Environmental Constraints and Organizational Failures: The Washington Public Power Supply System

Daniel Pope
University of Oregon

The Washington Public Power Supply System's (WPPSS) nuclear projects were a band of five white elephants stranded awkwardly in Ecotopia, the far Northwest corner of the United States. Despite costly care and feeding, two of them died young, in 1982; two others have hibernated for most of a decade and may yet be put out of their misery. Only one struggled slowly to a rather sickly maturity, but it has not won the affection of its neighbors.

The WPPSS plants are elephantine in another respect as well. Almost too immense to comprehend, they have served varied observers who have projected their ideas about modern American political economy onto the WPPSS story. Thus, for the free-market right the WPPSS fiasco shows the dangers of big government; costs mount when aggrandizing bureaucracies build their empires without having to face the stern realities of the market. For those on the left, WPPSS demonstrates the capture of purportedly public agencies by growth-oriented businessmen, power-guzzling factories, and greedy investment bankers. To anti-nuclear activists, there is a hopeful lesson in the Northwest citizens' revolt that helped to halt the WPPSS juggernaut. The Supply System and its allies have continued to defend it as a noble venture sabotaged by unforeseeable circumstances, overbearing regulators, and short-sighted interest groups. None of these views is without a germ of truth; none explains the whole story.

The WPPSS saga is well known in several circles--Northwesterners, especially those active in community affairs, the tens of thousands (perhaps as many as 75,000) of municipal bondholders whose portfolios were jarred by the 1983 WPPSS default, and the squadrons of lawyers who collectively may have billed half a billion dollars for work on the multifarious legal cases WPPSS spawned. For those less familiar with it, the following summary may serve as background for a discussion of the organizational dimensions of the WPPSS fiasco.

Pacific Northwest power planners in the late 1960s agreed that an era of rapid growth based on cheap hydroelectric power was coming to an end. In 1968 they proposed a Hydro-Thermal Power Plan which envisaged completion of twenty large thermal power plants (mostly nuclear) in the region by 1990. Who would build these facilities and how they would be

BUSINESS AND ECONOMIC HISTORY, Second Series, Volume Nineteen, 1990.
 ISSN 0849-6825.

financed were vexing questions, especially in light of long-standing rivalries among public and private utilities and different categories of power users. The Bonneville Power Administration (BPA), which transmitted electricity from the Federal Columbia River Power System, sought to mediate among different interests; however, it had its own stake in maintaining dominance in the region.

Northwestern public utilities (municipal systems, public utility districts, and rural cooperatives) feared that investor-owned utilities would control the new generating facilities unless they acted quickly. As Gus Norwood, a leading public power spokesman, put it in 1965, without "your own power supply or a very friendly power supply . . ., fast or slow, your electric system will die" [12].

Most of the publics, however, were too small to contemplate a 1200-megawatt nuclear project on their own. The Washington Public Power Supply System looked like a promising structure for cooperative ventures. Created in 1957 as a joint operating agency of smaller Washington State public-owned utilities, its major accomplishment had been to build and operate the Hanford N-Reactor's generating system that converted heat from a Federal plutonium-producing reactor into electricity. WPPSS was eager to volunteer when Bonneville called for organizations to build the next wave of plants. The Supply System's member utilities, along with virtually everyone else in the industry in the Northwest, extrapolated from past demand growth and anticipated that loads would continue to rise nearly seven percent annually. They also hoped to continue attracting the energy-intensive industries which had flocked to the Pacific Northwest during and after World War II.

Bonneville offered a strong inducement to WPPSS with a procedure known as net billing. In effect, net billing pledged BPA's revenues toward repayment of WPPSS borrowings. It made the energy the plants were expected to produce into a regional resource and likewise spread the risks of cost overruns or uncompleted projects among all of BPA's customers. Net billing also served to price expensive new nuclear power below its marginal cost and thus discouraged efforts to conserve it.

By 1973 WPPSS had decided to build three large nuclear plants. However, in that year, complex legal and financial problems brought net billing to a halt. Yet utility planners were more convinced than ever of the need for more generating capacity. WPPSS in 1974 agreed to undertake two more plants, this time without net billing's safety net. Under intensive pressure from BPA, WPPSS, and major power users, 88 regional public utilities signed participants' agreements for shares of WPPSS 4 and 5 project capabilities. These so-called "take or pay" or "hell or high water" agreements appeared to commit them to pay for their shares whether or not the plants ever generated a watt of electricity.

In August 1971 WPPSS began engineering work for its first nuclear plant (designated as WPPSS 2, it preceded the plant numbered as WPPSS 1). The Supply System predicted that the plant would be in operation by September 1977 and would cost less than $400 million. However, in May 1981, as construction limped on, WPPSS predicted completion in 1984 at a cost of about $3.2 billion. That was the record for the successful plant.

Each of the five plants slipped years behind its original schedule and each suffered billions of dollars in cost overruns. The original cost estimates for the plants totaled about $4.5 billion; the 1981 figures predicted it would take $23.8 billion to complete all five.

But of course they were not all completed. Among other problems, it was impossible after 1981 to raise the additional $13.2 billion needed to finish construction. WPPSS voted on January 22, 1982 to terminate plants four and five. In May it halted construction on WPPSS 1, and in 1983 ceased work on WPPSS 3. Because the terminated Plants 4 and 5 were not supported by net billing, the participating utilities now faced the distasteful task of repaying the $2.25 billion which had been borrowed before the bond market balked. Utilities felt the heat of angry ratepayers who, in a severe recession, had already suffered sharp increases in the cost of their electricity. An Oregon court ruled in October 1982 that the state's utilities had lacked the authority to enter into the WPPSS participants' agreements; although that ruling eventually was overturned on appeal, it foreshadowed the Washington State Supreme Court's decision on June 15, 1983 that the agreements were void according to Washington state law. Later that summer WPPSS defaulted on the WPPSS 4 and 5 interest payments, the largest municipal bond default in American history.

Throughout the 1980s, although the WPPSS projects seemed to generate more lawsuits than kilowatts, the region did not suffer power shortages and brownouts. Demand predictions which had justified the Hydro-Thermal program and the WPPSS projects had been wildly overstated. Electricity demand grew 3.7% per year in the 1970s (half the 1950-1970 rate) and only 0.5% annually from 1980 through 1987 [11, p. 8]. Energy planners in the Northwest faced the unfamiliar problem of managing surplus, not shortage. Although the region still enjoys the cheapest electricity in the nation, its energy future now is hardly more certain than it was a generation ago.

The Supply System's inability carry out its projects may well be seen as a blessing in disguise. Whatever one's view of nuclear energy, completion of the five plants by the mid-1980s would have saddled the Pacific Northwest with enormous excess capacity and sharp rate increases. However, the problems of construction that beset WPPSS bear analysis in their own right, for they point to both general difficulties inherent in large-scale, high-technology projects and specific weaknesses in WPPSS that made the System's failure so acute.

Evidence of important problems in the design and construction of the Supply System's five nuclear projects appeared early. Even before the Hydro-Thermal Plan was promulgated, the Washington Public Utilities Districts Association discussed the need to "bring management know-how into WPPSS . . ." and the desirability of "closer liaison with WPPSS on a management consultant basis" [6, p. 8]. WPPSS was a small organization that undertook a massive venture with very slim resources. In 1971, as construction of WPPSS 2 got underway, the Supply System employed 81 people; its administrative budget for the fiscal year beginning September 1, 1970 showed expenditures of only $250,500. Only about $9200 was budgeted for the System's WPPSS 2 project [5, p. 24; 4].

WPPSS minutes and other documents from the early 1970s, despite their bureaucratic understatement, indicate some of the problems plaguing the Supply System's leaders. Even before WPPSS obtained its construction permit, engineering and design activity and excavation work and other site preparation was underway. Burns and Roe, the architect-engineering firm for WPPSS 2, declared in February 1972 that the project "remains on schedule," but six weeks later WPPSS managing director J.J. Stein conceded that it was "slightly behind schedule" [14; 7, p. 4]. Over the next two years WPPSS meetings touched on a host of problems. Evaluation of the site's seismic potential went slowly, cold and wet weather in winters slowed construction, pipefitters and ironworkers went out on strike, WPPSS office space was inadequate, planning to provide flood protection turned out to be difficult, the surface of the main access road to the site could not bear its heavy loads, material deliveries ran slow. Managing Director Stein reported in early 1973 that the Supply System's staff was "spread mighty thin" and would have to continue to grow [8, p. 5]. By September, Board member Gordon Vickrey, representing Seattle City Light, the largest utility in the region, complained that the project was already a year behind schedule, though the contractors estimated a few months later that the slippage was only seven months. Although managers spoke about making up the delays, the 1973 Annual Report acknowledged that there was only a ten percent probability that commercial operation would begin as scheduled in September 1977 and a fifty percent chance it would not be completed six months later [16, p. 14].

These experiences on WPPSS Plant 2 were mirrored and magnified in later years and on the other projects as they got underway. Some of the incidents which were most costly and responsible for delay in fact took place well after the Supply System had grown into a large-scale organization. In August 1978, for example, heavy rains washed much of the excavation work for Projects 3 and 5 into local creeks. (These plants were twins, built on the same site; Plants 1 and 4 were paired in the same fashion.) Since the Satsop, Washington location normally receives about ninety inches of rain annually, lack of foresight can be blamed for at least part of this $51 million misunderstanding. In mid-1980 a 22-week strike at Projects 1, 2, and 4 (the ones located at Hanford) added, according to WPPSS's own estimate, $707 million to the cost of the plants [10, p. 74]. As if to avoid unseemly haste, a giant crane at Satsop collapsed that summer and held up work on Plants 3 and 5 for months.

By January 1981, when a Washington State Senate committee issued its report on the WPPSS projects, expected delays from the original completion dates ranged from 32 months for Plant 5 to 71 months for Plant 2. To compound the problem, the Supply System itself judged the new dates to be optimistic. Although it foresaw a 50% probability of finishing WPPSS-1 by the target date, the estimates for the other four plants ranged only from 5% to 16% [17, p. 20]. On average, for every month of construction activity while the committee conducted its inquiry, the projects slipped more than two months from their schedule.

There was no dearth of explanations for the woes of WPPSS. Management consultants, bond analysts, politicians, and WPPSS managers themselves offered diagnoses and proposals. According to the Supply System, forces beyond their control caused the problems. They pointed out--rightly--that cost escalation and lengthy schedule delays were endemic in the nuclear power industry. Initial cost estimates had assumed price stability whereas the seventies and beginning of the eighties had seen rapid inflation. Like others, the Supply System had to cope with shifting regulatory requirements which, they complained, accounted, directly or indirectly, for half of the cost overruns. Managers also pointed out that labor productivity on the WPPSS projects was low and wage rates relatively high.

Peter Hall, in *Great Planning Disasters*, commented that the uncertainty which bedevils the planning and implementation of large-scale projects is threefold. There is uncertainty about the relevant planning environment (UE), about decisions in related decision areas (UR), and about value judgments (UV). "At first glance the problem of uncertainty seems to live in the UE area, but . . . on closer analysis it proves to be in UR or UV or both" [3, p. 6]. This would seem to hold true of the WPPSS projects. Almost all independent management consultants who studied the Supply System concluded that the external pressures WPPSS experienced did not account for most of the difficulties. For example, an extensive study of the relationship between WPPSS and BPA in 1979 concluded that only about twelve percent of the cost of implementing change orders in project construction could be attributed to regulatory demands [1, ch.V, p. 13]. Nor were outsiders persuaded that WPPSS cost overruns reflected general inflationary patterns in the industry and the nation. In fact, WPPSS itself provided data showing that its capital costs per kilowatt were well above the nuclear industry average. The State Senate investigation compared each WPPSS plant with a nuclear project elsewhere begun at roughly the same time. In each case, delays on the WPPSS plant were longer and the expected date of completion was later [17, pp. 47-48]. As for labor costs, market differences mattered far less than inefficient utilization of the workforce. One audit found that construction workers on Plants 3 and 5 spent 53% of their work week unproductively. A WPPSS official testified that workers were not to blame. "Low productivity is generally our fault, management," he conceded [17, pp. 45-46]. Problems of equipment and material availability, overcrowding at work sites, and inspection delays each took hours out of the normal work week.

If WPPSS cannot be seen as victim of forces beyond its borders, we can suggest a second level of difficulties which we might label internal or structural. These include the role of the WPPSS Board of Directors, the status of staff and top management, legal impediments to successful contracting and construction management, and problems stemming from fast-track construction methods.

The WPPSS Board contained one representative from each of the member utilities and met quarterly. In most cases elected commissioners of Public Utility Districts (PUD's) in the state served on the Board. They were amateurs in the field of electrical power and they tended to represent the local perspectives of the PUD boards and rate payers who sent them. Rarely interested in rocking the boat, board members preferred to legitimize the decisions of the professional staff [5, pp. 32-36]. In the words of Glenn Walkley, a sheep rancher who served twenty-five years on the Board, "We're just humans. We figured these guys were building [nuclear plants] all over the world . . . We didn't see any particular reason they couldn't build them for us the same as they build them anywhere else" [2, p. 4]. The Board's Executive Committee met bi-weekly but its inclination to defer to management and its lack of an independent staff limited its power. Not until 1981 did the Washington State legislature mandate including Executive Committee members who were not local utility directors.

The top management of WPPSS was somewhat inbred. Owen Hurd, who had been the agency's Managing Director since its inception in 1957, had previously served as director of the Benton County P.U.D. J.J. Stein, an Executive Board member and former naval officer, succeeded him in 1971. Stein had served on the Grays Harbor County P.U.D. board for some twenty years. At his retirement WPPSS again chose from within its community, selecting Neil O. Strand, who had spent seven years in the organization. Strand was the first Managing Director with nuclear energy experience elsewhere, but this dated from the early 1960s. Strand apparently got the job in large measure because he would accept a salary of about $70,000, roughly half of what experienced nuclear project managers elsewhere were asking. Not until 1980 did the Board dismiss Strand; it then hired Robert Ferguson, former Deputy Assistant Secretary of Energy for nuclear programs. By then, even this highly-regarded "no-nonsense" manager could not staunch the flow of dollars without curtailing the projects.

The comprehensive management review by Theodore Barry & Associates noted other staff problems as well. Rapid growth had brought a great deal of technical talent into the System, but the balance among different units was uncertain, there appeared to be excessive duplication and overlap, and WPPSS employed a higher proportion of non-manual workers (about 35-45%) than did similar organizations [1, ch. 4, pp. 2-3].

Several legal constraints hindered WPPSS dealings with related organizations. One of the most galling was the provision that all contracts of $10,000 or greater had to be awarded competitively, to the lowest bidder. Especially on complex, high-technology projects, this was a penny-wise, pound-foolish requirement. It meant confusion and scheduling problems at the project sites, as dozens of contractors jostled for position and precedence. When inexperienced and inadequate contractors could not fulfill their agreements, costly change orders were required. Related to this, until 1977 state law mandated fixed-price or lump sum contracts. Although this at first glance might seem to put the risk on contractors instead of WPPSS, in fact it meant that WPPSS had to process change orders to revise contracts whenever conditions that the contractor could not control had changed. That WPPSS's internal procedures for handling change orders were deficient heightened the problem.

Construction contracts for high-technology projects fit several of the conditions Oliver Williamson has identified for high transactions costs in making and enforcing agreements between independent firms. Information asymmetries are likely, investments in specific assets may be necessary, and monitoring of performance is likely to be burdensome [18, 19]. When a Washingtonian in 1981 asked for copies of the contracts and related documents for WPPSS 4 and 5, the Supply System estimated that copying costs alone would exceed $100,000! The profusion of such agreements that the law mandated signaled endless problems for the Supply System.

Like most organizations in a hurry, WPPSS found the policy of fast-track construction alluring. Building began while design and engineering activities were still underway. Yet as Peter Morris and George Hough bluntly put it, "Research has shown that on high technology projects, concurrency [overlapping design and production schedules] inevitably leads to project overruns" [9, pp. 228-229]. As one management consulting firm pointed out to WPPSS in 1976, fast-track methods generally work best when 60 to 70% of design work is completed before construction contracts are put out for bid; the Supply System had started building much earlier [5, p. 49]. The American nuclear industry through the 1960s and early 1970s sought to build ever-larger plants, hoping to gain economies of scale, rather than to standardize a facility design. Thus, the WPPSS net billed projects were to be larger than any existing nuclear plants. WPPSS undertook fast-track construction on a venture that was not only a high-technology project but a novel one.

Though, as outlined above, many of the problems of the WPPSS projects stemmed from specific organizational deficiencies, its failures were far from unique. In his book, *Normal Accidents*, Charles Perrow contends that, in some systems, "Given the system characteristics, multiple and unexpected interactions of failures are inevitable" [13, p. 5]. These "system accidents" are "normal," not anomalous. Although he is talking about physical accidents, we might see the WPPSS projects as institutional accidents, organizational failures stemming from the very nature of the systems they embodied.

Interactive complexity is characteristic of systems plagued by normal accidents; this certainly describes the physical aspects of nuclear plant construction, especially under fast-track management. Concurrent design and construction means non-linear interaction of parts of the system. Construction incidents, for example, may require readjusting the design or engineering processes; engineering choices might have unexpected consequences for quality control or inspection procedures. Interactive systems also have many common-mode elements, units which serve more than one purpose. The rebuilding of a washed-out access road or the need to clear away a toppled construction crane are examples of common-mode failures. Further, as Perrow points out, problems in interactively complex systems are often not revealed clearly. Monitoring is indirect and causal relationships are not always intuitively obvious. Again, this is true of nuclear plant construction.

According to Perrow, the second condition for normal accidents is tight coupling, systems without slack and redundancy. In these, without a rapid, coordinated response, component failure may spread to other units. Unlike a nuclear plant in operation, a construction site is not inherently tightly coupled. Incidents may spread beyond their initial locale, but they will probably cause delay, not disaster. In Perrow's scheme, accidents in tightly coupled, interactively complex systems are likely to hurt "innocent bystanders" or future generations, but these third- and fourth-party victims probably would not be harmed in a construction site mishap [13, pp. 66-71]. Thus, nuclear plant construction projects themselves do not seem to fit Perrow's model very closely.

However, it may not be stretching things too far to apply Perrow's concepts to the WPPSS nuclear plants as part of a larger organizational system. For example, the process of demand forecasting, which produced the estimates justifying the projects, satisfies the condition of interactive complexity. The Pacific Northwest Utilities Conference Committee compiled the forecast by summing the estimates of individual utilities and firms which purchased power directly from Bonneville. In this procedure two different utilities might predict that a certain factory would come to their community. Each would include the anticipated load in its forecast; the PNUCC forecast would double count the plant's demand. The eagerness of WPPSS and others to build new facilities also created feedback loops to the forecasting process; anticipating new and relatively low cost electric supplies, forecasters predicted high levels of demand.

Another example came in the financing process. By the end of the 1970s WPPSS was the largest single issuer of municipal bonds in the country. Bond financing is in itself a tightly coupled process. Coordination of the elements of a sale is almost always closely scheduled; timing is all. The price of error or delay is often high. Moreover, the financing process generated its own feedback effects on load forecasting and construction planning. The need for more money for current construction activity could be met only if lenders were persuaded that demand for the projects would be sufficient. Thus, WPPSS continued to predict rapid demand growth in its bond statements long after the trend to slower growth was underway. Similarly, the Supply System prepared cost estimates and construction schedules with an eye to the bond market and then found itself lagging behind its unrealistic estimates [15]. These suggest an interactively complex system.

The larger failing of WPPSS was not merely a matter of cranes, concrete, and contractors. The projects, based on faulty projections, a belief in never-ending growth, and a faith in technological answers to social problems, were misguided from the start. But in examining WPPSS's organizational failures we may learn some cautionary lessons about the difficulties of large-scale projects. The system is not always the solution.

References

1. Theodore Barry & Associates, *Management Study of the Roles and Relationships of the Bonneville Power Administration and the Washington Public Power Supply System*, January 1979.
2. Daniel Jack Chasan, *The Fall of the House of WPPSS* (Seattle, 1975).
3. Peter Hall, *Great Planning Disasters* (London, 1980).
4. Owen Hurd to WPPSS Board of Directors, "Proposed General Administrative Budget, Fiscal Year 9/1/70 through 8/31/71," Box 7, Washington Public Utilities Districts

Association Papers, University of Washington Manuscripts and Archives Division, Seattle.
5. James Leigland and Robert Lamb, *WPP$$: Who Is to Blame for the WPPSS Disaster* (Cambridge, MA, 1986)
6. Minutes, Managers' Section, Washington Public Utilities Districts Association, 22-23 June 1967, Box 12a, Washington Public Utilities Districts Association Papers, University of Washington Manuscripts and Archives Division, Seattle.
7. Minutes, Public Power Council Participants' Meeting, 23 March 1972, Box 7, Washington Public Utilities Districts Association Papers, University of Washington Manuscripts and Archives Division, Seattle.
8. Minutes, Regular Executive Committee Meeting, Washington Public Power Supply System, March 30, 1973, Box 7, Washington Public Utilities Districts Association Papers, University of Washington Manuscripts and Archives Division, Seattle.
9. Peter W.G. Morris and George H. Hough, *The Anatomy of Major Projects* (Chichester, UK, 1987).
10. David Myhra, *Whoops!/WPPSS* (Jefferson, NC, 1984).
11. Northwest Power Planning Council, *1989 Supplement to the 1986 Northwest Conservation and Electric Energy Plan*, I (Portland, OR, 1989).
12. Gus Norwood, "Power Supply–Live or Die," speech to American Public Power Association, May 6, 1965, Gus Norwood Papers, Box 2, University of Washington Manuscripts and Archives Division, Seattle.
13. Charles Perrow, *Normal Accidents* (New York, 1984).
14. "Summary Hanford Number Two Progress Report Number 3, December 4, 1971 through December 31, 1971 Submitted by Burns and Roe, Inc.," 10 February 1971, Box 7, Washington Public Utilities Districts Association Papers, University of Washington Manuscripts and Archives Division, Seattle.
15. U.S. Securities and Exchange Commission, Division of Enforcement, *Staff Report on the Investigation in the Matter of Transactions in Washington Public Power Supply System Securities* (Washington, 1988).
16. Washington Public Power Supply System, *Annual Report 1973*.
17. Washington State Senate Energy and Utilities Committee, *Causes of Cost Overruns and Schedule Delays on the Five WPPSS Nuclear Power Plants*, I, January 12, 1981.
18. Oliver E. Williamson, *Markets and Hierarchies* (New York, 1975).
19. __________, *Economic Organization* (New York, 1986).