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## Chapter 6

# Deferred Construction and Repair/ Renovation

### Highlights . . .

- ◆ In 1996, 55 percent of research-performing institutions reported construction or repair/renovation projects that were needed but had to be deferred because funds were not available.
- ◆ The cost of these deferred projects was \$9.3 billion. Sixty percent of deferred capital project needs were for construction, and 40 percent were for repair/renovation.
- ◆ The top 100 research-performing universities accounted for 71 percent of the total deferred costs. Other doctorate-granting institutions accounted for 21 percent of the total deferred costs. Nondoctorate-granting institutions accounted for 8 percent of the total deferred capital project costs.
- ◆ Seventy-nine percent (\$7.4 billion) of total deferred capital project expenditures were included in institutional plans.
- ◆ Between fiscal years 1994 and 1996, deferred capital project costs included in institutional plans increased \$1.2 billion, from \$6.2 billion to \$7.4 billion in constant dollars. The majority of this increase was in deferred repair/renovation costs (an increase of \$970 million, compared with an increase of \$259 million in deferred construction costs).
- ◆ If combined with the conservative estimate of \$0.7 billion in deferred infrastructure costs that can be attributed to S&E research, the total deferred S&E research facilities and infrastructure needs of colleges and universities totalled \$10 billion.

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## Background

NSF's *Survey of Scientific and Engineering Research Facilities at Colleges and Universities* has provided considerable data on the amount, condition, and capital project activity in our nation's research-performing institutions since 1988. An issue of critical importance to policy makers and an important reason for the legislation mandating NSF's biennial facilities survey is the desire to determine how much more S&E research space colleges and universities need, as well as to determine the costs of repairing/renovating existing S&E research facilities.

This chapter reports on the costs of deferred projects for construction and repair/renovation that are necessary to meet existing S&E research commitments, but that cannot be funded with available resources.

## The Survey Questions

The 1996 *Survey of Scientific and Engineering Research Facilities at Colleges and Universities* expanded a question asked for the first time in 1994, in order to determine construction and repair/renovation costs that institutions had deferred. The earlier effort requested information only about deferred capital projects that were included in an approved institutional plan. In 1996, institutions reported separately the construction and repair/renovation costs for projects included in such plans, as well as for projects not included.

Four criteria were used to define deferred projects (see Item 7 of the survey in Appendix C):

- ◆ The project must be necessary to meet the current S&E research program commitments;
- ◆ The project was not scheduled for fiscal year 1996 or 1997;
- ◆ The project was not funded; and
- ◆ The project was neither for the purpose of developing new programs nor for expanding faculty beyond what is required to fulfill current S&E research program commitments.

Institutions also were asked to report their deferred central campus infrastructure construction and repair/renovation needs. These deferred needs were defined using the same criteria as for facilities, and institutions were asked to report separately those in institutional plans and those not in plans. Central campus

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infrastructure was defined as those systems that exist between the buildings of a campus and the nonarchitectural elements of campus design. Examples included central wiring for telecommunications systems, waste storage and disposal facilities, electrical wiring between buildings, central heating and air exchange systems, drains, sewers, roadways, walkways and parking systems. Plumbing, lighting, wiring, air exchange systems and the like that exist within a building or within five feet of the building foundation were considered building infrastructure and were excluded from this definition of central campus infrastructure.

## Data Considerations

The concept of need, particularly its application to S&E research space, is complex to define and measure. To attain consistency, the questions tie the notion of need to a defined boundary. Without such a boundary, a measurement of need readily becomes a measurement of hopes and wishes.

The term “research program commitments” forces respondents to consider only those R&D activities that are budgeted, approved, and funded, which precludes institutions from indicating they need space in a field within which they do not currently have a research program. The boundaries placed upon these definitions of need intentionally produce conservative estimates, rather than unbounded and untested wish lists.

In the 1994 survey, only 40 percent of all institutions indicated that they had an approved institutional plan that included deferred space. There was concern that the requirement for an approved institutional plan might have been too restrictive by excluding institutions which had real facilities needs but lacked an institutional plan. In 1996, all institutions were eligible to respond to the question on deferred needs regardless of whether they had an approved institutional plan. As a result, 55 percent of institutions indicated deferred needs for either construction or repair or renovation, allowing a more inclusive estimate than was available in 1994. Eleven percent of all institutions reported only needs that were not part of an institutional plan, presumably because a plan did not exist.

## Findings

### To What Extent Did Colleges and Universities Have Deferred Capital Projects for S&E Research Facilities?

In 1996, 55 percent of research-performing institutions reported construction or repair/renovation projects that were needed but had to be deferred because funds were not available. Eighty percent of these institutions had included these deferred projects in an approved institutional plan. Forty-five percent of the colleges and universities that reported deferred projects also identified projects that were not included in an approved institutional plan.

The total estimated cost for deferred S&E research construction and repair/renovation projects in 1996 was \$9.3 billion. This total includes both projects that were in institutional plans and those that were not (Table 6-1).

**Table 6-1. Expenditures for deferred capital projects to construct or repair/renovate science and engineering (S&E) research facilities by institution type, type of project, and whether project was included in institutional plans (dollars in millions)**

| Institution type                 | Included in Institutional Plans          |   | Not Included in Institutional Plans      |   | Total   |
|----------------------------------|--|---|--|---|---------|
|                                  | To construct new S&E research facilities | To repair/renovate existing S&E research facilities | To construct new S&E research facilities | To repair/renovate existing S&E research facilities |         |
| Total                            | \$4,629                                  | \$2,790   | \$1,046                                  | \$876   | \$9,341 |
| Doctorate-granting               | 4,307                                    | 2,495   | 1,004                                    | 763   | 8,569   |
| Top 100 in research expenditures | 3,480                                    | 1,653   | 904                                      | 601   | 6,638   |
| Other                            | 827                                      | 842   | 101                                      | 162   | 1,932   |
| Nondoctorate-granting            | 322                                      | 295   | 42                                       | 113   | 772     |

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

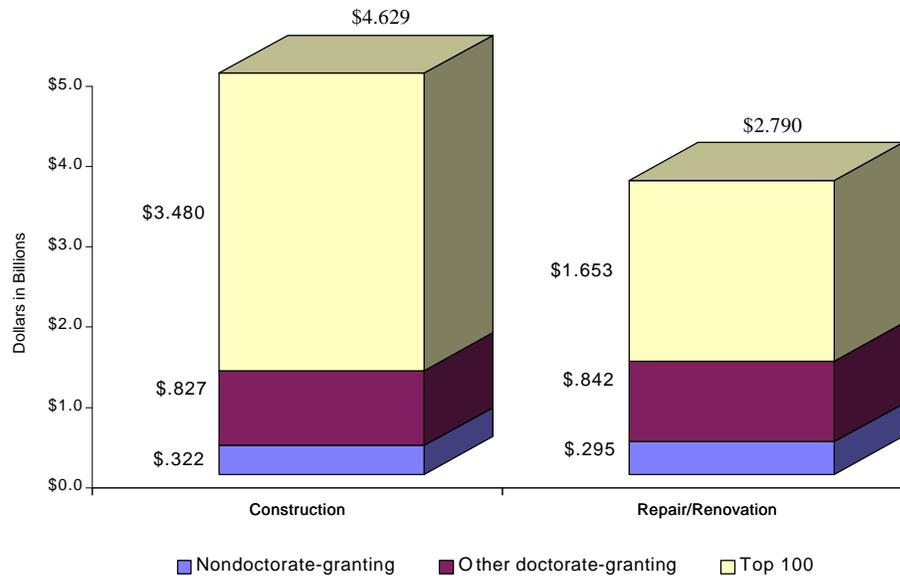
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Over three-quarters of the total deferred capital project expenditures reported by institutions (79 percent or \$7.4 billion) were included in institutional plans. While it is reasonable to suppose that the top 100 institutions would be more likely than other kinds of institutions to have extensive plans identifying deferred needs, this was not the case. Seventy-seven percent of all deferred capital project needs among top 100 institutions were identified in approved institutional plans (\$3.5 billion + \$1.7 billion divided by \$4.6 billion). By contrast, 86 percent of the deferred capital project needs of other doctorate-granting institutions and 80 percent of nondoctorate-granting institutions' deferred capital project needs were part of institutional plans. Deferred construction project costs were more likely than deferred repair/renovation project costs to be part of overall institutional plans. Eighty-two percent of all deferred construction costs were part of institutional plans, compared with 76 percent of all repair/renovation costs.

Overall, 60 percent of all deferred capital project needs (both those included in institutional plans and those not included) were for construction (\$4.6 billion + \$1.0 billion divided by \$9.3 billion). Top 100 institutions had greater deferred construction needs than repair/renovation needs (\$4.4 billion versus \$2.3 billion). For both the other doctorate-granting universities and the nondoctorate-granting institutions, deferred repair/renovation needs exceeded deferred construction needs.

The top 100 research-performing universities accounted for 71 percent of the total deferred needs, both those in and not in plans (\$6.6 billion divided by \$9.3 billion). Other doctorate-granting institutions accounted for 21 percent of the total deferred costs. Nondoctorate-granting institutions accounted for 8 percent of the total deferred capital project costs (\$.8 billion divided by \$9.3 billion) (Table 6-1).

**Figure 6-1. Unfunded Science and Engineering (S&E) Research Facilities Needs Included in Institutional Plans: 1996**



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

## How Have Deferred Needs Included in Institutional Plans Changed from 1994?

Between fiscal years 1994 and 1996, deferred capital project costs included in institutional plans increased \$1.2 billion, from \$6.2 billion to \$7.4 billion in constant dollars (Figure 6-1). The majority of this increase was in deferred repair/renovation costs (an increase of \$970 million, compared with an increase of \$259 million in deferred construction costs).

An increase of this magnitude in deferred project costs in a two-year period raises questions about how institutions assessed their deferred needs, and warrants a more detailed examination of the deferred needs reported by participants in the survey. One hypothesis is that the needs identified in the question did not represent the considered judgments of the institutions, but rather an ephemeral “wish list” of capital projects.

To determine whether this might be the case, the following test of the data was constructed. The institutions were split into three groups: one group wherein

deferred construction projects costs increased, one wherein the deferred construction costs remained the same, and one wherein deferred costs decreased (Table 6-2).

**Table 6-2. Change in deferred science and engineering (S&E) construction and repair/renovation needs reported in institutional plans: 1994 and 1996**

| 1996/1994 comparison               | Construction           |                          | Repair/Renovation      |                          |
|------------------------------------|------------------------|--------------------------|------------------------|--------------------------|
|                                    | Number of institutions | Change in aggregate need | Number of institutions | Change in aggregate need |
| Increased need                     | 84                     | \$2,850                  | 126                    | \$1,833                  |
| Constant Need/No Need <sup>2</sup> | 372                    |                          | 303                    |                          |
| Decreased Need                     | 104                    | -2,591                   | 130                    | -863                     |
| Total                              | 560                    | 259                      | 560                    | 970                      |

<sup>1</sup> Current dollars have been adjusted to 1995 constant dollars using the Bureau of the Census's Composite Fixed-Weighted Price Index for Construction.

<sup>2</sup> Of the institutions indicating constant need for construction, all but two indicated no need in either survey.

Of institutions indicating constant deferred needs in repair/renovation, all but one indicated no need in either year.

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

The deferred construction costs of 84 institutions increased between 1994 and 1996, the costs of 372 institutions remained constant, and the deferred costs of 104 institutions decreased. The increases represented an aggregate increase of \$2.85 billion, and the decreases represented an aggregate \$2.6 billion reduction in need, for a net increase of \$259 million in constant 1995 dollars.

The fact that deferred costs reported by some institutions decreased allows a test of how carefully institutions actually considered their needs in answering questions on deferred projects. If institutions carefully considered their deferred needs in responding to the question, then when they built space or scheduled construction, their needs would be expected to decrease. If, on the other hand, institutions were just reporting "wish lists," deferred project costs might not have much to do with what had recently been constructed. By implication, if there is a strong correlation between recent construction and decreased need, it is plausible that institutions had worked from something like an inventory of needs, and that as projects in an area were completed, needs in that area would be reduced. To test this, institutions were examined whose deferred capital project needs had decreased from the amount they reported in 1994 to the amount they reported in 1996. The size of the decrease was correlated with the amount of space either constructed in 1994-1995 or scheduled for construction in 1996 or 1997, since both of these should reduce reported deferred capital project needs. The correlation was .41, a moderate size correlation.

Apparently, the institutional plans for construction reported in 1996 took into account the amount of construction and construction scheduling that had occurred. By implication, deferred construction needs as reported by institutions represented

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thoughtful judgments about the institutions' actual construction needs and did not appear to be "wish lists" of desired research facility projects.

A similar test was performed using repair/renovation costs, with less clear-cut results. For deferred repair/renovation, 126 institutions' deferred repair/renovations needs increased (representing an aggregate increase of \$1.8 billion in deferred repair/renovation), 303 remained constant, and 130 institutions' deferred construction needs decreased (representing an aggregate \$863 million reduction of need), with a net increase of deferred repair needs of \$970 million in constant 1995 dollars. The amount of scheduled and completed repair/renovation activity was correlated .27 with the amount of decrease in need, a somewhat weaker correlation than was found for construction.

A case-by-case examination of the data suggested that when substantial repair activity occurred, the amount of repair reported as deferred decreased by more than the amount of the repair. It may be that some of the deferred repairs were redefined as need for construction, when the extent of repairs required became more evident. In any case, the judgment of deferred repair/renovation need seems to involve both: (1) assessing the amount of repairs needed and subtracting the amount of repairs completed or scheduled; and (2) making judgments about the balance of the deferred repair needs and how they should be handled.

A second hypothesis that could explain why construction and repair/renovation planned needs increased from 1994 to 1996 would be that institutions were more likely to report having institutional plans in 1996 than in 1994. In the aggregate, this does not appear to be the case for construction planning; 142 institutions reported deferred plans for construction in institutional plans in 1994, compared with 131 in 1996 (a decrease of 11). There was not a perfect overlap between the two years. Sixty percent of the institutions reporting construction plans in 1994 also reported plans in 1996, but 11 percent of institutions not reporting construction plans in 1994 did report them in 1996.

Table 6-3 shows differences between years in reporting of construction and repair/renovation deferred needs. The average cost of deferred construction needs of those reporting in 1994, but not in 1996, was a bit smaller than those reporting in 1996, but not in 1994 (\$22 million versus \$26 million). However, the number of institutions reporting deferred construction needs in institutional plans was somewhat larger (57 versus 46), so that the aggregate need was roughly constant (\$1.2 billion). Therefore, the net increase of \$259 million in deferred construction in constant 1995 dollars came mainly from those reporting deferred construction plans in both years (because the average sizes of their plans increased from \$37 million to \$41 million).

**Table 6-3. Consistency in reporting deferred construction  
and repair/renovation needs: 1994 and 1996  
(in millions)**

| <b>CONSTRUCTION</b>          |                              |                                   |  |  |   |   |
|------------------------------|------------------------------|-----------------------------------|--|--|---|---|
| <i>Need in<br/>1994 Plan</i> | <i>Need in<br/>1996 Plan</i> | <i>Number of<br/>Institutions</i> | <i>1994 Cost of<br/>Deferred<br/>Need <sup>1</sup></i> | <i>Average 1994<br/>Cost of<br/>Deferred<br/>Need <sup>1</sup></i> | <i>1996 Cost of<br/>Deferred<br/>Need</i> | <i>Average 1996<br/>Cost of<br/>Deferred<br/>Need</i> |
| No                           | No                           | 372                               | -  | -  | -   | -   |
| Yes                          | No                           | 57                                | \$1,265  | \$22   | -   | -   |
| No                           | Yes                          | 46                                | -  | -  | \$1,183                                   | \$26  |
| Yes                          | Yes                          | 85                                | 3,105  | 37   | 3,447                                     | 41  |
| Total                        |                              | 560                               | 4,370  |  | 4,630                                     |   |
| <b>REPAIR/RENOVATION</b>     |                              |                                   |  |  |   |   |
| <i>Need in<br/>1994 Plan</i> | <i>Need in<br/>1996 Plan</i> | <i>Number of<br/>Institutions</i> | <i>1994 Cost of<br/>Deferred<br/>Need <sup>1</sup></i> | <i>Average 1994<br/>Cost of<br/>Deferred<br/>Need <sup>1</sup></i> | <i>1996 Cost of<br/>Deferred<br/>Need</i> | <i>Average 1996<br/>Cost of<br/>Deferred<br/>Need</i> |
| No                           | No                           | 303                               | -  | -  | -   | -   |
| Yes                          | No                           | 56                                | \$355  | \$6  | -   | -   |
| No                           | Yes                          | 90                                | -  | -  | \$1,184                                   | \$13  |
| Yes                          | Yes                          | 111                               | 1,465  | 13   | 1,606                                     | 14  |
| Total                        |                              | 560                               | 1,820  |  | 2,790                                     |   |

<sup>1</sup> Current dollars have been adjusted to 1995 constant dollars using the Bureau of the Census's Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

The average cost of deferred repair/renovation projects did not change much (\$14 million versus \$13 million) between 1994 and 1996 for institutions reporting in both years. Therefore, to account for the increase in deferred repair/renovation projects, attention should be focused on institutions reporting in one year and not the other. This examination yields two observations: (1) more institutions reported deferred repair/renovation projects in 1996 than in 1994; and (2) the average amounts per institution reported were much larger in 1996 than in 1994. Thirty-four more institutions reported deferred repair/renovation projects in 1996 than in 1994 (201 versus 167). The institutions reporting deferred repair needs for the first time in 1996 reported much larger deferred repair needs than those who reported in 1994 but not in 1996 (an average deferred need of \$13 million per institution compared with \$6 million). Thus, a larger number of institutions reported larger deferred projects accounts for the large increase in planned repair/renovation.

In sum, then, there is good reason to believe that deferred needs for capital projects included in institutional plans actually increased from 1994 to 1996 by nearly \$1.7 billion. Most of this increase was due to increased needs for repair/renovation (\$1.1 billion). This increase in repair/renovation deferred needs was due to an increased

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number of institutions identifying larger deferred needs on the average. The smaller increase in deferred construction needs (\$.6 billion) was largely accounted for by the increasing scope of existing deferred construction projects among roughly the same institutions in 1996 as in 1994.

Since estimating the costs of deferred projects is of great policy relevance, an alternative method of estimating unfunded construction and repair/renovation needs was tested to determine whether it yielded an estimate consistent with this estimate of \$9.3 billion. That approach relied on institutional estimates of how much additional space was needed in each field and what proportion of the space in the field required repair/renovation. This alternative, described in Appendix E, yielded an estimate (\$8.0 billion) in fair accord with the current method. This convergent validation provides additional assurance that the estimate of \$9.3 billion in unfunded need for construction and repair/renovation of S&E research space is a reliable one.

## To What Extent Did Colleges and Universities Have Deferred Capital Projects for the Central Campus Infrastructure?

The facilities in which S&E research is conducted are supported by a campus infrastructure of walkways and roads, wiring for telecommunications and electricity, sewers and drains, air handling, waste storage and disposal and the like. It is difficult to establish how much of this central campus infrastructure supports the work of S&E research compared with other academic or residential needs. As noted in Chapter 1, 56 percent of all academic space is devoted to S&E, and nearly half of that space (48 percent) is for S&E research. There is concern that central campus infrastructures are not adequate to meet S&E research burdens on them.

In 1996, research-performing institutions reported deferred construction and repair/renovation costs affecting their central campus infrastructure. The estimated costs for these projects, both those included in institutional plans and those that were not, totaled \$2.5 billion (Table 6-4).

**Table 6-4. Expenditures for deferred capital projects to construct or repair/renovate central campus infrastructure by institution type, type of project and whether project was included in institutional plans (in millions of dollars)**

| Institution type                 | Included in Institutional Plans                |   | Not Included in Institutional Plans            |   | Total |
|----------------------------------|--|---|--|---|-------|
|                                  | To construct new central campus infrastructure | To repair/renovate existing central campus infrastructure | To construct new central campus infrastructure | To repair/renovate existing central campus infrastructure |       |
| Total                            | 761  | 897   | 171  | 625   | 2,454 |
| Doctorate-granting               | 738  | 814   | 170  | 623   | 2,345 |
| Top 100 in research expenditures | 538  | 729   | 155  | 491   | 1,913 |
| Other                            | 200  | 85  | 15   | 132   | 432   |
| Nondoctorate-granting            | 23   | 83  | 1  | 2   | 109   |

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Approximately two-thirds of the total deferred cost to either construct or repair/renovate the central campus infrastructure (68 percent) was included in institutional plans (\$761 million + \$897 million divided by \$2.5 billion). Almost all of the deferred central campus infrastructure costs estimated by the nondoctorate-granting institutions (97 percent, or \$23 million + \$83 million divided by \$109 million) were included in institutional plans.

It should be noted that this \$2.5 billion in deferred central campus infrastructure costs is in addition to the \$9.3 billion identified above. Since 56 percent of all academic space is devoted to S&E, and 48 percent of that space is research space, a conservative estimate of S&E research needs for central campus infrastructure might be calculated as \$.7 billion ( $\$2.5 \text{ billion} \times .56 \times .48$ ). It should be recognized that (1) S&E research is probably more demanding of central campus infrastructure than other space, and (2) it is more difficult to prorate infrastructure costs than research facilities costs. Thus, \$.7 billion is a very conservative estimate of the S&E research infrastructure deferred project costs.

Combining this \$.7 billion with the \$9.3 billion in deferred S&E research capital projects estimated above, the total deferred S&E research facilities and infrastructure needs of colleges and universities totalled \$10 billion.