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ABSTRACT The late 19th-century discovery of X-rays befuddled not only the scientific world but also the medical and legal worlds. The possibility of looking into the human body as if through an open window challenged the time-honored medical monopoly over the inner cavities of the human body. Likewise, the possibility of visualizing objects unavailable to the naked eye challenged the established legal theories and practices of illustration and proof. This paper describes the reactions to those challenges by the medical and the legal professions in the USA. The two professions are treated as connected social institutions, producing ongoing negotiations through which legal doctrines affect medicine no less than scientific discoveries and medical applications affect the law. This joint analysis rewards us with a rich story about an early and overlooked chapter in X-ray history on the professionalization of radiology, the origins of defensive medicine, and the evolution of the legal theory and practice of visual evidence.

Keywords defensive medicine, expert testimony, professionalization of radiology, science and law, scientific evidence, visual evidence

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Tal Golan

The early years of X-ray practice in the USA have been described as ‘a piebald proceeding, a sort of Joseph’s coat of many colors, which fitted no one’ (Brecher & Brecher, 1969: 104). Indeed, commencing early in 1896, X-ray practice in the USA remained for more than 20 years an unregulated territory, inhabited by a welter of photographers, electrical engineers, physicists, medical novices, and other speculative minds, attracted by the mystique of the new rays and the simplicity of their apparatus. It was only in the 1920s that an organized medical specialty, radiology, was able to successfully claim a monopoly over X-ray practice and institute common standards of education, training, competence, and ethics.

The medical mobilization in response to the biggest development of fin-de-siècle science, the discovery of X-rays, has attracted considerable scholarly attention. Some historians focus on the social and institutional intricacies involved in the molding of the expertise of the photographer, the electrician, and the doctor into a new profession (Reiser, 1979: 45–68;

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Howell, 1995). Others emphasize the difficult theoretical and technical challenges that faced the development of X-ray technology (Arns, 1997). Still others ponder the great epistemological barriers involved in shifting from the verbal and the tactile to the visual (Pasveer, 1989; Lerner, 1992). This paper would like to invite the law to the table. The discovery of X-rays, the paper suggests, affected legal practice no less than it affected medical practice, and the reaction of each of the two professions needs to be understood within the context of the other.¹

What follows is an account of the reactions to the discovery of X-rays by the medical and legal professions in the USA.² The two professions are shown to have carried on negotiations through which legal doctrines affected medicine no less than scientific discoveries and medical applications affected the law. The law is shown to have been not only an important patron of early X-ray practice, but also an influence on the legitimization of X-ray images as credible medical evidence. Similarly, X-ray technology is shown not to have been a mere handmaiden to the law, but an engine in the development of legal theories and practices concerning visual evidence. The analysis of these mutually constitutive developments rewards us with a rich story about an overlooked chapter on early X-ray history. This story involves the professionalization of radiology in the USA, the origins of defensive medicine, and the evolution of US legal theories and practices of visual evidence.

Enter the Rays

Professor Wilhelm Röntgen of the Bavarian University of Würzburg first made his discovery of X-rays public in December 1895. The notion of a new kind of ray, unrefractible and indifferent to electromagnetic fields, befuddled the scientific world and precipitated feverish research into their nature and implications for the long-standing theories of light and matter. Popular culture was equally mesmerized. The notion of a 'dark light' that could penetrate flesh as easily as glass and produce photographic images of the skeleton was intoxicating. Overnight, the mysterious rays became popular icons constantly encountered in advertisements, stories, songs, and cartoons. More than 1000 papers and 50 books were published on the subject in 1896 alone (Glasser, 1933: 29–46; Knight, 1986; Holland, 1964).

The doctors were as excited as everyone else by the new discovery. To determine the position of broken bones, the late 19th-century surgeon had to manually probe the injury. Deformity, due to displacement or swelling, was the most important diagnostic clue. This did not preclude the possibility of congenital asymmetries, or of fractures that caused no deformity. Abnormal mobility was the second clue. But cases of fissure, or of incomplete or intra-articular fractures, were not always recognizable. Then there was the 'forlorn hope of the surgeon': crepitus – the sound generated by grating bones. But again, not all fragments could be brought against

each other, and not all injuries generated sounds. In addition, the transmission of the sound through the bone could lead to a false impression of the seat of the fracture. This is to say that late 19th-century orthopedic diagnosis was a trying task, for doctor and patient alike, and in many cases, doctors had no choice but to resort for their diagnosis to the patient's own account of pain and loss of function (compare Thomas, 1886; Stimson & Rogers, 1895). The notion that they could visually inspect not to mention photograph the hidden bones excited many doctors. 'The surgical imagination can pleasurablely lose itself in devising endless application of this wonderful process', mused one doctor in the *Medical News*. 'If it becomes possible to drive these mysterious rays through the entire body as clearly as they now penetrate the hand, the realm of utility will be practically boundless' (Cattell, 1896: 169–70).

Other doctors preferred to reserve judgment. No one was sure what these rays really were, and although it was clear how to produce anatomical images with them, securing a good image was far from simple. The complex relations between the electrical characteristics of the tube, its gas pressure, and the properties of the rays it emitted were far from being understood. X-ray operators were aware that the tubes could emit X-rays with varying degrees of penetration. Some rays were 'soft' and could barely pass through the skin. Others were so 'hard' that they passed through the thickest bones, and produced little contrast on the photographic plate.³ X-ray operators were vaguely aware that the properties of the rays were determined by gas pressure in the tube. The higher the vacuum in the tube, the 'harder' the X-rays it emitted. The degree of vacuum, however, varied from tube to tube, and from minute to minute within the same tube. Worse still, a tube might have a low vacuum but still deliver rays of high penetration, and high-vacuum tubes sometimes refused to emit any rays at all. Bewildered, X-ray operators speculated about the 'seasoning' of the tubes. If properly used with suitable intervals of rest, a given tube might become 'seasoned' within a few weeks, or it might take several years. And no one had an explanation for this.⁴ A great part of the operator's expertise was to know his tubes by heart, and choose the right one for the specific task. 'It seemed, at times', one operator later recollected, as 'though gas tubes had been invented for the specific purpose of trying man's soul' (Hodges, 1945: 439).

The limitations of the infant technology were therefore many. Indeed, even if the operator got lucky enough to produce a clear image, there was neither a body of anatomical knowledge that would confer a precise meaning upon the image, nor a medical language by which such meaning could be communicated (Pasveer, 1989; Lerner, 1992). Thus, the majority of medical practitioners considered the new invention as 'more an interesting toy than a weapon of value in medicine', and preferred to stick to their time-tested methods of manually probing the injury in order to diagnose the position of the bones (Barclay, 1949). 'It may not be unreasonable to hope for much more important results in the near or remote future', commented early in 1896 the influential *Journal of the American*

Medical Association. 'At present however, the limitations of the methods are too great and the medical nature of the discovery is, as yet, a largely unknown quantity' (Editorial, 1896b: 436).⁵

Value, however, is in the eye of the beholder, and while the medical profession did not consider X-ray technology to be of much practical value, the legal profession developed keen interest in it. To understand the legal interest we need to consider the state of medical expert testimony in US courts at the end of the 19th century.

The Late 19th-Century Crisis of Expert Testimony

The sale of expert advice did not become widespread in US courts until the middle decades of the 19th century. Once it did, though, complaints quickly accumulated about the curious spectacle of partisan expert witnesses zealously opposing each other on the witness stand. According to Judge Emory Washburn, who spoke on the subject in 1866 before the members of the American Society of Arts and Sciences, a US judge should have considered himself fortunate when he had not, 'when trying a case involving inquiries to be answered by experts, again and again felt that the opinions advanced by the witness had more to do with promoting that cause of the party in whose favor he appeared than the furtherance of justice'. Four years later, in 1870, a prize-winning study of expert testimony at the Harvard Law School reported in detail on an 'unmistakable tendency on the part of eminent judges and jurists to attach less and less importance to testimony of this nature', and explained it by 'the surprising facility with which scientific gentlemen will swear to the most opposite opinions upon matters falling within their domain'. Many shared this bleak view. Remick Waite Morrison, Chief Justice of the US Supreme Court, wrote in 1874 that '[w]hoever has read the reports of trials or been present at them, in which experts are arrayed against each other, prostituting at times the science which they professed to represent, needs not be told, that the subject of expert testimony as now understood, is one of no ordinary importance' (Washburn, 1866: 49; Anonymous, 1870: 227, 428; Morrison, 1874: 134–35).

The 1880s and 90s saw the volume of medical and other expert testimony continue to increase, while the respect paid to it by the courts continued to decrease. The reform of expert testimony became one of the hottest topics in the meetings of the various medical and bar associations that mushroomed in late 19th-century USA.⁶ The reform suggestions, as one judge later reminisced, 'were as numerous as prescriptions for the cure of rheumatism and generally about as useful' (Kidd, 1914: 217). The doctors blamed their disagreements on the adversarial procedures of expert testimony that promoted partisanship and prevented the appropriate resolution of the medical issues presented in court. The lawyers and the judges blamed the disagreements on the deficient state of medical knowledge or on the moral corruption of the experts who sold their

authority to the highest bidder. The medical community repeatedly demanded that the legal system reform its procedures of expert testimony and employ the expert independent of the parties, either as part of a special tribunal, or as an advisor to the court.⁷ Alas, even those in the legal profession who empathized with the frustrated experts were reluctant to dissent from the legal axioms of the adversary system. The creation of special scientific tribunals ran counter to the fundamental political right to a trial by a jury of one's peers; and allowing the court to call in experts independent of the parties was counter to two other equally fundamental postulates: the right of the parties to furnish all evidence, and the neutrality of the court. The legal profession therefore rejected these suggestions of reform as remedies far worse than the disease.⁸

With no resolution in sight, the legal and medical camps grew increasingly belligerent. Expert testimony, which had seemed to emerge before the Civil War as a vital civil function of the medical profession, had become a major source of discontent by the century's end. Instead of bringing the legal and medical professions closer, it was drawing them further apart. The judges grew weary and wary of the spectacle of medical experts contradicting each other on the witness stand. The medical profession grew impatient with the courts' practice of forcing doctors under the pretense of public service, and without paying them properly, to testify as to the results of their tests. Meanwhile, the lawyers were taking advantage of both sides, setting the medical practitioners against each other in insanity, poisoning, malpractice, will, and other trials (Tighe, 1983; De Ville, 1990; Mohr, 1993).

By 1896, the year the USA was introduced to X-rays, judicial trust in expert testimony seemed to have reached rock bottom (Kinne, 1896; Foster, 1897–1898; Trowbridge, 1896; Eindlich, 1898). 'It is difficult to conceive of language within the bounds of decent and temperate criticism, which ought to be regarded as excessively severe in commenting upon the expert testimony nuisance as it has, of late years, been infesting our courts', commented Judge Gustav Eindlich before the members of the prestigious Law Academy of Philadelphia.

In the way of wasting the public's time, in the way of burdening litigants with expense, and in the way of beclouding the real issues to be tried and effecting miscarriages of justice, it has grown to the proportions of an offensive scandal. Instead of being an aid in the administration of the law, it has become a positive hindrance to it. Instead of assisting in the approximation of the truth, it has become the means of obscuring it . . . expert testimony is today discredited and rightly discredited by the courts, and ridiculed by the hard common sense of the people. (Eindlich, 1896: 9–11)

Malpractice litigation constituted one of the main sources of this legal frustration with medical expert testimony. Heightened expectations and demand created by advancing medical technology and by rising pre-occupation with health and physical appearance, coupled with a growing population of lawyers eager to take such suits for contingency fees as high

as 50%, created an epidemic of malpractice litigation throughout the second half of the 19th century. The majority of these malpractice lawsuits were orthopedic cases usually involving compound fractures where patients often found themselves with demonstrable problems and sued the doctors who took care of them. Once in court, these cases usually turned into prolonged and costly battles between competing medical experts who constantly failed to agree with each other about their findings (Smith, 1941; Sandor, 1957; De Ville, 1990).

The courts therefore had little to lose by turning to the new X-ray technology. True, X-ray photography may not have been more reliable than palpation, but the palpating experts constantly failed to agree with each other, leaving the lay jurors in an awkward position in which they had no other evidence to decide upon, except what the obviously partisan experts – selected and paid by the litigants – had told them. Having direct access to the disputed facts via properly verified X-ray images, the courts hoped, would enable them to reduce malpractice litigation and shorten its course, and allow lay jurors to make better-informed decisions. Thus, despite the fact that many physicians viewed the infant technology as unreliable, and even though fundamental questions of what X-ray images conveyed and who should be considered a competent X-ray expert were still under discussion, the US courts began to use X-ray images as evidence in December 1896, only months after the discovery of X-rays was first made public (Golan, 1998).⁹

The legal embrace of X-rays was abetted by the fact that their early application was considered to be a new specialty in the field of photography. X-ray images were produced inside the same dark rooms, by the same materials and chemical processes used in regular photography. Accordingly, many of the workers actively engaged in making X-ray images were photographers, and those physicians ‘desiring to acquire a knowledge of X-ray work’, were advised to ‘first serve an apprenticeship in a photographic gallery’ (Stern, 1896). The result was that the anatomical images produced by the new X-ray technology were generally thought of as photographs, which were admissible in court as illustrative evidence (Stern, 1896; Fuchs, 1956).

The Legal Doctrine of Illustrative Evidence

Regular and X-ray photography were part of a new class of machine-made testimonies that rose to dominance during the second half of the 19th century. Ever alert and never involved, machines such as microscopes, telescopes, high-speed cameras, and X-ray tubes threatened to turn human testimony into an inferior mode of communicating facts as they purported to communicate richer, better, and truer evidence, which often was inaccessible by other means to human beings. The emblem for this new type of mechanical objectivity was visual evidence. ‘Let nature speak for itself’ became the watchword, and nature’s language seemed to be that of

photographs and mechanically generated curves (Daston & Galison, 1992: 81).

Nineteenth-century US courts, with their processes of fact-finding and proof traditionally geared towards the reception of viva voce testimony by human witnesses, found it hard to adapt to this new logic of persuasion. Machines may have promised to succeed where human beings failed, but they could not be put under oath, interrogated, and cross-examined. The incipient conflict came to a head in the 1870s and 80s, with the deployment of photography in a constantly broadening range of legal contexts. Was the photograph an especially privileged form of evidence, nature's unmediated testimony? Or was it an especially repugnant form of evidence, a human artifice claiming to be mechanically objective? Late-19th-century lawyers fought bitterly over these questions and the result was a fascinating legal discourse concerning the meaning and epistemological status of the photograph.

Photographs were not the first visual images used in court. Man-made images – maps, plans, models, diagrams, portraits, paintings, and so on – had been in legal use for centuries. Dependent by their nature on human observation and unavailable for cross-examination, these images were never considered as having evidentiary value of their own. They served only to *illustrate* verbal testimony. As such, their legal status had not attracted the attention of 19th-century scholars on evidence. This quickly changed with the advent of the first visual technology – photography. During the early 1880s, the long used but never formalized legal practice of man-made images served as a base for a new evidentiary doctrine, illustrative evidence, which stipulated the legal status of visual evidence (Mnookin, 1998).

The new doctrine crowded all visual images, machine-made as well as man-made, into a category termed illustrative evidence, which was admissible for illustrative purposes only, to aid the witness in explaining and the jury in comprehending the testimony given in court. The traditional admissibility test used to establish the veracity of man-made images – having a witness familiar with the represented object testifying under oath as to the accuracy of the representation – was readily applied to photographs too. The demand that photographs be certified by an eyewitness testimony provided a powerful check on photographic evidence and preserved the status of the traditional eyewitness, whose mediating presence in court seemed threatened by this new species of machine-made testimony. All together, then, the doctrine of illustrative evidence seemed an attractive solution that gave photographic evidence a recognizable identity, an uncontroversial past, and hopefully a predictable future (Editorial, 1894; Lawyer, 1895; Mnookin, 1998).

Still, containing the suggestive force of the photograph by treating it as just another species of visual image was only partially successful. It worked well at the level of formal admissibility, which was controlled by the judiciary, but the judges had far less control over how evidence was used inside the courtroom.¹⁰ The courts may have conceptualized photographic

evidence as a mere handmaiden to human testimony, but the jury often treated the photograph as independent evidence that represented its subject matter directly. Thus, once the photograph was allowed into the courtroom, it was no longer clear as to where illustration ended and proof started, or who was illustrating what: the photograph illustrating the testimony or the testimony illustrating the photograph.

Thus, by the end of the 19th century, photography was well established in the US courtroom as a powerful evidentiary tool. Still, its theory and practice embodied the deep judicial ambivalence towards photography. Formally, as John Wigmore, the leading authority on evidence, put it, the photograph was:

[S]imply nothing. Except so far as it has a human being's credit to support it. It is mere waste paper – a testimonial nonentity. It speaks to us no more than a stick or a stone. It can of itself tell us no more as to the existence of the thing portrayed upon it than can a tree or ox. We must somehow put a testimonial human being behind it (as it were) before it can be treated as having any testimonial standing in court. It is somebody's testimony, or it is nothing. (Wigmore, 1904: section 790)

Yet, inside the courtroom, photographs often functioned as independent, sometimes central, pieces of primary evidence that afforded the greatest certainty about what was shown 'inside' them. The discrepancy was not intolerable, and trial judges certainly did not seem troubled by it. They allowed witnesses, including expert witnesses, to use photographic evidence to explain their testimony but usually forbade them to instruct the jury what was 'in' the photographs. The final interpretation of the content and credibility of photographic evidence was left to the discretion of the jury, and through this uncensored discretion the popular understanding of the photograph as a privileged form of evidence continued to exert a powerful influence in the courtroom (Kenner, 1905; Mnookin, 1998).

This rather intricate judicial strategy worked well as long as two conditions were met. The first one was explicit: human testimony must stand behind the photograph. The second was more tacit: the jury was expected to readily comprehend the photographic evidence and to use the intuitive information it conveyed to better understand other evidence in the trial. But what to make of photographs that represented evidence unavailable to the naked eye? How could human testimony be provided to vouch from personal knowledge to their accuracy? And what to make of photographs that did not convey intuitive information easily accessible to the jury? Could the jury be trusted to read them properly? The courts came to face these difficult questions by the century's end, with the spread of X-ray photography.¹¹

The Legal Embrace of X-Rays

In December 1896, Judge Owen E. Lefevre of the District Court of Denver, CO, became the first US judge to admit X-ray images into his

court in a malpractice suit. Here is how he described the considerations behind his decision to do so:

[We] have been presented with a photograph taken by means of a new scientific discovery the same being acknowledged in the arts and in the science. It knocks for admission at the temple of learning and what shall we do or say? Close fast the doors or open wide the portals? These photographs are offered in evidence to show the present condition of the head and neck of the femur bone which is entirely hidden from the eye of the surgeon. Nature has surrounded it with tissues for its protection and there it lies hidden; it can not, by any possibility, be removed or exposed that it may be compared with its shadow as developed by this new scientific process. In addition to these exhibits in evidence, we have nothing to do or say as to what they purport to represent; that will, without doubt, be explained by eminent surgeons. These exhibits are only pictures or maps, to be used in explanation of a present condition, and therefore are secondary evidence and not primary. They may be shown to the jury as illustrating or making clear the testimony of experts. (*Smith v. Grant*, quoted in Editorial, 1896a)

Judge Lefevre addressed the X-ray plates offered in evidence as if they were regular photographic plates, imprinted by X-rays instead of light rays. If X-ray images are photographs and photographs are illustrative evidence, he reasoned, then X-ray images are illustrative evidence, admissible as secondary evidence to aid the witness in explaining his or her testimony. Lefevre was aware that his two-step analogy strained the already uneasy foundations of the legal category of illustrative evidence. As he readily acknowledged, the standard legal test used to establish the veracity of illustrative evidence was not applicable to X-ray images. Whatever it was that they depicted, it was hidden from the naked eye. Thus, no witness could be provided who could vouch from personal knowledge to the accuracy of the representation. Without such standard eyewitness testimony, as one judge who refused to allow X-ray evidence into his court had explained, 'there is no proof that such a thing is possible. It is like offering the photograph of a ghost when there is no proof that there is any such thing as a ghost' (Withers, 1934: 100).¹²

Judge Lefevre bypassed this difficulty by suggesting that the X-ray plates could be admitted upon verification not of the accuracy of their representation but of the reliability of the process that had produced them. The idea was not entirely new. Quite a few courts had referred to the deterministic nature of the photographic process as a central constituent of the photograph's reliability (*Cowley v. People*, 1881; *Franklin v. State*, 1882). Reliability verification, however, was difficult to perform and most courts satisfied themselves with having an eyewitness testify to the accuracy of the representation (Lawyer, 1895). Now Lefevre suggested that when such a witness could not be provided, verifying the reliability of the process should suffice. To this end, Lefevre shifted the accepted balance between the interwoven understandings of photographic evidence and emphasized the hitherto suppressed view of photographic evidence as the product of a

scientific process capable of offering reliable representations, indeed even of things unseen:

During the last decade at least, no science has made such mighty strides forward as surgery. It is eminently a scientific profession, alike interesting to the learned and to the unlearned. It makes use of all science and learning. It has been of inestimable benefit to mankind. It must not be said of the law that it is wedded to precedent; that it will not lend a helping hand. Rather, let the court throw open the door to all well considered scientific discoveries. Modern science has made it possible to look beneath the tissues of the human body, and has aided surgery in telling of the hidden mysteries. We believe it to be our duty, if you please, to be the first to so consider it in admitting in evidence a process known and acknowledged as a determinate science. The exhibits will be admitted in evidence. (*Smith v. Grant*, quoted in Editorial, 1896a)

Other judges soon adopted Lefevre's solution and began to admit X-ray images on the strength of the argument that photographic evidence could be admissible upon proof, not of its intrinsic accuracy, but of the reliability of the processes that produced it. 'New as this process is', reasoned the Tennessee Supreme Court in September 1897, 'experiments made by scientific men, as shown by this record, have demonstrated its power to reveal to the natural eye the understructure of the human body, and that its various parts can be photographed as its exterior surface has been and now is' (*Bruce v. Beall*, 1897). Being the first supreme court to deliberate the admissibility of X-ray evidence, the opinion of the Tennessee Supreme Court carried great weight throughout the country. Within a month, in October 1897, X-ray images were admitted for the first time in a criminal trial.¹³ In 1899, the Supreme Court of Maine declared that the judge presiding at a trial could admit X-ray images at his discretion. In 1901 the supreme courts of Massachusetts, Wisconsin, and Washington DC reached similar conclusions, and in 1902, 1904, and 1905, Nebraska, Illinois and Arkansas also fell into line (Goodrich, 1903; Scott, 1929; Collins, 1964; Halperin, 1988; Wigmore, 1904: section 795).

Thus, by the start of the 20th century, a growing agreement had emerged among US courts concerning the admissibility of X-ray images. Understood as a variant of photographic evidence, X-ray images were linked together with regular photographs into the category of illustrative evidence. The courts were aware of the fine line they were walking. 'It is not to be understood', cautioned the Tennessee Supreme Court, 'that every picture taken by the cathode or X-ray process would be admissible. Its competency, to be first determined by the trial judge, depends upon the science, skill and intelligence of the party taking the picture and testifying with regard to it, and that lacking these important qualifications it should not be admitted' (*Bruce v. Beall*, 1897). Such caution, however, fell well within the established doctrine of illustrative evidence, which treated the photograph as a fallible human artifice that needed to be carefully verified. The methods of verifying regular photographs and X-ray images may have differed, but the courts discounted the difference. 'There would seem to be

no reason for making a distinction between an X-ray and a common photograph', proclaimed the Supreme Court of Washington DC, 'that is, either is admissible as evidence when verified by proof that it is a true representation of an object which is the subject of inquiry' (*Miller v. Dumon*, 1901).

But while a certain agreement was achieved concerning the admissibility of X-ray images, a considerable amount of disagreement remained about what to do with them after they had been admitted into court. Underlying the application of photographic evidence, indeed the whole legal category of illustrative evidence, was the presumption that the average juror could use the intuitive information it conveyed to better understand the rest of the evidence. However, unlike regular photography, the information conveyed by X-ray images was not intuitive. The human body, an object of varying densities, produced under the X-rays an image of superimposed shadows of varying opacity. The information conveyed in the image was of contours and densities without real perspective. The only perspectival information lay hidden in the sharper shadows outlining nearer objects. To correctly read the lesson of any X-ray picture, one had also to make a mental adjustment for the disproportion created by the obliqueness of the rays, caused by the fact that they were not parallel but emanate from a point. Thus, once the courts began to admit X-ray images, a demanding problem emerged: could the jurors interpret the images correctly by themselves or should experts be allowed to explain to the jury what they saw in the image?

The judicial solutions to this problem varied, exposing in the process some of the potential interpretive conflicts buried deep within the doctrine of illustrative evidence. The rules of evidence dictated that expert witnesses should be allowed to advise the trial jury on the evidence only when it was clear that the jurors did not have sufficient knowledge to enable them to draw an informed decision from the evidence. That, however, was clearly not the case with photographic evidence, which was assumed to be freely accessible to the jury, and was tacitly treated in court as independent evidence that speaks best for what it shows. Recognizing the difficulty, Judge Lefevre tried to resolve it by allowing experts to tell the jury what they thought they saw in the X-ray plates, while still saving the last word for the jurors, who were allowed to take the X-ray plates into the jury room, examine them, and interpret their meaning. However, many of Judge Lefevre's colleagues, who accepted his invitation to think of X-ray images in terms of photographic evidence, rejected his solution. Photographic evidence, they insisted, was designed to explicate oral testimony, not the other way around. Thus, they forbade experts from telling the lay jury what in their opinion was in the images. 'No argument is required to show', explained an Iowa Appellate Court in 1907, as to why it had been an error for a lower court to allow a doctor to testify about what appeared in an X-ray image, 'that photographs are the best evidence of what appeared in them' (*Elzig v. Bales*, 1907). Thus, experts were usually allowed to describe in general terms only what a certain bodily condition

would look like on the X-ray plate, and they had to leave it to the jury to decide whether that was also the case in the specific image before them (Wilson, 1922).

The Medical Campaign Against The X-Rays

The medical profession watched the legal developments with a growing sense of alarm. It was common knowledge among physicians that malpractice juries were strongly biased towards the usually poorer and indisposed plaintiffs (Sanger, 1879; Law, 1896; De Ville, 1990: 138–55; Golan, 1998). Thus, the possibility of having their clinical judgment subordinated in malpractice suits to the authority of the X-ray image as interpreted by the jury, seemed like a nightmare (Price, 1897; Tracy, 1897). The legal fraternity was castigated for the increasing malpractice fad, and the various local medical societies called special meetings to discuss means of protection ‘against unjust and malicious suit for malpractice, instituted by irresponsible parties, and conducted ordinarily by impecunious attorneys upon shares’ (Editorial, 1897a, 1897b). The acceptance of X-ray photographs as evidence, everyone seemed to agree, had a deep bearing on the future of surgical practice. Here is how Denver’s *Daily News* explained to its readers the implications of Judge Lefevre’s decision:

It means that unless a physician is absolutely certain that he knows what is the matter with one of his patients, he must shadowgraph them and make a correct diagnosis with the X-ray aids, or the first thing he knows someone will attack him in court and by shadowgraphs prove that the doctor was a long way off from the correct treatment. Whether this will mean that each doctor will have to carry an X-ray laboratory and dark room around with him when he makes his calls, or will be obliged to cart each of his patients to his office and there do the shadowgraph act, does not appear, but it seems certain that some easy method of knowing that he is all right will be a necessity to the physician with reputation and property to protect. (Editorial, 1896c)

The deployment of X-ray images as legal evidence became a central topic in all of the major US medical meetings of 1897. The two general concerns among doctors were that it would stir up a new outbreak of malpractice litigation, and that the new technology, which seemingly allowed jurors and lawyers direct access to the disputed facts, would undermine the authority that medical witnesses had so far enjoyed in the courts. ‘There could be no doubt that skiagraphs will figure largely in suits for damages’, William White, professor of clinical surgery at the University of Pennsylvania, warned the members of the American Surgical Association at their 1897 annual meeting in Chicago. ‘They have already been admitted in evidence in such cases, and it is probable that juries will with increasing frequency have to decide whether to place greater weight on deformity as shown by skiagraphs or on expert evidence as to the absence of genuine disability’ (White, 1897: 70).¹⁴

Professor White had two suggestions for how to counter the looming danger. First, members of the profession had to modify their practice and

make sure 'that in all obscure, complicated, and unusually difficult cases the help afforded by the Röntgen rays shall be secured by the surgeon, even if it is done chiefly with the view to his own protection'. At the same time, the medical profession had to fortify its courtroom authority in face of the new technology. In particular, the profession had to make sure that no one would assume 'that the clinical experience and the judgment based upon it should be subordinated to the pictorial testimony of the skiagraph' (White, 1897: 70).

The discussion that followed White's talk illustrated the depth of the medical profession's anxieties about the legal implications of the X-rays. 'I have talked the medico-legal side of this question over with several of our judges, and some of them are going to admit these skiagraphs', reported Dr Richardson of Harvard and Massachusetts General Hospital. 'We could not bring up a more important subject at this time A great deal of trouble is going to result from these pictures'. Dr Fowler of Brooklyn concurred: 'Personal damage lawyers will enter into collusion with those in charge of the X-ray studios, and patients who from curiosity or other motives apply for skiagraphs will be encouraged to institute legal proceedings to recover damages for alleged improper treatment'. Agreeing that 'there is no doubt that many suits for malpractice will result', the participants decided to appoint Professor White chairman of a committee that would look into this troubling issue and recommend further actions (White, 1897: 83–84, 88).

The powerful railway companies also felt threatened by the new rays. They had long considered their trains to be filled with 'men and women who long for a wreck, a jolt, a fall, something on which to base a claim'. To counter such claims, the railway companies employed armies of surgeons in towns along their tracks in order to provide medical assistance to both trainmen and passengers 'in the manner which is most conducive to the interests of the Company' (Fairbrother, 1902: 254; Shikes, 1986: 202). They also paid leading physicians lavish salaries to represent them in court. The concern with a new outbreak of 'X-ray litigation' therefore became the central topic at the 1897 meeting of the American Academy of Railway Surgeons. In his opening address, Dr Harvey Reed, a professor of surgery at Ohio Medical University and chief surgeon of the University Hospital, who was just about to be nominated surgeon-general of Wyoming, declared that:

As long as it is possible to take radiographs of the normal limb, which gives the appearance of being fractured, and on the other hand, when skiagraphs are taken of fractured limbs that fail to show the existence of the fracture, we are compelled by the circumstances to distrust its accuracy, and for that reason if for no other, we consider it a dangerous source of evidence which should not yet be admitted by our courts. (Reed, 1898: 1016)

Once again, the discussion following Reed's opening address was most revealing. 'If the profession treats it as it usually does everything new', warned Dr William Grant of Denver, the X-ray 'will prove an instrument of

danger. It will be an expensive thing for the surgeon.'¹⁵ Dr Lacey of Iowa agreed:

It seems to me that if a skiagraph were placed before the jury it would injure the case in which the surgeon might be deeply interested. So I feel that the Academy, as well as other associations of this character, should be guarded in pronouncing the X-ray, or skiagraphs, of such vast importance until their actual value is demonstrated. (Reed. 1898: 1017)

Dr Galbraith of Omaha concurred: 'It would be a grave mistake for us to place ourselves in a position to state that it is necessary for the X-ray to assist us . . . for we will receive much abuse in times of tribulation from such recommendation.' Dr James Burry of Chicago, one of the few US physicians who had mastered the new X-ray technology, tried to be more practical: 'We can not keep it out of court', he reminded the participants. 'Supposing we are all on the defense side, the plaintiff will bring it into the court.' Dr Cole of Helena, MT, backed him up: 'It is useful. It has come to stay and will unquestionably be used hereafter to an extent perhaps which we do not anticipate.' The conclusion reached by the members of the American Academy of Railway Surgeons was similar to that reached by the members of the American Surgical Association – that the best that could be done was to have X-ray technology's 'proper limitations defined', so that 'no one should think that the X-ray is a referee or is the final arbiter in the matter'. No one who could serve as a juror, that is (Reed, 1898: 1017–19).

Meanwhile, the ominous predictions about an outbreak of 'X-ray litigation' quickly materialized. Professor Pratt of Chicago complained in 1898:

Ever since its discovery, especially in the last year, every malicious person who can scrape up enough money to pay for a shadowgraph is having one taken for the purpose of bringing a damage suit for personal injuries or malpractice. It is coming to this: That a surgeon is not safe unless he has a shadowgraph taken before and after each operation. It is surprising to see the number of damage suits now pending against corporations, individuals and especially surgeons for supposed injuries sustained or for malpractice, depending entirely on the shadowgraph as evidence. (Pratt, 1899: 546)

The participants of the 1898 annual meeting of the American Association of Physicians and Surgeons were warned that 'negligence will be claimed for failure to use it [X-ray] in all cases where bad results follow'. The lecturer, Dr Frank Ward Ross of New York, cautioned all practitioners 'to take unusual care in giving opinion of a case without the consent and knowledge of the attending physician, particularly where a suit for malpractice is likely to ensue', and urged them to 'shape our examinations in this line as to make them conform to the rules of legal evidence in all its technicalities, or our work may not only be productive of no good, but may be an actual source of menace to us personally and professionally' (Ross, 1899: 502–03).¹⁶

The Professionalization of X-Ray Practice

The last years of the 19th century were therefore characterized by a seemingly incongruous medical reaction to the new X-ray technology – while its reliability was relentlessly attacked, its practice was constantly recommended. The orchestrated effort to undermine the reliability of the new technology reached its peak in the 1900 meeting of the American Surgical Association, with the publication of the official report of the Committee on the Medico-Legal Relations of the X-rays, appointed at the 1897 meeting. Read by the chair of the committee, Professor William White, the conclusions of the long and detailed report were that ‘the routine employment of the X-ray in cases of fracture is not at present of sufficient definite advantage to justify the teaching that it should be used in every case’, and that ‘skiagraphs alone, without expert surgical interpretation, are generally useless and frequently misleading’. Following the publication of the report, the members of the American Surgical Association unanimously voted for a resolution that the skiagraph be inadmissible as evidence in court, because ‘being a picture of a shadow and not of the object, it is inaccurate and unreliable’ (Editorial, 1900; Grant, 1901).

By 1900, however, the tide was already beginning to turn. Improved equipment, accumulated expertise, better recording media, more refined techniques, and a mushrooming body of literature were producing not only better images but also an increasingly organized and confident group of experienced medical practitioners who could speak for the significance of the new technology. In December 1900, the first organized meeting of X-ray operators attracted 150 medical practitioners to New York, and the national organization they founded, the American Röntgen Ray Society, worked hard during the following decades to obtain recognition of X-ray practice as a medical specialty.¹⁷

Dr Carl Beck of New York was one of the more active voices among this growing group of X-ray boosters. By 1900 he had carried out more than 3000 X-ray sessions, and his 1904 publication list included 76 articles and a book on the rays. For Beck, ‘the proofs of the immense usefulness of Röntgen rays in surgery are so overwhelming, indeed, that to discuss them would be carrying owls to Athens’ (Beck, 1900: 285). Still, the initial reaction of the profession did not surprise him:

The Röntgen rays have brought about a revolution. They show the conditions as they are, and are impolite to do so without the slightest regard for great authorities. No wonder such brusque information was received with a feeling of uneasiness, often by the same men who should have been but too glad to learn of their diagnostic errors in order to correct them. (Beck, 1904: 339)

The source of Röntgenology’s infamy within the medical profession, according to the proponents of the new specialty, was the unfortunate combination of the strangeness of its subject and the simplicity of its apparatus. The mystique of the new rays attracted many speculative minds and the simplicity of the apparatus allowed many of them to enter the

exciting new field. The key then to the rehabilitation of the field was its professionalization, that is, the replacement of the individual X-ray operator who developed and marketed his own expertise by an organized community of medical specialists, who shared and were defined by medical standards for education, training, competence, and ethics.¹⁸ Here is how a prominent member of this new group of X-ray confidants, Dr Charles Leonard, put it in 1901:

The reasons that so-called fallacies and errors have been found in this method and make it necessary to discuss its accuracy is that as a method of diagnosis, it has been entrusted to persons deficient in that professional education that is essential to the accurate employment of any method of diagnosis. The pictures made by lay operators have been accepted as valuable clinical data, and read, often incorrectly, by those who did not know how they were made. Can the medical or lay public be blamed for doubting their accuracy or for believing that they can tell as much by this new method of examination as the members of the profession? . . . The Profession must see to it that this evidence is only given by experts, reliable professional men. Its true value and accuracy will then be evident. (Leonard, 1901: 275)¹⁹

The constant threat of malpractice suits, which was a major reason for the medical campaign against X-ray technology, was turned by the proponents of the new specialty into an effective argument for embracing their specialty. Whether the medical profession likes it or not, they observed, the pictorial testimony of the X-ray image will play a central role in malpractice and other cases. Thus, instead of fighting the new images, the medical profession should learn to use them to its benefit. Instead of undermining their reliability, it should strive to monopolize their interpretation. And instead of castigating the legal fraternity for deploying them, the doctors should welcome it as a partner in their effort to regulate X-ray practice. Collaboration, Dr Mihran Kassabian, chairman of the Medico-Legal Committee of the newly founded American Röntgen Ray Society, appealed to both professions, would be of unquestionable value to all sides:

First to the physician, in sustaining double diagnosis; secondly to the patient, who is suing for damages, and thirdly to the judge and jurymen, to whom medical nomenclature is unintelligible, and to whom 'seeing is believing' . . . The physician by this means will avoid the possibilities of wrong diagnosis, and if they should be brought, he has a means of protecting himself. In addition, many suits may be discouraged, or compromises effected outside the court, by the ability to give a clear and definite statement of the condition of the injury. (Kassabian, 1901: 416)²⁰

The first 20 years of the 20th century indeed saw the rise of the medical specialty that came to be known as radiology (Brecher & Brecher, 1969).²¹ The radiologists struggled long and hard to differentiate themselves from the welter of individual X-ray operators – photographers, physicists, engineers, electricians, and so on – who were producing X-ray

images, which arguably were as good as those produced by anyone else. To that end, the medical practitioners distinguished the production of the images from their interpretation. Everyone could produce the images, they maintained, but only a few could read them. 'The language of an X-ray picture', as the author of an important medical book on the rays put it in 1902, 'is intelligible only to those who speak it themselves. Behind the picture must be the trained understanding of what it ought to represent' (Monell, 1902: 170–71). Mastering the technology, the radiologists emphasized time and again, was not enough. To read the images with any reasonable degree of accuracy – to be able to distinguish between normal and pathological appearances and between essential and accidental details – one needed to know anatomy, histology, and pathology in detail, and to be familiar with the various ways both normal and abnormal conditions appear on the X-ray plate. Without such knowledge, no meaningful reading of the images was possible. An X-ray image, as Dr Lange, a radiologist to the Cincinnati Hospital, put it in his 1907 summary of the first 10 years of radiology in the USA, 'has no intrinsic value. It is worthless, even dangerous, unless in the hands of one able to correctly interpret it' (Lange, 1907: 79).²²

The distinction between production and interpretation allowed the radiologists to shift the focus of their growing discourse from the technology to its human agents. Instead of blaming the 'failure' of the rays on the deficient technology, which was shared by all operators regardless of their training, the radiologists were now blaming it on the incompetence of the non-medical operators. 'The Skiagraph is never wrong', the slogan ran, '[w]hen error exists it lies in its interpretation' (Lange, 1907: 82). '[T]here are fallacies and errors and distortions referable to this means of diagnosis', Kassabian explained to the members of the prestigious New York Medico-Legal Society. 'But it is not the science that is at fault, but the incompetence of the persons entrusted with the work of making the X-ray examinations' (Kassabian, 1901: 408). 'When this point of view has become more prevalent', concurred in 1908 another radiologist:

[t]he pictorially excellent skiagraph of a hand or a foot made by some enthusiastic amateur will no longer excite wonder, and the photographers, electricians, and janitors who now make the so called X-ray photographs in many hospitals, will have their activities transferred to other fields where they will be less menace to the public health. (Carman, 1910–1911: 122)

The growing specialty attempted to monopolize not only the interpretation of the images but also the physical prints themselves. George Stover, professor of radiology and Dean of the Denver Medical College, instructed the general practitioners in 1910:

It is not well for you to send your patient to the Röntgenologist for the purpose of 'having an X-ray picture taken'. It is not the picture you wish; it is the opinion of this consultant you desire; it happens that he bases his opinion largely on the information he gains by means of Röntgenographic

examination. His opinion should be given to you, not to the patient The records, notes, and plates of the Röntgenologist are in the nature of privileged communication, and should be regarded technically as being as confidential as the information acquired in the consulting room. (Stover, 1910: 17)²³

Led by Stover, the American Röntgen Ray Society passed at its 1910 annual meeting an official resolution that 'endorses the views . . . vesting a property right in the radiogram with the radiographer, inasmuch as the radiogram is a part of his clinical record of examination'. According to the Society, the service that the paying patient was entitled to was the radiologist's opinion, not the image. The image was to be kept away from the inquiring eyes of the patient, carefully filed with the complete case record, available for inspection on proper demand. Furthermore, since a lawyer could compel the radiologist to present the image in court, the radiologists were advised that 'it is necessary to see that the written reports on X-ray examination are not burdened with too much gratuitous surgical information' (Skinner, 1913: 31).

Thus, by the second decade of the 20th century, an organized community of medical specialists had emerged that made increasingly successful claims of monopoly over the ownership, control, and interpretation of X-ray images. By that time, X-rays no longer enchanted the public. The rays were integrated into the scientific theories of radiation and matter, and the growing awareness of their dangerous nature diminished lay interest in them. The popular press stopped printing the images alongside explanations of what they represented, and the advertisers and the poets moved on to new icons. The increasingly specialized apparatus also was no longer a bargain, and the nonspecialists found it too costly to keep up with the pace of technological change that quickly consigned their equipment to the scrap heap. In short, the X-ray image ceased to be a part of the layman's universe and became the private property of the radiologist (Eliot, 1916: 483).

The increasingly specialized X-ray technology was gradually black-boxed, and when not totally ignored by the radiological discourse, it was treated as an unproblematic and controllable factor. At the same time, the images it produced were problematized and presented both as a human construct prone to manipulation and a code that needed to be cracked. The differentiation between the stable technology and the problematic images, between the routine production of the images and their artistic interpretation, and between the medical and nonmedical actors was institutionalized via a division of labor and status. The American Röntgen Ray Society closed its ranks before non-medical practitioners. The non-medical operator who had once dominated the field was turned into a radiographer – an invisible technician in charge of the mechanical stage of the actual image-making. The medical operator became a radiologist – a keen-eyed expert whose specialized training made him competent to interpret the enigmatic images and whose professional ethics made him suitable to represent them before the visually impaired public.²⁴

The Silent Witness Doctrine

The early decades of the 20th century saw the US courts struggling to adapt to the changes in the cultural and professional status of X-ray images. What they had embraced as a new species of evidence that would allow the lay judge and jury direct access to the disputed facts was turning into exclusive domain, accessible to experts alone. The judges were ready perhaps to sanction medical monopoly over X-ray images outside the courtroom, but not inside it. X-ray images were photographic evidence, and as such they were claimed inside the courtroom by a mightier monopoly – the institution of the lay jury, the ultimate trier of facts. Still, the judges were well aware that if X-ray images were to appear authoritative in the courtroom, they needed the sanction of the medical community and its new specialty. Thus, while holding the jury to be the final authority on X-ray images, the judges nevertheless were searching to carve a more significant role for the radiologist in the courtroom.

The courts found little difficulty in carving a meaningful role for radiologists in the admissibility stage, where photographic evidence was treated as a fallible human artifice that needed to be carefully verified. The illustrative evidence doctrine permitted a witness to present a visual representation instead of a verbal description, as long as the witness could verify that the evidence was an accurate representation of what he had seen. Unfortunately, X-ray images, by their nature, could not be verified by such eyewitness testimony. In the absence of such testimony the courts looked for other ways to establish the reliability of the images. Some judges agreed to allow the substitution of expert testimony by radiologists for eyewitness testimony, stating that the anatomical images reproduced the conditions being represented with reasonable accuracy. Most courts, however, opted to rely on circumstantial evidence in order to establish the reliability of X-ray images. The procedure generally adopted was the one suggested by Judge Lefevre, that is, summoning expert witnesses familiar with the various stages of the process by which the particular image had been produced to testify that the process had been applied in a way that was known to produce satisfactory results (Wilson, 1922: 215, n. 39, 40). Once it had been established that a skilled operator, operating with adequate equipment under proper conditions, had produced the particular image, the X-ray image was admitted into the courtroom as a graphic expression of the expert witness's testimony to be weighed by the jury. That was where the troubles began.

Inside the courtroom, the conception of X-ray images as mute objects that needed someone to speak for them ran directly counter to the implicit but powerful legal understanding that properly verified photographic evidence spoke for itself. Thus, in spite of the growing authority of radiologists, many judges continued to forbid them to tell the jury, except in general terms, what in their opinion was the meaning of the images. 'Skiagraphs or X-ray photographs are the best evidence of what appears thereby', explained an Iowa court in 1919, expressing why it found a

certain medical testimony to be a reversible error, 'and physicians should not be permitted in a personal injury action in which such evidence is introduced, to interpret and explain same' (*Lang v. Marshalltown L. & R. Co.*, 1919).

The radiologists protested repeatedly. The X-ray image, they maintained, is 'as far from being a photograph as possible for two things to differ'; its lay interpretation was 'worthless, or worse than worthless', and 'there is really no more reason why a jury should be allowed to see the skiagram than that there should be exhibited to them the clinical thermometer, stethoscope, measuring tape, and chemical apparatus, etc' (Stover, 1898: 801–02; Lange, 1907: 79; Stover, 1910: 16). The judges never seriously entertained the possibility of shifting the responsibility for interpreting the images from the lay jury to the radiologists. Nevertheless, the judges did become increasingly aware of the need to ensure that lay jurors should have access to reliable expert guidance before they decided on the evidence. This led some of them to rethink the practice of treating properly verified X-ray evidence as independent evidence that could speak for itself. 'Nobody but an X-ray expert could tell anything from the plates', declared an often quoted appellate decision in 1915:

I do not think that the doctrine that an ordinary photograph is the best evidence of what it contains should be applied to X-ray pictures. They constitute an exception to the rule concerning ordinary documents and photographs, for the X-ray pictures are not, in fact the best evidence to laymen of what they contain . . . The opinion of the expert is the best evidence of what they contain – the only evidence. (*Marion v. Coon Construction Co.*, 1915)

The disunity of judicial opinion continued well into the 1920s. Eventually, the courts came to endorse expert testimony as an essential element in the process that made the X-ray image reliable evidence. In time, the courts also took judicial notice of both the reliability of X-ray technology and the difficulties of nonexperts in reading its images (Scott, 1942: section 269).²⁵ That greatly simplified the admittance of X-rays in evidence, which now required only that the expert testify that the particular X-ray image offered in evidence was properly produced and identified. At the same time, the courts did not explicitly deviate from their illustrative evidence doctrine. Instead, they treated X-ray evidence as an exception to the doctrine, necessitated by the unavailability of direct eyewitness testimony.²⁶ Experts were increasingly allowed to interpret the images for the jury. And once the first expert had finished, it was common and general practice to permit other witnesses – for plaintiffs or defendants – also to comment on and draw inferences from the images. In short, the courts treated X-ray images as substantive evidence of the conditions revealed by them, while still discounting regular photographs by admitting them only as illustrations.

The judicial attempts to sustain the authority of the illustrative evidence doctrine by treating X-ray evidence as an exception were only partially successful, however. If X-ray images were admitted on proof of

the reliability of the mechanical process through which they were produced, why shouldn't regular photographs be admitted according to the same criteria? If the legal procedures ruling regular photography were applicable to X-ray photography, why not vice versa? Indeed, in the absence of clear doctrinal distinctions between regular photographs and X-ray images, the X-ray admissibility procedure was gradually recognized as being applicable to regular photography too. By the end of the second decade of the 20th century it was already generally acknowledged that regular photographs could be authenticated not just by an eyewitness, but by any witness judged competent by the court to speak for the reliability of the process that had produced them (Anderson, 1929).

The practical implications were minor at first. Litigation tactics and economics still dictated that photographs should be authenticated by eyewitnesses and X-ray images by radiographers and radiologists. Nevertheless, the theoretical implications were far-reaching. The basis on which X-ray images were admitted was extended to include not only the observation powers of the verifying witness, but also the reliability of the mechanical process that produced them. The essential relationship underlying the doctrine of illustrative evidence – the association between the visual evidence and the witness whose perceptions and knowledge it purported to represent – was severed. Thus, it was no longer clear why properly verified X-ray evidence should be treated in court merely as illustrative of the expert's testimony and not as independent evidence illustrated by expert testimony. Henceforth, visual evidence was no longer just another mechanism by which human witnesses communicated their knowledge to the tribunal. Machine-made pictures were now, potentially at least, independent evidence that could serve as direct evidence of the things depicted by them.

The courts were not eager to advance an alternative theory under which photographic evidence could be admitted independently of the illustrative evidence doctrine. Without such a theory, the issue was left to the broad discretion of the trial judges. Such judges sporadically recognized the photograph's independence, but without expressly recognizing that they were deviating from the illustrative theory. Instead they resorted to various kinds of specific factual elements as a sufficient foundation for admission.²⁷ Legal commentators recognized the anomaly of the situation.²⁸ In 1944, a popular handbook on evidence warned its readers that 'some photographs, even though offered as explanatory of condition, take on a double character and are both illustrative of what the witness describes and mediums through which original evidence reach the jury' (McKelvey, 1944: sections 380, 669). Two years later, in 1946, Dillard Gardner, Chief Librarian of the North Carolina Supreme Court, made a strong appeal for a new theory of visual evidence that would reflect the way photographic evidence was actually used in court:

The X-ray, which is a photograph whose accuracy cannot be checked by human vision, is welcomed in court, while the photograph, whose accuracy can be independently verified, is at times coldly turned aside. An X-

ray neither verified nor accepted as competent is admitted and the court takes judicial notice that what it represents is accurate, while a competent, verified photograph has, at times, been limited to the doubtful status that it may be used only to 'illustrate testimony' . . . We have drifted into this strange anomaly in our law by losing sight of this significant fact: photographs may, under proper safeguards, not only be used to illustrate testimony, but also as photographic or silent witnesses who speak for themselves. (Gardner, 1946: 244)

The conservative approach of the illustrative evidence doctrine, Gardner contended, may have been justified when photography was not yet well developed, so that the sponsoring witness was also testifying to the accuracy of the photographic process. However, this accuracy was now universally recognized. Thus, the time had come for the courts explicitly to recognize that photographs were not only illustrative of other evidence but could also tell their own stories.

Gardner's plea for a new theory of admissibility for visual evidence failed to impress the courts. New visual technologies were introduced into the courtroom, which expanded the realms of visual evidence and increasingly turned judge and jury into virtual witnesses who could judge the facts as if they had seen them directly with their own eyes. Most of these technologies – 16-mm motion pictures, already at work since the early 1920s; color photography, which was introduced in the early 1940s; and videotapes, which appeared in the late 1950s – seemed to pose little difficulty for the courts, which continued to muddle along within their established evidentiary framework. But in the late 1960s, with the introduction of the surveillance camera, the watchdog of the modern public sphere, the issue of whether a photograph could be admitted as independent evidence that tells its own story rather than illustrates the testimony of others was finally put squarely before the court.

Surveillance cameras, just like X-ray machines, provided valuable images for which no verifying eyewitness could be provided. However, unlike X-ray machines, surveillance cameras needed no one to speak for them in court. They produced traditional photographic evidence that conveyed intuitive information readily accessible to the jury. Thus, for the first time, the courts faced machine-made visual evidence that no longer was required to be coupled with human agency to express what it contained.

The status of surveillance camera evidence was gradually resolved during the 1970s in a series of cases involving bank robberies and check frauds. In these cases the courts admitted surveillance camera photographs on proof of the reliability of the process that had produced them. Then, the courts allowed the lay jury to extract the identity of the perpetrators from the photographs – a finding that was not supported in any way by verifying witnesses but was clearly based on the photographs alone.²⁹ This, of course, was vigorously contested by the defense as a violation of the illustrative evidence doctrine. In order to justify the decision, appellate

courts attempted for the first time to advance a general theoretical approach that explicitly recognized machine-made pictures as reliable representations of what they depict. Under this approach there was no longer a need for a witness to testify that the photograph offered in evidence accurately represents what he or she observed. The appellate decisions were readily embraced and have since grown into a recognizable alternative to the illustrative evidence doctrine for the deployment of visual evidence in court. The alternative approach came to be known as the 'silent witness' doctrine, for it finally recognized that, in some cases, the photograph could 'speak for itself' and not for a human patron (Olson, 1980; McNeal, 1984).

Conclusion

Standard accounts of science in the courts tend to cast the trial judge in the role of the conservative gatekeeper who guards the courtroom doors, admitting only the most reliable species of scientific evidence. The scientific expert, on the other hand, is cast as the enthusiastic proponent of ever-new methods, many of which turn out later to be less efficacious than promised (Huber, 1991; Foster et al., 1993; Angell, 1996; Farber, 1997; Foster & Huber, 1997).³⁰ Our case study of the legal and medical reactions to the discovery of X-rays tells a different story, in which the judge was eager to admit X-ray photography into the court despite the fact that among physicians the infant technology was widely viewed as still unreliable, and even though questions were still under discussion about what X-ray images actually conveyed, and who should be considered a competent X-ray expert.

The quick legal embrace of X-rays strongly affected the reaction of the medical community. Doctors were concerned that the new X-ray images would boost malpractice litigation and undermine their major line of defense: the authority medical witnesses had so far enjoyed in the courts. This twofold threat produced what might be considered as the first instance of defensive medicine. The medical profession campaigned against the new images, undermined their reliability and castigated the legal profession for deploying them. Meanwhile, doctors sent their patients to X-ray sessions in order to protect themselves from malpractice suits. In time, the reaction of the medical profession began to change. The double threat of undermining medical authority and boosting malpractice litigation became incentives for joining with the legal profession in an effort to regulate X-ray practice and secure a monopoly over the interpretation of the new images.

The developments within the medical community, in return, had deep bearings on the development of the legal practices and theories of visual evidence. Late-19th century US courts had relied on a practical arrangement by which photographs were admitted in evidence as illustrative of human testimony, but were often treated in court as substantive evidence that spoke for itself. X-ray evidence challenged both elements of this

arrangement. It was difficult to conceive how X-ray images could be admitted as an appendage to eyewitness testimony. It was equally hard to see how, once admitted, they could be treated in court as independent evidence that spoke for itself. This dual challenge forced the courts to address some of the conflicts buried within the seemingly robust doctrine of illustrative evidence. First, the courts removed or relaxed the demand that machine-made images must be certified by eyewitness testimony alone. Next, they made an exception to the demand that the lay jury should be the sole adjudicator of what was 'in' the images. Finally the courts recognized that machine-made images could serve not only to illustrate human stories but could also tell their own story.

Does that mean that the long and deep judicial ambivalence toward machine-made images has been resolved? Not necessarily. As commentators keep noticing, machine-made images continue to challenge the boundaries we so laboriously erect in the courtroom between lay jurors and experts, human beings and machines, and nature and artifice (Brain & Broderick, 1992; Daemmrich, 1998; Jasanoff, 1998; Mnookin, 1998; Dumit, 1999). Who is illustrating what in the courtroom: the image illustrating human testimony or the testimony illustrating the image? Who is authorizing what: the expert the machine or the machine the expert? Who is allowed to decide what's in the picture: lay jurors or experts? The rising tide in and out of court of new visual technologies and of authority claims made by experts in the name of these technologies, indicates that these questions, which have accompanied us for 150 years by now, will not disappear any time soon.³¹

Notes

1. The connections between science and law constitute a favorite Science and Technology Studies theme. For a major study of these connections in the late 20th century see Jasanoff (1995). See also the many papers of Gary Edmond and David Mercer (1996, 1998, 1999, 2000). On law as an influential partner in the legitimization of scientific evidence, see Cole (1999). On science as an influential partner in the development of legal jurisprudence and practices, see Golan (1999). On the important role the legal system played in the life of another thriving 19th-century scientific community, the microscopists, see Golan (2000). On the similarities between lawyers and Science Studies scholars, see Lynch (1998).
2. There were other perspectives to this story, especially of those who lost out: the electricians, photographers, janitors, and so on. This paper concentrates, however, on those who climbed to ascendancy and gained social legitimacy and legal recognition as X-ray professionals.
3. Wilhelm Röntgen (1896: 274) advanced the tripartite classification of the X-rays to soft, medium, and hard in his original lecture.
4. This kind of discourse dominated the field for years to come. See for example Quimby (1912).
5. For a similar statement 3 years later, see Stimson (1899: vi).
6. The scientific community lacked the organization, status, and political resources needed to seriously challenge the legal system; see Kohlstedt (1976). Most attempts to reform the legal procedures of expert testimony were initiated by members of the medical and legal professions. For the medical attempts, see Mohr (1993: 197–212). For a long list of legal lectures and discussions on expert testimony, see the entry

- 'Evidence, Expert' in Dooley (1942: 176–77). For discussions by men of science, see Editorial (1872), Herschel (1886), and Himes (1893).
7. One of the first reform bills was written in 1874 by Judge Emory Washburn, who headed a joint effort of the American Academy of Arts and Sciences, the Suffolk District Medical Society, the Boston Society for Medical Observation and the Boston Society for Medical Sciences. See Editorial (1874). See also Symposia (1884).
 8. For a summary discussion on the legal response to the reform attempts, see Kidd (1914). See also Learned Hand (1901), Friedman (1910), and Note (1910–1911).
 9. X-ray images were first admitted in evidence in America on 3 December 1896. See Editorial (1896b: 145) and Withers (1934: 100–01).
 10. In most states, the trial judge was not allowed to comment on the evidence to the jury. See Sunderland (1914).
 11. 'Photographs', 'skiagraphs', 'shadowgraphs', and 'radiographs' were the first names given to X-ray images. For the origins and reasoning behind these names, see Goodspeed (1896).
 12. For the production of 'ghost' photographs in court, see the 1869 case of William H. Mumler discussed in Mnookin (1998: 27–34).
 13. Haynes murder trial, Watertown, New York. See Anonymous (1898).
 14. For parallel discussions at the 1897 annual meeting of the American Medical Association, see Leonard (1897) and Willard (1898).
 15. Dr Grant was talking from personal experience. He was the first US physician to be successfully sued on the basis of X-ray photographs. See Golan (1998).
 16. Dr Ross repeated the warning before the prestigious New York Medico-Legal Society. See Ross (1898).
 17. Other important societies were Philadelphia's, New York's and New England's Röntgen Ray Societies.
 18. This professional ideology was prevalent during the early 20th century among various practitioners' communities in the USA. See Haskell (1984).
 19. See also Leonard (1905).
 20. See also Kassabian (1904).
 21. For a foreign perspective, see the report of a German doctor on his US tour (Krause, 1909).
 22. Compare this with Wigmore's comment on regular photography (Wigmore, 1904: section 790).
 23. See also Lange's advice: 'Under no circumstances should the plate or print be put in the hands of the patient, because of the readiness with which such evidence lends itself to unscrupulous criticism and manipulation' (Lange, 1907: 82). See also Albers-Schoenberg (1914).
 24. On 'seeing' as a socially situated and historically constituted professional discourse, see Goodwin (1994). On the practices through which visual objects of knowledge that animate a professional discourse are constructed and shaped, see Goodwin (1995). On the maintenance of professional jurisdiction over another species of evidence, fingerprints, see Cole (1998).
 25. Judicial Notice is a legal procedure of convenience whereby the court recognizes that a certain factual claim had reached the stage of a generally known truth, thereby relieving the litigants of the burden of producing evidence to prove that claim time and again.
 26. Photographs of other objects unavailable of direct eyewitness testimony, such as latent fingerprints, hairs, and carpet fibers, were also treated as exceptions to the doctrine and were verified and interpreted to the jury by experts.
 27. The paradigmatic case was *People v. Doggett* (1948). In that case a husband and wife were convicted of oral sex perversion. The only evidence introduced at the trial was a photograph taken of the defendants in flagrante delicto. No verifying witness was available, of course, but the photograph was admitted anyway. See also *Hartley v. A.I. Rudd Lumber Co.* (1937), *Carner v. St. Louis-San Francisco Ry. Co.* (1935), *Watkins v. Reinhardt* (1942), and *Lohman v. Wabash* (1954).

28. See for example the attempt to create a new evidentiary status – best secondary evidence – in order to describe the status of photographs in court. Mack (1914–1922, 22: 992). See also Anderson (1929) and Scott (1942: section 1).
29. The leading cases were: *United States v. Hobbs* (1968), *United States v. Taylor* (1976), *United States v. Calyton* (1981). See also the following cases where the defendants took the incriminating photographs: *Bergner v. State* (1979), *State v. Holderness* (1980).
30. For critique of these widely disseminated polemics, see Edmond & Mercer (1999, 1998) and Chesebro (1993).
31. A partial list of such visual technologies includes: voice and retina prints, bite mark comparisons, scanning electron microscopic analysis, computer modeling, simulation and animation, DNA typing, computerized tomography, positron emission tomography, and magnetic resonance imaging.

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