Appendix to "Product Liability: An Interaction of Law and Technology"
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CASE A

A. Case Characterization

1. Product Description

The product which was the subject of litigation was a printer-slotter machine. The basic function of the machine is to print advertising and labelling material on corrugated cardboard and to cut and score the cardboard for later assembly as cartons. The machine is used only in an industrial setting and covers a floor area of approximately 8' × 15'. The machine operates as follows. Printing dies are stapled on large rotating wooden rolls. The ink is transferred to these rolls by a series of smaller rolls from the upper portion of the machine. Because this machine is equipped to print in two colors, there are two sets of ink-transfer and die-mounting rolls. The machine was designed to open to a width of 30" in order to change the dies. When the machine opens there is a clear passageway in the center of the machine which permits a worker to enter and make die changes on the rolls. Since this is a two-color machine, there is one set of rolls on each side of the passageway.

The back (feed) end of the machine is equipped to feed the cardboard into the first set of rolls for printing purposes. The cardboard then passes through the second set of rollers located on the front or exit end of the machine. When the cardboard emerges from the second set of rollers, it passes into the slotter phase of the machine which is integrally attached to the front set of printing rolls. Adjustable knives are located at this stage to score and cut the cardboard.

The principal driving motor is located at the back end of the machine and transfers power to both sets of rolls and the knives and scores, using gears. When the machine is opened, the front end rolls and knives and scores are mechanically disconnected from the driving motor and
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are inoperative, even though the primary motor may be energized. In effect the feed end of the machine could function from the primary motor even when the machine sections were separated. A stop button with an additional manual lock-out capability was built into the original machine.

There is an ancillary power source which is used to jog the printing rolls, either while mounting the dies or mutually aligning the two rolls on the front and back ends.

An automatic washing attachment was subsequently added to this machine. In order for washing to take place, the rolls must be rotated by the primary motor. If both feed and exit ends are to be washed, the machine must be run in the closed position. The feed end can be washed alone when the machine is separated since the feed end rolls can still be driven by the primary motor.

2. Accident Description

The injury to the plaintiff occurred when he entered into the open passageway of the printer-slotter. Since the machine separation only prevented power transfer to the front end, there was still power available to the rolls on the entry end and they were in fact rotating at the time of injury to the plaintiff.

The plaintiff, while walking through the passageway to turn on an auxiliary piece of equipment (staple gun) at the farther end of the passageway, suffered injury when a rag he was carrying was caught up in the rolls and his hand was drawn inward.

3. Defect Description

The machine as designed permitted the feed end rolls to operate from the primary motor while the machine was open. This capability of the feed end to operate while the two machine sections were separated constituted the alleged defective design.

The alleged defect was introduced by way of a design alternative, installation of a breakaway switch which would cut off the primary power to the feed end when the machine is open. The installation of a spring-loaded refrigerator door-type switch was suggested as a means of eliminating the alleged defect. This testimony was countered with the assertion that experience had shown that refrigerator door-type switches were easily bypassed. The countering testimony also suggested
that a machine with a bypassed or broken safety device was more dan-
gerous than a machine with no safety devices at all.

4. Unreasonably Dangerous Nature of the Defect

a. Alternatives to Reduce Danger

As described in the previous section, the alternative to reduce danger was used to introduce and reinforce the allegation of defect by the plaintiff's expert. In addition to questioning the effectiveness of the breakaway switch, defendant's expert pointed to the use of the already present manual lock-out as a more foolproof procedure.

b. Probability and Gravity of the Harm

The only testimony with respect to the probability of harm is infer-
ential, addressed to the circumstances under which a worker would walk into the passageway between the separated sections of the machine.

5. Causal Relationship Between the Defect and the Resulting Harm

The causative agent in this case is recognized as the revolving rolls but is not, except by inference, characterized in relation to the alleged defect.

6. Whether this Harm is Appropriately Assignable to this Defect

The defendant never raised the question of whether plaintiff was excluded from the protected class. Plaintiff assumed that the inference of proximate causation would naturally be drawn and offered no tes-timony on this point.

B. Critical Analysis

1. Product Description

A comprehensive product analysis was indispensable in this case. As set forth earlier, a product design cannot be condemned as unreason-
ably dangerous solely on the basis of the plaintiff's injury. A product design is a compromise between competing elements of function, use, safety and cost.

Let us consider the competing factors which come into play in the design of this machine:
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(1) The necessity for the machine to open for the purpose of changing dies on one or both sets of rollers (front and feed ends).
(2) The necessity of having the feed end of the machine operative when machine sections are separated.
(3) The effect of subsequent design modification as a result of the installation of automatic washers for the cleaning of rolls.
(4) The functional advantage of simultaneously setting scores and knives on the inactive front end while permitting operation of the automatic washers and rollers on the feed end.
(5) An understanding of the time sequence in setting up, cleaning, and operating the machine within the pay incentive scheme of the plant.
(6) The operational feasibility, cost and effectiveness of various kinds of breakaway switches.
(7) The necessity of cleaning both sets of rolls subsequent to single color printing.
(8) A precise description of the location and direction of rotation of all rotating rolls.
(9) The location of all controls and auxiliary power sources with a clear understanding of their functional purposes.
(10) The perception of the open machine as an access route to auxiliary equipment.
(11) The necessity of two auxiliary power sources, one for die changing and color registration and the other for opening the machine.

To evaluate whether the machine was defective and unreasonably dangerous, it was essential to understand the interplay of the factors listed above. The question of establishing a defective and unreasonably dangerous product cannot be addressed without litigation laying a foundation for the jury's understanding of the machine in terms of its function, use, safety, and cost.

In attempting to evaluate the usefulness of the machine one must understand the productivity level of the machine. If there was nothing to be gained by permitting the setting up of the knives and scores on the inoperative front end of the machine and simultaneously operating the automatic washers on the feed end (with rollers moving), then in fact we may have identified an element intrinsic to the question of the unreasonably dangerous aspect of design of the machine. That is not
to say that even if a high productive purpose had been established for this dual function that the negative would follow, since the machine still might be characterized as unreasonably dangerous. But without some quantitative understanding as to possible time savings on the machine if the two functions could be done simultaneously, we are at a loss to evaluate the usefulness and desirability of the design. At the same time it may well be that the machine communicated to the operators an expectation of time-saving which when tied to the work incentive plan may have encouraged a dangerous pattern of conduct. What is crucial at this point is that nowhere in this trial were these factors addressed and evaluated within the context of a comprehensive description of the machine in its environment. If in fact this simultaneous mode of operation could have produced substantial time and production savings, it was crucial that such information surface comprehensively. Such information would have supported the existing design as serving a useful function, rather than constituting a defect. Ironically, the suggestion of time-saving incentive and product usefulness arose uncontroverted and appeared to substantiate and justify the motive of the plaintiff to walk inside a machine while the back rollers were in motion. Thus, in our judgment, the jury was presented with half-a-fact. Down-time operation (time when machine is not operating and workers are earning at a lesser rate) was addressed only to justify the plaintiff’s conduct in operating the feed end of the machine, but was never addressed in terms of the desirability of the design feature in not having a breakaway switch.

This phenomenon of presenting product description and viewing product desirability only through the plaintiff’s actions in relation to the injury-producing machine is one that we have found to be oft-repeated. In design defect cases where the issue addressed is the global acceptability and utility of the product, this problem of evaluating the product from a particular plaintiff’s vantage point may distort legitimate consideration by focusing away from the product.

Another aspect of the product that should have been examined was the relationship between the rolls on the feed and exit ends of the machine. It might have been that, even in single color operations, sufficient quantities of ink were transferred to the exit rolls from the ink on the feed rolls. Both sets of rolls would then require cleaning after every operation, and there would be no acceptable reason to continue to run the feed end alone when the machine was open (at
which time the front end is inoperative). Thus, on the one hand there would be no necessity to ever operate the feed end alone. On the other hand there would also be no incentive to do so and hence the likelihood of an operator engaging the feed end would be remote. In this context, the incremental cost of installing a breakaway switch on the printer-slotter might well turn out not to be justified, so that after balancing all the factors, this machine might not be unreasonably dangerous in its present form. Again we cannot draw hard conclusions since these issues were not addressed in litigation.

2. Accident Description

Aside from the obvious purpose of showing that there has in fact been an accident, accident description serves to establish the causation link-up between defect and injury, and within this context the accident description here appears as entirely adequate. However, plaintiff's failure to adduce an adequate product description in terms of the product in its environment and defendant's failure to pursue and highlight this inadequacy leaves the jury in the position of being convinced that the accident happened but without an appreciation of whether this accident was bizarre or not, a question highly pertinent in determining whether this harm was assignable to this defect, i.e., the proximate cause issue.

Unless the jury has had the opportunity to appreciate the complete elements of machine operation, they are ill-prepared to comprehend the likelihood of first, plaintiff's presence in the open passageway, second, the likelihood of his arm being caught in moving parts of the machine, and third, the likelihood of his arm being caught in that specific region of the machine containing rolls which could have pulled his arm into the mechanism.

The accident description in this case failed to provide the jury with sufficient data to permit them to intelligently appraise the nature of risk to the plaintiff and the likelihood of the accident actually occurring.

3. Defect Description

The alleged defect in this case was a design which permitted the feed end of the machine to operate when the machine was in an open position. However, the fact that the feed end of the machine could operate in an open position is not a priori evidence of a defect, but rather this
capability must be viewed within the context of whether such a function can be justified or not.

It is important to note that the limited information that did surface with regard to usefulness and desirability of the actual design came through sporadically and imperfectly from the plaintiff and his co-workers. The experts did not address themselves in any meaningful way to these issues. The only time the plaintiff's expert expressed his view as to design principles, he made the erroneously simplistic statement that "machines are to be made as safe as humanly possible." It goes without saying that this does not coincide with the standard of "unreasonable danger" described earlier. It is clear that the experts' role in this trial was so narrowly defined that they neither examined nor evaluated the broad issue of usefulness and desirability of design. They were apparently asked to testify with regard to breakaway switches and did just that. They were in fact plugged into a very small aspect of a much more complex case. In fact, they should have been employed in describing and evaluating the trade-offs in terms of function, use, safety and cost.

4. Description of the Unreasonably Dangerous Nature of the Defect

a. Alternatives to Reduce Danger

The previous discussion leads us directly into the narrow role to which the experts did address themselves. If they served any function in this trial it was to suggest the possibility of a design alternative to prevent the feed rolls from turning when the machine was open. In this case the totality of the expertise went to the feasibility of a breakaway switch. Plaintiff's expert used as an example a spring-loaded refrigerator door-type switch that would always eliminate power to the feed rollers with the machine in an open position. Defendant's expert suggested that such a switch might easily be bypassed by employees. Even in this role, the experts did not seek to convey a comprehensive understanding of the breakaway switch concept as one of possibly several alternatives. The material was presented to project an image of an alternative, using a simplistic analogy not necessarily directly germane to this machine and its problems.

b. Probability of Harm

This issue has considerable importance in this case. From our understanding and evaluation of the printer-slotter, there is legitimate doubt
as to the likelihood of this accident occurring in the manner described by the plaintiff. The defense expert described the only possible location of a roller capable of engaging the plaintiff’s arm as being approximately 43” high and 12” back into the machine. Given the plaintiff’s testimony of the rag hanging from his hand while walking through the machine passageway, it becomes difficult if not impossible to accept the inference that the rag was caught while hanging from the plaintiff’s dangling hand.

It is important to evaluate why the evidence was permitted to pass minimum standards. As pointed out earlier, the design can be evaluated from the perspective of the accident and the injured plaintiff or from the acceptability of the design itself. If danger exists to plaintiffs as a class it is because certain kinds of harm are so probable that they warrant precautions being taken against their occurrence. Individual events are of significance only because they indicate to us in a concrete setting what kinds of injuries we ought to protect against. In this instance the probability of harm appears to be quite remote. The evidence as to the actual occurrence came out at the tail end of the trial through the defendant’s expert. Plaintiff’s expert simply did not address himself to the likelihood of harm and truly did not understand the only way in which this accident could have occurred. We thus find ourselves faced once again with a genuine problem. The focus of this litigation remains the injury-occurring event. If we are to evaluate the probability of harm as a function of design acceptability, we believe that focus on the event and the specific accident must be broadened to encompass the product and the usefulness of its design.

5. Causal Relationship Between the Defect and the Resulting Harm

To the degree that the plaintiff has been able to establish that the capacity of the feed rollers to operate with the machine in an open position is a defect, it follows directly that the “defect” caused the injury. The deficiencies in the area of causation, however, in this case stem from the insufficiency of the product and defect descriptions, so that the jury is invited to find liability solely on the basis that the accident occurred rather than that it was caused by a defective product.

6. Whether this Harm is Appropriately Assignable to this Defect

We confront the dilemma of identifying the plaintiff as one of a protected class in the absence of a product description which permits
the jury to comprehend the likelihood of first, plaintiff's presence in the open passageway, second, the likelihood of his arm being caught in the moving parts of the machine and third, the likelihood of his arm being caught in the specific region of the machine containing rolls which could have pulled his arm in. If plaintiff has traditionally relied upon the fact of accident occurrence alone to demonstrate the assignability of this particular harm flowing from this defect, it has equally been traditional for defendant to attack such a conclusion. In this case, the question could only have been properly resolved had there been adequate product and defect description. However, the scant treatment accorded this basic question in the trial was ill designed to elicit jury understanding. To rebut a presumption which may be seen to arise from evidence of the injury, defendant must first define the perimeters of likely harm. In this case, defendant's only testimony on the proximate cause question was produced almost casually in terms of the height of the rollers and their distance in from the passageway. To pose the proposition primarily in terms of saying that the accident shouldn't have happened, as defendant did, is likely to reinforce plaintiff's position rather than undermine it. The question is properly posed in terms of the likelihood of such an event occurring, and such a proposition can be persuasively made out only in terms of defendant's product description underlining the remoteness of the probability of plaintiff's hand coming into contact with the running machine.

C. Conclusion

In our opinion, this litigation was a trial not of product liability but of injury liability. This incorrect focus was the direct result of the litigants' failure to address the totality of the product's function and use. While plaintiff's failure to pursue a product orientation is understandable, the defendant apparently acknowledged the alleged defect by suggesting that the breakaway switch might be bypassed and hence would not have been curative. By failing to challenge plaintiff's expert's posture that the only operative criterion was "as safe as humanly possible," defendant allowed plaintiff to shift the focal question away from establishment of defect to the question of the proper method of preventing this accident.

The case started and ended with the injury and the focus was on the use of a refrigerator door-type switch to prevent the harm. Not only
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was the emphasis on the injury-causing event, but even before the major elements had been established, the evidence highlighted the detailed nature of the injury. Before the product was even remotely described, the injury was the pervading presence.

It may be that unless the litigation process is amenable to reorientation whereby the focus is shifted from plaintiff and his injury to the product in its environment, proper evaluation of the defectiveness and unreasonable danger of the product may not be possible.

**CASE B**

A. *Case Characterization*

1. *Product Description*

The product is a pickling machine consisting of a central cylinder and piston. Attached to the top of the piston is a framework from which 16 chains are suspended. Each set of four chains can support up to approximately 4 tons of steel sheets. The lowest loop of each chain, called the bull link, fits over a lug projecting from the side of the rack holding the steel sheets. Three of the four racks are immersed, at any one time, in pickling or rinsing solutions. To aid in the pickling and rinsing operation, the piston supporting the chains oscillates vertically through a distance of approximately one foot. The remaining set of chains is used to support the rack upon which the next batch of unpickled sheet is loaded. The rack, loaded with unpickled sheet, is brought by a cart to a point just beneath the continually oscillating fourth set of chains (since all four sets of chains are attached to the piston framework, all four sets are continually oscillating). Two employees, one on each side of the rack, then attach the bull links at the end of each chain to the lug at each of the four corners of the rack. This is possible, despite the continual oscillation of the chains, since the rack to be fastened is at floor level, while the other three racks are submerged in pickling pits below floor level. There is thus slack in the fourth set of chains.

The dimensions of the lug, the bull link, and the regular links attaching the bull links to the framework are as shown on Figure 1. The metal specified for the lugs, bull links and chains was "acid-resistant."

The purchaser of this machine received booklets describing the ma-
chine and listing replacement parts. Chains, however, were not included in this list of replacement parts. The manufacturer supplied complete sets of specifications and drawings, including drawings of the chains. Neither the booklets nor the drawings contained any warning regarding the conditions under which chains should be replaced.

Despite the anti-acid specifications of the chains, the corrosive action of the pickling bath caused a reduction in the cross-sectional area of the chain metal. The purchaser had replaced the chains (including bull links) at irregular intervals, procuring these replacements from the
2. Accident Description

While the two employees were engaged in slipping the bull links over the lugs of the rack loaded with unpickled steel, the loaded rack lifted a few inches and tipped, either slipping onto or overturning onto one of the employees, killing him. The surviving co-worker did not actually observe what caused the rack to tip.

It is the premise of the plaintiff that the overturning of the rack was caused by the inadvertent engagement of one of the regular links (not the bull link) of the constantly oscillating chain onto the lug.

3. Defect Description

There were, based upon the plaintiff's premise, two defects which were necessary and sufficient to have caused the accident, namely, the constant oscillation of the chains and the engagement of regular chain link and lug, whether by virtue of lug design or enlargement of the interior dimensions of the regular links through corrosion (it should be noted that as originally designed, the interior dimensions of the regular links would not permit engagement of the chain on the lug).

The question of the utility of the continued oscillation of the chains during the hook-up period was addressed during the trial by means of testimony that the manufacturer had recommended such a procedure as indispensable for effective pickling. This was countered by testimony that stopping oscillation during the hook-up period would not impair the effectiveness of the pickling operation. No other question concerning utility of the product with respect to its function and use was addressed during the trial.

With regard to the question of enlargement of the interior dimension of the regular links, no evidence was produced concerning either manufacturer's instructions or the purchaser's procedures regarding the conditions under which chains were to be replaced. The only testimony adduced concerning the enlargement of the interior dimensions of the chain was found in references to state standards regarding conditions calling for replacement of chains and cables.

The sole testimony regarding design defect of any of the component parts was directed to the question of the geometry of the lug.
4. Description of the Unreasonably Dangerous Nature of the Defect

a. Alternatives to Reduce Danger

There were five alternatives to reduce danger suggested by the testimony. They were: 1) altering the geometry of the lug; 2) altering the geometry of the regular link; 3) stopping oscillation of the chains during rack loading; 4) removing the chains from the vicinity of the lugs; and 5) more frequent chain replacement. One of plaintiff's experts made reference to the first four alternatives. Defendant's experts testified with respect to the latter three alternatives.

b. Probability and Gravity of the Harm

Another employee testified that in the past regular chain links had engaged a lug about three or four times a year. Plaintiff's second expert testified that one regular link on the one chain he tested could have engaged a lug of the original dimension. He did not examine the 15 other used chains.

5. Causal Relationship Between the Defect and the Resulting Harm

The causation issue was a recurrent theme throughout this entire trial. Three of plaintiff's witnesses, two co-workers and his first expert, referred to the plaintiff's theory of causation (a regular chain link engaging a lug) as the only possible explanation of the accident. Plaintiff's fourth witness, an expert, offered testimony demonstrating the plausibility of such an occurrence.

Defendant, through cross-examination and his own witnesses, rebutted plaintiff's theory of causation by suggesting a possible alternative explanation, such as debris in the vicinity of the rack that tipped, which engaged both chain and lug, causing the rack to tip.

6. Whether this Harm is Appropriately Assignable to this Defect

No suggestion was made by defendants that plaintiff would have been excluded from the protected class had the accident occurred as premised by plaintiff. Plaintiff relied entirely upon a presumptive inevitability of the inference of proximate causation being drawn, offering no evidence of either direct or indirect nature.
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B. Critical Analysis

1. Product Description

A thorough product description, encompassing its function, use, and environment, was particularly essential in this case for the following reasons: 1) this was a complex piece of equipment, the operation of which lay outside the ordinary experience of the layman (juryman); and 2) the absence of direct observation of how the cart was lifted. The sporadic description which emerged was inadequate to meet either of these requirements.

The description of the machine began with reference to its function, as described by an employee who worked on this machine. The description was less than complete and may have been misleading because the photographs used to assist in the employee’s description did not show the chains in the position they were in at the time the accident occurred. An additional fallacious element was introduced because the photographs did not show the chains in an oscillating condition, but as static. The oscillation of the chains in proximity to the lugs during the loading operation was the critical element to support plaintiff’s hypothesis as to the alleged defect; the lack of any adequate visual aid to assist the jury to appreciate the machine in operation was a serious flaw in product description. Following this patently inadequate description of this machine, plaintiff provided excruciatingly detailed information about the chain and lug dimensions. While product description was addressed approximately 43 times during plaintiff’s case, only on 2 or 3 occasions was the product described with reference to its general operation, and these descriptions were inadequate. The remaining product descriptions were in reference to chains and lugs.

The consequences of the inadequacies of such description could only have been to leave the jury with insufficient information concerning the product and its use, resulting in the jury’s inability to judge the possibility of existence of the alleged defect.

Perhaps a more basic inadequacy in the product description was the failure to identify the part of the product alleged to be defective, i.e., the chain, the lug, or, alternatively, the totality of the machine. An inevitable consequence of such failure of specific product identification was the obscuring of defendant identity. If the alleged defect lay in chain design or in failure to adequately plot out a chain replace-
ment schedule, then either the chain manufacturer or the total machine manufacturer or both could have been discerned as the appropriate defendants. Lug design, oscillating practice or other modifications of procedures or design look rather to the machine manufacturer as the proper defendant. Lack of mention of chains as replacement parts in the manufacturer's manuals was not explored by the plaintiff as indicative of a defect in the product design. Instead, the defendant's position that enlargement of the links' internal dimensions was either to be expected as normal wear and tear or that the employer failed to replace the worn chains at the proper time obscured, if not obliterated, any clear picture of the plaintiff's alleged defect.

2. Accident Description

The sole purpose to be served by the accident description is to tie this product to this plaintiff. Here the only available testimony of the accident was as adequate as the circumstances permitted, given the lack of direct observation of the mechanism that caused the cart to tip.

3. Defect Description

Since there was no direct observation of what caused the cart to tip, the plaintiff's theory of defect and causation had to be established as the most probable of all plausible alternatives. No theory was ever advanced that human agency, such as a person tipping the cart over, brought about the accident. Therefore, the choice among explanations of the accident was limited to mechanical causes. Plaintiff's first expert, a safety engineer, was not asked to address himself to product description, and therefore his testimony regarding the cause of the accident was rendered ineffective. His description of causation made passing reference to three possible design alternatives which would have prevented the accident, but these matters were never broached as elements in establishing defective design.

While the expert's opinion as to cause of the accident may have been accurate, i.e., "that the dangling chains [engaged] one of the lugs on the carrier plate and [tilted] the carrier so that the plates thereon were tilted over and flew out," his failure to have laid a foundation, by very explicitly defining the defect upon which to base his conclusion, undermined the effectiveness of his opinion. By this we mean that if the manufacturer bore liability it was because the product he had designed was to involve the interaction of chain links and lugs of progressively
changing dimensions due to corrosive attack. If this defect was to be established, it could only be done by focusing on the product in its actual environment. The tendency to look at a product as an isolated object rather than as an integral part of a system had serious implications for this case. In our opinion, the principal barrier to the expert's providing a total perspective of the machine to support his opinion was his occupational pre-disposition to accident prevention rather than to defect analysis.

The concept of defect from the perspective of a safety expert is to focus on the causative agent and seek means to prevent this accident in the future. The approach is first and foremost a prospective one. Simply to describe mechanical means for preventing an accident is not the equivalent of establishing a defect in the design of the machine. The jury is entitled to conclude that the accident was an aberration and not the consequence of a defective design. It may be possible that the expert was simply inadequate, but it is significant to note the disciplinary bias that the expert brought to bear in this situation. In order to have established the alleged defect, the engagement of chain link on lug, it was necessary to support the hypothesis with measurements as complete as possible and to negate the probability of all other mechanical explanations of how the cart tipped.

Plaintiff's second expert, a mathematician and chemical engineer, made measurements on all of the regular links of only one of the sixteen chains which had been on the pickler at the time of the accident. Using a wooden mock-up of the lug, sized as originally designed, he demonstrated that one regular link of the one chain examined could fully engage his mock-up of the lug. He also testified that a number of other regular links on that same chain could engage the lug in a skewed position. Plaintiff's second expert's testimony, while probative as far as it went, was marked by several glaring deficiencies in establishing the probability of chain-lug engagement as the defect. These deficiencies were: 1) his use of a lug mock-up of original dimensions rather than replicas of the actual worn and corroded lugs; and 2) his failure to make measurements of every regular link of each of the sixteen chains which had been on the pickling machine. Had these measurements been made, it would have been possible to establish the number of links which could have engaged the actual lugs and hence establish some degree of probability of the event occurring.

It is significant to note the limited role played by the expert.
Whether by his own choice or that of plaintiff's attorney, his function was that of a "link measurer" rather than as an analyst reviewing a product in its total environment.

Neither of the witnesses made any attempt to refute alternative explanations. Consequently, the totality of expert testimony concerning the alleged defect bordered on the speculative.

4. Description of the Unreasonably Dangerous Nature of the Defect
   a. Alternatives to Reduce Danger

   While the first four of the stated alternatives (see page 508), those advanced by plaintiff's first expert, should have merited serious consideration, they were presented in an offhand manner in response to a question asking the cause of this accident. Pursuit of these points would have strongly reinforced the existence of defect as advanced by plaintiff. Defendant's experts admitted that stopping oscillation was feasible and had indeed been implemented subsequent to the accident without impairing the function of the pickler. Early chain replacement, as implied by state safety regulations, was strongly advanced by one defendant's expert as an alternative.

   Plaintiff's ineffectual pursuit of these alternatives, casually suggested by his first expert, foreclosed a ready opportunity to use these alternatives as a means of partially meeting the burden of establishing the defect.

   b. Probability and Gravity of Harm

   The evidence with regard to probability of harm was limited, with only the statement of lug engagement on a frequency of three or four times a year. The minimal impact of this testimony could have been reinforced by plaintiff's strong assertion of the available alternatives to product design and operation.

5. Causal Relationship Between the Defect and the Resulting Harm

   Causation is a term of legal conclusion. It is the legal link between the alleged defect in the product and the injury. Causation, therefore, cannot exist in any abstract form, apart from defect or harm. While it may be obvious in every instance of litigation that there has been injury, the cause of the injury must be shown to flow from an established defect.

   The only eyewitness saw the rack begin to lift, but he did not see
the causative agent. It was the causative agent which would have had to be established as the defect. Consequently, the mere observation of the tipping of the cart which in fact caused the harm fails to establish in and of itself the existence of the defect. If the alleged defect, i.e., the engagement of regular chain link on lug, had been clearly established, the proof of causation would have been largely made out. In order to enhance the plausibility of this defect having been the causative agent, plaintiff should have shown that all other possible explanations for the cart tipping were less likely.

Here the evidence introduced to show causation was perhaps sufficient in its own narrow context, but the dependancy of that conclusion upon the prior establishment of defect renders the presentation ineffective. It appears that causation evidence was introduced to establish defect rather than to follow upon the proof of defect.

In our opinion, the evidence of causation may have been persuasive enough to convince the jury that engagement of regular chain link on lug was the causative agent of the accident, but that the plaintiff failed to establish this agent as the defect in the product design.

6. Whether this Harm is Appropriately Assignable to this Defect

In any given case not only is it necessary to establish that a defect caused an injury, but that the injury occurred as a result of a predictable interaction of the injured party and the product. We note, parenthetically, that the predictability is that viewed by the ordinary man.

In the instant case, plaintiff clearly falls within the protected class in that he was a worker engaged in his assigned task in working with the machine. Consequently, no evidentiary emphasis was placed on this aspect of the case.

C. Conclusion

A product description must be sufficiently detailed and comprehensive so as to afford the jury a sense of security in their assessment of the alleged defect and its unreasonable danger. We view, in this case, the inadequate product description as one of the critical shortcomings of plaintiff’s presentation. An immediate consequence of this was that plaintiff never clearly established a particular defect and hence never adequately identified the appropriate defendant.
Despite the lack of an adequate product description, a more comprehensive investigation of actual chain link and lug dimensions (of each chain and each rack) could have supported with more conviction the existence of a defect, as distinguished from the causative agent. Plaintiff's first expert, the safety engineer, was so pre-occupied with accident prevention that his investigation was superficial with respect to establishing the defective nature of this product. The proper level of product orientation would have permitted him to assert his conclusions regarding the basis for liability more convincingly. Plaintiff's second expert, the mathematician-chemical engineer, had a better appreciation of the nature of the evidence needed to demonstrate the existence of a defect; his testimony lacked impact because it was insufficiently comprehensive to establish credibility in his conclusions.

Failure of the plaintiff to provide an adequate product description coupled with the incomplete investigation conducted by the experts provided, it would appear, an insufficiently persuasive basis for the jury to find liability.

Viewing the problems we have described in a somewhat broader perspective we believe that there exists a tendency throughout this trial of using an expert for narrow and limited purposes. In a sense the expert is safest when he is brought in to plug a hole or fill a gap in making out the elements of a cause of action. However, in so defining his role we lose the educational dimension. If the expert is to bring to bear his breadth of understanding his role must be considerably expanded from that which was evidenced in this case. He must introduce an element of sufficient understanding of the product to serve as a foundation for the specifics of his testimony.

In our opinion, one of the significant deficiencies in the trial of this case was that both defect and causation had to be determined by speculative extrapolation from evidence that was unnecessarily incomplete. At the time of the accident, if the offending chains and rack had been marked and isolated for examination, there would have been little need for the rank speculation indulged in at the time of the trial. The tests which could have been conducted might have been finally determinative as to causation. Indeed, there might have been matching scrape markings on chain and lug which would have conclusively established the causation factor. This failure to control and preserve evidence is especially serious in an industrial setting because the resources for immediate accident investigations and prevention are ever-
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present. To be compelled to try a complex causation issue three years after the fact with such scant evidence is of questionable value.

**CASE C**

**A. Case Characterization**

1. **Product Description**

   The product is a metal slitting machine. Its function is to slit large coils of steel sheet into desired widths. The slit steel is then recoiled. The slitting is accomplished by circular knives that can be adjusted to meet the desired widths. The two sets of knives are mounted on rotating arbors. The arbors rotate at high speeds during the normal slitting operation. There are, however, instances when it is necessary to rotate the arbors at a lower speed. This is done when the arbors are cleaned and when adjustments are made in the process of setting up the knives. The various control switches are placed at several locations in the vicinity of the machine.

   Because of the nature of the litigation it is crucial to understand the relationships among the parties of this law suit. The product was not assembled by one manufacturer. Three parties were involved in putting the machine together in order to make it operational. Manufacturer A produced a switch apparatus which accomplished only two functions—jog forward and jog reverse. This apparatus was located on the machine. The purpose of these switches was to make the slight rotational adjustments of the arbors. There were two other controls which could move the arbor forward (at varying speeds) but they were not manufactured by Manufacturer A.

   The major assembler of the slitter machine, Manufacturer B, essentially put together all the integrated units that were part of the machine and sold them to the third party who was the employer of the plaintiff. The employer made the external electrical connections using his own staff and made changes in some parts of the machine under the direction of Manufacturer B. One of the additions made by the employer under the direction of B was the inclusion of another set of switches at the operator's platform which could accomplish the same jogging function as the switch manufactured by A.

   In order to relocate the knives on the arbor, the lock nut holding the entire knife mechanism onto the arbor had to be loosened. This
was accomplished by an employee using a spanner wrench on the lock nut. The spanner wrench used by the plaintiff-employee was specially designed by Manufacturer B to fit into recesses in the lock nut (see Figure 2) and had no protective devices for shielding the user's hand.

2. Accident Description

Plaintiff suffered serious injury to his hand while loosening the lock nut on an arbor in order to readjust the knives for a new run. These adjustments were being made in accordance with standard procedure. While the wrench was in place in a recess of the lock nut and the plaintiff's hand was on the wrench handle, the arbor rotated momentarily. As a result, the spanner wrench rotated and the plaintiff's hand was jammed between the wrench handle and the housing of the machine.

3. Defect Description

The plaintiff contended that the machine self-started as a result of some unknown defect in the electrical system. He alternatively sought to prove that the design of the spanner wrench was defective in that it had no device to protect his hand from this type of injury and that such design contributed to the jamming of his hand against the machine housing.

The primary emphasis in the trial, however, was the attempt by the plaintiff to establish a production defect in the electrical controls. Although plaintiff's employer was also involved in the assembly process, plaintiff could accomplish little by proving that the employer was responsible for any electrical malfunction, since the employer was cloaked with the immunity of workmen's compensation. Although the manufacturer of one of the switches, A, was a party defendant, it is clear that plaintiff did not direct his attack exclusively at A for the reason that there were other electrical devices (not manufactured by A) that could have been the source of defect. Thus, the principal thrust was against the machine manufacturer and assembler, B.

In production defect cases there is generally little question concerning the unreasonably dangerous aspect of the defect. If the defect as alleged by plaintiff is proved to exist and if it is in fact causal and, as a matter of policy, the harm is appropriately assignable to the defect, then almost by hypothesis the defect is unreasonably dangerous. Thus
the focus here was on whether or not a defect existed in the machine at the time of the accident.

It was plaintiff's contention that the arbors were activated by some internal electrical defect in the machine (switches, electrical circuitry, etc.). His claim was very simple indeed. If no human agent started the machine, then there was no alternative explanation but that the machine self-started due to an internal defect. The case is the equivalent of a negligence res ipsa loquitur situation. In this type of case plaintiff's claim is that this kind of event does not happen in the absence of defect, although admitting that he has no hard proof as to what the defect is and where the defect is to be found. Defendant's rebuttal in this case followed classical lines. He attempted to leave the jury with the belief that a human agency (other employees) were responsible for starting the machine. He strengthened his position by bringing forth testimony (expert and lay) that no defect was found after a post-accident examination of some of the machine's electrical controls and wiring.

We proceed immediately to our critical analysis of the presentation of evidence. The issues concerning unreasonable danger, causation, and harm assignability are not germane to the production defect aspect of this case.

B. Critical Analysis

1. Product Description

Although the product description is relatively satisfactory when viewed at the close of the entire trial in that we believe that a lay jury could comprehend the function of this machine, there is considerable reason for dissatisfaction with the flow of evidence used to introduce the product. The methodology used by trial lawyers to describe the product is the question and answer method. It is by its nature choppy and fragmentary. No attempt was made to introduce the product and its operational characteristics as a totality. It should have been possible for the parties, between themselves or under the supervision of the court, to reach agreement as to a neutral product description which would set forth the normal functional level of this machine.

2. Accident Description

The accident in this case was simple and easily understood. Although there was some controversy as to the details of the accident, e.g., the loca-
tion of plaintiff's hands at the moments immediately preceding the accident, this discrepancy apparently had little significance on the liability picture.

3. Defect Description

I. PRODUCTION DEFECT

a. Safety Inspection

Before facing the problem of evaluating the expert testimony which went to the probability of a defect self-starting this machine, we believe there is a threshold problem in the evidentiary function served by an employer's post-accident safety inspection. There was voluminous testimony by members of the employer's staff that they had undertaken a searching investigation of the entire machine to determine what caused the accident. All switches had been removed and inspected to check for short circuits, etc. They sought to determine the cause of the accident, and did in fact accomplish a thorough safety check of the machine.

We believe that it is important to focus on the predispositions inevitably present in the employer's safety investigations and their impact on product litigation. Will a safety investigation by an employer's safety staff produce the necessary data for later litigation? Plaintiff and employer may both be searching for a possible defect but their goals are diverse. Plaintiff's interest is historical—the employer's is functional. For the employer the paramount question is accident prevention. When he makes a judgment that the injury-occurring event will not be repeated, he will close his investigation. In this case, the employer's safety inspection uncovered no indication of the cause of this accident, and he concluded that whatever may have been the causative agent, there was no necessity for any remedial action to prevent future events of this nature. Plaintiff, however, cannot be satisfied with future prediction. He must prove the existence of an accident-causing defect. This is not to say that the interests of the two investigating processes are not identical for a substantial portion of the investigation but they can and do diverge. This can be indicated at several levels:

(i) In attempting to determine how far to press the investigation for telltale evidence of defect, the employer will consider several possibilities. He will take into account the possibility that an employee may have intentionally or inadvertently engaged the switch. He may con-
sider a possibility (suggested at trial) that the defect arose from some slight problem with the electrical circuitry of a non-repetitive nature ("foreign matter got lodged mechanically in that contactor"). If he is satisfied that no corrective action need be taken following a basic inspection which reveals no obvious electrical problems and no post-accident malfunction of the machine and switches, the employer will then reach a conclusion of no defect. His investigation may be thorough for his purposes. He is entitled to reach an institutional conclusion of no defect. His notion of defect is defined in terms of corrective action (i.e., a prospective test). If no corrective action need be taken he legitimately concludes from his perspective that there was no defect.

Yet we should not lose sight of the judgmental perspective of the employer. He is evaluating the possibility of another employee engaging the switch and the possibility of a non-repetitive malfunction, and is in effect weighing those factors against the cost of further investigation and the cost of further delay in the use of the machine. We do not question the legitimacy of his perspective but only note that it is of limited utility in determining legal liability (e.g., if in fact foreign matter was only present at the time of the accident, it could constitute a product defect).

(ii) Further investigation may also include the cost of a substantial tearing down of the machine in order to determine what actually happened. For example, in this case it is apparent that the switches were not torn apart but only examined for short circuits. Hundreds of feet of electrical circuitry were not disassembled to determine whether a defect existed. The fact that there is an "accident investigation" does not mean that it will be accomplished in the same manner and with the same end in view as required by the plaintiff for proving the existence of a defect.

Plaintiff, if given the opportunity, would have to focus on the remotest possibility, even if it is of a non-recurring type, because he must establish a defect. If such a comprehensive investigation is to be undertaken, we then have to come to grips with the question as to whether such an investigation is economically feasible and whether it would be permitted by the courts.

b. The Hypothetical Question

This case presented a hypothetical question to the jury. The expert was asked the following:
"Now assuming, Mr. ——, that this machine was in an operable condition, and assuming that at the time and place in question the disconnect switch was on, that the other buttons which are used to activate the arbor rolls on this machine were not depressed or touched by any human, that there were three persons standing in and around this machine but none of them touched any of the jog buttons, or any of the other buttons which would activate the arbor, assuming these things to be true, and assuming that the plaintiff here in this case, was busy adjusting, or attempting to adjust, the spacers and the cutters on the arbor, or was about to do it, and in the process of using a spanner wrench to disconnect the spacers and the cutters, and so forth, on the arbor the machine became activated, thereby causing the wrench to turn and crush his hand, assuming all those things to be true, could you state whether or not this, or under what conditions this machine operated, whether it functioned properly or improperly?"

The expert replied: "Well, under the conditions as you state them, the only way the machine could have been energized, been operated, would be by a malfunction of either the switch or the electrical circuitry."

The problems raised by this question are most significant. The witness here was asked to assume the truth of a set of facts. In this case the crucial fact which he had to assume as true was that no human agency touched the control buttons. The witness was asked to utilize this fact in the question at the level of 100 per cent probability of truth. Yet, facts are not put in evidence at that kind of probability level. The burden of proof in a civil case is far less than that.

The standard technique for rebutting such an opinion is to cross-examine the expert to question whether his opinion would hold up if the facts were varied. Thus, a frontal assault on the facts as assumed by the expert is undertaken. What is not done, because the trial mechanism does not permit it, is to undertake an examination of the expert's opinion at various probability levels of the facts.

Let us suppose that the expert in this case were asked to assume that the probability of a human agency being involved was 30 per cent; would he then have an opinion as to the cause of the accident? It is suggested that this approach would have presented the true issue of the case. The expert would have been forced to assess the probability of a human agency engaging the machine versus the probability of the machine self-starting. Perhaps the expert would have been unable to
state an opinion based on this set of assumed facts. We should then at least have had testimony addressed to the crucial problem of the case.

The question as asked and answered was trivial at best. If in fact there were no human agency which touched the control switch then there is only one inference—that is, that the machine malfunctioned. The real question in this case was to evaluate the two competing possibilities. The jury was in a position to make some judgment of the credibility of witnesses as to whether co-employees did start the machine. The jury could gauge their doubts as to the validity of their testimony. Assuming that the possibility of human agency interfering with the machine was remote, is it more or less reasonable than the possibility that the machine engaged from mechanical malfunction? Perhaps the chance of malfunction is remote as well. But the jury must choose from competing possibilities.

Admittedly an expert can testify that it is possible that the machine malfunctioned by self-starting without leaving telltale clues that it had done so. Yet, that kind of testimony will be of little value to the plaintiff. He cannot prove his case by possibilities and cannot carry his burden of proof in that fashion. To accomplish his burden he must insist on the absolute 100 per cent probability of the assumed facts and force the expert to a conclusion. Yet, the true value of the expert is to bring his evaluative sense to the facts of a particular case. We are not permitted at present to ask the expert to evaluate the level of certainty of the facts which are part of the hypothetical question and reach a conclusion. This would be invading the province of the jury.

The present approach is unrealistic and technically unsound. We ask the expert to assume facts A, B, and C at the level of 100 per cent probability and then proceed to weaken the factual base for his opinion on cross-examination. At no point do we ask the expert for his evaluative sense on the facts as they may be evaluated by a human being—who would evaluate them at a level of probability ranging anywhere from 0 per cent to 100 per cent. The expert is not permitted to face the real issues.

c. Ancillary Defects

Throughout the trial there existed an undercurrent concerning other defects that existed in the slitter machine. A major issue in the trial concerned the control that manufacturer— assembler B re-
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tained over this slitter machine. If in fact the machine had been completed and delivered at the time of the accident, plaintiff would have the burden of proving that whatever defect was present existed at the time of delivery of the machinery. Thus, if it were possible to show that at the time of the accident B was still working on the machinery to correct original bugs and had thus not delivered the slitter to the employer, the plaintiff would only have to prove the defect that caused the injury.

There were, however, two other reasons for pursuing this line of inquiry into ancillary defects. Plaintiff sought to leave the jury with the general impression that the machine was not debugged and that in fact many other things were not working properly, both in the electrical system and in other parts of the machine. The desire of the plaintiff was to lead the jury to the conclusion that in an incompletely debugged machine odd things happen—thus accounting for this accident. The trial judge was sensitive at first to the prejudicial aspect of this testimony and sought to limit it carefully. Later this evidence was allowed in during cross-examination. The true question was of course the marginal relevance of this kind of testimony and the need to balance whatever probative value it might have against its prejudicial aspect.

The third reason for attempting to prove that B was in fact in control of the slitter machine was that plaintiff had been working on the machine without turning the power disconnect off. There was ample testimony that this was not proper safety conduct. As the judge later instructed the jury (perhaps erroneously) this behavior could amount to assumption of the risk. Plaintiff's excuse for working with the power disconnect on was that he was instructed to do so by an employee of B who was on the job site and was working on other parts of the machine. It was thus necessary to establish that B was supervising the use of the machine on the job site.

Of all the proffered reasons the second has the greatest significance within the context of this trial. A plaintiff with a marginal defect case (at best one that is unexplained and undetected) could introduce evidence of other defects and insinuate machine malfunction. Again it is crucial to note that the legal issue is relevancy. How is a trial judge to make the determination that this evidence is relevant—that is, of sufficient probative value to admit it in the trial? He can only do so by permitting an expert to testify as to its possible importance given a fact
situation like the one before the court. The expert would then be able to make an evaluative judgment as to whether or not in this case the incidence of other defects should be given some weight. To present pure statistics would be availing. Firstly, no self-respecting scientist would present such statistics. They are unavailable and if they were available they would be subject to such attack on cross-examination that it would be valueless to present them. Secondly, plaintiff cannot prove his case on such speculative grounds.

It is important to note here that if we do not permit this type of evaluative evidence into the case we are again missing the central issue. The purpose of this case was to choose between competing possibilities—human error v. machine error—each remote. The decision to exclude any reference to the other defects would have required plaintiff to carry a burden of proof that he could not bear. Ironically, the decision by the trial judge to later permit some of this evidence in on cross-examination presented a serious problem of relevancy. The tactic of counsel at this point was to bring in the other defects to show that the machine could have malfunctioned because it had other things wrong with it as well. So in a period of twenty minutes he introduced a litany of differing defects that had been encountered in the eight-month life of the machine.

One is struck by the quality of the testimony and its utter lack of meaning to a lay jury. Defect after defect was mentioned and there was no attempt to introduce an evaluative component to the testimony. Admittedly, opposing counsel could and did attempt to indicate that several defects had little to do with the electrical starting mechanism. The true issue in the case was whether or not such other defects lent credence to an explanation of an electrical defect which, although remote, was still more believable than the possibility of human error. The only testimony that would have confronted the issue squarely would have been expert testimony that would have made that kind of evaluation of alternate remote possibilities. But that today is not possible since it would be an invasion of the province of the jury.

Instead we opt for testimony that addresses these possibilities without an evaluative sense. We ask lay juries to weigh between two experts who testify that either the possibilities are real or are not real. We ask the jury to do the evaluation that is impossible for them because, even if they can understand the scientific testimony, they cannot gauge its probative strength. With regard to the human error testimony, the
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jurors are permitted to draw on their evaluative sense of human behavior. When it comes to the scientific testimony, no jury in the process of a two day trial can develop an evaluative sense to weigh the scientific testimony. We currently then deny them the input of the scientist who could make that evaluation if he were permitted to balance the human and scientific facts.

The issue of unreasonable danger did not arise in the context of the alleged production defect in the electrical system. If the defect existed it was per se unreasonably dangerous and in this case the causative agent and the harm assignability would be foregone conclusions.

II. DESIGN DEFECT—SPANNER WRENCH

There existed in this case a hint of an alternative defect, i.e., the improper design of the spanner wrench. This wrench, which was provided by the manufacturer, was used to loosen and tighten the end plate on the arbor. It is exceedingly difficult to evaluate the impact of this aspect of the case because the issue was so mishandled by counsel on both sides. The focus, whenever the issue was brought up, turned always to the admissibility of the very wrench that was in use at the time of the accident. This raised the problem in this case of the admissibility of post-occurrence modifications, since the wrench had been subsequently altered to provide a safety guard. The trial judge consistently suggested to the plaintiff that he introduce a like wrench without the modification and indicate possible alternative design changes. The suggestions were unavailing, and the only design testimony that came in was oral testimony from plaintiff's expert.

To the degree that the issue was presented it was inadequately probed. There was no examination of possible disadvantages of such an alternative design. Furthermore, plaintiff's expert indicated that the purpose of an alternative design was to prevent injury due to the wrench slipping out of the hole. If this would have been the only reason for providing the guard then the harm resulting from the machine activation may have fallen outside the scope of harm assignability due to this defect.

C. Conclusion

This case, under present evidentiary rules, is, in our opinion, probably unlitigable for the reasons set forth in our analysis of the expert testimony regarding the existence of a defect. It may well be that the
kind of expert testimony which we envisage as necessary may not be obtainable. If an expert is to be called upon to weigh the relative probabilities (both human and mechanical) in order to establish defect, he will be asked to perform a task which experts may be unwilling to undertake. They may feel that it forces on them a speculative role in the decision-making process. Be that as it may, if an expert is unwilling to make this evaluation, a fortiori a lay jury should not be permitted this latitude. This much is certain: to permit the selfsame analytical process to be undertaken through the use of a hypothetical question which assumes the absolute truth of contested facts is to engage in a charade. If the true issue cannot be litigated because it is too speculative, it cannot be legitimatized by stating the question in terms of unrealistic extremes.

CASE D

[Prefatory Note: It should be explicitly stated that this case material was available to us in an abstracted form only, consisting solely of that portion of the trial transcript which, by stipulation of the parties, was reproduced as an appendix to the briefs filed in the appeal of this case. Although we may indulge a presumption that all relevant material from the full transcript was here reproduced, the abbreviated transcript presents a picture of a very tightly litigated case, and such inference is not one necessarily to be drawn. Although we believe the material available was sufficient to permit a jury conclusion of liability, extraneous and irrelevant testimony which may have been part of the trial proceedings was presumably omitted from the abbreviated abstract.

It should also be noted that this case proceeded on a negligence theory of liability, rather than on a premise of strict product liability.]

A. Case Characterization

1. Product Description

The product in this litigation was an industrial grinding wheel used to refinish the surface of rolling mill rolls. This wheel was 36 in. in diameter, 4 in. in thickness, and weighed 353.2 lbs. The wheel was fabricated by using rubber bonding rather than the more common shellac or resinoid bonding.
The wheel was manufactured by compression molding. It is customary to imbed three steel “safety rings” into the wheel while pouring the ingredients into the compression mold. After compression molding the wheel was removed from the mold and moved by conveyer to an oven for curing. After curing, recesses were machined around the hub. The wheel was inspected several times during the course of manufacture. These inspections consisted of measuring, weighing, and visually examining the wheel. The inspections usually occur after compression molding, after machining the recesses, and finally after an overspeed test. This wheel was rated at 742 rpm. Before it was shipped, the wheel had been tested at a 50 per cent overspeed or 1113 rpm.

The wheel was mounted on the spindle of a motor and fastened by six nuts and bolts. The operator then routinely strikes the mounted wheel and listens to the reverberation for indications of cracks or flaws. After the wheel was mounted, protective guards were placed on the grinder, leaving only a portion of the wheel exposed to contact the surface of the roll.

The grinding operation itself is divided into three stages: roughing, shaping, and finishing. These operations are carried out at different rotational speeds. An uncalibrated rheostat was used to control the rotational speed of the motor. The name plate on the motor indicated a speed range of 550-1040 rpm. The rheostat was marked at the ¼, ½ and ¾ positions without reference to any speed. In actual operation, the grinding wheel is brought into contact with the rotating roll to be finished. The operator controls the speed of the grinding wheel and the speed of the roll, as well as the contact pressure between the two. As the contact pressure is increased, the speed of the wheel decreases somewhat.

Subsequent to the accident it was discovered that the maximum motor speed was actually 1395 rpm rather than the 1040 rpm listed on the motor name plate.

The wheel sold for about $200.00. The cost of the materials is about $75.00.

Although three rings had originally been imbedded in this particular wheel in accord with standard manufacturing procedure, only two remained in the wheel when it was shipped. The region originally occupied by the third ring was filled in by the wheel manufacturer with an epoxy resin.
A small chip on the periphery of the wheel was also noted. This area was ground down by the manufacturer prior to shipment.

2. *Accident Description*

After completing the roughing operation, the plaintiff turned the rheostat up to a point between the half and three-quarter positions. Shortly thereafter he heard a rumbling noise and the wheel disintegrated and the guard broke loose. Plaintiff was injured when struck by flying parts of the wheel.

3. *Defect Description*

Plaintiff contended through his expert that a number of defects existed in this grinding wheel. These were, in order of presentation: a) 5 batches of the ingredient mixture were used, rather than one; b) the absence of the third safety ring; c) the epoxy patch; and d) the sulfur content, a binder constituent in the wheel, was less than that specified. Plaintiff's expert ultimately isolated the absence of the safety ring as the principal defect.

Defendant's response was couched in terms of the absence of negligent behavior. He attempted to counter by suggesting that since the wheel passed the overspeed test, there was no negligence in manufacture.

4. *Description of the Unreasonably Dangerous Nature of the Defect*

The questions of alternatives to reduce danger and probability and gravity of the harm were never directly addressed. Plaintiff suggested that proper procedure, in the presence of the alleged defects, was to scrap the wheel. Defendant countered by stating that the wheel in its altered condition, *i.e.*, with the epoxy filler, was at least as strong as an unaltered wheel (defendant's contention was that the absence of a third safety ring had no effect upon the performance of a new wheel). Plaintiff's expert suggested that the effect of the alleged defects was to provide a high probability of wheel failure under normal operating conditions.

5. *Causal Relationship Between the Defect and the Resulting Harm*

In the opinion of plaintiff's expert, "this wheel broke because of a defect which was created when the safety ring was removed from the molding of it and breaks were occasioned, some of which remained after the wheel was shipped, and it failed at very much lower centrif-
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ugal forces and work forces than any wheel of this type could reason-ably be expected to fail.” He supported his opinion by citing the size of the fragments into which the wheel broke. He characterized the fragments as large, indicating “some locality of weakness which allowed it to break with the application of the work force.”

Defendant, citing his successful overspeed test during manufacture, contended that such test proved that no defect was present. He then advanced overspeed as the only plausible explanation of the disintegration. In fact, one of defendant’s experts interpreted the size of the fragments as indicative of an overspeed failure. Interestingly enough, defendant’s other expert, the employer’s safety expert, contradicted the assertion that large fragments were associated with overspeed failures. It is significant that although both plaintiff’s and defendant’s experts agreed in characterizing the fragments as large-sized, they drew precisely opposite conclusions from these data as to its identifying the causative agent.

Defendant introduced additional evidence in the form of noting the absence of a crack in the arbor hole, a condition he claimed is always present if a defect causes disintegration, to support his overspeed hypothesis.

6. Whether this Harm is Appropriately Assignable to this Defect

Defendant apparently never questioned the appropriateness of plaintiff as a foreseeable injured party.

However, he did attempt to introduce two intervening causes: (1) the foreman’s knowledge of the speed limitation of this wheel as compared to grinding wheels generally used for this purpose, and (2) the overspeed condition that existed in the grinder. There was, however, no attempt to evaluate this grinder overspeed against industry-wide standards.

If in fact overspeed, either intentional or inadvertent, was a most unusual occurrence, a substantial proximate cause question would be presented.

B. Critical Analysis

1. Product Description

The description of the manufacture of the product in this case was ironically complete, comprehensive, and comprehensible, even though
it was introduced in the context of a negligence question rather than one of strict product liability. This description of the manufacturing of the product was provided by experts.

Although the plaintiff described his use of the grinding wheel with clarity, we note again the emphasis of description of product use emanating solely from plaintiff's individual encounter with the product. What was totally lacking in this case was any description of industry-wide practice. The defendant in this case manufactured a grinding wheel marked specifically to be used at a maximum rotational speed of 742 rpm. Plaintiff in his testimony indicated that he paid no attention whatsoever to rotational speed and there is strong implication that the wheel was being used well above 742 rpm (perhaps as high as 1100-1200 rpm). We now face the question of what role wheel speed markings played in industry-wide use. If in fact such markings were widely disregarded (as stated by plaintiff with regard to his own practice) defendant may bear the burden of such foreseeable misuse. On the other hand, if the industry practice was to pay scrupulous heed to the maximum wheel speed rating, there could be a serious question as to misuse of the product. Thus, the jury, in our opinion, was not given adequate information to determine the actual use of this product vis-à-vis industry-wide standards.

It becomes apparent that plaintiff is most likely to provide a detailed description of the manufacturing process (and thereby that aspect of the product description) in order to establish a basis for the manufacturer's alleged negligence. In this type of negligence case the specific accident provides a lesser contamination of the description of the product. The accident description is recognized as providing an insufficient basis for establishing liability.

2. Accident Description

The accident description here is apparently adequate for the purpose of establishing harm, but it would not seem to unduly color the whole of the litigation. This impression may well be attributable to the availability of only a partial transcript.

3. Defect Description

The identification of a defect is not germane, per se, to a conclusion of negligence. The additional burden to be met by plaintiff in establishing negligence is the demonstration that the defect would have been
disclosed by adequate standards of manufacturer's care. Unless a defect is attributable to a lapse of standards of due care no negligence liability exists, even though there may have been a defect and liability in a strict product liability sense. Given the nature of this alleged defect, the question of disclosure through adequate standards does not apply. Therefore, in this case the evidentiary burden would have been identical had the matter been litigated as a strict products liability case.

Plaintiff's expert, while eventually settling upon a single defect, had alluded to three other possible defects, thus creating an overall aura of defective manufacture. However defensible such testimony might be in establishing negligence conduct, it would have no place in products liability cases.

While defendant acknowledged the alteration to the wheel, which plaintiff characterized as a defect, he refused to concede that the wheel's performance under the recommended operating conditions would be at all impaired.

4. Description of the Unreasonably Dangerous Nature of the Defect

As noted above, this element received little attention and merited little.

5. Causal Relationship Between the Defect and the Resulting Harm

The causation issue was the central element in this case as litigated. As mentioned previously, it was discovered subsequent to the accident that the actual speeds of the grinder motor were far in excess of those printed on the name plate. In light of this subsequent test, a plausible inference may have been drawn that at the time of the wheel's disintegration it was running in excess of its rated capacity. Thus the issue of causation was finely drawn.

The size of the wheel fragments, characterized as "large" by experts of both plaintiff and defendant, was used to draw opposite conclusions as to causation. Plaintiff contended that this evidence supported his conclusion that the defect (cracks due to the absence of the safety ring) caused the disintegration at loads below those which this wheel could be expected to sustain. Defendant testified that the disintegration was attributable to overspeed.

Although this causation issue was on trial, and although it was an appropriate jury question, the jury's determination as to whether the wheel disintegrated because of defect or overspeed could only be made,
we believe, on the basis of their evaluation of the experts' credibility. This reasonably complex technological question concerning relationship of fragment size to failure mode was probably beyond the capacity of a lay jury to decide in the absence of suitable personal experience or additional factual information.

While the causation emphasis was and should have been the size of the grinding wheel fragments, this was not the central element in the hypothetical question asked of plaintiff's expert. Overspeed had essentially been eliminated as a causative agent in the phrasing of the hypothetical question. The only remaining inference was that a defect caused the wheel to disintegrate. We are thus again presented with a hypothetical question similar to that in Case C. The expert's opinion as to defect and causation was drawn without truly weighing the two competing causative agents.

6. Whether this Harm is Appropriately Assignable to this Defect

As noted above, the issue was never litigated. While a legitimate proximate cause issue relating to overspeed might have existed, the defendant's failure to introduce the norms of industry-wide practice prevented the development of this aspect of the case.

C. Conclusions

There are four features of this litigation which we feel deserve amplification. 1) Though not the central issue of a negligence case, the product manufacture was comprehensibly described. Such description made it possible for the causation issue to surface in a meaningful context. If such a level of description can be accomplished in a negligence case, it is evident that it can be done in a strict liability case, where product description is crucial to establishment of liability. However, product litigation requires the additional description of the function, use, safety and cost of the manufactured product. 2) While the focus was properly placed on the issue of causation, we fear that the jury could not properly assess the comparative worth of the opinion of the experts. Insufficient objective data were produced to provide a substantial foundation for the jury to ascribe disintegration to overspeed or inherent defect. We are tempted to conclude that this deficiency may appear in many products cases. 3) Our criticism of the experts in this case stems from our belief that their opinions as to causation were
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weakly supported. Plaintiff's expert, whose qualifications became a basis for appeal, did not provide, in our opinion, a factual basis for concluding that the absence of one of three safety rings caused the wheel to fail. There was a similar lack of evidence by defendant's principal expert to support his opinion of failure due to overspeed. 4) Although we have refrained from addressing this matter earlier, we note that it was suggested that there had been tampering with, and loss of, the remaining wheel fragments. Again, the matter of evidence preservation and control compels our attention as a possibly significant problem in product litigation.

CASE E

Prefatory Note

We consider the subject case to be of special significance to our study for several reasons. The case was comparatively well tried and involved extensive pretrial work. In addition, the qualifications of the experts, in general, were most impressive. Furthermore, the case was skillfully directed by a trial judge who was acutely aware of the central issues and actively intervened to bring them to the fore. The case essentially revolved around the question of whether a product failed principally due to a single load (impact) or progressively by fatigue which resulted from a manufacturing defect. This issue is complex and reappears in a large percentage of products cases. The analysis of the product failure requires careful scientific documentation along with a comprehensive evaluation of the accident environment.

We believe that this case illustrates in dramatic fashion that we do have serious problems in the product liability litigation process: a) an inadequate product description; b) expert witnesses' conclusions of 100 per cent or 0 per cent probability as to the cause of the failure despite the unlikelihood of such definitive conclusions being technologically realistic; c) expert witnesses who presented conclusions apart from the totality of the circumstances surrounding the accident; d) the particular failure of plaintiff to avail himself of the full range of technological investigatory techniques which may have provided a firmer foundation for his conclusions; and e) plaintiff's injury occupying the central position in the litigation, prior to, and irrespective of, a legal basis for liability.
These problems persist despite the competence of the experts and counsel and the guidance of a perceptive trial judge.

A. Case Characterization

1. Product Description

This case involved a semi-trailer truck that had been driven about 90,000 miles in the year between manufacture and the time of the accident. The focus of the litigation was the right front leaf spring of the tractor (cab). The leaf spring connects the right side of the front axle to the frame of the tractor. Its function is to provide flexibility between the tractor body and the wheels. The leaf spring is fabricated from a series of metal strips of varying lengths which are bolted together. The two longest leaves on the upper surface of the leaf spring are curved to fit over a cylindrical bushing at each end of the spring. Bolts through these bushings or eyes fasten the spring to brackets. The brackets are in turn attached to the frame of the truck. While the bolt through the front eye is fastened directly to the bracket and thus remains stationary, the rear eye is connected by means of a shackle which permits the rear end of the spring to move fore and aft as the spring deflects under normal use. The spring broke just behind the front eye (see Figure 3).

2. Accident Description

The injury to the plaintiff occurred on the early morning (3:30 a.m.) of a summer night. Plaintiff was driving his fully loaded truck, having just left his home for a long-distance haul. Just before coming to the site of the accident he was signaled by an oncoming truck that a dangerous condition lay ahead. He slowed his truck down and was traveling in the 40-50 mph range when he struck the left rear of a car. The truck subsequently went out of control and struck an embankment off the right side of the road. The truck climbed the embankment and overturned, coming to rest on the roof of the cab and trailer. Injuries sustained to the plaintiff-driver, who was trapped in the overturned truck, left him a paraplegic—totally paralyzed below the eighth vertebra.

3. Defect Description

Subsequent to the accident it was discovered that the right front leaf spring had fractured just behind the front eye. Plaintiff contended that the fracture was initiated by defects in the manufacturing process. The
two manufacturing defects identified by plaintiff were: (1) gouge marks on the main leaf in the vicinity of the front eye, and (2) undesirable microstructure near the surface of the main leaf in the vicinity of the front eye which caused a structural weakness in the metal. Plaintiff alleged that these defects led to premature fatigue failure of the leaf spring, which caused the truck to go out of control. Defendant denied that the metal had substandard properties and that the gouge marks had any influence on the fracture. He buttressed this conclusion by pointing out that the fracture originated beneath the surface, ruling out any causative relationship between either of the alleged defects and the resulting fracture.

4. *Unreasonably Dangerous Nature of the Product*

This case as litigated involved alleged production defects. If in fact it is found that there is a causal connection between defect and injury, the issue of unreasonable danger need not be addressed, since production defects which cause harm are by definition unreasonably dangerous.

5. *Causal Relationship Between the Defect and the Resulting Harm*

The causation issue was central to this case and was hotly contested at several levels. The vital issue here was the establishment of the time of leaf-spring fracture. If fracture occurred prior to any abnormal impact, the mode of fracture would have been fatigue. However, this fatigue must be shown to have derived from the alleged defects.

Other possible times of spring failure could have been upon impact with the automobile or with the embankment. Had the failure been occasioned by impact with the embankment the alleged defects would not have been the cause of the injuries (the inference being that loss of control prior to impact with the embankment was the result of driver error). Had the failure occurred either prior to or upon impact with the car it is apparent that the truck would go out of control, causing the truck to impact with the embankment. If the alleged defects had resulted in substandard material, which allowed the fracture to occur upon impact with the car, the alleged defects would have caused the injuries. Legal liability would then attach unless it could be shown that a non-defective spring would also have fractured under such impact. If the alleged defects were not the causative agents, the only remaining theory of liability would be crashworthiness or defect of
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design. All these various possible theories of causation are illustrated in Figure 4.

6. Whether this Harm is Appropriately Assignable to this Defect

In production defect cases, attachment of liability would occur when the defect had been shown as causal. Consequently, in this case the harm is assignable to this defect.

B. Critical Analysis

1. Product Description

The product involved in the litigation was not in reality the totality of a tractor-trailer truck. The specific product in question was the right-front leaf spring. To understand how this spring functioned required a clear picture of the relationship of the spring to the axle and the frame of the truck. This was crucial for two reasons. First, it was necessary to understand the sources and magnitudes of loading on the spring since there was controversy as to whether there were stresses of sufficient magnitude to cause the observed failure. Indeed, if stresses at the point of failure were minimal, premature failure would not have occurred even if the alleged defects were present. Second, it was crucial to understand the dynamic behavior of the front wheels and axle both prior and subsequent to the leaf spring failure. Both of these issues involve matters of considerable complexity and require sophisticated quantitative and intuitive reasoning on the part of experts. Yet, these issues were tried to a lay jury on the basis of a completely inadequate description of the function and use of the leaf spring assembly.

At the very least a model demonstrating the physical relationship between wheel, axle spring, and frame should have been utilized at the outset to educate both judge and jury. This deficiency was compounded by the absence of the broken leaf spring during the first few days of the trial. All that was available to the jury during the critical testimony of plaintiff’s experts were inadequate photographs of isolated parts and photomicrographs of steel structures at or near the fracture site.

In addition, adequate product description should, in a production defect case, include a basic description of normal average quality. In a case involving the metallurgy of a product one must understand that, at some level, all products contain metallurgical flaws. Whether any
THEORIES OF CAUSATION
CASE E

Spring Failure → Loss of Control From Spring Failure → Impact with Car → Impact with Embankment → PLAINTIFF'S THEORY (Abandoned)

Fatigue Crack → Impact with Car → Spring Failure → Loss of Control From Spring Failure → Impact with Embankment → Spring Failure → NO RECOVERY FOR PLAINTIFF

Impact with Car → Loss of Control - Driver Error → Impact with Embankment → Spring Failure → NO RECOVERY FOR PLAINTIFF

Impact with Car → Spring Failure → Loss of Control From Spring Failure → Impact with Embankment → Spring Failure → NO RECOVERY FOR PLAINTIFF

Material Not Substandard → Design Defect Test Of Crash Worthiness → PLAINTIFF MUST ALLEGED DESIGN DEFECT IF MATERIAL IS NOT SUBSTANDARD

ALLEGED DEFECTS
a. Gouge Marks
b. Improper Mat'l

SUBSTANDARD MATERIAL

Figure 4
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given flaw is a defect requires a standard against which it must be measured. This standard must be clearly defined and must be understood by the jury.

It is important to note here the distinction between design and production defects. In the former we examine the adequacy of the product line against a given standard of reasonableness for all products of that type. In the latter we may admit the adequacy of defendant’s product standard but seek to measure the allegedly defective specific product against the defendant’s normal average quality. A premise in production defect cases is that when a product does not meet normal average quality it is by definition defective and unreasonably dangerous. This premise is not necessarily valid for it is readily apparent that substandard quality alone, relative to defendant’s normal average quality, is not the equivalent of a specific product’s being defective and unreasonably dangerous. While the offending product might have a flaw, it might not be legally defective and unreasonably dangerous. Thus, in this case the gouge marks on the spring leaf, although admittedly a flaw, might not be a defect in the legal sense. A similar conclusion might also be reached with regard to the adequacy of the microstructure at the surface of the spring. It too must be measured against some standard.

Our reaction is mixed as to the adequacy of the evidence with regard to the standard of normal average quality. Plaintiff’s expert testified as to the inadequate microstructure of the steel in the vicinity of the fracture. He suggested that the absence of tempered martensite near the surface was a defect in the steel. He also suggested that the reason for the absence of tempered martensite was that quenching took place at too slow a rate.

Strangely, defendant did not adequately rebut plaintiff’s expert on the adequacy of the microstructure. Instead defendant focused his attack on the proper time allowable for quenching. The diversity between the conflicting experts was very sharp. Plaintiff testified that 1-2 seconds was the maximum time for cooling; whereas, defendant’s experts claimed that 90 seconds was allowable. It is apparent that defendant sought to use this technique to discredit plaintiff’s expert. Nevertheless, the jury was left with the impression that the microstructure was indeed inadequate and little testimony was offered to indicate whether it met normal average quality standards. The testimony that was adduced was highly technical in nature and failed to
compare the questioned steel with some accepted standard of normal average quality, such as SAE standards for acceptable microstructures. Instead the gamesmanship of the adverserial system supplanted engineering documentation.

The evidence with regard to the gouge marks was pervasive throughout the trial. It is safe to say that the spectre of these gouge marks was of symbolic importance throughout the trial. They served as a highly visual and easily understandable flaw in the leaf spring. When all else failed, plaintiff returned to the gouge marks. Yet, the requirement of unreasonable danger for strict liability was assumed rather than proved. Plaintiff sought to connect the gouge marks with the causation issue. The defendant, however, made no attempt either to discuss the gouge marks relative to industry standards or to compare these springs with industry standards. Such discussion may have permitted the conclusion that these were only flaws within acceptable industry standards rather than defects. Thus the normal average quality problem was never clearly addressed.

In earlier case analyses we indicated that there should be emphasis on trying the product first and foremost. The influence of the injury-producing event on the trial is profound and the question logically arises as to whether it is possible to try the product, in a production defect case, apart from the specific injury. In our critical analysis of defect we shall examine the import of the expert testimony on this question. We note at this point the possibility of trying the product alone on the basis of expert testimony without involving the entire injury-causing evidence.

2. Accident Description

The accident description was crucial to the plaintiff's case in that the witnesses' description of the erratic behavior of the truck after it struck the automobile was consistent with the pattern of loss of control which would develop in the event of a spring failure prior to or upon impact with the car. This description both reinforces the plaintiff's expert testimony on defect and tends to negate a conclusion of impact failure due to collision with the embankment.

As we shall note in our critical analysis of defect description and causation, there were inherent ambiguities in the testimony of both plaintiff's and defendant's experts concerning the time at which the spring failed. Consequently, the testimony of lay eyewitnesses to the
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accident provided the jury with corroborative evidence showing that the spring failure occurred prior to collision with the embankment.

While the two eyewitnesses' testimony gave credence to the loss of control shortly after impact with the car, plaintiff's own accident description at the trial was not consistent with the eyewitnesses' testimony. His testimony admitted only of the implication of spring failure prior to the impact with the car. Had this been accurate, the truck most probably would have immediately veered to the right, forcing both the car and the truck into the embankment immediately. The logical implications and inconsistencies of plaintiff's testimony were never pursued. The inconsistencies of this testimony may well have been resolved with the introduction of accident reconstruction evidence, but none was forthcoming.

3. Defect Description

The plaintiff's choice of theory required that he prove failure of the leaf spring through fracture or progressive fatigue. The fatigue failure had to be linked with either or both of the alleged flaws (i.e., (1) gouge marks and/or (2) improper microstructure near the surface). The expert testimony as to whether the fracture was the result of progressive fatigue or alternatively from a single load sometime during the accident was in sharp divergence. Plaintiff's experts testified that the fracture could be nothing other than fatigue failure emanating from the alleged defects. They totally and completely discounted the possibility of single-load failure. Peculiarly, the defense never rebutted the somewhat cavalier conclusion of fatigue failure stemming from surface defects, especially in light of their observation that the fracture originated beneath the surface.

Defendant's experts testified that the fracture indicated none of the signs of fatigue failure and hence there was no other explanation but single-load failure unrelated to the alleged flaws. This polarization of the testimony, as we have seen in earlier cases, characterizes much product litigation. Neither expert gave even the slightest credence to the opposing theory.

In this case if defendant prevails on the "no defect" theory, the case is at an end. If indeed defendant's experts are believed, there is no need to investigate the circumstances of the accident as to what tell-tale evidence may ensue. The "no defect" testimony is scientific in nature and stems from examination of the fracture surfaces and the micro-
structure. If defendant's experts upon examination conclude that there is clearly no defect and they are believed by the jury at 100 per cent level of probability, no alternative remains but a failure due to a single load uninfluenced by the presence of the alleged flaws. Such testimony requires no strengthening nor could it be weakened by circumstantial evidence arising from the accident. If one could be 100 per cent certain of scientific conclusions, there is not much left for confirmation. This case then could have been tried as a "pure" product liability case with focus on the product and the product alone. The plaintiff-paraplegic could have remained at home while the experts decided a rarefied question, i.e., was this fatigue or impact failure based solely upon examination of the fracture surface.

The jury could have instead, in its trial of the "pure" products case, believed the plaintiff's experts at 100 per cent level of certainty and attributed the spring failure to fatigue induced by the flaws. In order to assess liability, however, it would have been the responsibility of the jury to determine that the spring failure induced by fatigue caused the truck to go out of control.

It is our belief, based upon our examination of the physical evidence, that it was not possible to establish with anything approaching 100 per cent certainty whether the failure was the result of fatigue stemming from the alleged flaws or from single load impact having no relationship to the flaws. Consequently it was imperative to support one or the other of the proffered conclusions by introducing lay testimony concerning behavior of the truck prior to, at the time of, and subsequent to the time of impact with the automobile. When the physical evidence is insufficient to permit conclusions to be drawn with a reasonable degree of certainty (as we suspect is often the case), the corroborative evidence of lay witnesses may well be indispensable as the requisite "indicator" evidence. In those cases in which the technical evidence is inconclusive, the lack of supportive lay testimony may preclude the possibility of litigating the case at all.

One of the greater failings of this litigation was the lack of synthesis of the lay testimony regarding truck behavior with the testimony of the experts concerning the manner in which the spring broke. Had this synthesis been overtly made for the jury, the task of evaluating the interminable and highly complex technical testimony regarding the nature of the fracture surfaces might well have been reduced to man-
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ageable proportions. In fact, had this synthesis been the focal point for the technical testimony, the temptation to address the question in terms of absolutes from viewing the fractured surface alone may well have been resisted.

The extensive technical testimony on the evidence of the fracture surface might well have been justified had the most sophisticated testing techniques been employed to support the experts' contentions; the failure to employ such advanced techniques militates against the dogmatic statements of these experts. We further suggest that the inconclusive nature of the evidence might have been the result of inadequate or incomplete testing, and had the more sophisticated testing techniques been employed, they may well have provided a firmer foundation for the dogmatic assertions of the experts.

An interesting, if abortive, attempt was made by defendant to introduce additional evidence on the nature of the fracture surface. A leaf of a new spring had been pulled to failure in tension in defendant's laboratory. The fracture surfaces were shown to plaintiff's second expert, without describing the mode of failure, and he was asked to identify whether the failure resulted from fatigue or application of a single load. The expert's answer was inconclusive.

The sole design of this strategem was an attempt by defendant to impeach plaintiff's witness. The judge, however, did not permit defendant to identify the manner in which the leaf had failed. Thus the jury was unable to assess the expert's inability to reach a conclusion or to compare by visual examination the characteristics of the actual failure surface with that produced in the laboratory.

We believe that had defendant introduced this evidence with full disclosure of the nature of the failure it might have offered strong support for defendant's contention that the actual failure resulted from impact alone. It is precisely evidence of this type that should be introduced to enhance jury comprehension of the technical issue in production defect cases.

4. Description of the Unreasonably Dangerous Nature of the Product

Since this case, as litigated, was predicated upon production defects, there was understandably no offer of evidence concerning the distinct question of unreasonable danger. It has been noted that when the injury has been caused by a production defect (not a flaw in manufacturing), the unreasonably dangerous nature of the defect is assumed.
5. Causal Relationship Between the Defect and the Resulting Harm

a. Causation of Spring Failure

Ultimately, plaintiff's sole theory was that the spring failed prior to impact with the automobile from fatigue induced by either or both of the alleged production defects: gouge marks and/or improper microstructure (plaintiff adverted to, but finally abandoned, an alternative theory that the spring failed upon impact with the automobile. Failure at this point presumed that the alleged defects had so weakened the spring as to make failure inevitable upon routine impact). Apart from the appearance of the fractured surfaces, it was essential that the plaintiff show the origin of longitudinal stresses of varying intensities and duration sufficient to have induced the alleged fatigue failure. Plaintiff's second expert concluded that these longitudinal stresses were induced by the normal bouncing of the front wheels over ordinary road protuberances. He indicated that the physical evidence of the fracture surface suggested a fatigue failure, but that this evidence was not unambiguous. It was necessary for him to support the evidences of fatigue with theoretical calculations showing the existence of longitudinal forces capable of inducing fatigue. He further buttressed the conclusion of fatigue failure by observing that the damage to the automobile was so minimal that the spring could not have failed as a result of the truck's impact with the car. We believe that this synthesis (the use of calculations to reinforce the theory of fatigue failure coupled with the use of physical evidence of damage to the automobile to minimize the probability of impact failure) is precisely the prime role which the expert should play in product liability litigation. Plaintiff's first expert, however, a metallurgist by training, presented testimony on improper microstructure which was so unclear and so unsupported by adequate testing and documentation as to do no more than present an "aura of defect" rather than well-supported engineering conclusions. All this expert could do was to present evidence of flaws, although he chose to characterize these as defects which he concluded with 100 per cent probability led to fatigue failure. Plaintiff's metallurgical theory of fatigue failure was strongly buttressed by testimony of the truck manufacturer's chief metallurgist, who characterized the fracture in the main leaf as a fatigue failure and the fracture in the wrapper leaf as an impact fracture.

Defendant's experts countered with three alternative suggestions:
1) that the microstructure was nondefective; 2) that the gouge marks were at most flaws, never rising to the level of defects; and 3) that the causative agent of the failure was not fatigue, but rather impact with the automobile or the embankment. One of defendant's experts reviewed plaintiff's calculations on the magnitude of the longitudinal forces and concluded that the calculations were in error. The defendant's expert's own calculations indicated forces of too low a magnitude to induce fatigue failure of the spring. He also offered calculations of the impact force arising from contact with the automobile, concluding that the impact was so great as to have caused a non-defective spring to fail (another of defendant's experts completely discounted this second suggested theory, and unequivocally stated that the spring fractured upon impact with the embankment). There was no other explicit testimony offered by defendant's experts on this aspect of causation.

b. Causation of Loss of Control

Had the plaintiff's experts' theory of spring failure been totally accepted by the jury, it would still have been necessary to prove that loss of control was attributable directly to this failure. Plaintiff's only evidence was that offered by plaintiff's second expert, who testified that this failure of the right front spring would cause the truck to veer uncontrollably to the right. Defendant apparently acceded to plaintiff's view that had plaintiff's theory of spring failure accounted for the fracture, loss of control would have followed directly. Defendant was presumably compelled to this accession in light of defendant's own movie showing that the truck would go out of control to the right immediately following spring fracture.

6. Whether this Harm is Appropriately Assignable to this Defect

As earlier indicated, in production defect cases assignability questions present no problem when the defect has been shown as causal. Here that situation obtains.

C. Conclusions

We might begin our conclusionary remarks for this case by reiterating our initial observation that the trial judge exercised a very active role in controlling the direction of the evidentiary presentations and in fact often intervened during direct and cross-examination of witnesses
with questions designed to clarify points of obscurity. Despite the willingness of the judge to so intimately involve himself in the minutiae of the trial and the peculiar strength he lent to the proceedings, stemming from his sophisticated insight into the legal elements of the cause of action, we are compelled to note the limitations inherent in the role of the trial judge.

By way of illustration, inadequacy of product description (a common phenomenon in products litigation) at best admits of a curative service by the judge. If the plaintiff has failed to elicit a comprehensible description of the product within the context of its use, the single most crucial element in any products case, the trial judge can do no more than lead witnesses to elaborate upon their initially sparse, haphazard, or overly technical oral presentation. Such a patchwork task, no matter how painstakingly pursued, can never adequately serve to raise jury comprehension to the level which could have been achieved in this case by a direct comprehensive initial presentation of the use and function of the spring enhanced by mock-ups, movies of the product in use, or other visual aids. Within the framework of our adversarial system then, primary responsibility for adequate litigation procedures rests upon counsel (and primarily counsel for plaintiff) and to the degree that they fail to respond to their obligations even the most willing trial judge can do little more than serve a palliative function in many fundamentally important areas of the products litigation process.

Nonetheless, we do not wish to suggest that the trial judge must in the future continue to chafe helplessly as he presides over a disjointed and obtuse presentation of complex matters which could be made comprehensible to a lay jury. Ultimately, the trial judge retains the power to non-suit a plaintiff who has failed to carry his burden of proof; it may be that this traditional weapon is well suited to compel an intelligible plaintiff’s presentation.

A second area of concern in this trial is the propensity of litigants’ experts to present their conclusions as 100 per cent certain. Recognizing that admission of opinion testimony by experts is tolerated (despite its intrusive effect upon the fact-finding role reserved exclusively for the jury) because the expert presumably is best equipped to analyze and synthesize complex technological matters, counsel has too readily succumbed to, and courts have too readily acquiesced in, techniques of proof in this area which are unwarranted even given the rationale of
the exception. We suggest that to confront a jury with two experts, each speaking in the mystical jargon of his profession and concluding with a dogmatic assertion which admits of no contrary possibilities, is to place a responsibility for choice upon that jury which it has not been equipped to meet. Despite the often desultory attempts to discredit the expert during cross-examination by counsel’s resort to other esoterica of the profession, the two experts are often as two ships that pass in the night. Each dredges up certain concepts of his specialty, asserts that they are operative in this case, and firmly concludes that the inevitable deduction based upon this technical data is as stated. Little or no attempt is made to synthesize technological material with such non-technological evidence as may exist (and which might serve as invaluable indicators between conflicting technical conclusions), and all recoil from any suggestion that the proffered opinion could be less than Revealed Truth. We would observe that such an approach to employment of expert testimony is not merely self-defeating but leaves the jury in the untenable position of having to select one dogmatic assertion over another without sufficient insight to evaluate the manner in which the experts reach their conclusions. Relevance remains a criterion for the expert no less than for the lay witness and the expert should be constrained to tie his theories to the evidence and to perform this task of synthesis before the jury, not merely in the solitude of his laboratory. Compelled to engage in such a demonstration of his analytical processes, looking to his ultimate synthesis, may well make for a more balanced presentation of evidence and afford the jury some leverage in dealing with the question of liability. If counsel persist in using the expert to simply plug an evidentiary hole, however, this abuse of the expert, the jury and the judicial system is likely to continue. The ability of a trial judge to ameliorate this situation is less clear, but the charge to the jury may afford an opportunity to comment upon the credibility of the completely dogmatic witness.

In evaluating the presentation of the causation testimony we are struck by the incredible complexity of expert testimony. In one instance plaintiff’s expert set forth a highly sophisticated theory to explain the presence of stresses which could give rise to fatigue failure. The defendant sought to rebut this theory by disputing the mathematical calculations of plaintiff’s expert. One may wonder how a jury was to evaluate subject matter that would be a challenge to a university class in advanced dynamics. We have alluded to the difficulty
that a jury has in bringing to bear an evaluative sense to conflicting expert testimony. It is hard to imagine a more vivid example of this phenomenon than that present in this case, where the jury saw the spectre of two sophisticated experts hypothecating an obtuse theory based on complex mathematical calculations. If the jury digested this crucial information then their powers of comprehension and understanding are indeed admirable.

In addition, we note that the theory presented by plaintiff to explain the presence of longitudinal stress raises a serious problem. The theory was presented to the jury without empirical verification by testing. It would seem that minimum standards for the admissibility of theoretical propositions should be established. Where testing is feasible, it would seem improper to present an untested and unverified theory. To rely on cross-examination to accomplish this desired goal is to shift the burden of evaluating the prima facie case from plaintiff to defendant. Furthermore, since the judge will have to rule on the adequacy of plaintiff's prima facie case on a motion for directed verdict at the close of plaintiff's case, he must be the arbiter of the minimum quality of plaintiff's evidence and should thus have available to him a standard by which to judge the minimum acceptability of theoretical evidence.

The previously-noted temptation to use the witness as a plug finds startling confirmation in this case. Despite a plethora of expert witnesses testifying to the indicia of fatigue failure and impact failure, literally no mention was made of a readily-observable phenomenon which was strongly suggestive of a non-fatigue conclusion. Visual examination of the surface of the fractured part reveals stalactite-like structures within the metal, known as delamination. All available data concerning this phenomenon indicates that it does not occur in conjunction with fatigue activity. The failure to advert to or to employ such strong indicator evidence to buttress a suggested conclusion of non-fatigue may bespeak the kind of tunnel-vision approach to expert testimony which simply seeks out the accommodating witness to fill out the case. More seriously it may reflect a fear on defendant's part that reference to such structures to aid in refuting a fatigue hypothesis may raise a spectre of yet another defect. This failure to employ all available evidence to reach a conclusion was coupled with what we believe was a lack of use of advanced and sophisticated testing and observation techniques. We suspect that this was due to a lack of com-
petency on the part of plaintiff's first expert and perhaps a lack of time for defendant's principal experts who were brought into the case just prior to trial. Regardless of the reasons, there was no justification for the lack of adequate testing and documentation.

Further, we can characterize the activities surrounding evidence preservation as no less than disdainful. If the circumstances of the accident can account for the initial cavalier attitude toward the truck and its constituent parts (leaving the truck in an open lot exposed to the elements and possible vandalism), subsequent behavior toward the evidence bordered on the incredible. Partial disassembly of the truck to recover the broken parts was carried out without retaining the bolts which connected the spring to the truck frame; destructive testing was carried on over a substantial part of the fracture surface; and no steps were taken to preserve the remaining undestroyed evidence or metallurgical samples from deterioration. Inasmuch as the fracture surface did not offer conclusive evidence of the cause of the failure even had the evidence been well preserved, it was incumbent upon the experts and counsel to make every effort to maintain the evidentiary material in the best possible state so as to introduce no unnecessary additional element of uncertainty. A minimal obligation to the court requires that elementary safeguarding procedures be observed, and the absence of such routine precautions should serve to invoke the sanction of the court, on its own initiative if necessary, against those who were in a position to protect evidence and failed to do so. Certainly the most effective form of sanction would be to deny the offending party the right to employ evidence garnered in blatant disregard of principles of evidence preservation.

In the final analysis, hard judgments must be made with regard to whether or not a case can be tried on the available evidence. When the issue is as difficult of resolution as that involved in the instant case, to try the case with evidence offered in such an advanced state of deterioration may be tilting with windmills. At a certain stage of evidence deterioration prior to the trial, the decision must be reached as to the ultimate value of litigation.

In light of these enumerated deficiencies, it is not surprising that the injuries of the plaintiff became the focal point of the case. Plaintiff's counsel is well content to let the jury dwell upon the misery of his client and is likely to downplay any element in the case which would
divert the attention of the jury from that central fact. Having laid a sufficient background to allow the case to be considered by the jury on the question of liability, plaintiff's case is likely to be injury-oriented (defense counsel is generally powerless to prevent such a shift in focus). If such a tactic by plaintiff's counsel may be expected, the elevation of this aspect of the case to premier importance invites a jury, already presented with two nearly incomprehensible technological explanations, diametrically opposed and dogmatically stated, with an opportunity to resolve a difficult if not impossible task on comprehensible and humane grounds. To suggest that they may often resort to such an expedient is to reflect less on the jury system than on the context and level of products litigation.