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SANTA BARBARA • SANTA CRUZ

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November 9, 1992

UCLA SCHOOL OF MEDICINE
HARBOR - UCLA MEDICAL CENTER
DEPARTMENT OF RADIOLOGY
1000 CARSON STREET
TORRANCE, CALIFORNIA 90500

Samuel Chilk, Secretary of the Commission
U.S. Nuclear Regulatory Commission
Docketing and Service Branch
Washington, DC 20555

Subject: Letter of Peter Crane dated 10/31/92 regarding PRM-20-
20, PRM-35-10, PRM-35-10A, and the 23 October 92
meeting of the ACMUI

Dear Mr. Chilk:

I am writing to correct the scientific mistakes and misunderstandings contained in Mr. Crane's letter of 31 Oct. 92, and to point out that certain opinions ascribed to me by Mr. Crane are grossly inaccurate. Fortunately my opinions are amply documented, in writing, in your office, so this should be quite straightforward. I recommend that Mr. Crane review my Petition dated 12/26/90, my important Addendum of 6/12/92, and my comments of 3/14/92 concerning the ACNM Petition.

My Petition was written at the request of Hal Peterson, who was embarrassed at the uncorrected errors in 10 CFR Part 20, and who urged me to "write a Petition YESTERDAY". At the time, the new Part 20 was supposed to go into effect 1 Jan 92, and we did not have many months to waste. I argued at the time that I did not want to write another petition (I wonder why?), but he insisted it was the only option open, and that is how I spent Christmas Eve, 1990. It was hastily done, and recommended honoring the methodology of NCRP no. 37, getting rid of the "30 mCi rule" for all radionuclides other than I-131, and retaining the 5 mSv maximum for members of the public from patient sources; this is in keeping with the most recent recommendations of NCRP, ICRP, and the IALA. I recommend that Mr. Crane review this literature as well, as NRC asserts frequently that it uses such sources for its standards.

Much later, after discussing the issues at leisure in much more detail with members of NCRP, ACNP, SNM, and NRC, I wrote an Addendum covering the "30 mCi" issue. Due to the fact that the "30 mCi" value was embarrassingly based on a naive mistake by the AEC in the early 1950's and never fixed thereafter, and due also to the fact it is not mentioned anywhere in NCRP no. 37 (nor should it have been), I made a scientifically valid case for a "default" value of I-131 patient discharge which came out to 33

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mCi. However, there is excellent reason to raise that number, especially for athyreotic carcinoma patients with normal renal function. NCRP no. 37 lists limits of 50 mCi for certain home situations and 80 mCi for even more restrictive home situations. Mr. Crane should familiarize himself with these qualifiers, because he is obviously unfamiliar with these long-accepted concepts. NCRP no. 37 is the law in California; the "30 mCi rule" does not exist here. We in California try to base our policies on scientifically valid health physics.

When the ACNM Petition was submitted, I used my comment opportunity to remind NRC that my Petition was drowning at the bottom of Mr. Roecklein's "in" pile, and that it needed resolution. The concept of sending patients home with 400 mCi of NaI-131 was ludicrous. Although I could theoretically concoct a situation where it could possibly be justified, there are not too many patients who would qualify as hermits in isolated areas. In any case, I stated:

"The one aspect of the petition that causes me some concern is the claim of safety of an outpatient dose of 400 mCi. I have not reviewed data supporting this argument and would appreciate the opportunity to do so. Although I'm sure that safety could be satisfied, it would appear to require some very specific circumstances".

As there are no data that could possibly support this except in highly unusual situations, the point is moot. Mr. Crane should also know that I requested that ACNP (absolutely not related in any way whatsoever to ACNM), SNM, the American College of Radiology, and Jack Goodrich, M.D., past ACMUI member, make similar points in their comment letters. I explained to the American Hospital Association that this was NOT a good way to save money, and made a presentation against the ACNM Petition at last Spring's CRCPD meeting at the request of Terry Frazee of the State of Washington.

I hope that NRC clearly understands that I am not now, nor have I ever been, a member of the ACNM nor an espouser of 400 mCi I-131 doses dispensed to patients in an uncontrolled manner. However, NRC's "30 mCi" rule is scientifically unfounded and constitutes bad physics, just as ACNM's claims are unsupported by scientific data.

All I am trying to do is challenge NRC to make an intellectually defensible, scientifically valid regulation based on best available scientific data and scientific judgment. I urge NRC to entertain only scientific discussion, and eschew scientifically

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uninformed nuclear hysteria from any source. NRC's independent status insures it does not have to honor outside opinion flawed by ignorance. One would hope NRC would not have to honor inside opinion flawed by ignorance, either.

Mr. Crane asks NRC to regard him somehow as a knowledgeable professional on the subject of I-131 for thyroid cancer, based on his personal experience with the disease. Having read Mr. Crane's present missive, and a previous related document at the time the Commission signed the scientifically insupportable "Quality Management" thing, let me assure you, as a knowledgeable professional on the subject of I-131 for thyroid cancer, that Mr. Crane is well-qualified to be a patient, and nothing more. For example, if Mr. Crane really had a partial thyroidectomy in 1973 and then 2 doses of 29.9 mCi each 10 and 11 years later to ablate the remnant, it is no wonder he had recurrences, and it is surprising he isn't in malpractice court. Knowing the excellence of NIH, however, I would tend to doubt the validity of his account.

As far as his story about his confinements, let me explain that one does not need "thick paper" on the floor, only absorbent material with a plastic backing. As far as "smelling strongly of seaweed", this is pure confabulation. In the first place we do not give iodine, we give iodide. Iodide does not smell like seaweed. Second, the mass of 150 mCi of I-131 is $(150)(131)(8)(24)(60)(60)(8.87 \times 10^{-17}) = 1.2$ micrograms. Normal stool contains 10-50 micrograms per day. The average person contains 30,000 micrograms of the element iodine, and another microgram or so, even if converted to a volatile form, should not make his deodorant fail. Mr. Crane's story about his contaminated computer case is indeed a physics first. "...radiation from stray drops of urine had probably penetrated the thick concrete walls of the bathroom and reached the case. A month later, the case had cooled down to the point that I could collect it from Radiation Safety." Quick, Mr. Bernero! We need at least three contracts to starving DOE labs to understand this new phenomenon. "Beta creep"? Good God! Have all our shielding calculations been for nought all these years? My Uncle Joe Fertik, who designed the 14 foot concrete vault around the very first Oak Ridge reactor after W.W. II, died last year at 94, and never knew. If a gamma ray sneaked through and hit the case it should last no more than about a picosecond at most. A month? Wow!

Mr. Crane makes some other interesting statements, quoting such incontrovertibly superb scientific sources as the New York Times

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for data on childhood thyroid cancer near Chernobyl. I recommend that Mr. Crane read Hull AP: Post Chernobyl childhood cancers reported. The Health Physics Newsletter, vol. 20, Nov. 1992, (cover story). There are some interesting problems with Russian "data" at this point.

Mr. Crane's naivete' concerning the first Petition I wrote in June, 1982, with Mr. McElroy's help, is surprising. Mr. Cunningham instructed Mr. McElroy to help me write the Petition. I didn't know how to write regulatory language, and it was Mr. McElroy's job to help me do that. NRC had written some very poor quality and dangerous regulations in 1987, and Mr. Cunningham realized that the language had to be fixed, and asked us to do it together. It was an "inside" job from the start. Mr. Cunningham gave us some very tough boundary conditions, but we did the best we could. This was before NRC rammed through the petitioner's "Gag Rule" without opportunity for public comment. If I were to write my own petition to change Part 35 today, with none of Mr. Cunningham's constraints, I would get rid of nearly everything in it, and upgrade education and experience criteria for nuclear medicine physicians so that NRC stopped licensing incompetent physicians who don't even know what Part 20 is, let alone the basic science necessary to comply with it. Nuclear Medicine would be subject to performance standards only. The only reason we have completely prescriptive regulation is that performance standards require thorough understanding and judgment, and NRC itself cannot seem to rise to that level. So yes, Mr. Crane, the staff "is passing judgment on a petition that the staff itself helped to write", and I did not "misspeak".

Mr. Crane is a lawyer. It is not surprising that he is thoroughly unfamiliar with the areas of nuclear medicine, nuclear pharmacy, and basic nuclear sciences, because he has never had any education, training, or experience in these fields. However, one may expect certain professional behavior from a lawyer. For openers, one would expect him to read the obvious background material on a case, so that he would be aware of the facts. It is well known that I do not deprive the NRC of my opinions on subjects involving my expertise, and a short search on Mr. Crane's part would surely have yielded the facts he so desperately lacked. Although he would not have understood my calculations, he could have asked an expert for some help. He could even have called me! He would, however, have been expected to understand the English. It is not acceptable professional behavior for an NRC lawyer to attempt to deceive NRC about the opinions of an NRC advisor and consultant, refuse to even bother with the facts, and expect NRC licensees to continue to support him with User Fees. I object to his continued employment at NRC.

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In addition to being of no value as a nuclear expert, he is, in my opinion, behaving in an unacceptable manner for a lawyer.

Thank you for the opportunity to comment on this most informative comment letter.

Sincerely,



Carol S. Marcus, Ph.D., M.D.
Director, Nuclear Med. Outpt. Clinic
and
Assoc. Prof. of Radiological Sciences
UCLA

cc: Peter Crane
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Commissioner Gail de Planque
Commissioner Forrest Remick
Commissioner Kenneth Rogers
Commissioner James Curtiss
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Mark Rotman
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CSM:sfd

October 31, 1992

To: Secretary of the Commission
U.S. Nuclear Regulatory Commission
Attention: Docketing and Service Branch

From: Peter G. Crane *PGCrane*

Subject: DOCKET NOS. PRM-20-2G, PRM-35-10, AND PRM-35-10A
(PATIENT RELEASE CRITERIA FOR PATIENTS TREATED WITH
RADIOPHARMACEUTICALS)

The following are comments on the amended petition for rulemaking filed by the American College of Nuclear Medicine (ACNM), as noticed in the Federal Register with a request for comment. I realize that the Federal Register notice states that comments received after July 17, 1992, will be considered only if it is practical to do so. I hope that the Commission will nevertheless elect to take my comments into account, because I believe my experience as a nuclear medicine patient, treated with a total of 760 millicuries of radioactive iodine as an inpatient and an outpatient, may be of some value in weighing the merits of the petition. I apologize for the lateness of my comments. I was living on an atoll in the Central Pacific at the time that the American College of Nuclear Medicine first proposed (on January 14, 1992) that the 30 millicurie limit be eliminated for outpatient treatments with radioiodine, and that "confinement" of patients be redefined to include "remaining in a private residence." Although I rejoined the NRC in May, 1992, I was not aware until October 30, 1992, when I first saw the transcript of the meeting of the Advisory Committee on the Medical Uses of Isotopes, that such a proposal was under consideration.

I should emphasize that although I am now an employee of the Nuclear Regulatory Commission, I am submitting these comments in my capacity as a member of the public, rather than in my official role as Counsel for Special Projects in the Office of the General Counsel. I am writing these comments at home, on my own time.

The ACNM proposes to allow patients to be treated with Iodine-131 in doses of up to 400 millicuries on an outpatient basis. The argument is made that the increased dose to family members from the patient is compensated by the benefit to the family of having the patient at home. It is further proposed that the definition of "confinement" -- since at present, persons receiving doses in excess of 30 millicuries of I-131 must be confined until their activity level declines to prescribed levels -- be revised to include an instruction to remain at home. The 30-millicurie limit would be abolished, and the dose to the maximally exposed member of the public would be increased from

100 millirem to 500 millirem.

My experience with I-131, as an outpatient and as an inpatient, began in 1973, when I had a partial thyroidectomy for papillary thyroid carcinoma. I received diagnostic doses of I-131 -- in what amount I no longer recall -- at that time and in subsequent checkups. In 1983 and 1984, as an outpatient, I was given two doses of 29.9 millicuries each to ablate (burn out) the thyroid remnant. For several years after that, I was tested with diagnostic scans of either 5 or 10 millicuries of I-131. In 1988, after a scan showed evidence of new growth, I received 100 millicuries as an inpatient. In 1989, after another positive scan, I received 150 millicuries as an inpatient. In 1990, I received two more treatments as an inpatient, each of 150 millicuries, and in June 1991, I had a fifth inpatient treatment, again of 150 millicuries. All seven treatments were given at the National Institutes of Health. Earlier this month, after a 10-millicurie diagnostic scan, I was pronounced free of any sign of suspect tissue.

Persons who have not had inpatient treatment with I-131 have no reason to be familiar with what it entails. Because the patient becomes a radioactive source, emitting contamination through bodily fluids of all kinds, special precautions are taken. The floor is covered with thick paper, fastened to the wall with duct tape, because the iodine exuded through the skin of the patient's feet will otherwise contaminate the floor. All taps at the sink are covered with duct tape. Male patients are instructed to urinate sitting down, in order to minimize the possibility of contamination, and patients are told to flush the toilet twice. The patient is cautioned that any books he or she brings into the room will have to be discarded or retained until their radioactivity has diminished to acceptable levels. At mealtimes, the patient is allowed to open the door momentarily to take the tray off the proffered cart; after the meal, one deposits one's tray and its contents in the trash, to be disposed of as low-level waste. Because the iodine in the patient is excreted through perspiration as well as through urine, the room tends to smell strongly of seaweed. Except for the people from Radiation Safety who test the patient for radioactivity, and the people who collect the trash, no one enters the room.

As I developed experience with radioiodine treatments, I learned how to make conditions more livable. By wearing rubber gloves at all times, I could keep my books from being contaminated. On one occasion, however, when Radiation Safety was checking me and my belongings for release, I was told that while my laptop computer, borrowed from NRC, was clean, its case was not. I expressed amazement; I had not touched the case since entering the room two days earlier, whereas I had been handling the computer, albeit with rubber gloves, extensively. It was explained to me that the case was on the side of the room close

to the bathroom, and that radiation from stray drops of urine had probably penetrated the thick concrete walls of the bathroom and reached the case. A month later, the case had cooled down to the point that I could collect it from Radiation Safety.

Under the regulations now in force, one cannot be released from inpatient confinement until the level of residual radioactivity in one's body is equivalent to that of someone who has received a 30-millicurie dose. Extensive advice is given as to precautions to be taken on returning home: always flush twice, urinate sitting down, bathe frequently, minimize contact with and proximity to children, sleep apart from your spouse for a week, do not handle food that others will eat, etc. I followed those instructions rigorously. It was not that difficult to do so; I could understand the instructions and their rationale, my wife could serve the food, set the table, and make the children's lunches, and we had a bathroom in the basement that no one in the family but me ever used.

Even so, it is not easy to avoid physical contact with children who are used to hugs and kisses, especially when one of your first objectives is to preserve a sense of normality in the household. On one occasion, I had just returned from a one- or two-night stay in NIH thinking rather smugly that with various distractions, my wife and I had succeeded in keeping the children blissfully unaware that anything seriously out of the ordinary had occurred. It took my daughter, then about 6 years old, only about 20 minutes to figure out that I was keeping my distance from her. She burst into tears and asked me, "Daddy, will you still love me after you die?" This from a child who has never heard the word "carcinoma" or its equivalents spoken in front of her in reference to her father.

My family is fortunate: we are a two-parent household, we have a spare bathroom and a spare bed, and we are educated enough to appreciate the significance of radiation protection guidance. But imagine the single parent who does not have anyone else to do the shopping, prepare the meals, set the table, make the sandwiches for the children's lunches, bathe the children, and so on. Imagine also the mother, frightened at the diagnosis she has received, who wants only to hug her children to herself. Imagine the family that lives in a small apartment, with one bathroom shared by all and no spare bed. In short, there are cases where it may be better by far for children to be farmed out to a relative or a family friend for several days than to remain at home with a parent who is a radiological hazard.

Speaking from experience, it is not always easy to remember at all times to follow the radiation protection guidance one has been given. Especially in the home, one tends to follow habit, and when a child reaches up to you for a goodnight kiss, one may kiss her without thinking about it. But all my experience

involves being at home with an activity level in my body of 30 millicuries or less. Can you imagine how much worse the problems would be, and how much more serious the unintended exposure... if a patient is at home with 300 millicuries of I-131 working its way through his or her system?

The transcript of the ACMUI meeting shows Ms. Brown, the patient's representative on ACMUI, asking -- with a common sense practicality that reflects credit both on her and on the Commission that decided to add such a representative to the Committee -- for "some basic information to follow the issue here. Is the person that before this change would have been hospitalized and now is likely to be able to go home -- is that patient going to feel bad? Is it someone who is likely to go home to bed, or is it someone who would have just been feeling fine in the hospital and feeling fine at home -- is it just that you don't want them to expose other people?" (Transcript, pp. 471-72). To this, Dr. Cool of the NRC staff replies, "I am not sure I am really in a position to address how they may feel."

It may strike some as anomalous that the staff, in the issues paper prepared for the ACMUI meeting, should justify its proposed elimination of the 30-millicurie limit in part by pointing to "the emotional benefit provided the patient when in the direct care of family members," while at the same time confessing ignorance as to whether patients physically "feel fine" or "feel bad." Can an agency which exists to protect people from the harmful effects of radiation be unaware of patients' physical condition and yet offer opinions on their psychological state?

I, however, am "in a position to address how they may feel." Any patient being treated for carcinoma with a therapeutic dose of I-131, whether it is 30 millicuries or 400, is already severely hypothyroid, having been removed from all thyroid medication several weeks in advance of the scan. As a result, the person is physically in a state of extreme exhaustion. (When President Bush was recovering from his I-131 treatment for Graves disease, and was hypothyroid from having his thyroid ablated, there was comment in the press as to his surprising breach of protocol in sitting down in the presence of the Queen of England. Any veteran of I-131 treatments could have come up with the explanation: he was too weak to stand up a moment longer.) The patient's reflexes are slowed, making driving more hazardous. Mental processes are also slowed down, and there is a loss of short-term memory. All these factors make it less likely that a patient will remember and follow radiation protection guidance if treated as an outpatient, especially at the extremely high doses envisioned by the petition. (To my knowledge, 400 millicuries is a massive dose, used only with advanced metastatic disease. On one occasion, when I was in NIH, I was told of a patient who was hospitalized for eight days after a 300-millicurie dose.)

In addition, one of the most common effects of I-131 treatment is nausea. (As one reads the transcript of the October 1992 ACMUI meeting, one finds frequent references to patients vomiting.) As an inpatient, one is instructed to call the nurses' station at the first sign of nausea, so that appropriate medication may be given. Vomiting presents problems for hospital Radiation Safety departments, because they must enter the radiologically contaminated room in order to clean up. Consider, however, how much worse it would be if the patient is at home, vomiting, and unprotected family members, rather than Radiation Safety personnel with rubber gloves and other protective gear, are having to clean up, probably without thinking for a moment, under the stress of the situation, of the radiological implications.

There are other reasons to keep a patient hospitalized: for example, to remind the patient to suck hard candies, in order to purge the salivary glands of radioiodine. Is the patient at home likely to remember that he or she is supposed to be sucking sourballs at frequent intervals? I doubt it.

The question is asked by Ms. Brown, the patients' representative on ACMUI, at p. 472 of the transcript, "if this is a guy who might just, not having taken an altruism test, would go down to the 7-11 and stand behind me and my kind and get a pack of cigarettes." I can speak to that. Even though one is weak, it takes little effort to drive to a store, and one may do so either from necessity -- some patients must shop and prepare food for themselves -- or without thinking about the radiological consequences to others. On one occasion, I was released from NIH after a treatment and decided to stop into a nearby toy store to pick up a homecoming present for my children. Slap bracelets were the fad that winter, and I had handled the store's whole assortment before it suddenly hit me that I had contaminated them all. Rather than have a child's contamination on my conscience, I bought 22 slap bracelets and kept them in a drawer for a month or two to cool down before giving them away.

But suppose it had never occurred to me, or suppose the product had been one costing not a dollar apiece but \$50 apiece. What then? Suppose that the patient, full of 400 millicuries of I-131, stops by the grocery store, and, forgetting the fact that he or she is just out of the hospital, picks and chooses among the peaches and tomatoes as he or she has always done, leaving behind contaminated fruit and vegetables for the next shopper. What about the patient, traveling home by public transportation, who cannot find a seat, and therefore spends half an hour or an hour exuding radioiodine onto the strap or pole of a subway or bus? Has the staff thought about this at all when it speaks in the issues paper about the "infrequent nature of the exposure to members of the public"?

At p. 518 of the transcript, Dr. Siegel asks for a "worst case scenario." Dr. Marcus replies, on the following page, by describing the Arizona misadministration in which a woman received 100 millicuries of I-131 by mistake : "what we had as worst-case situation where someone behaves normally -- kisses the children, kisses husband -- all this stuff." I believe that this understates the problem. We have to consider contamination of food, contamination of the bathroom, the child who sits in a parent's lap (thereby receiving a dose from the patient's bladder), the child who crawls into bed with the patient at night and lies near the patient's thyroid, and a range of other possibilities. I realize that the NRC staff's issue paper states that licensees would have to evaluate individual circumstances (including the presence of children in the home; before allowing the patient to be treated as an outpatient, but I question whether, in reality, a detailed and thoughtful evaluation of actual exposure pathways would take place, if hospital personnel are under pressure to cut costs by minimizing in-patient I-131 treatments.

Of all the reasons offered by the staff in support of removing the 30 millicurie limit, the first one is the most revealing: "the benefit afforded the patient in reduced hospital costs." I am no expert on the financing of medical care in America, but it is my strong impression that very few patients pay their own bills in hospitals. Rather, the bills are paid by insurance companies or by Federal or state bodies. Hospitals are no longer reimbursed for their actual costs, but at the levels that various governmental authorities see fit to pay. Thus to the extent that the hospital's cost exceeds the reimbursement, the hospital is out of pocket; and to the extent that the hospital can cut costs by turning inpatients into outpatients, the hospital stands to profit. In short, I am prepared to agree with the NRC staff that cost is the primary justification for this proposed change, but I cannot see that cost to the patient plays much of a role.

In sum, I see no good reason for changing existing requirements. The 30-millicurie level or equivalent is a known benchmark. Providing latitude to hospitals to cut costs by turning highly radioactive patients loose on their families and the community at large may provide health care providers with short-term economic benefits, but it carries serious risks to public health and safety. Confinement to one's own residence is not equivalent to confinement in radiological isolation; it is self-delusion to imagine otherwise.

Ironically, this proposal may well be contrary to the longer-term economic interests of the regulated community. When there is a perception of a public health need and a regulatory vacuum, other agencies, Federal or state, step in, with

unpredictable results. Moreover, giving discretion to hospitals as to whether to release patients with large amounts of radiopharmaceuticals in them is an invitation to lawsuits charging that they have exercised their discretion unwisely. The following scenario for a lawsuit is not so very improbable: "Hospital X, you elected to treat my ex-boyfriend with 400 millicuries of I-131 as an outpatient. He then came and spent the night with me, without telling me about his treatment. You should have known that he was dangerous and that his judgment was impaired. I now have received a dose to my thyroid, I'm seeing a psychiatrist because of my fear of developing cancer, and I am suing you for x millions of dollars for the physical and psychological harm I have suffered." Stranger lawsuits than that are filed every day.

It is worth noting that Dr. Marcus, praising the NRC staff's proposed resolution of the outstanding medical issues, speaks of the "40-month gestation," and says that the staff's proposal "is far better than the petition Mr. McElroy help [sic] me write." Transcript, p. 363. Given that Mr. McElroy was until recently a member of the NRC staff, could the staff clarify whether in this proposal it is passing judgment on a petition that the staff itself helped to write, or did Dr. Marcus misspeak?

It is a blessing, however, that we have a responsible ACMUI majority to speak up in opposition to the position espoused by Dr. Marcus and the NRC staff. As one reads the transcript, the contrast is startling: at the same time that Dr. Marcus is urging that patients with 400 millicuries be treated as outpatients, Dr. Siegel is worrying that there is a regulatory gap, in that patients with 5 millicuries are not being given guidance about protection for family members. Transcript, p. 512. I can vouch from recent experience for the validity of Dr. Siegel's concern. On October 6, 1992, I received a 10-millicurie diagnostic dose of I-131 at a well-known teaching hospital in the Washington area. I asked the technologist specifically whether there were any precautions I should take with regard to my family. The answer was "None -- though you might not want to get close to babies." My own memory was hazy on radiation protection matters, and I was used to dealing with larger doses, so I was prepared to believe this; nevertheless, from what I thought was an excess of caution, I used the basement bathroom most of the time, washed my hands frequently, let my wife pour the children's milk at the dinner table, and so on. Fortunately, my scan was negative, which means (I believe) that most of the iodine was excreted fairly rapidly through my urine. But I am sure that if I had been cautioned along the lines suggested by Dr. Siegel in the discussion beginning at p. 512, I would have been more circumspect than I was in physical contact with my children in the days following the administration of the dose.

Dr. Marcus and the NRC staff make the point (Transcript, p.

505) that raising exposure limits to family members fivefold -- to 500 millirem per year to a member of the family -- can be justified because, in Dr. Marcus's words, they "have some benefit to go with the risk."

Ever since Jimmy Carter quoted his daughter in a pre-election debate, people who quote their children on issues of public policy invite ridicule, but it's a risk I'm willing to take. From years of experience, my children now know a lot about radioiodine and the precautions that go with it -- perhaps on some points more than the NRC staff -- so I described the issues at the dinner table last night, and the proposal to relax restrictions on exposure to family members. The first question was, "Why?" I said that people thought, among other things, that it was good for children to have their parents around. My six-year-old son exclaimed, "Crazy!" My eight-year-old daughter then clarified the point: "It isn't crazy that it's good for children to have their parents around, but it is crazy for children to have their parents around if it's going to make them sick."

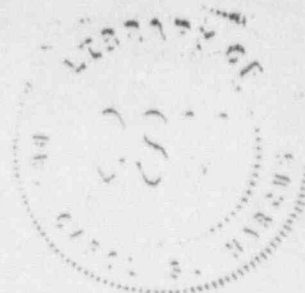
Doses of I-131 to parents can make children sick. Dr. Marcus, at p. 216, refers to the Tripler incident, in which a Micronesian woman, given a diagnostic dose of I-131 as part of thyroid cancer followup, unwittingly gave an enormous dose of radiation to the thyroid of her newborn baby through her breast milk. In Dr. Marcus's words: "I remember being up until 11:30 at night with a reporter from a newspaper in Honolulu, to prevent her from writing an article in the Honolulu newspaper that basically suggested that Chernobyl had happened to Tripler because of an enforced press release by the NRC even before the dosimetry was done on the baby." Since the Tripler incident, I have served in Micronesia as an administrative judge with the Nuclear Claims Tribunal of the Republic of the Marshall Islands; I have met many Marshallese thyroid patients who were treated at Tripler; and I am keenly aware of the extremely valuable service that Tripler, motivated by altruism alone, provides for the people of the former U.S. Trust Territories in the Pacific. Nevertheless, in the instance referred to by Dr. Marcus, there did occur, through error, what might be called a Chernobyl for one. It resulted in the destruction of a baby's thyroid gland.

The New York Times recently reported that a team from the World Health Organization, visiting the area near Minsk, Russia, had come up with wholly unexpected findings: deaths from thyroid cancer (normally a disease slow in its onset and progress, with high cure rates) among children exposed to I-131 after Chernobyl. This is not the time for the NRC to be approving regulatory changes that will have the effect of exposing American children to more I-131.

Finally, I would draw the staff's attention to Dr. Flynn's troubling comment, at page 423-24 of the transcript, that "a lot

of things are being covered up and not talked about, that I hear about myself, and not making their way into reporting [as misadministrations]." I believe that the NRC staff, instead of expending its resources on proposals to loosen current regulations for the protection of the public, should be applying its energies to making existing regulations more effective, and complied with more fully.

cc: ACMUI members



Understanding Behavior in Escalation Situations

BARRY M. STAW* AND JERRY ROSS

Everyday observation reveals that both individuals and organizations often become overly committed to losing courses of action; in a sense, throwing good money after bad. More than 10 years of research on this escalation problem shows that persistence is associated with at least four major classes of determinants: project, psychological, social, and organizational variables. The influence of these four sets of variables evolves over time, forming a dynamic model of behavior in escalation situations.

It is frequently observed that individuals as well as organizations can become locked in to the existing course of action, throwing good money or effort after bad. This "decision pathology" has been variously labeled the escalation of commitment (2), the psychology of entrapment (3), the sunk cost effect (4), and the too-much-invested-to-quit syndrome (5). We will review the state of research on this problem and then provide a summary theoretical model along with some guidelines for future research.

Classes of Escalation Determinants

AT AN EARLY STAGE OF THE VIETNAM WAR, GEORGE BALL, then Undersecretary of State, wrote the following memo to Lyndon Johnson, warning him about the likely consequences of making further commitments of men and material:

The decision you face now is crucial. Once large numbers of U.S. troops are committed to direct combat, they will begin to take heavy casualties in a war they are ill-equipped to fight in a noncooperative if not downright hostile countryside. Once we suffer large casualties, we will have started a well-nigh irreversible process. Our involvement will be so great that we cannot—without national humiliation—stop short of achieving our complete objectives. Of the two possibilities I think humiliation will be more likely than the achievement of our objectives—even after we have paid terrible costs" [1 July 1965 (1), p. 450].

George Ball's remarks were not only prophetic about the U.S. experience in Vietnam. They also pointed to the more general problem of coping with what are now called "escalation situations." These are situations in which losses have resulted from an original course of action, but where there is the possibility of turning the situation around by investing further time, money, or effort.

The frequency of escalation situations can be depicted by everyday examples. When an individual has a declining investment, a faltering career, or even a troubled marriage, there is often the difficult choice between putting greater effort into the present line of behavior versus seeking a new alternative. At the organizational level, similar dilemmas occur. Laboratories must make difficult decisions about whether to continue with or withdraw from disappointing research and development (R&D) projects; banks must decide how to manage their involvement in nonperforming loans; and industrial firms often need to determine whether to abandon a questionable venture versus investing further resources. In each of these situations

Much of the early work on the escalation problem focused on psychological factors that lead decision-makers to engage in seemingly irrational acts—that is, behavior not explained by either objective circumstances or standard economic decision-making (5–7). In response, some researchers have stressed that escalation does involve rational decision-making, because individuals do attend to the economic realities of escalation situations once they are made salient or clear to the person (8). Alternatively, others have found (9) that escalation behavior can be depicted as a rational calculus, but this requires going beyond the narrow economics of the situation to include many psychological and social costs of withdrawal, such as the personal and public embarrassment of admitting failure.

Debates over the rationality of behavior in escalation or any other situation are not likely to be settled soon. In fact, these arguments may detract attention away from the central phenomenon of interest, which is the tendency of individuals and organizations to persist in failing courses of action. To understand this tendency, one must account for a variety of forces, both behavioral and economic. We will therefore summarize research on four classes of determinants: those associated with objective characteristics of the project as well as psychological, social, and organizational variables.

Project Determinants

Project variables are the most obvious determinants of persistence in a course of action. Research has shown, for example, that commitment is affected by whether a setback is judged to be due to a permanent or temporary problem (10); by whether further investment is likely to be efficacious (11); by how large a goal or payoff may result from continued investment (7); by future expenditures or costs necessary to achieve a project's payoff (12); and by the number of times previous commitments have failed to yield returns (13).

A few project variables are less obvious causes of persistence. Endeavors such as R&D and construction projects often foster

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commitment because there is a long delay between expenditures and economic benefits. In these cases, shortfalls in revenue or outcomes may not be monitored closely or cause alarm, since losses are (at least initially) expected to occur. In other cases, projects may continue, in part, because they have little salvage value and involve substantial closing costs if terminated in midstream (8). For example, the World's Fair Expo 86 reached the point late in its construction in which continuation was expected to produce large losses, but even larger losses would have been sustained if the project had been aborted before its formal opening (14). In a few cases, projects can become so large that they literally trap the sponsoring organization into continuing the course of action. The Long Island Lighting Company's construction of the Shoreham Nuclear Power Plant is an example of such a no-win situation, in which persistence was seen as costly, yet withdrawal was (until very recently) viewed as bringing even worse economic consequences to the organization (15).

Psychological Determinants

In addition to the objective properties of a project, several psychological variables can also influence persistence in losing courses of action. Probably the simplest of these determinants are information processing errors on the part of decision-makers.

Although accounting and economics texts routinely state that investments should only be made when marginal (future) revenues exceed marginal costs (16), people may not actually behave this way. Consider the responses of college students to the following two questions posed by Arkes and Blumer (4):

Question 3A. As the president of an airline company, you have invested 10 million dollars of the company's money into a research project. The purpose was to build a plane that would not be detected by conventional radar, in other words, a radar-blank plane. When the project is 90% completed, another firm begins marketing a plane that cannot be detected by radar. Also, it is apparent that their plane is much faster and far more economical than the plane your company is building. The question is: should you invest the last 10% of the research funds to finish your radar-blank plane? Yes, 41; No, 7.

Question 3B. As president of an airline company, you have received a suggestion from one of your employees. The suggestion is to use the last 1 million dollars of your research funds to develop a plane that would not be detected by conventional radar, in other words, a radar-blank plane. However, another firm has just begun marketing a plane that cannot be detected by radar. Also, it is apparent that their plane is much faster and far more economical than the plane your company could build. The question is: should you invest the last million dollars of your research funds to build the radar-blank plane proposed by your employee? Yes, 10; No, 50.

These data clearly indicate that sunk costs (those previously expended but not supposed to affect investment decisions) are not sunk psychologically. They continue to influence subsequent investment decisions.

Not only do escalation situations involve sunk costs in terms of money, time, and effort; they also are framed as losing situations in which new investments hold the promise of turning one's fortunes around. Unfortunately, this is exactly the context in which Kahneman and Tversky (17) and others (18) found individuals to be risk-seeking. People take more risks on investment decisions framed in a negative manner (for example, to recover losses or prevent injuries) than when the same decision is positively framed (to achieve gains).

The miscalculation of sunk costs and negative framing can be characterized as rather "cool" information processing errors, as heuristics (however faulty) called on by individuals to solve escalation problems. Escalation situations can also involve "warmer," more motivated cognitions, however. Self-justification biases (19) have been singled out as a major motivational cause of persistence.

In one of the earliest escalation experiments, Staw (6) hypothe-

sized that people may commit more resources to a losing cause so as to justify or rationalize their previous behavior. He suggested that being personally responsible for losses is an important factor in becoming locked in to a course of action. This hypothesis was first tested in an experimental simulation with business school students. All subjects played the role of a corporate financial officer in allocating R&D funds to the operating divisions of a hypothetical company. Half the subjects allocated R&D funds to one of the divisions, were given feedback on their decisions, and then were asked to make a second allocation of R&D funds. The other half of the subjects did not make the initial investment decision themselves, but were told that it was made by another financial officer of the firm. Feedback was manipulated so that half the subjects received positive results on their initial decisions, while half received negative results.

Data from Staw's study showed that subjects allocated significantly more money to failing than to successful divisions. It was also found that more money was invested in the chosen division when the participants, rather than another financial officer, were responsible for the earlier funding decision. These results suggest that individuals responsible for previous losses may try to justify (or save) their earlier decisions by committing additional resources to them. Also, because both high- and low-responsibility subjects faced a negative financial scenario (one with previous losses), it can be argued that justification motives may affect commitment above and beyond any sunk cost or framing effects. Several experiments have replicated this self-justification finding with similar responsibility manipulations (20).

Closely related to the self-justification explanation of persistence are the findings of other motivated biases. Cognitive studies show that people slant data in the direction of their pre-existing beliefs and discredit information that conflicts with their opinions (21). Parallel effects in the escalation area have demonstrated that decision-makers responsible for a failing course of action tend to make greatest use of positive and exonerating information (22). Thus, it appears that justification motives may not only affect decisions to save a risky course of action, but may also affect the accuracy of data on which such decisions are made.

In addition to efforts to justify behavior, some passive self-inference processes may also affect individuals in escalation situations. Salancik (23) and Kiesler (24) have posited that individuals are likely to become especially bound or committed to a prior behavior when (i) the individual's acts are explicit or unambiguous, (ii) the behavior is irrevocable or not easily undone, (iii) the behavior has been entered into freely or has involved a high degree of volition, (iv) the act has importance for the individual, (v) the act is public or is visible to others, and (vi) the act has been performed a number of times. These six self-inference conditions assume that individuals draw inferences about their own behavior and the context in which it occurs. Though self-inference theories are less motivational than those that use self-justification concepts (no needs for rationalization are implied), the two approaches overlap almost entirely in their empirical predictions (25).

Social Determinants

Although most of the research on escalation has dealt with psychological or project variables, escalation situations are often more complicated social phenomena. For example, administrators may persist in a course of action, not just because they do not want to admit a mistake to themselves, but because they hesitate to expose their errors to others. Fox and Staw (26) tested this notion of external justification in a role-playing experiment. They found that

subjects holding administrative roles with low job security and lack of support by management allocated the greatest resources to a losing course of action. Conceptually similar results were reported by Brockner, Rubin, and Lang (12). They found persistence to be highest under a large audience, high social-anxiety condition and interpreted these results as a face-saving effect. Additional evidence of face-saving can also be found in the bargaining literature (27), in which it is common to find an escalation of hostilities as both parties refuse to back down from earlier positions. For example, using Shubik's (28) dollar auction game, Tegar (5) found that competitive bidding was influenced first by a simple desire to make money, then as a way to recoup prior losses, and finally, as a means to defeat the other party.

The external binding of people to behavior may also be important in escalation situations. Just as it is possible for individuals to form personal beliefs through a self-inference process (23, 24), observers tend to infer motivation and personal characteristics to actors after observing their behavior (29). Thus, people's social identity may become externally bound by their actions with respect to a project. Though no research has specifically tested this idea, one would expect decision-makers to be most closely identified with a project when their advocacy of it has been public, explicit, perceived to be high in volition, and repeated. At the extreme, a project may start to carry the name of its sponsor (for example, "Reaganomics" or "Thatcherism"), increasing the binding of the person to the behavior, thus making withdrawal from the course of action much more difficult.

Although face-saving and external binding can both be viewed as social factors that increase decision-makers' costs of withdrawal, research has also isolated some social rewards for persistence. Staw and Ross (30) had business students study the behavior of managers in a failing situation. Managers were described as either persisting in a losing course of action or switching to another alternative. The descriptions read by subjects also noted that managers' persistence or experimentation led either to further negative results or ultimate success. As predicted, managers were rated highest when they were persistent and successful. Most interestingly, the data also showed a significant interaction of persistence and outcome. This interaction can be interpreted as a "hero effect"—special praise and adoration for managers who "stick to their guns" in the face of opposition and seemingly bleak odds (31).

Organizational Determinants

Since many of the most costly escalation situations involve the persistence of an entire organization (rather than an isolated individual) to a losing course of action, it is important to consider some organizational determinants of persistence. Unfortunately, few organization-level studies have yet been conducted. Therefore, we are forced to rely more on relevant theory than concrete data in outlining likely organizational determinants of escalation.

Probably the simplest organizational determinant is institutional inertia. Just as there is less than full consistency between individual attitudes and behavior (32), there is also a very loose coupling between organizational goals and action (33). Organizations have imperfect sensory systems, making them relatively impervious to changes in their environments. And, because of breakdowns in internal communication and difficulties in mobilizing their constituents, organizations are slow to respond. Thus, even when the need for change is recognized, it may not occur. Moreover, if actions require altering long-standing policies, violating rules, or discarding accepted procedures, movement is not likely to happen at all, even though (to an outsider) it may seem obviously useful.

Organizations attempting to withdraw from a losing course of action must also contend with political forces. Not only those who are directly involved with a project will resist its dismantling, but so too will units interdependent or politically aligned with the venture. This can become a special problem when projects are important or central enough to have political support on governing bodies and budget committees charged with their fate. As Pfeffer and Salancik (34) have shown in their research on organizational decision-making, organizational actions may turn as much on politics as any objective economic criteria.

At times, a project's support can go beyond politics. The project may be tied so integrally to the values and purposes of an organization that it becomes institutionalized (35), making withdrawal almost an "unthinkable" proposition. Two examples illustrate the problem. The first is Lockheed's L1011 Tri-Star Jet program. Although most outside analysts found the plane unlikely to earn a profit, Lockheed persisted in the venture for more than a decade, accumulating enormous losses (36). The issue was not ending the project, *per se*, but in having to reinterpret the company's role in commercial aviation. For Lockheed to drop the L1011 meant having to change its identity from a pioneer in commercial aircraft to that of simply a defense contractor. Pan American Airlines recently faced a similar institutional issue. More than most airlines, Pan Am suffered major losses after deregulation of the industry. However, as losses accumulated, it successively sold off most of its nonairlines assets. First, the Pan Am building was sold to meet debt obligations. Then, as losses continued to mount, the Intercontinental Hotel chain was sold. Finally, Pan Am was forced to sell its valuable Pacific routes to United Airlines. Withdrawing from the real estate and hotel business was probably an easier decision for this organization than ending the more institutionalized airline operations, irrespective of the economics involved.

The Dynamics of Escalation

This review of escalation research has been more illustrative than exhaustive. Yet, it is evident from even this brief summary that studies of escalation behavior have focused primarily on psychological determinants, with social and organizational variables only recently receiving attention. Unfortunately, this difference in research emphasis has had less to do with the relevance of particular determinants of escalation than the difficulty of operationalizing concepts and conducting empirical studies at more macroscopic levels. Because many of the most disastrous escalation situations involve larger social entities such as governmental and business organizations, further macro-level studies of escalation are therefore needed.

As we have noted, escalation situations are also a forum for a variety of forces, both behavioral and economic. Consequently, an important question for future research is how these various forces combine to affect behavior in escalation contexts. Already some research suggests that escalation behavior may not only be multi-determined, but also temporally dependent. That is, escalation situations may change character over time, such that different determinants of persistence and withdrawal become dominant at separate stages in an escalation cycle. A preliminary model of how the influence of several key variables may unfold over time, based on two field studies of naturally occurring escalation situations (14, 15), is shown in Fig. 1.

The first phase of escalation is dominated by the economics of a project, with the decision to begin a course of action made largely on the basis of the anticipation of economic benefits. However, when questionable or negative results are received (at Phase 2), the

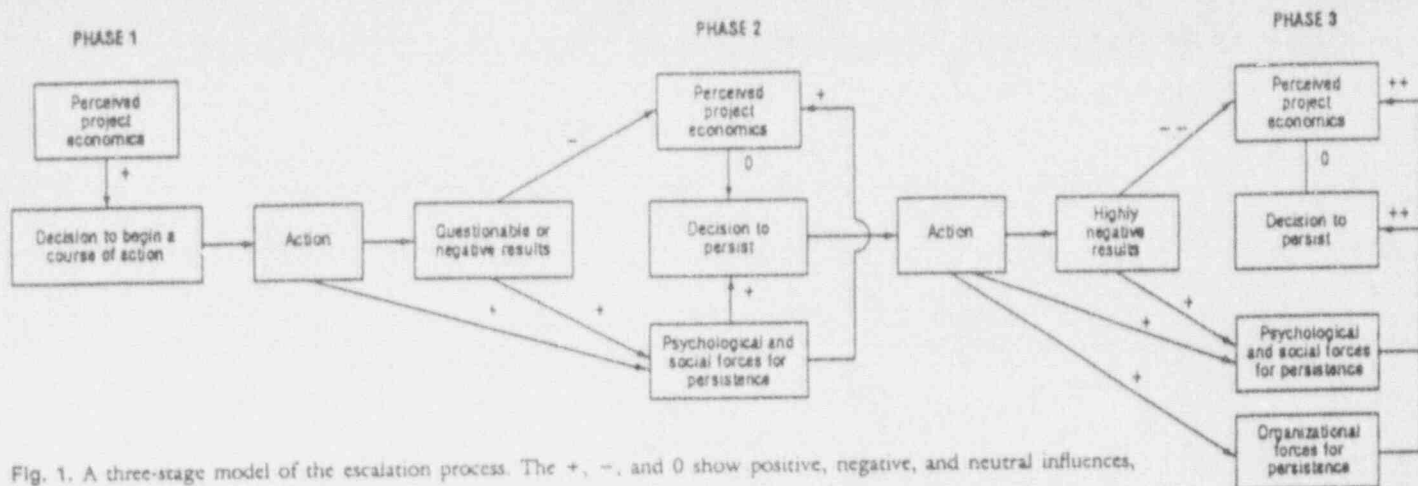


Fig. 1. A three-stage model of the escalation process. The +, -, and 0 show positive, negative, and neutral influences, respectively.

decision to persist is based not just on project economics, but also on psychological and social determinants. Assuming that psychological and social forces are strong enough to outweigh (or bias) any negative economic forecasts, further investment or persistence in the project is likely. If this additional investment does not turn the situation around and further negative results are received (at Stage 3), withdrawal tendencies may be heightened. Unfortunately, at this advanced stage in the escalation cycle any withdrawal tendencies (due to negative project economics) may be counterbalanced and biased by organizational forces for persistence. Thus, as economic outcomes worsen over time, it is possible for projects to be maintained by the accumulation of psychological, social, and organizational forces, each adding some weight to the decision to persist in a course of action.

At this time, the idea of distant stages of escalation remains more of a heuristic for understanding the process of persistence than an empirically tested theory. Yet, two in-depth field studies—an analysis of British Columbia's decision to hold Expo 86 (14) and an examination of Long Island Lighting's commitment to the Shoreham nuclear power plant (15)—have provided support for a temporally based model. In each situation, economic variables were salient early on and psychological and social variables became important after negative consequences started to accumulate, whereas organizational determinants were manifested rather late in the escalation cycle. Of course, whether these time dependencies are always abrupt enough to constitute distinct stages, or whether in other contexts a more gradual shifting of influence occurs, is still an open question.

No doubt an important step in validating a temporal model of escalation will be the isolation of critical incidents setting off or preconditioning particular determinants of persistence. If these preconditions are found to follow a predictable sequence (that is, arising early or late in the escalation cycle) across a variety of contexts, then a strong case can be made for a temporal model.

In searching for the preconditions of escalation, we would argue that escalation situations typically involve the following sequence of events. First, in launching a new product or project, individual "project champions" will not only work hard to promote the venture but in so doing will probably sow the seeds for subsequent commitment (for example, via self-inference effects). Once questionable or adverse results are received, a negative perceptual frame and sunk costs may then become associated with the project. At this time, those who have had an active hand in developing the project will likely suffer personal embarrassment (or even loss of employment) with the failing situation, leading to self-justification and face-saving effects. And, once the losses associated with the project are

fully recognized throughout the organization, external binding of the proponents to the project (for example, "that's Jim's baby") is likely to make withdrawal even more costly to the individuals involved. Finally, assuming that the project does survive several rounds of negative feedback, then more global, organizational processes may start to manifest themselves. Political support may arise as individual careers and whole departments become dependent on the project. And, if the project lasts long enough, withdrawal can become extremely costly not only in terms of the economics involved, but also in terms of the identity of the firm itself.

As elaborated here, the sequence of critical incidents in escalation situations may tend to move from the individual, to the interpersonal environment, and then to the larger organization. We believe this is a natural evolution as project originators (or champions) try to defend a losing course of action, first by themselves (via risk-taking and information biasing) and then by the mobilization of resources involving the larger organization. Additional research on the development of escalation situations is obviously needed to verify these temporal dynamics.

Escalation as a Multidetermined Event

Since several sources of commitment can be triggered by losing courses of action, one might conclude that persistence is an overdetermined variable, an almost inevitable consequence of escalation situations. A contrary view is that escalation is created by a series of small-impact variables, each insufficient by itself to cause one to remain in a losing situation. For example, if economic losses are large and they occur early in a project's life cycle, withdrawal may well be the dominant response. However, if losses do not appear until later in the process (after several behavioral effects have been initiated), then persistence could be the typical response. Thus, the speed and severity of negative economic data could be a crucial element in how relative forces unfold in escalation situations. Though not an explicit test of this hypothesis, an experiment by Golz (37) has shown how sensitive investment decisions are to the pattern of negative consequences. A slow and irregular decline may not only make a line of behavior difficult to extinguish (in the reinforcement theory sense), but may also allow the forces for persistence to grow over time. Adding support to this "unfolding argument" is a study by Brockner and Rubin (3), in which they found that negative economic data prompted withdrawal when it was introduced early in an escalation situation, but had little influence when introduced after the decision to commit resources had already been made.

Conclusion

As shown by our temporal model, escalation situations contain a confluence of forces—some pulling toward withdrawal and others pushing toward persistence—with their relative strengths varying over time. This dynamic view of escalation is consistent with the contextualist perspective (38) in which social reality is seen as dependent on the situation in which it occurs. Contextualist reasoning supports the continued pursuit of case studies on the dynamics of escalation situations and supports efforts to add realism to experimental tests. Greater efforts are needed to capture experimentally the life-span of escalation episodes so that the relative influence of contributing variables can be tracked over time. Only with such temporally based studies, from both the laboratory and the field, are the dynamics of escalation situations likely to be fully understood.

REFERENCES AND NOTES

1. The New York Times (based on the investigative reporting of Neil Sheehan), *The Pentagon Papers* (Bantam Books, New York, 1971).
2. B. M. Staw, *Acad. Manage. Rev.* 6, 577 (1981).
3. J. Brockner and J. Z. Rubin, *Entrapment in Escalating Conflicts* (Springer-Verlag, New York, 1985).
4. H. Z. Arkes and C. Blumer, *Organ. Behav. Hum. Decis. Processes* 35, 124 (1985).
5. A. Tegar, *Too Much Invested to Quit* (Pergamon Press, New York, 1980).
6. For example, B. M. Staw, *Organ. Behav. Hum. Performance* 16, 27 (1976).
7. J. Z. Rubin and J. Brockner, *J. Pers. Soc. Psychol.* 31, 1054 (1975).
8. For example, G. B. Northcraft and G. Wolf, *Acad. Manage. Rev.* 9, 225 (1984).
9. B. M. Staw and J. Ross, in *Research in Organizational Behavior*, L. L. Cummings and B. M. Staw, Eds. (JAI Press, Greenwich, CT, 1987), vol. 9, pp. 39–78.
10. L. Leatherwood and E. Conlon, "The impact of prospectively relevant information and setbacks in persistence in a project following setback" (working paper 85-1, College of Business Administration, University of Iowa, 1985).
11. B. M. Staw and F. V. Fox, *Hum. Relat.* 30, 431 (1977); T. Bazerman, "Resource allocation after success and failure: The roles of attributions of powerful others and probabilities of future success" (Department of Management, Texas A&M, College Station, TX 91983).
12. J. Brockner, J. Z. Rubin, E. Lang, *J. Exp. Soc. Psychol.* 17, 68 (1981).
13. B. E. McCain, *J. Appl. Psychol.* 71, 280 (1986).
14. J. Ross and B. Staw, *Adm. Sci. Q.* 31, 224 (1986).
15. "Escalation and the Long Island Lighthouse Company: The case of the Shoreham Nuclear Power Plant" (Working paper, Institute Européen d'Administration des Affaires, Fontainebleau, France, 1989).
16. P. A. Samuelson, *Economics* (McGraw-Hill, New York, 1988); C. T. Hornigren, *Cost Accounting: A Managerial Emphasis* (Irwin-Hall, Englewood Cliffs, NJ, 1982).
17. D. Kahneman and A. Tversky, *Econometrica* 47, 263 (1979); D. Kahneman and A. Tversky, *Science* 211, 453 (1981).
18. M. A. Davis and P. Bobko, *Organ. Behav. Hum. Decis. Processes* 37, 121 (1986).
19. E. Aronson, *The Social Animal* (Freeman, San Francisco, 1984); L. Festinger, *A Theory of Cognitive Dissonance* (Stanford Univ. Press, Stanford, CA, 1970).
20. M. H. Bazerman, R. I. Beekun, F. D. Schoorman, *J. Appl. Psychol.* 67, 873 (1982); M. H. Bazerman et al., *Organ. Behav. Hum. Performance* 33, 141 (1984); D. F. Caldwell and C. A. O'Reilly, *Acad. Manage. J.* 25, 121 (1982).
21. T. Gilovich, *J. Pers. Soc. Psychol.* 44, 1110 (1983); C. Lord, L. Ross, M. R. Lepper, *ibid.* 37, 2098 (1979).
22. E. J. Conlon and J. M. Parks, *J. Appl. Psychol.* 72, 344 (1987).
23. G. R. Salancik, in *New Directions in Organizational Behavior*, B. M. Staw and G. R. Salancik, Eds. (Krieger, Malabar, FL, 1977).
24. C. A. Kiesler, *The Psychology of Commitment* (Academic Press, New York, 1971).
25. P. E. Tetlock and A. Levi, *J. Exp. Soc. Psychol.* 18, 68 (1982).
26. F. V. Fox and B. M. Staw, *Adm. Sci. Q.* 24, 449 (1979).
27. H. Raiffa, *The Art and Science of Negotiation* (Harvard Univ. Press, Cambridge, MA, 1982).
28. M. Shubik, *J. Conflict Resolut.* 15, 109 (1971).
29. E. E. Jones and K. E. Davis, in *Advances in Experimental Social Psychology*, L. Berkowitz, Ed. (Academic Press, New York, 1965), vol. 2.
30. B. M. Staw and J. Ross, *J. Appl. Psychol.* 65, 249 (1980).
31. M. G. Evans and J. W. Medcalf, *Can. J. Adm. Sci.* 1, 383 (1984).
32. M. P. Zanna and R. H. Fazio, in *Consistency in Social Behavior*, M. P. Zanna, E. T. Higgins, C. P. Herman, Eds. (Erlbaum, Hillsdale, NJ, 1982).
33. J. G. March and J. P. Olson, *Ambiguity and Choice in Organizations* (Universitetsforlaget, Bergen, Norway, 1976).
34. J. Pfeffer and G. R. Salancik, *Adm. Sci. Q.* 19, 135 (1974); G. R. Salancik and J. Pfeffer, *ibid.*, p. 453.
35. P. S. Goodman, M. Bazerman, E. Conlon, in *Research in Organizational Behavior*, B. M. Staw and L. L. Cummings, Eds. (JAI Press, Greenwich, CT, 1980), vol. 2, pp. 215–246; L. G. Zucker in *Research in the Sociology of Organizations*, S. Bacharach, Ed. (JAI Press, Greenwich, CT, 1983).
36. U. E. Reinhardt, *J. Finance* 28, 821 (1973).
37. S. M. Gola, "A learning-based analysis of escalation of commitment, sunk cost, and entrapment," paper presented at American Psychological Association meeting, Atlanta, GA, August 1988.
38. W. J. McGuire, in *Advances in Experimental Social Psychology*, L. Berkowitz, Ed. (Academic Press, New York, 1984).
39. Supported by the Institute of Industrial Relations, University of California, Berkeley.

