Laws of Men and Laws of Nature

THE HISTORY OF SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA

TAL GOLAN

HARVARD UNIVERSITY PRESS
Cambridge, Massachusetts
London, England 2004

Laws of Men and Laws of Nature

THE HISTORY OF SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA

TAL GOLAN

HARVARD UNIVERSITY PRESS
Cambridge, Massachusetts
London, England 2004

Laws of Men and Laws of Nature

Printed in the United States of America

Library of Congress Cataloging-in-Publication Data
Golan, Tal.
Laws of men and laws of nature : the history of scientific expert testimony in England and America / Tal Golan.
p. cm.
Includes bibliographical references and index.
ISBN 0-674-01286-0 (alk. paper)
1. Evidence, Expert--England--History. 2. Evidence, Expert--United States--History. I. Title.

KD7521.G65 2004
347.42'067--dc22

2004042215

For Dana

Contents

	Introduction	*1*
1	"Where There's Muck There's Brass": The Rise of the Modern Expert Witness	*5*
2	The Common Liar, the Damned Liar, and the Scientific Expert: The Growing Problem of Expert Testimony	*52*
3	Who Shall Decide Where Experts Disagree? The Nineteenth-Century Debates	*107*
4	Blood Will Out: Distinguishing Humans from Animals and Scientists from Charlatans	*144*
5	The Authority of Shadows: The Law and X-Rays	*176*
6	Science Unwanted: The Law and Psychology	*211*
	Epilogue	*254*
	Notes	*267*
	Index	*315*

Acknowledgments

It would be impossible to properly thank the many historians, scholars, judges, scientists, lawyers, archivists and colleagues who contributed to this book by offering valuable materials, guidance, commentary and criticism. What follows is no more than a start. My editor Elizabeth Knoll has been a constant source of support and much-valued advice. David Lieberman and Thomas G. Barnes initiated me into the mysteries of Common Law and showed me how to handle its subtleties. Roger Hahn, Alex Pang, Sheldon Rothblatt, Carla Hesse, David Hollinger, Barbara Shapiro, Chris Kutz, Roger Smith, Jennifer Mnookin and the late Amos Funkenstein have spent many hours with me, discussing my ideas and providing me with invaluable guidance. My father-in-law, Leon Linskill, helped me to decipher obscured eighteenth-century materials and took great care in keeping my English proper. My dear friend Noah Efron has offered me unending camaraderie, energy and brilliance. I thank them all.

Institutional help was crucial to the completion of this book. UC Berkeley's history department and the Office for the History of Science and Technology provided me with the best education I could have hoped for. The inter-library loan unit at UC Berkeley admirably coped with the wide range of my requests. A two-year post-doctorate fellowship at the Dibner Institute for the History of Science and Technology, in MIT, provided me with access to the some of the finest libraries in the world and plenty of time to develop my ideas. The Rothschild Fund

gave me much-needed financial support and the Ben Gurion Research Institute in Israel proved to be an excellent place to work on and finish the book.

A slightly different version of Chapter 4 appeared as "Blood Will Out: Distinguishing Humans from Animals and Scientists from Charlatans in the Nineteenth-Century Courtroom," *Historical Studies in the Physical and Biological Sciences* (2000) 31:93–124. Some parts of Chapter 5 appeared as "The Authority of Shadows: The Legal Embrace of the X-Ray," *Historical Reflections* (1998), 24:437–458. I thank both journals for permission to use some of that material here.

Finally there is John Heilbron, to whom I owe more than words could convey. His teachings are all over this book.

Laws of Men and Laws of Nature

Introduction

THIS IS A HISTORY OF SCIENTIFIC expert testimony in Common Law courts. Situated at the intersection of the two dominant institutions of science and law, scientific expert testimony has long been overlooked by both. Historians of science ignored it because they did not consider courts of law to be important sites of scientific activity before the twentieth century. Historians of law ignored it because they never considered science to be a significant factor in the development of judicial practices and jurisprudence related to evidence. As a result, there is relatively little scholarship about the history of the relations between the two most authoritative institutions in modern Western culture—science and law.

This book explores these relations. It describes the emergence of the law as a major patron of nineteenth-century science, a role it fulfilled in several ways. It was a patron in the most literal sense: expert testimony, arbitration, and counseling constituted a lucrative sideline activity for many men of science. In addition to funding scientists, the courts also underwrote scientific progress; the constant demand for additional and better scientific evidence spurred important discussions on central scientific issues such as standardization, accuracy, and reliability. Finally, the adversarial realities of the legal system provided a fertile breeding ground for an intensive nineteenth-century discourse on what it meant

to be a man of science in an increasingly professionalized and industrialized world, and on the character of the scientific community—its function in society and the values by which it judged the work of its members.

Science and technology affected law no less than law affected science. New legal apparatuses evolved during the nineteenth century to deal with the rising tide of litigation involving complex scientific argumentation. Patent law evolved into a major mediator between the producers of scientific knowledge and those who adapted it to the various wants of society. The legal domain of regulation evolved to control the risks that scientific knowledge and its technological products created for public safety and the environment. Finally, and most important for this book, scientific and technological developments introduced, sometimes within days and weeks of their discovery or invention, novel forms of knowledge claims into the courts. These claims continually challenged judicial practices and inspired developments in the jurisprudence of evidence.

This leads us to the question of appearances. We are accustomed to thinking of science and law as two fundamentally distinct cultures. Science deals with nature, we are told, and law with society. Science organizes our knowledge of the world; law directs our actions in it. Science is an open-ended, impartial search for truth; the law is a normative process that ultimately seeks closure.[1] It is equally true, however, that science and law are mutually supporting belief systems and deeply connected social institutions heavily invested in each other. Scientific knowledge and techniques have played a growing role in the spread of justice in modern society. Institutions of the law have helped to clarify the character of legitimate scientific knowledge and practices and to readjust the social and institutional relations that their application required. We should not be surprised, therefore, to discover that the courts have not been neutral gatekeepers that simply exclude unreliable scientific testimony but rather active partners in the production and maintenance of credible scientific evidence. Similarly, we should not be surprised to find that science has been no mere supplicant to the law, but, again, an influential partner in the production and maintenance of credible legal theories and practices for fact-finding and proof. Here, then, lies the challenge of this book, to transcend the dichotomies of science and law. The result should be read not as a history of English patent law or American forensic science but as an exploration of key moments in the evolving relations between the expanding cultures of law and science on both sides of the Atlantic.

The account that follows is chronological, but its geography is more complicated. The book starts in late-eighteenth-century England with the birth of the modern partisan expert witness and with the legal embracing of Newtonian philosophy as a legitimate expertise. It ends in late-twentieth-century America, with the U.S. Supreme Court dipping into the murky waters of the philosophy of science in an effort to establish criteria that would allow the courts to distinguish between good and bad science. In between, this book explores important turning points in the practices, debates, and jurisprudence of expert testimony in England and America. Each chapter describes how an important set of scientific developments in engineering, chemistry, industry, public health, microscopy, experimental psychology, and other areas challenged the laws of evidence and the practices of expert testimony and produced new jurisprudence in patent law, nuisance law, expert medical and scientific testimony, the admissibility of visual images, and so on.

Mapping broadly the uncharted territories that lie between law and science, this book provides a much-needed historical perspective on the state of scientific expert testimony in Common Law courts today. The scientific controversies that accompanied many high-stakes legal cases that turned on scientific evidence—whether notorious criminal cases, such as the 1995 O. J. Simpson trial or the 1997 trial of Louise Woodward, or civil cases such as the tobacco, Bendectin, and breast-implant mass tort litigations—have been seen by many commentators as a sign of moral corruption. America's courts, they warn, are being swamped by "junk science" produced by opportunistic scientific experts at the behest of unscrupulous attorneys, who are able in the name of science to persuade credulous juries to acquit wealthy defendants or award millions of dollars each year to plaintiffs spuriously suing deep-pocketed corporations. Other critics blame the scientific disagreements on faulty legal procedures governing expert testimony. The adversarial nature of the legal process, they argue, promotes partisanship and prevents the appropriate resolution of the scientific issues presented in court. But whether they blame the experts or the law, almost all critics assume that the scientific disagreements in court are an aberration. If charlatanism and partisanship could somehow be swept aside, they believe, disagreement would diminish, and perhaps even disappear altogether.[2]

Not all scholars see the disagreement among the scientific witnesses as detrimental to either justice or science. Some maintain that the scuffles between scientists in court reflect the actual day-to-day workings of a healthy scientific community that constitutes an integral

part of society.[3] Thus, where the majority of commentators see decadence and unnecessary partisanship, these scholars see a normative commitment by the adversarial legal system to develop two sides to every story; where others cry judicial ineptitude, they celebrate the superior ability of the adversarial procedures to disclose areas of uncertainty and inform the public of the interpretive conflicts and normative biases left unacknowledged by the scientific community; and where others emphasize the importance of reliable expert guidance for the maintenance of a healthy judicial process in a society that grows exponentially in specialization and sophistication, they emphasize the importance of deconstructing expert authority through the adversarial process for the maintenance of a healthy political discourse.

Underlying this debate is one premise shared by all—that the malaise of expert testimony is a sign of our times, the result of the growing difficulties of the courts and the public in handling the increasing complexity of modern science.[4] This assumption, we shall quickly see, is mistaken. Far from being new, the putative problem of scientific expert testimony in Common Law courts has a long and rich history. Discontent with scientific expertise in the courts has existed as long as there have been scientific expert witnesses, and by the mid-nineteenth century, the debate over the meaning of these conflicts and the ways to resolve them had all the features that today are blithely assumed to be new. Understanding the long, twisted roots of today's conflicts will not in itself resolve the vexed debate about the role of science in the courts. If anything, it may suggest that current conflicts are more deeply ingrained and hence less ameliorable than many pundits would like to believe. But it will, at least, reveal that these conflicts are less a product of human and institutional pathology than they are an illustration, should we need one, of the complexity of the ongoing social negotiations needed to harmonize laws of men and laws of nature and to cut truth and justice to human measure.

1

"Where There's Muck There's Brass": The Rise of the Modern Expert Witness

> Lord Mansfield was a surprising man; ninety-nine times out of a hundred he was right in his opinion or decisions. And when he was wrong, ninety-nine men out of a hundred could not discover it. He was a wonderful man!
>
> ~Remark attributed to Lord Chancellor Thurlow, quoted by James Oldham, *The Mansfield Manuscripts*

THIS CHAPTER RECOUNTS a late-eighteenth-century legal episode that serves in the legal literature as the origin story for the rise of expert testimony in the modern Anglo-American legal system. The case could have become an origin story because by the time it occurred both lawyers and men of science had obtained the same sort of authority they now exercise in their respective spheres. At the start of the eighteenth century, natural philosophy was but a bookish study of nature in general. By the end of the century, it had narrowed its focus to the inanimate world, supplemented learning from books with experiments, borrowed some mathematics, and showed indications of practical utility. Meanwhile, the lawyers were solidifying their control of the production of evidence and its deployment in the courtroom. At the beginning of the eighteenth century, the judiciary dominated criminal proceedings, and the accused represented themselves. Evidence was mostly adduced either by direct in-court altercation between accuser, accused and witnesses, or by the judge, who examined the parties and the witnesses himself. By the end of the century, the lawyers had reduced the trial judge to an umpire, took over the examination of witnesses, developed the techniques of cross-examination, established

their right to argue points of law, and completely transformed the English legal system into the adversarial system as we know it today.[1]

The expert did not fit easily into this new adversarial environment. Traditionally, experts appeared in court either as a part of the jury or as court advisors. In both cases, their performance was initiated and controlled by the court, which assumed the impartiality of the experts. But during the eighteenth century, as the court gradually assumed a neutral position, as the litigants started to summon their own experts to represent them before the jury, and as adversarial ideology was given free reign, a new place had to be found for the expert. The incipient conflict came to a head in 1782, in the civil case of *Folkes v. Chadd.* In this case, also known as the Wells Harbor case, litigants summoned to court several sorts of "men of science," to testify before the jury as to what had caused the decay of a certain harbor on the Norfolk coast of England. The testimony of one of these experts, a prominent Newtonian philosopher, was disallowed because of the lawyers' objection that his philosophical explanations were a "matter of opinion, which could be no foundation for the verdict of the jury." On appeal, Lord Mansfield, chief justice of the King's Bench, found the silencing of the philosopher to be an error and granted a new trial on the ground that the philosopher's theory "was very proper evidence."[2]

Lord Mansfield's opinion in the Wells Harbor case has served in legal literature as the principal precedent that shaped the most dominant option of using experts' knowledge in the modern Anglo-American courtroom—that of calling experts to testify before the jury as partisan witnesses. It has been unanimously declared "the foundation of the rules governing expert evidence." Some went even further and considered it "the court's seal of approval on the whole adversarial apparatus including contending experts, hypothetical questions, and jury evaluation."[3] Still, in spite of its prominent status, the Wells Harbor case has received almost no attention from historians of either law or science. All sources refer either to each other or to the original legal report of *Folkes v. Chadd,* which was published in 1831, half a century after the events of the case.[4]

This opening chapter offers a close and detailed analysis of the Wells Harbor case. When its legal, social, economic, engineering, and scientific backgrounds are reconstructed, the Wells Harbor litigation indeed emerges as an important historical junction in the evolving relations between science and law—but for reasons other than those so far suggested by historians. In *Folkes v. Chadd* Lord Mansfield was not intent on inaugurating a new practice of calling experts as partisan witnesses, nor on solving the difficulties that await such a practice in the adversarial courtroom. Rather, Mansfield was trying to clarify the legal status of a nascent species of expert—Newtonian philosophers, who expressed in court theories whose position on the legal continuum between fact and speculation was yet unsettled. Mansfield's solution, which shaped the practice of modern expert testimony for the next two centuries, maintained that the law should not give preference to one kind of science over another and required that all kinds of science be heard in open court.

In developing the many dimensions of *Folkes v. Chadd,* this opening chapter has a three-part agenda. First, it outlines the long career of the expert in Common Law courtrooms from its early medieval origins to the late eighteenth century, thereby providing the background for the rest of the book. Second, recounting the contest of authority and expertise among the various sorts of men of science—handled not retrospectively, by historians or philosophers, but contemporaneously by the rough epistemology of the legal process, the chapter offers a unique picture of late-eighteenth-century English science, one that is not washed out by the bright light of the Newtonian sun. Third, pointing to the gulf between the facts and the thinking that went into *Folkes v. Chadd,* and its subsequent reputation, the chapter suggests a reformulation of the conventional narrative describing the rise of modern expert evidence. The modern expert witness was indeed the creation of the late eighteenth century. However, far from being deliberately molded as a judicial solution to the problem of partisan expertise in the adversarial courtroom, the expert was conceived as a necessary exception, the only source of information the new system could not rationalize under its evolving doctrines. And such the expert would stay—a freak in the new adversarial world, an incompatible and inharmonious, yet indispensable and influential, figure in the modern adversarial courtroom.

The Decay of Wells Harbor

The town of Wells is situated on the north coast of the county of Norfolk, England. Its inhabitants like to call their town Wells-Next-the-Sea, but it has been centuries now since the sea slipped away from the town, leaving only its name behind. To get to the sea, one has to cross a strip of extensive salt marshes, wide sand dunes, and long shingle spits. Created by the ceaseless sedimentation of the wild North Sea, the

strip ranges from three-quarters of a mile to three miles in breadth and stretches for many miles eastward and westward of Wells. The strip is elevated above the neap tides, and the sea makes its appearance on it only in an incomprehensibly intricate net of creeks, branching and subbranching to infinity. Some of the largest creeks are big and deep enough to serve as safe harbors. Such is the harbor of the small town of Wells. It extends sinuously for more than three miles through the sandy and shingle beach and through the low and flat marshes until it reaches the quay of the town.[5]

The north coast of Norfolk was notorious for being one of the most dangerous and most fatal to sailors in all Britain, and Wells Harbor has been from time immemorial a safe haven for ships that routinely dared the wild North Sea on the busy route between London and the northern coasts of Great Britain. As a gate to an agricultural county, Wells was also a seaport that handled considerable imports of coal and exports of corn and malt to London and the Continent during the seventeenth century. It was thought of such importance that a Parliamentary Act was passed in 1663 that allowed the town to tax the goods imported there in order to enlarge the quay and cover its maintenance.[6] For the maintenance of the harbor itself, having no river or any other inland fresh water source, Wells had always relied on the strength of the ebbing tide to scour the rich silt that the violent tides and winds constantly deposited at its bottom. While filling the harbor's channel, the influx of the tide filled all the other creeks and gullies, and in spring the tides overflowed the entire salt marshes, creating a natural reservoir that covered thousands of acres. With the ebbing of the sea, much of this water ultimately collected in the central channel of Wells Harbor, providing sufficient scouring to maintain its depth and safety. At the beginning of the eighteenth century the deeper part of the channel, called the pool, where the ships anchored, was reported to be so deep that even at low tide two or three tiers of vessels could lie afloat and swing around.[7]

Situated near the "Good Sands" region, the reputed birthplace of the Agricultural Revolution, during the eighteenth century Wells Harbor became the second largest harbor for the exportation of malt within the kingdom, second only to Great Yarmouth, in East Norfolk. The prosperity of the region was due neither to its sandy soil nor to its dry climate, but rather to the successful application of new farming methods imported from the continent for the purpose of increasing revenues. Well-placed to enjoy the growing demands of the urban markets both at home and across the North Sea, a new breed of capitalistic farmers evolved in Norfolk. They were led by landowners who realized

that large profits could be made and were eager to experiment with new methods of farming that would produce an ever-larger surplus for sale. By the end of the eighteenth century, Norfolk's harbors were shipping more grain than all the rest of England combined, and its husbandry came to be known worldwide as the Norfolk system.[8]

Salt-marsh silt forms very fertile soil once the salt has been washed out. For this reason many salt marshes along the eastern coast of England have been reclaimed for farmland. Reclamation along the north coast of Norfolk, where fertile land is exceedingly scarce, has been going on since Roman times. Reclamation reached its culmination in the late seventeenth and early eighteenth centuries, during which time nearly eight thousand acres of coastal marshland were embanked and reclaimed from the North Sea. Around Wells, Sir Thomas Coke, first Earl of Leicester, and Sir Charles Turner, Lord of Wells Manor, two of the biggest local landlords and leaders of the new farming movement, reclaimed close to eight hundred acres of salt marshes on both sides of the harbor's channel between 1719 and 1721. The embankments erected to prevent the tidal water from flowing through and over the reclaimed marshland greatly weakened the body of backwater available for scouring the harbor. The effect was quickly noticed. Just a few years later, in 1725, according to an eyewitness account, "the said harbour of Wells, its channel and pool, have very sensibly decayed, as have done all the channels that has been anyways deprived of their ancient stock of back waters." Soon the parts of the harbor furthest from the sea became clogged to such a degree that the quay became inaccessible to shipping and the greater part of the cargo had to be carried to and from the town by lighters.[9]

Wells Harbor was not the only Norfolk harbor that suffered from the massive reclamation of coastal marshlands. The fresh water harbors at King's Lynn and Wisbech went into decay after the monumental seventeenth-century reclamation project of the vast marshland known as the Great Bedford Level shut out the tides that kept the mouth of their rivers open. The Sussex port of Rye was so silted up after the reclamation of its bordering marshes that a new entrance to the harbor had to be cut in 1724, and a large stone sluice had to be built to keep it clean. "If private men, to get a little land, may be guilty of such encroachments," a Norfolk pamphlet from 1724 expressed local frustration, "all our ports may be ruined in time, in the same manner that Lynn, Wisbech, and Rye have been."[10]

To remedy the growing problem of their harbor, a group of Wells merchants agreed to finance a sluice that would scour the harbor and

keep it open. It is not clear whom they hired to do the job. Turning to foreign help in drainage and other hydraulic matters was not unusual in early-eighteenth-century England, which still depended for its engineering "even more than we did for our pictures and music, on foreigners."[11] Most of these hydraulic experts were recruited from the neighboring Low Countries, where much practical knowledge had already been accumulated on such matters. The experts hired by Wells merchants erected dams and cut new passages so as to redirect some of the creeks and gullies branching from the harbor's main channel into a large creek opposite the quay, the mouth of which was artificially contracted. The flooding waters lying in these various creeks created a reservoir that discharged itself forcefully into the main channel through the narrow opening of the large creek. Freestone Sluice, as it was called, started to operate in 1748, and for a while it successfully scoured away the mud that disturbed the upper parts of the harbor. With time, however, the mouth of the sluice widened and its effect was gradually impaired. In addition, in 1758, Sir John Turner, heir of Lord Charles Turner, embanked and reclaimed another 172 acres of salt marsh, among them a 66-acre site called Wharham Slade that had previously supplied Freestone Sluice with much of its water. This further reduced the reflux of the ebbing waters in general and the scouring powers of the sluice in particular. Within a few years, the combined effects of the deteriorating sluice and the new embankment brought the harbor to a worse state than ever.

Fearing for the loss of their harbor, local merchants, ship owners, and inhabitants entered into a voluntary subscription and secured a large loan. With these resources a bigger sluice was built upon a new site in the remaining unembanked part of the salt marshes in 1765. In 1768, the town succeeded in obtaining a Parliamentary Act that allowed it to increase the duty on incoming cargo and to use it to pay its encumbering debt. The Act further ordered the appointment of a board of commissioners for the harbor with the powers "to make such bye-laws, rules, orders, and regulation, as should be found necessary for the purposes of . . . the improving, preserving, and maintaining the harbor, quay, and other works belonging thereto."[12] The newly appointed board constituted a rough model of the harbor's uneasy politics. On one side sat the town merchants and the ship owners whose livelihood depended on the harbor. On the other side sat Sir John Turner and Thomas William Coke, the two local landlords who owned the reclaimed marshlands adjoining the harbor. The underlying tensions soon surfaced as new predicaments began to multiply.

One of the great advantages of Wells Harbor had been the northwest direction of its channel, which coincided with the flow of the rising tide and allowed vessels to come from the sea through the channel and into the pool with relative ease. During the 1760s and 1770s, the mouth of the channel had changed its orientation, moving considerably toward the east so that it ended up facing northeast by east. As a result, the tide, which flowed from northwest to southeast, drove the vessels across the channel and into the eastern bank. This meant that no vessels could enter the harbor safely without a strong leading wind, and many ships had been lost, to the great disadvantage of the port. In addition in 1777, the new sluice that had successfully cleared the harbor for a while was found to have been nearly destroyed by a sea worm that had attacked the timber with which it was built. The commissioners sought advice from a local engineer named Wooler, who advised them to build an entirely new sluice, made of stone so that the worms could not touch it. Because of the expense (over £2000), the advice was rejected. The previous debt was not yet fully paid, and the commissioners knew that the duty under the present Act was a great burden on the merchants and could not be further raised without losing trade from the port. Unable to raise the money for a new sluice and confident that the embankments on the marshlands were the first and principal cause of all of Wells Harbor's troubles, the commissioners of the harbor considered their legal options for bringing the embankments down.

Enter Law

The decision to go to court was not taken lightly by the commissioners. To start with, Turner and Coke sat on the board and could offer formidable opposition. Second, the legal action could turn into a protracted and costly business that would force the commissioners to proceed through two systems of justice. As a general rule, late-eighteenth-century Common Law took a hard-nosed attitude toward private improvements that hindered navigation in public waterways. These were considered a public nuisance, an offense against the King's subjects, indictable as a misdemeanor. Still, not every structure erected in tidal water was, *ipso facto*, a public nuisance, and not every recognized nuisance was to be eliminated, especially if the damage could be compensated.[13]

Whether or not a nuisance existed was considered a question of fact to be decided by a jury in a Common Law court. In the still largely rural

and agricultural society of the eighteenth century, the standard that the jury followed in such cases was the absolute right to free use and enjoyment of land. According to this conservative guiding rule, which had remained remarkably constant since the Middle Ages, any conduct producing unreasonable interference with the use of a neighbor's property constituted a legal nuisance.[14] Therefore, the commissioners stood a good chance of winning their cause in court. Alas, Common Law courts were only empowered to grant damages. Thus, even if successful, the commissioners could still find themselves forced to seek an order for abatement from the Chancery Court, a notoriously time-consuming and costly procedure.

The commissioners sought the advice of Mr. Nash Grose, a veteran Serjeant-at-Law who enjoyed a prosperous practice in the central court of Common Pleas. The experienced Grose advocated a cautious approach. "All the embankments," he pointed out, "were Nuisance at the time they were made; but some of them have existed so long that there will be some Difficulty in getting them removed." If the commissioners wanted to pursue the matter in court, Grose advised, they should use the money raised following the Act of 1768 to indict "those persons who have made or continued the last of the Embankments which are prejudicial to the Harbour." However, Grose recommended that before making such an attempt, the commissioners write to Sir John Turner, "stating the inconveniences occasioned by the embankments and begging him to remove them . . . [For] he may find out some plan to remove the nuisance complained without doing much injury to the land embanked, which would be the most desirable object on both sides."[15]

Sir John was a recognized leader of the "the Norfolk science of agriculture," which turned Norfolk into the principal site of what contemporaries called "the agricultural revolution." This so-called revolution hinged on the alteration of the traditional patterns of communal land ownership. This was done throughout the eighteenth century by a flood of Parliamentary Enclosure Acts that wiped out the traditional rights of commonage by requiring that private land be fenced off from common land. Enclosure, not unlike the contemporaneous conversion to the metric system across the Channel, offered the best way forward from the confusion of traditional practices to the orderly methods of the new scientific spirit. Fencing made systematic cultivation possible. It kept one's livestock in, kept other people's livestock out, and liberated the landowners from the need to consult others about what they should do. Backed by the Enclosure Act, landowners were able to take advantage of the gradual collapse of the old village economy to perform massive purchases of land intermixed with or adjacent to their property. Their objective was to create large consolidated estates that would allow for the concentration of capital, rationalization of labor, and mechanization of production. In this emerging protocapitalistic environment, the science of agriculture became "the most useful science a gentleman can obtain," tending, as it was claimed, "to the increase of both private property and public benefit."[16]

According to Arthur Young, the great publicist of scientific farming during the late eighteenth century, "it would seem that the farmers of Wells neighborhood owe more to Sir John Turner than to anyone else." On his estate Sir John experimented with husbandry, forestry, and crop rotation. The embankment he erected in 1758 was no doubt part of his systematic reclamation of the fertile marshland, which otherwise served only as a sheepwalk and as a meager common for cattle.[17] Such improvements required prudent administration and sizeable resources. The large-scale operation, the ceaseless conversion and reconstruction, and the legal expenses involved in the redistribution of the land necessitated large investments, which were tied up for a long time before they showed a return. Some landowners eventually got hefty returns from their improved estates—no one more so than Turner's famous neighbor, Coke of Norfolk. Coke inherited his estate in 1776, at the age of 22, and within the next forty years spent more than half a million pounds upon its improvement, thereby almost tripling its yearly rental value from £12,332 to £31,050.[18] Other landowners, however, piled up mainly debts. Such seemed to be the case with Sir John Turner. Old, indolent, and heavily in debt for mortgages on his estate, his response to the commissioners' request to take down his embankment was one of delay and evasion. Frustrated, the commissioners finally decided to seek justice in the courts.

Twice a year, around January–February and July–August, all twelve judges of the three central courts—King's Bench, Common Pleas, and Exchequer—would leave their comfortable Westminster seats for two or three weeks to spread royal justice among the counties of England. These judicial tours were called assizes. The counties were grouped into six assize circuits, and a pair of judges, each from a different court, rode each circuit, trying before local juries the cases originating there. One judge presided over the criminal cases and the other over the civil ones.[19] The commissioners took their cause to the assizes for the county of Norfolk, held in Norwich. There, a grand jury found for an indictment against Sir John, declaring his 1758 embankment a public

nuisance and ordering it to be taken down. Obstinate, Turner still refused to abate and his lawyers continued to temporize. Then, in June 1780, just before the commissioners were ready to proceed with their legal action in the summer assizes, Turner died. Alarmed by the delay that Turner's death might engender and by a new inspection showing the continuing deterioration of their harbor, the commissioners resolved not to wait any longer and to employ men in order to cut open the embankment. The decision was reached despite the violent objection from the other great landlord on the board, Thomas Coke, who warned the commissioners that any similar attempt to destroy his embankments would be defended by him "as if his house was attacked."[20]

Turner's heirs were his two daughters, and his two sons-in-law, Sir Martin Browne Folkes and Robert Hales, jointly managed the insolvent estate. Notified of the commissioners' intentions, they were advised against physically resisting the cutting. Instead, they filed a bill in Chancery Court requesting that it direct the commissioners to refrain from any activity that would injure their property. "We are willing," they declared," to try it by any Action they think fit, or the Court shall approve, whether we are entitled, or Sir John had not a Right to make this Erection and to continue it, or whether they have any Right to complain of it as a Nuisance . . . We desire only that irreparable Mischief may not be done to the bank till it is tried." Approving, the Chancery Court issued an injunction against the commissioners and ordered the dispute to be brought before the court of the King's Bench.[21]

The main features of the eighteenth-century procedures of Common Law had already been fixed by the beginning of the fourteenth century, when every legal action derived its final authority from a specific royal mandate, called a writ. Each writ specified the reasons for its issuance and the agencies enjoined for the specified actions to be taken. This highly formal system of writs served also as the main classificatory scheme for Common Law, and eighteenth century legal procedures were still organized around it. By that time, however, this genuinely medieval mechanism had been transformed into a labyrinth of technicality through which none but the most skillful or most fortunate could find their way. Eighteenth-century suitors were required to select, at their peril, the appropriate writ for their cause of action, and then strictly follow its ancient procedures. These typically required the parties to frame a single narrow question of fact to be decided by the trial jury. This was done during a pretrial stage called *pleading*. The pleadings were launched by the plaintiffs' written declaration, explaining their claim in strict conformity with the original terms of their chosen writ. Upon receiving the opening declaration, the defendants would choose either to *demur* (attack it in point of law) or to *plead* (oppose it in point of fact). By choosing to demur they would be admitting the plaintiffs' version of the facts but denying that it disclosed a legal cause of action. By choosing to plead they could either make *dilatory pleas* (opposing the legal action on technicalities such as choice of jurisdiction or writ) or *peremptory pleas* (impugning the right of action itself). If making peremptory pleas, they could choose to go either by *traverse* (denying the plaintiffs' statement of facts *in toto)* or by *confession and avoidance* (admitting the statement of facts but adding others that contravened it). Pleas could then be followed in succession by a replication, a rejoinder, a surrejoinder, a rebutter, a surrebutter, and so forth *ad nauseam*.[22]

Exercising this black-letter art of pleading, the legal representatives of the Turner estate and the commissioners of Wells Harbor finally agreed that the method of litigation be this: Folkes and Hales would bring an action of trespass against the commissioners as if they had actually cut their embankment down. This would place the burden of proof on the commissioners, who would try to justify cutting down the embankment by showing that it was a nuisance "which any of the King's Subject has a right to abate." The narrow question put before the jury to decide would therefore be whether the mischief that the bank did to the harbor was a justification for the cutting. If the trial jury decided that the cutting was unjustified, then the injunction would stand and the commissioners would have to compensate Folkes and Hales for their expenses. If the jury decided that the cutting was justified, then Folkes and Hales would have to compensate the commissioners for their injuries and probably also destroy the embankment. The trial itself, where the jury would hear the facts of the case, was set to take place in August 1781, at the summer assizes for the county of Norfolk in Norwich.[23]

Enter Science

Sir Martin Browne Folkes was a descendant of highly scientific lineage. His grandfather was Sir William Browne, president of the Royal College of Physicians. His uncle and godfather was Sir Martin Folkes, Newton's handpicked successor as president of the Royal Society of London. Named after both famous relatives, Sir Martin Browne Folkes

owned a large estate near Lynn, Norfolk, which he no doubt farmed scientifically. We should not be surprised therefore that in preparing for the coming trial he enlisted the services of science in the shape of Robert Mylne, F.R.S. Mylne agreed to come to Wells, study the harbor and its surroundings, and submit a report as to whether and in what ways the embankment erected in 1758 affected the harbor.

Ten years earlier, in 1771, Robert Mylne had been among the seven founding members of the Society of Civil Engineering, whose formation best symbolized the emergence of the new English profession of civil engineering during the late eighteenth century. On the Continent, the profession of civil engineering was already well established, and official academies had long taught the preparatory sciences and arts necessary for able professionals to comprehend the technicalities of the projects they took part in. In England such establishments did not exist. There works of civil engineering such as fen drainage, construction of canals, mills, bridges, turnpikes, and improvement of harbors and rivers had long been undertaken, if not by foreigners, then by a welter of craftsmen, millwrights, stone masters, surveyors, and instrument makers. These craftsmen made up for their lack of formal education with much technical ingenuity, but they never saw themselves as part of a larger vocation.

This state of things was changing fast during the latter part of the eighteenth century in response to the rapid increase in the number and scale of public and industrial works throughout the country. The overwhelming demand for expert planning and professional supervision turned what used to be at best a haphazard occupation into a promising and respected career. By 1781, at least half a dozen well-known engineers had their own independent consulting practices, while many others had regular employment managing the construction of canals, lighthouses, bridges, and harbors; supervising fen and coal mine drainage; and designing water mills, steam engines, and other machinery required by the fast-growing industry.[24]

Mylne came from a distinguished Scottish family that had provided master masons to the Scottish Crown since the sixteenth century. He was born in Edinburgh, where his father, in addition to being the city surveyor, had an extensive architectural practice. In 1754, at the age of 21, Robert went to Rome, where he studied architecture for four years. In 1759, he returned to England just in time to win the prestigious competition for the design of the Blackfriars Bridge on the Thames. His controversial bridge introduced for the first time into England the

elliptic arch, and its successful completion in 1769 made Mylne famous. Known as an architect-engineer, a common Continental liaison but unique in England, he soon developed a thriving private architectural-engineering-surveying practice. His specialty remained bridges, but his designs were varied. Among other things, he was appointed architect of St. Paul's Cathedral and chief engineer of the great New River Company, which supplied water to London. A recognized leader of this new and rising order of professional men who called themselves civil engineers, Mylne was often invited to Parliament to testify before the various committees of the House of Commons that dealt with the improvement of internal navigation so necessary for the growing economy. Occasionally, he also served as an arbitrator for the King's Bench, settling legal disputes the royal judges thought fell within his professional expertise. Securing Mylne as his expert, Sir Martin Browne Folkes retained therefore the services of an eminent professional who was considered as authoritative in his own field of civil engineering as any doctor or lawyer could be in their respective professions.[25]

In October 1780, Mylne traveled to Wells to study the problems of the harbor. The report on his findings was long overdue, but when it finally arrived in late May 1781, it contained all that the lawyers for Turner's estate could have hoped for. Mylne's conclusion was clear: the troubles of the harbor could not be attributed to the said embankment or to any other embankment. What had caused the decay of the harbor were the vast quantities of materials discharged at the immense western estuaries by six rivers—the Ouse, Nene, Witham, Trent, Wharfe, and Swale—and deposited along the north coast of Norfolk by the rising tides and the strong winds of the North Sea. "The Sea is embanking, of itself, the whole Coast, and the time will probably come," Mylne predicted, "when this Harbor will diminish to a creek and that again, by slow Degrees, to a solid land."[26]

Mylne made sure to support his opinion with careful calculations and factual observations, and to illustrate it by two maps carefully made under his direction by local surveyors. According to Mylne's calculations, more than sixteen hundred acres of unembanked marshes and another 150 acres of creeks and inlets existed on both sides of the harbor. What could the sixty-four acres of embanked marshland that were the object of the dispute do, he asked, that these unembanked 1750 acres could not? If anybody was to blame for the decay of the harbor, it was those who had designed the sluices. Only contracting the mouth of the creeks, instead of incorporating a true stop gate to retain

the backwater to a full head before letting it out, the two sluices failed to exploit the full scouring impact of their retained backwater. With the coming trial in mind, Mylne concluded his report by indicating to his employers his willingness to help disprove the accusations against them from the witness stand:[27] "Human Nature is too apt to form Systems and draw Conclusions, without sufficient Observation and Scrutiny. Too often the Search is made for an evil in our neighbor's property, when, perhaps, it is to be found at home. The facts herein stated, I am ready to testify when required; and the deductions made from them, I hope will be found to be well founded in the Opinions of impartial Men."

Experts in the Courtroom

The English jury system had long acknowledged the importance of experts like Mylne in cases such as that of Wells Harbor, where the disputed facts were such that the jury lacked sufficient knowledge to draw an informed decision. "If matters arise in our law which concern other sciences or faculties," declared an English judge in 1554, more than two centuries before the Wells Harbor case, "we commonly apply for the aid of that science or faculty, which it concerns. Which is an honorable and commendable thing in our law. For thereby it appears that we don't despise all other sciences but our own, but we approve of them and encourage them, as things worthy of commendation."[28] Over the centuries, the court had developed two procedural options to deploy such men of science, who, from their special training and experience, could instruct the court and the jury in regard to the disputed facts. The first option was to call them as jurors. The second option was for the court to nominate them as consultants whose advice the court or the jury could adopt as they pleased. There was also a third option, which was for the parties to call them as witnesses testifying on their behalf. However, there was no special procedure to define witnesses as experts as was the case with court experts or those serving in expert juries. In the absence of such a procedure they were regarded and treated merely as witnesses.

Expert Juries

Summoning to the jury people with special knowledge concerning the disputed facts of the particular case was originally but a natural

extension of the medieval community-based jury, whose basic principle was that "those were to be summoned who could best tell the fact, the *veritatem rei.*" Drawn from the vicinity where the case arose, and chosen because of their direct knowledge of the facts of the case and of the reputations and intentions of the parties involved, the medieval jurors functioned as witnesses, investigators, and decision makers all at once. They went around informing themselves before and during the trial and based their decision on what they personally knew and what they had learned "through the words of their fathers and through such words of persons whom they are bound to trust as worthy." On occasion, however, the jurors needed specialized knowledge in order to do justice. In these cases, special expert juries were assembled under specific writs.[29]

Trade disputes were probably the most frequent cause for summoning expert juries. Juries of goldsmiths, booksellers, wine merchants, attorneys, and fishmongers, to name but a few, were often summoned to investigate and decide whether a specific guild's trade regulations had been violated. Such cases, we are informed, show that "the practice was well established in the fourteenth century of having the issue actually decided by people especially qualified." A second class of "expert juries" came to be defined under the writ *de medietate linguae* (of the half tongue), which secured the right of a foreigner to request a trial where at least some of the jurors were from the defendant's own country and were able to understand his or her point of view and explain it to the rest of the jury. The traditional right for a *de medietate* jury was gradually extended also to Jews (but not gypsies), Welshmen (but not Scots), clerics, university scholars, merchants, and other guild members.[30]

A third class of expert juries included all-female juries summoned as experts in cases involving sexual assault, pregnancy, and childbirth. Of these, the most common was the jury of matrons, which was usually impaneled in criminal trials and consisted of married women or widows experienced in childbirth. Another, less common jury of this class came to be defined under the twelfth-century writ *de ventre inspiciendo* (to inspect the belly). Under this writ the court would impanel a jury of experienced women for the limited purpose of establishing disputed facts of pregnancy. Unlike the *de medietate* jury, which functioned both as an investigator and as a decision maker, the *de ventre* jury functioned only as an investigative body whose conclusions were presented as advice to the court.[31]

Court Experts

As with the jury of experts, the second option for deploying experts in the courtroom—that of an expert nominated by the court—dates back to the early days of English Common Law. Historians have unearthed many cases in which the court chose to consult directly with independent experts. The earliest reference we have is from 1299, when physicians and surgeons in London were called to advise the court on the medical value of the flesh of wolves. Medical advice was most often sought in cases of malpractice or when the nature of wounds was an issue. The advice of grammarians was also in demand in cases where the disputed facts concerned language. We know of cases from 1429, 1494, and 1554 in which the court referred to the practice of consulting grammarians on the meaning of Latin pleas and commercial instruments as an old and well-established practice. In all of these cases, the experts apparently were summoned to advise the court rather than to provide evidence to be evaluated by the jury. In 1619, for example, two physicians advised the court that a wife might bear a legitimate child "forty weeks and nine days" after the death of her husband. The conclusion must have satisfied the court, because it instructed the trial jury to use it as *datum* in their final conclusion.[32]

In juryless courts, such as the Patent and Admiralty Courts, experts sat alongside the judge providing him with their advice. The custom was said to have been adopted during the fifteenth century from the international court of the Councils of the Sea, which in earlier times sat in Barcelona and settled disputes among members of the Merchants' and Mariners' Guilds. The judges of this international court conferred with the authorities of the guilds and in case of conflicting advice took the independent advice of professional navigators. Based on this custom, the Admiralty Court consulted regularly with the elders of the Corporation of Trinity House, the famous club of sea captains that was chartered by Henry VIII in 1514 and performed many official marine functions such as licensing and supervision of lighthouses. Juryless trials had their own advantages, and the Admiralty Court prospered in the early modern period by offering its clients speed and predictability. By the eighteenth century, the King's Bench had also adopted the practice of consulting the Trinity masters in maritime cases.[33]

The eighteenth century saw the culmination of the use of expert knowledge under traditional procedures of both the expert jury and the court expert. At the height of its popularity, the practice extended from factual decisions to actual rulings upon points of law. In 1730, a Parliamentary statute united all kinds of special juries under the new procedure of the "struck jury," which allowed the parties to strike names from an unusually large panel of prospective jurors. In the second half of the eighteenth century, this powerful procedure was used by Lord Mansfield to train a corpus of merchant-jurors to act as a permanent liaison between law and commerce. The advice of his merchant juries accounted in large measure for Mansfield's monumental success in creating a coherent merchant law within Common Law. Lord Holt in 1703, Chief Justice Lee in 1753, and Lord Hardwicke in 1755 chose the other option and nominated merchants as court experts with whom they would consult before ruling in trade cases. Lord Mansfield also used this procedure in insurance cases.[34]

Experts as Witnesses

Experts appeared also as witnesses, called by the parties in the case to support their cause in court. This practice had become increasingly common since Tudor, and later Stuart, England, which experienced an enormous expansion in the volume of civil litigation. "The English people," according to one historical account, "were never before nor since so litigious and law minded as during the reigns of Queen Elizabeth I and her two Stuart successors."[35] The growing population, a buoyant land market, and the expanding national and international commerce were all factors that brought more business to the courts. These same forces also dissolved the medieval system of self-informed juries by disintegrating the static communal organization that supported it. By the sixteenth century, the selection of trial jurors was already determined at least as much by status and administrative experience as by geographical proximity to the location where the offense had occurred.

Once the jurors ceased to be truly local, they must have found it impossible to acquire relevant knowledge of the trial's issues before they came to court. Other means were required to present them with the relevant facts in court. On the Crown side in criminal proceedings, a system of magistracy developed, which took over the production of evidence and its presentation in court. Officials involved in the process of the arrest—justices of the peace, constables, coroners, and bailiffs—began to play an increasingly active role in gathering evidence to be used in court.[36] On the civil side, however, no such official mechanism existed, and it was the interested parties who became the principal