFS), which includes both academic and practitioner members, and holds a large annual meeting focused on research in the field. Laboratories have a national association as well, the American Society of Crime Laboratories/ Directors (ASCLD); its accreditation board certifies laboratories through audits and administers competency and proficiency testing for analysts. Criminalists in some states also have associations at the state level, which lab
personnel are encouraged to join, and these hold meetings and local training sessions hosted by specific laboratories.

Additionally, many subfields of forensic science have their own professional associations, including the International Association for Identification (representing fingerprint analysts), the Society of Forensic Toxicologists – American Board of Forensic Toxicology, The Association of Firearm and Tool Mark Examiners. The National Institute of Justice also supports Scientific Working Groups for many of the forensic subfields, including firearms and toolmarks, DNA analysis, toxicology, document examination, gunshot residue, and fire and explosives analysis which have boards that meet and decide on standards. Criminalists often subscribe to listservs associated with these groups, to keep abreast of developments in their particular field.

The two social worlds in which criminalists are embedded, science and law, are characterized by different but overlapping logics, norms, and practices. Perhaps not surprisingly, Merton’s (1973) norms of science (communality, universalism, distinterestedness, and organized skepticism) appear in many of the views expressed by analysts in the lab. Analysts commented on their own objectivity and neutrality as they pursued knowledge of the results of their cases, making comments such as: “I don’t have a horse in the race;” “It doesn’t matter to me what the results say.” Typical practices of bench science were evident in the daily work: validation of methods, cautious following of scientific protocols, and obsessive prevention of contamination (Barley and Bechky 1994).

The norms and practices of justice entailed working in the public interest, for a large county bureaucracy. Forensic analysts perceived legal norms as contrasting with
the neutrality of science. Rather than the scientific pursuit of ‘truth,’ law is about using evidence for ‘proof’ in an adversarial system. They claimed that “all the lawyers care about is winning,” and often worried about how their results would be represented in court. At a professional meeting, one criminalist reminded his colleagues, “However attorneys use the information, it is incumbent upon us to be scientists. We are the advocates for the evidence. Our mission should be to carry out good science regardless of the outcome.”

However, as Jasanoff (2005) notes, a more nuanced image of law and science takes into account the overlaps of the two worlds. Both are knowledge-building systems, albeit with different goals. Fact-making in law is about creating knowledge related to justice in a particular case, while in science it is about seeking truth detachable from where it was produced. Moreover, the practices of science were originally adopted from those of law, and in the case of forensic science, the parallels are clear. For instance, the accountability needed to pursue criminal justice is in sympathy with many scientific practices. Worrying about the chain of custody and carefully documenting every piece of evidence at all times dovetails with the meticulous scientific work of evidence analysis. In toxicology, for instance, the care and attention needed to keep track of which blood vial belongs to which suspect (as analysts move samples from the freezer to the GC/MS instrument) goes hand in hand with the care and attention needed to follow the scientific protocol explaining which standards to add to each vial and how long to rock the vials to break up blood clots. The similarities and differences between these two overlapping institutional systems create strains on the work of forensic scientists.

Research site and methods: Ethnography of Western County Crime Lab
The main ethnographic field work for this analysis took place from February 2009 through August 2010 in a crime laboratory in a Western State. Western County Crime Lab is one of the largest crime laboratories in the state, reporting to the District Attorney’s office in a major metropolitan area. I studied the four applied science units inside the laboratory – Forensic Biology (DNA), Controlled Substances, Toxicology, and Comparative Evidence. Forensic Biology comprised 18 criminalists, including 3 supervisors, and was the unit responsible for screening evidence for biological fluids and performing DNA analysis of those samples. This unit also managed and monitored the county’s contributions to the CODIS database of unknown profiles and profiles of known felons, which is used, for instance, to develop cold hits. Controlled Substances was made up of 8 criminalists including the supervisor who reviewed all of the narcotics cases. The remaining criminalists analyzed physical drug evidence and also performed comparative and trace evidence analysis. This included shoeprints and other comparative trace evidence such as duct tape, analysis of gunshot residue (GSR), fire debris analysis and pepper spray and dye pack analysis. Several were training to analyze glass and hair evidence.

The Toxicology unit comprised 9 toxicologists, including one supervisor, and the unit was responsible for analysis of drugs in the body. The DUI program for the county was also under this unit’s purview – they managed all the breath alcohol instruments in the police agencies and some members of the group were also certified to testify in court to alcohol and drug effects on the body. Finally, the comparative evidence unit, made up of 7 criminalists and a supervisor, was divided into two subunits: a three person latent fingerprint processing unit and a four person firearms and toolmarks unit. The print unit
did not perform fingerprint identification, but processed items for latent prints and took
digital photographs that were sent to requesting agencies for identification. The firearms
unit performed function testing of firearms, firearms identification, distance
determinations, and managed the IBIS database.

I spent three to six months in each unit doing participant observation three days a
week, although due to chain of custody concerns, I was more of an observer than a participant. I had access to most areas of the lab except the evidence lockers, but I was not allowed to touch any of the case evidence, which kept my participation to a minimum. However, I had opportunities to practice some forms of analysis. For instance, I processed my own indented writing, I ran my own buccal (cheek) swab through the entire DNA profiling sequence, and I test fired firearms both in the lab and at the Sheriff’s Range. I spend time with every analyst in each unit, many for multiple days, as well as every supervisor, as they all went about their regular duties in the lab (and on some occasions, in court). I attended unit, supervisor, and all-staff meetings as well as eight training sessions given by lab members to the agency populations, defense attorneys, and the District Attorney’s office.

Near the end of the fieldwork at Western County Lab, I interviewed a subset of analysts in each unit, as well as every supervisor and the director and deputy director of the lab. These semi-structured issues focused on career histories, experiences testifying in court, and controversies or changes in analytic practices. I also toured three other laboratories in the state, and interviewed the director of each of them (during failed attempts to get access to these labs as I began the project). After the field work at Western County Lab, I visited a county crime laboratory in an Eastern state, where I
interviewed the deputy director and spent the day observing the work of the DNA, comparative evidence and controlled substances units. Finally, I attended three professional meetings, including a three-day statewide criminalists meeting, a two-day statewide laboratory managers meeting, and a one-day local criminalists’ continuing education meeting.

The attention of the National Academy of Sciences to forensic science during my fieldwork provides a point of entry to understand the relationships between the professional subfields of forensic science, as it highlighted the differences between DNA analysis and other subcommunities of forensics. DNA has become the gold standard for forensic evidence, and this new status has resulted in what I call ‘DNA envy’ among the other subfields. The recent NAS report, by exempting DNA analysis from the criticisms it leveled at the rest of the forensic science field, heightened this sense of envy. The professional scrutiny engendered by the report has triggered controversies over analytic and reporting practices among members of some of the other subcommunities.

**DNA Envy and the Legitimacy of Forensic Science**

In the last decade, there has been a shift in the work within crime laboratories as technical advances in biology such as PCR have made it easier to analyze and interpret DNA evidence and DNA analysis has become an established investigative tool. As Lynch, Cole, McNally and Jordan (2009) show, after surviving court challenges, the methods used in forensic biology have become the gold standard of forensic science practice. The image of the scientific unassailability of DNA evidence is not only pervasive in the media (Toobin 2007), but also within the legal and criminal justice arenas (Saks and Koehler 2005).
DNA’s pride of place in the forensic science toolkit has altered the ecology of forensic science, prompting changes in how forensic evidence is perceived and evaluated. Of course, DNA is just as fallible as other forensic sciences (and other sciences in general). But the legal standing and the public belief in the scientific objectivity of this evidence has created fluctuations in the status order of forensic science. Below, I show how other forensic disciplines have encountered challenges to the legitimacy of their practices through comparisons to DNA analysis. I unpack the practices of creating and reporting DNA evidence and compare them with the practices of controlled substances, firearms, and toxicology. Exploring the responses of other subcommunities to the challenge raised by the standards of DNA analysis enables me to expose the tensions between science, law, and judgment that make a myriad of institutional pressures real for the work of forensic scientists.

Producing DNA evidence. DNA analysis begins with items of evidence (primarily clothing and swabs from bodies) that may contain biological fluids such as blood and semen. The analyst screens the items for fluids, taking a sample through cutting or rubbing, and extracts the DNA from the sample by chemically breaking down and washing the cells in the sample. Then, the analyst amplifies the DNA in the sample, isolating and copying particular regions of the DNA strands through the addition of enzymes and proteins and by putting it on a thermal cycler which heats and cools the sample multiple times, enabling copying of the segments (called STR fragments). A part of the sample is then loaded on an instrument that performs capillary electrophoresis, where the STR fragments are separated in a thin glass column, and the amounts of each
segment are detected. The amounts are converted and recorded as peaks on an electropherogram.

The analyst then identifies the peaks as the alleles for each locus, and creates a table of 16 loci to present in the final report as the DNA profile for that sample. This report, along with the analysts’ notes and the original files from the instrument, are then reviewed by a second analyst, who asks questions and suggests revisions before the report is sent to a supervisor for an administrative review and then released.

In court, the analyst presents these tables, along with her conclusion, which is often an attribution about the source of the DNA profile that refers to population statistics. For instance, the report could contain a conclusion such as, “The suspect is included as a
possible contributor to this DNA mixture. The probability that a person selected from the population at random would be included in the combination of alleles present in this mixture is: 1 in 260,000,000,000 in the Caucasian population.”

The graphs and tables created by DNA analysts produce an impression of scientific objectivity that other forensic disciplines lack, to varying degrees. With a DNA analysis, the (legal) parties involved can review the documentation (raw data and graphs) from the capillary electrophoresis and the tables created by the analyst – these become visible and verifiable scientific evidence. As sociologists of science have long known, much of the work of science entails the translation of the natural world into such inscriptions (Latour and Woolgar 1979; Lynch 1988). When creating documents and displays, scientists simplify the messy natural world, select particular aspects to represent, and “work methodically to expose, work with and perfect the specimen’s surface appearances to be congruent with graphic representation and mathematic analysis” (Lynch 1988: 218). This scientific translation role is often fulfilled by laboratory technicians and other non-PhD holding scientists (Barley and Bechky 1994; Shapin 1989).

Such inscriptions are used to convince other scientists and interested publics of the validity of results and the clout of science (Latour and Woolgar 1979; Fujimura 1988). Moreover, science studies scholars have demonstrated the power of visual representation in the courtroom, pointing to the importance of visual authority for convincing juries (Jasanoff 1998) and documenting the ways in which expert witnesses frame evidence. For instance, Goodwin (1994) shows how the use of coding schemes, material representations, and discursive frameworks transformed the vicious beating of
Rodney King into a series of rational escalations and de-escalations of force in response to an aggressor.

In the course of the last decade or so, as DNA evidence was challenged in the courts, the field of forensic biology established practices for representing evidence in ways that appeared credible, legitimate, and scientifically objective, as described above. DNA has become the new infallible standard of forensic evidence that other forensic disciplines feel pressure to emulate.

**DNA envy at multiple institutional levels.** One consequence of the privileged position granted to DNA evidence was a pervasive feeling of DNA envy within the professional world of forensic science. Within Western County Lab, the forensic biology unit, known as the “DNA princesses,” was envied for the resources they commanded. Members of other units often snarkily commented that more equipment, funding, grants and staff were available to this area than any other. Such resentment also appeared within forensics professional associations. For example, a group of trace examiners acted on their belief that DNA analysis was getting more than its fair share of attention and resources by forming a new national professional association, issuing a flyer that opened, “Since the wide scale application of DNA has taken hold of the forensic sciences, trace evidence examinations have taken a back seat.”

Beyond envy, the other forensic sciences have felt pressure to change their work practices. At a large annual professional meeting I attended, in a presentation on

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3 DNA analysis is messy and fallible, as all sciences are. While the tables and graphs look quite neat and impersonal, the process of producing a profile requires analysts to do multiple rounds of interpretation to create conclusions. Graphs are marred by stutter, imbalanced peaks, dropoff, and spikes, caused by technical issues with instruments and dirty and degraded DNA samples. Such anomalies, interpreted by analysts, get neated through the representation process (Jordan and Lynch 1998).

4 Forensic scientists recognize differences in their subfields both in the degree of scientific objectivity and the perception of scientific objectivity.
courtroom admissibility a firearms examiner repeatedly referred to how the National Academy of Sciences compared other disciplines to DNA, exclaiming “We can’t be like DNA, no matter how much they want us to be, it is just impossible!” The perceptions and responses of members of different subfields to this pressure highlights how work within different occupational communities influences change in a larger field. In the controlled substances area (also called the narco unit), there was a longstanding internal debate within the scientific community that was rekindled by the NAS’s indictment of the field. The firearms area suffered external criticism from the courts, the media, and academics, which challenged the science of firearms examination and made accusations of bias, causing examiners to reflect on their practices. Finally, in toxicology, the criticisms in the NAS report about measurement error were picked up by an enterprising defense attorney, and his successes in court challenges influenced the speed of change in their protocols for reporting results.

**Narco: The internal debate over convincing practice.** Among analysts in controlled substances, there was a debate between East and West Coast professionals around the use of crystal testing for identification. There are two scientifically valid ways of determining the identity of a drug – microcrystallography and GC/MS (gas chromatography/mass spectrometry). The older chemical method is microcrystallography, or crystal testing, in which a chemical reagent is added to a drug, causing crystalline precipitate to form. The size and shape of the crystals, as seen under a microscope, are characteristic of particular drugs. These tests can be performed in minutes: the preparation of the slide is straightforward and the crystals precipitate rapidly. Analysts examine the slide under the microscope as the crystals form, then the
slide becomes overcrowded and they dispose of it. They note the crystals’ distinct shape by both naming the shapes (as “feathery Ks,” “rabbit ears,” “clothespins,” “hockey sticks,” “daggers,” “3-D jacks”) and drawing a picture of what they see.

![Image of crystalline structure of cocaine – called “daggers” (downloaded from dps.alaska.gov).](image)

In GC/MS a drug is put into a solvent and processed through the instrument, creating a graph. The Gas Chromatograph separates the mixture’s components, and then the Mass Spectrometer hits the material with a beam of high-energy electrons, which creates positively charged ions that decompose into fragments. Under these conditions, no two substances create the same fragmentation pattern. Both the retention time from the GC and the ion spectrum from the MS are recorded as output graphs from the instrument. The instrument includes a library of retention times and ion spectra of known substances, and the sample is then matched against the drug library and a sample of the known substance. Unlike the impermanent and fleeting crystal test, GC/MS instruments produce documentation and raw data that is visible and verifiable.
In the Western US, analysts typically used crystal testing for most controlled substances, relying on GC/MS for “unknowns” and a few drugs that were not identifiable by their crystals. In contrast, in the Eastern US, GC/MS was the method of first choice for identifying controlled substances. While the narcotics analysis community agreed that both methods were scientifically valid, there was an internal debate within the community about the use of crystal tests. In Western County Crime Lab, analysts were concerned that the outcome of this debate might lean toward the certification body prohibiting crystal tests, because East Coast analysts preferred instrumentation, and they were felt to be overly represented on the board of their scientific working group. In the analysts’ reactions to this debate, we can see how issues of visibility and verifiability contrasted with the analysts’ values of efficiency, autonomy and judgment.

*Visibility of crystal tests.* Visibility was considered an important epistemological aspect of producing drug evidence. The analysts drew a picture of what they saw under the microscope, and as one controlled substances analyst noted, “in the report, we
describe what we see, we don’t just say ‘this is meth.’” Additionally, the analysts in the lab had been discussing whether or not the lab might purchase digital cameras for their microscopes. This was not an inexpensive option, although as one of the analysts pointed out, it would be a lot cheaper than purchasing additional GC/MS instruments for all of the analysts.

*Verification of crystal tests.* Because crystal tests provided “less certainty” than the chemical profile produced by the GC/MS instrument, the guidelines of the scientific working group (SWG-DRUG) already required that two tests be performed on each sample, using different solvents. Current practice, therefore, was to provide verification of the results of the first crystal test with a second, different crystal test. There were also some discussions within SWG-DRUG about requiring that a second analyst visually review the crystals. This would be time consuming, because crystals form very rapidly, so a second analyst would have to perform a duplicate set of crystal tests from scratch, doubling the time the analysis took.

*Subcommunity values: Efficiency, autonomy and judgment in drug identification*

Potential changes such as purchasing additional equipment for analysis, digital imaging, or verifying visually by another analyst were considered by lab members to be costly and time consuming. For instance, crystal tests take about 5 minutes per sample while GC/MS analysis takes an hour. Because the law allows limited time for charging suspects in narcotics cases, the narcotics analysts were under enormous time pressure to report their results. They strongly valued efficiency in processing cases, to the extent that

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5 This is particularly relevant given the recent Supreme Court case (*Melendez-Diaz v. Massachusetts*, 557 U.S. 305 (2009)) which ruled that such blanket report certificates (used in a different US state) violated defendants’ sixth amendment rights.

6 I was unable to see some forms of microcrystals in the lab because I couldn’t get my eyes onto the scope before they overcrowded the slide.
at least one or two analysts clocked themselves on “typical” cases (which, in Western Lab, tended to be methamphetamine cases).

More troubling to the analysts, however, was the loss in autonomy and control over the work implied by a move to instrumentation. The work of analyzing controlled substances through GC/MS was seen as simple and requiring less judgment. David, one of the analysts in the narco unit, explained, “On the East Coast, the instruments are there and ready to go, just dilute and shoot. Any schmo from the street can do it, just let them on the instrument. With crystal tests, we have to validate [the procedure] and train people to do crystals.” Such training entailed coursework in which novices worked side by side with experienced analysts on specially equipped microscopes in order to identify the crystalline forms properly. Potential changes to their current practice threatened the analysts’ sense of craft training and judgment.

**Firearms: External pressure to become more scientifically valid.** In the case of firearms examination, external influences had been pushing the discipline to change. Firearms examination, a type of toolmark analysis, is a comparative evidence discipline. Comparative evidence subdisciplines bore the brunt of the public criticism as a result of the publication of the NAS report in 2009. In the media and the courts, the predominant sentiment expressed has been concern that there is no scientific basis for a “match” of the evidence in these areas. As Mike, an analyst in a different unit noted, “The rap on toolmarks is, ‘You guys should be like DNA. Why can’t you be like DNA? We like DNA!’” (emphasis his). Pressure came not only from the media, which reported widely on the NAS report, but from court cases in which defense attorneys were increasingly trying to exclude firearms testimony from consideration. Firearms examiners were being
attacked on the stand in court, where their credibility as expert witnesses was questioned, and academics were filing briefs claiming that their analysis was not scientific.

At a state criminalists meeting I attended, some examiners responded defensively to these attacks by critiquing the critics, challenging them because they lacked training as firearms examiners. One speaker presented photos of academic critics, listing their affiliations and calling out notable participation in courtroom activities (i.e. “he was the first one to come out against us,”) and noting that it is hard to testify in these cases, “especially when it is you going up against a report with 20 PhDs on it.” Others used these critiques to call for an examination of practice with an emphasis on bias and objectivity. One examiner presented what he learned from his experience with defense attorneys questioning his testimony in court. Before discussing how examiners might guard against bias in their identifications, he pointed out, “It is easy for us to point fingers at these critics and say ‘They don’t know how to do firearms examination.’ But they are basing their critiques on our own testimony, and it is up to us to be more convincing…. Sometimes motivation for change comes from the outside. They are giving us a good kick in the pants to motivate us.”

DNA envy, heightened by pressure from the media and the legal system, and intensified through interactions with colleagues in professional associations, was reflected in competing practices inside the firearms lab. For instance, one common type of examination in the firearms unit was to match the bullets and cartridge cases found at a crime scene to a gun found on a suspect or at the scene. In this type of comparison, the examiner test fired the gun in the range at the lab, and collected the bullets and cases. When a gun is fired, the tool creates microscopic marks on the bullets and cartridge cases
from the lands and grooves in the barrel and the other mechanical parts of the gun such as the firing pin. The examiners used a comparison microscope to compare the microscopic marks (called striae) found on the test fires to the striae on the bullets and cartridge cases found at the scene.

![Figure 4](downloaded from Michigan.gov)

A method had been developed in the firearms community to quantify these identifications. Called CMS, this method required examiners to count consecutively matching striae. The threshold number of striae was based on a statistical analysis of “best known non-matches” from guns from the same manufacturer. There was a set of heuristics for CMS, such as “you need two groups of three consecutive striae within the firing pin impression” before you can identify a match. In Western County Crime Lab, none of the three qualified examiners used CMS regularly to identify a match. They were all trained in and conversant with the CMS rules, but did not believe these rules were as conservative as their own judgments. However, they recognized the appeal of CMS to outsiders. As Tom, a Western County examiner, noted, “Some people like CMS, because numbers are easy to understand. They are universal; everyone knows what you mean.”

*Visibility in firearms identification.* Increasingly, firearms examiners have accepted that visibility is an important epistemological aspect of firearms identification.
Several firearms examiners pointed out this change: “We used to say, ‘I know a toolmark when I see it,’” and “I know it like my mother’s face.” This was no longer acceptable for reports or testimony, as one examiner explained. “We can’t do that anymore. Now we have to document. In today’s lab, you better have the images to back it up.” Examiners created detailed note packets as they progressed through their comparisons over the course of several days, recording digital images of every set of matching (or not matching) striae, including those from the firing pin impression, extractor marks, and chamber marks. As Adam, an experienced examiner, told me, “You want the note packet to support [your judgment] on the stand. Multiple outsiders have seen my work, reviewed it, and it has never been challenged.”

Verification in firearms identification. Unlike in the narcotics unit, where a second set of analyst reviews of identification was under initial discussion, in the firearms unit a second examiner already followed the first through every step of a firearms comparison, looking through the microscope at each set of striae. This examiner signed off on every page of documentation, verifying his agreement with the first examiner’s assessment. The process was called a technical review, but in practice resembled a communal judgment made through a back and forth dialogue between the examiners. This dialogue was not only about the particulars of a set of striae, but also about how to create an image that would be more convincing.

For instance, Tom was the second examiner on an identification that Adam was working on, and he came over to look at the striae on the firing pin impression. Tom adjusted the microscope, reversing the image of the firing pin to a different angle. Adam, looking at it on the screen, said, “I looked at it that way, and it is not as good, go back to
the way you just had it. It is a challenge to image it, maybe adjust the light.” Tom flipped it and pointed at a set of lines on the image on the screen. Adam said, “We’re at 40x [magnification], you can see it better, there’s a whole section of agreement, light and dark, you can see a whole set of them.” Tom replied, “Too bad you can’t rotate it more, get light in from the side.” Adam said that he wanted to image it first, and then saved these image of these two places to his notes as FPI (firing pin impression) 2 and 3.

Tom then told Adam, “You are almost right there for identification.” Adam disagreed: “I think it’s an identification already.” Earlier that day, Tom had told me that examiners can have slightly different standards for identification, but as long as they agree on the conclusions, he was comfortable with it. Now, he pointed out to me, “See, Beth? I might do one more picture; he is comfortable already.” Adam elaborated, “I don’t believe it is random agreement at this point. You want me to do one more?” Tom suggested that he look at the chamber marks, and he said that he planned to continue to that next.

Tom then said, “I might turn it first and adjust the lights.” He rotated the image and shined the light in a different direction, but Adam was worried about the contrast, and also adjusted the light a bit. At this point, Tom decided that this new image was not any better than the prior two images that Adam already took. When he mentioned this to Adam, Adam replied, “I think those marks are too fine. Let me move on to the extractor.” Tom, moving away, said, “I’m happy with this, and you probably will have extractor and chamber marks too.” Adam finished, “I’m happy with the images I took. I’m moving on to the extractor, I will call you over then.” This joint work, which was typical of the way examination and review happened in the firearms lab, incorporated
both the examiners’ judgment of the striae and their interest in creating the clearest and most convincing images for the notes on the case, making the evidence visible and verifying it.

**Subcommunity values: Holism, subjective judgment and autonomy in firearms identification.** The tension between creating “objective” evidence that was more mathematized (Lynch 1988) and using their expert judgment manifested when the examiners talked about different methods of identification. The examiners at Western County Crime Lab were not fans of CMS, and spoke of it somewhat derisively. They were all trained in the method, but none of them used it regularly in their examination and testimony. Tom styled CMS as “more of a tool that I might use when I’m on the fence, when my criteria is borderline. I’m actually more conservative than CMS. I don’t go to it immediately.” Adam described how examiners in other labs used CMS for testifying: “Some people physically write on their notes, they’ll mark up a group of 7 [striae], write next to it in a silver pen on the image, “times 7.” They think this makes them more objective than me. But [firearms] is a subjective discipline. It is the totality of the mark I am looking at… There are a million factors that create the image, and it comes down to the subjective opinion of the examiner.” Western County firearms examiners valued their pattern recognition abilities, holistic training, and experience, and chafed at the notion that identification could be objectified through standardized heuristics.

**Toxicology: Potential legal challenges speed changes in practice**

Forensic toxicologists detect and identify drugs and poisons in body fluids, tissues and organs. The toxicology unit at Western County Lab received multiple boxes of samples of blood and urine to test for drugs in the body, and each analyst was assigned to
an instrument and downloaded a computerized list of cases to analyze for a particular class of drug each day. The challenge to toxicologists’ practice revolved around the reporting of blood alcohol analysis (called BAC). Blood alcohol analysis was done through gas chromatography, which separates alcohol from other volatiles in the blood, and compares the alcohol peak to ones obtained with known blood alcohol standards. The toxicologists’ work consisted of preparing the samples to be analyzed on the instrument, loading and starting the instrument, making sure the instrument worked properly, and checking the results of the analyses.

For instance, one morning Jason had a set of 40 blood alcohol cases on the computer list when he arrived. He handled these in a batch on the instrument. First, he printed out the list, and created a sequence list for the instrument. Then he pulled the appropriate boxes out of the refrigerator and found the samples, placing them in a rack in the order they appeared on the list. He labeled all the vials with his initials and date, and put them on an instrument to rock them, ensuring that there were no clots when he drew the sample for the instrument (the collected samples all contain anticoagulant but rocking is a standard practice in toxicology labs). While they were rocking, he set up the instrument, checking on the sequence list and choosing the appropriate method for blood alcohol. He then drew samples and added an internal standard (n-propanol), using a mechanized pipette to draw both together and put a small bit in each small vial in a tray. He did the same for the quality controls and the acetone markers, the results of which tell the analyst if the instrument functions the same throughout the run and distinguishes between alcohol and acetone. In between each sample, he wiped the pipette clean, and after the tray was finished, he sealed all the vials and loaded them into the instrument.
(checking the vial numbers against the list again). He started the run, which would take about 5 hours.

The next day, he conveyed the gas chromatography results from the instrument to the lab’s computerized report system, printed and checked the 100 page report both for sample accuracy and to make sure the instrument performed correctly (noting internal standards and retention times) and transferred his written information about the standards and instruments to a log the lab kept for traceability purposes. Afterward, another analyst would download the report and review the results, attach a review checklist, and send the packet to the supervisor, who would release the results to the DA’s office.

My first day in the toxicology lab, the analysts joked with me that they were the “OCD unit”: the most important aspect of their job was making sure that they were matching the correct samples to the individuals on the list. Every step taken in the analysis process was checked off on this list as the toxicologist looked at the labels on the vials, and made new matching labels as samples were moved from place to place and the original vials were finally replaced in their boxes. As Jason said, “Occasionally you get a normal person in toxicology and they annoy the rest of us by not putting things back in the right place or forgetting to label something.”

With the release of the NAS report in 2009, attention was drawn to laboratory error, and in particular, to measurement error. Western County Lab was already adjusting their practices and protocols to conform to ISO17025, a set of general laboratory standards recommended by ASCLD for future lab accreditation. The toxicology unit was revising their protocols in accordance with ISO, and one requirement was the creation of a 3 year plan to “apply procedures for estimating uncertainty of
measurement.” The analysts had already developed this plan, and then heard that a
defense attorney handling a case in their jurisdiction had hired an expert witness with
plans to attack them on the basis of a lack of reported measurement error. Therefore they
implemented their plan immediately, rather than over the three years required for
accreditation.

*Visibility in Blood Alcohol analysis.* The reports on individual cases of BAC were
not lengthy, but included comparisons to standards, and the notes on the report contained
identification and dates of standards as well as instrument information. The analysis was
instrumental and standardized, and the parties in the legal system were very familiar with
the structure of the report. Although some sources of potential measurement error were
traced by the lab, these aspects of the analytic process were not visible in the report.

*Verification in Blood Alcohol analysis.* The invisibility of sources of
measurement error in the report, however, did not mean that the lab was neither aware
nor concerned about uncertainty of measurement. The BAC protocol already required
that they trace the instruments, reagents, and standards in a log. The state law required
that BAC measurements had a confidence interval of +/- 5%, and that was also the
ASCLD requirement, so the lab had been reporting results at the 95% confidence level.
With the move to ISO, they were preparing to accurately measure and report out the
uncertainty of measurement on the basis of the protocols they had already been using.

The NAS report noted that “the assessment of the accuracy of the conclusions
from forensic analyses and the estimation of relevant error rates are key components of
the mission of forensic science” (National Research Council, 2009: 106). However, the
report barely mentioned toxicology as a forensic discipline, and did not criticize
toxicological analysis at all. As Jason, one toxicologist, noted in an outreach session for the law enforcement community, “I’ve heard lots of defense attorneys say that labs are scrambling to put in uncertainty due to the NAS report. This is not true, we were already doing it… uncertainty of measurement is not just spurred by NAS, it is called out in many documents in scientific fields, it is scientifically known.” He presented several slides of citations from these documents, adding, “It is being addressed in other places [related to forensic science] such as ISO 17205 and NIST 1297 sec 2.1.”

He also explained that uncertainty measurement was based on historical data that the lab had already been collecting since they updated their protocol over 5 years ago. “So the instrument is the same instrument we’ve been using for 5 years, and our method hasn’t changed…. We average out our quality control data, and we not only use that historical data, but go through every step of the procedure and assess it for uncertainty. If you use glassware, or pipettes, every piece of equipment, the reagents, all are assessed for uncertainty. We quantify them, normalize them, and then combine and express them together.” He also described the idea of traceability, in which the analysts connected the laboratory measurements to NIST standards, such as the weights they used to calibrate their balances.

Subcommunity values: Error-free blood alcohol analysis. The changes the toxicology unit had made to their reporting procedures to include measurement error, while indirectly related to the NAS report and the professional accreditation process, were instigated by a particular court case. A defense attorney had been winning cases in other states by questioning laboratories’ omission of measurement error, and was training and encouraging other defense attorneys and experts across the country to do the same.
In Western Crime Lab, a specific case in their jurisdiction arose in which the defense attorney was planning to challenge the toxicology results on this basis, and call an engineering expert from one of these other states. The toxicologist who performed the analysis and the unit supervisor put together the procedure and statistical analysis in order to prepare for his testimony.

In their presentation to the legal community, the toxicologists were clearly proud of their new practice of reporting measurement error. They were now able to report out a measure of BAC (the maximum allowable BAC is .08) with a range of +/- .003 and a confidence interval of 99%. The “OCD” unit had always been concerned that they make no errors, and thus the new practices were consistent with their subcultural values. Moreover, the process of changing their protocols was challenging and put the laboratory on the cutting edge of statewide practice. As Jason joked with the defense attorneys at the end of his presentation, “You all have great questions. I don’t want to see you in court! I’ll email you with the jurisdictions that haven’t done uncertainty measurement yet. Western County is kind of leading the state. So try your luck, bring it!” Their pride at developing a leading edge protocol also reflected the increased autonomy that the project demanded from the analysts, which contrasted with the repetitive practices of their daily work.

**Discussion: Controversies Compared**

Examining the controversies generated in response to the challenge of DNA envy enables us to see the relationships between the institutional arrangements of science and law and the work practices of forensic science. Changes within forensic science were being driven by media attention, the legal system, professional debates and the work of
particular subfields. These pressures were filtered through the occupational communities of the criminalists, as analysts evaluated their work practices in terms of the relevant epistemology, technique and morality.

Both science and law are matters of concern to analysts – the practices that turn the products of their work into evidence take the results of science and make them meaningful and convincing in a courtroom. For instance, firearms examiners spent much of their time creating images to support their judgments in court (one mentioned to me, “I’ve become an excellent photographer since starting this job”). In toxicology, Jason noted that although “we know all about uncertainty in science already,” the lab was responding to the legal pressures to provide measures of this uncertainty. The importance of legal concerns was also evident in the narcotics crystal test debate, which turned not at all on the science of the analysis: the analysts agreed that all of the practices constituted “good science.” Instead, the debate in the lab focused on how to change practices so that the science appeared to be more scientific to outside members of their institutional communities while maintaining their quick turnaround practice.

Balancing scientific and legal concerns was a concern shared by the entire field of forensic science. These concerns were construed within forensic scientists’ experience of their everyday work – in all cases the analysts were interested in maintaining or increasing their judgment and autonomy. The ways in which firearms examiners, toxicologists, and narcotics analysts were discussing and changing their practices reflect the interpenetration of epistemic and technical aspects of visibility and verifiability with subcommunity values and demonstrate how external institutional conceptions of ‘objective’ scientific evidence were drawn into lab practice. None of the groups wanted
their judgment removed from the analytic process, but all could see the value of presenting evidence that looked “more like DNA” evidence in its visibility and verifiability. Within all the communities in Western County Lab, there was a sense of inevitability around these issues – analysts believed that all of forensic science was moving in this direction.

This is not to claim, however, that technological change in the form of the particular epistemological characteristics of DNA analysis explains the evolution of forensic science practice. Past evidentiary analyses have been considered the “gold standard” of forensics; most notably fingerprint analysis, as Cole (2001) has documented, but even dust captured the imagination of past practitioners of forensics science (Burney 2013). DNA analysis is merely the current favorite, offering a set of justifications which other practitioners could evaluate in terms of their technical, epistemological and moral constraints.

This analysis, however, suggests several possibly important dimensions influencing change in forensic practice: the degree of interpretation involved in their technical assessments, how much courtroom work each group performed, and the immediacy of the challenge to their regular work. These dimensions illustrate the value of investigating work communities, and point to issues deserving further investigation when thinking about the evolution of knowledge work.

*Degree of (perceived) interpretation.* The subdisciplines of forensic science developed at different times and places and, as a consequence, varied in their technical characteristics. For instance, as noted earlier, the debate among narcotics analysts was one of evolving scientific practice. External publics saw the GC/MS procedure as more
objective and modern than crystal testing. For instance, during the time of my fieldwork, a narcotics lab in California came under media scrutiny for drug theft and poor management, and the news reports labeled the crystal tests performed in this lab as “outdated tests” that produced “telltale crystal patterns” in contrast to the “sophisticated drug analysis instruments” the lab should have been using (Van Derbeken 2010).

This news story evokes competing images of forensic analysis as subjective craft or objective science: “telltale patterns” are opposed to “sophisticated instruments.” While all the patterns of forensic analysis require analysts to interpret them (including DNA results), instrumentation, by objectifying the results, is perceived as requiring less personal judgment and susceptibility to bias (see also Porter 1995). With DNA reports, the mediator between the evidence and the jury was removed through the analysts’ graphical representations of the results – the tables and the probabilities took the person out of the judgment. The same was true in toxicology, where the analysis was already fully instrumented and the reports were then made more probabilistic with the addition of measurement error. This was less true of narcotics reports, in which the analysts drew the crystal patterns freehand and gave them descriptive labels. And it was even less true in firearms examinations, in which the examiners touted their holistic judgment and subjective opinion of the mark. Knowing something “like your mother’s face” was likely to be perceived as even more subjective and personal than a drawing.

The difference in degrees and types of interpretation of the forensic sciences was not only noted by the public, but by the criminalists themselves. While all of the subdisciplines of forensic science required the analysts’ interpretation in order to make judgments about the evidence, these judgments reflected varying levels of “scientific
objectivity” in terms of both technique and perception. For instance, Tim, a lab supervisor, responded to my question about the NAS report’s criticisms of forensic science by saying:

There are differences. Having somebody put a mysterious off-white powder onto an instrument, say the IR [infrared spectrometer], and it comes back as cocaine base. A thousand people could test that same sample, and they sure as heck better all get cocaine base. There’s no room for negotiation. There’s no room for doubt, or interpretation, or even discussion. Versus, I’m going to put it at the other end of the spectrum, bite mark interpretation, which I think most genuine forensic scientists are a little hesitant about, but there is still a forensic Odontology section of the American Academy. Our lab director thinks QD [questioned documents] is voodoo?!? Wow. Bite marks, way out there. Earology? There are some folks in California working on that!

So, how many points does it take for a fingerprint? How many matching, consecutive matching, for firearms to match? How many similarities in questioned documents? How many points on a shoe, until you can say that shoe and only that shoe? These are different parts of forensics than DNA, which has a classic sort of a, “Hey, we can put numbers on it.” But, I think even the DNA folks make certain assumptions. And (when you talked about) the biggest task for them is deciding which way to count the statistics; I mean that has a certain subjectivity to it, in its own right. So while DNA is the gold standard in forensic science, I’m not convinced that all of those statistics are as accurate as they would like you to believe.

I think they will never be equal. They can’t be. The idea that somebody can do toxicology and say there’s five milligrams per liter, or something like that, I mean that’s sort of a hard science, the same thing with chemistry. But then, you get into something like hairs. Wow. Do I believe in hair comparison? Yeah, as long as it’s taken in context. I think all of these things need to be taken in context.

Differences in the degree of interpretation created different perceptions of scientific objectivity across the subdisciplines, which could be seen in these three examples. In the media and the larger scientific community as represented by the NAS, firearms was perceived one of the least objective and scientific disciplines, with attendant concerns about bias and error. These differences echo the distinction between
mechanical objectivity and trained judgment in the sciences (Daston and Galison 2007; Porter 1995); should judgments be made by an impartial person (or computer) that follows rules or by a trained expert? In the case of forensics, our justice system seems to prefer rule following (Lynch et al. 2009).

This difference was also historically contingent, because firearms and fingerprint analysis were older forensic sciences, and their practitioners had qualified as experts in court at a time when they could claim expertise through experience rather than through representations of statistics. So for firearms examiners, accustomed to holistic judgments and “calling it like I see it,” having their evidence challenged in court was a new experience. Porter (1995) argues that “trust in numbers,” or a reliance on mechanical objectivity, is a standard of credibility that is relied upon in times of challenge; when disciplines are socially strong, they advance the ideal of trained expert judgment. In the case of forensics, the rise of DNA might represent a historical pivot point at which credibility is particularly low.

Courtroom experience. A related difference in analysts’ responses to pressures for change is their courtroom experiences at work. On average, analysts testify in less than 2% of the cases they process. At Western County lab in 2009, the laboratory processed 19,000 cases, 1800 of which were major cases (which would involve DNA or firearms). Analysts in the lab testified a total of 87 times in court, about a third of which were major cases, and the rest toxicology and narcotics. And analysts told me that the only unit in which testifying was common was toxicology. While a DNA analyst might go to court once a year, toxicologists were frequently called to testify in DUI cases.
Narcotics analysts were rarely in court, partially because of a law in the state that allowed police officers to testify to their results if the lawyers agreed.

Toxicologists are called to court often because “DUI is big business; for some attorneys it is a lot of what they do.” As a consequence, as many of the toxicologists (and other analysts) reported to me, it is very demanding to testify in toxicology, because the defense attorneys are well trained. As one toxicologist pointed out, the defense attorneys are more experienced with the relevant challenges to their cases than those in the other areas, including homicide. “They have classes that they take on how to attack or defend DUI,” and they know more about the science involved in the toxicological analysis. Therefore, toxicologists are accustomed to regularly facing scientifically well-informed questions and challenges on the stand.

In contrast, the scientific practices of narcotics analysis did not receive close scrutiny in the courtroom. Narcotics analysts were not called to the stand very often, and when they had testified in controlled substance cases, their expertise had not been challenged by lawyers. One analyst told me:

The thing about controlled substances is, nobody, none of the lawyers, care how we got our conclusion. The defense doesn’t care and the prosecution doesn’t care. Maybe the judge cares, but he doesn’t get to ask. They just don’t care at all, because the question of whether it’s the drug or it isn’t, that’s never the part of controversy. I’ve done some—I think I’m at about 3,200 analyses so far, I’ve testified six or seven times and I’ve never been challenged as to the science. Ever…. When I started out I was kind of anxious about being challenged on science, but I’ve realized that it’s probably not going to happen, ever. That’s not the question, the question is whether or not it is a usable dose… enough to get high.

Similarly, firearms examiners rarely testify in court. My two informants with decades of experience in the field had more experience in the courtroom, but one examiner had been handling cases at Western County lab for three years before my
arrival and testified for the first time near the end of my fieldwork. When the firearms examiners did testify, they were not challenged, as noted earlier by one senior examiner. While firearms examiners in other jurisdictions had been challenged as to the admissibility of their evidence, these challenges were not experienced in Western County.7

This suggests that courtroom experience conditions the reactions of subcommunities to external pressure. In toxicology, where analysts frequently testified, they viewed testimony as a more “typical” part of the work, and responded with relative aplomb to testimony challenges. In contrast, narcotics analysts were shielded from testifying and this aspect of the work therefore did not affect their regular practice. Finally, like DNA analysts, firearms examiners rarely testified. In the past they had qualified easily as experts and suffered few challenges. The current, more hostile courtroom climate was a significant change in their status, which could be seen as framing their defensive responses. Lifshitz-Assaf (2014) suggests that the defensive response of NASA scientists to the challenge of incorporating non-expert solutions into their practice was a consequence of their identity as research scientists whose work was to solve problems. The relationship of work experiences to identity, and how this affects changes in practice, is a topic worthy of future investigation.

*Immediacy of challenge to work practice.* This range of responses among the various subfields can be analyzed in a more granular fashion by considering the specific ways in which comparisons to the gold standard of DNA evidence interfered with their

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7 The firearms examiners at Western County Lab were very friendly with both prosecutors and public defenders in the county, playing on sports teams with them and joining them on trips to the firing range. This friendliness was not typical for analysts in any other unit. However, I have no explicit evidence about the implications of these relationships.
work. As Heimer (1999) illustrates, groups vary in their influence on the basis of their representative presence at the moment in organizations at which action takes place. Toxicologists were about to be challenged in actual testimony about measurement error, so this challenge had an immediate and direct effect on their work. In contrast, in firearms the challenge to their work was more ambiguous. While the firearms examiners in Western County were acutely aware that their subcommunity had been targeted by NAS, it was not clear what the implications were. Other members of their professional association were being challenged in court but the challenges had yet to be successful: firearms testimony had not been denied admissability. Inside the unit, the examiners did not believe they were biased. They were proud of their expertise, they valued their holistic, subjective judgment, and they had a reputation for being macho, independent gun enthusiasts (as did most firearms analysts in the broader forensics community), so resistance was natural for them. Narcotics analysts were envious of DNA analysis only at the level of resources. They were not being challenged from the outside at all, so any “controversy” over practices was internal, at the level of their professional association. While I heard many complaints about how eliminating crystal tests would turn them into “button pushers” or “schmos” with no judgment, there was no immediate reason to make any change in the lab.

Conclusion. Because criminalists produced hybrid facts – scientific evidence used in making legal judgments – evaluations of both a scientific and legal nature applied to their work. As a consequence, their activities in the laboratory and the courtroom were all implicated in how their knowledge practices changed after the challenge issued by the NAS report. Closely examining the everyday work of forensic scientists enables a fuller
understanding of how scientific and technical constraints, public and legal scrutiny, and occupational values are interwoven in the evolution of forensic evidence and knowledge.


Lakhani, Karim, Hila Lifshitz-Assaf, and Michael Tushman. 2013. Open Innovation and Firm Boundaries: Task Decomposition, Knowledge Distribution and the Locus of


