A Financial Planning Model for Estimating Hospital Debt Capacity

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As HOSPITAL FACILITIES AGE and rapid changes in medical technology lead to the need for new kinds of space, many hospitals are faced with urgent demands for remodeling and new construction. Funds for needed capital expenditures must come from three sources: patient revenues, pilanthropy, and debt financing. Before embarking on a major capital improvement program, a hospital's management must carefully analyze the institution's current and projected cash flow position to determine if it can afford to assume the requisite amount of debt. If, at first, the cash flow is inadequate, hospital management must scale down the project or else devise viable financial strategies for generating the necessary cash flow. A financial model can aid management in working out these strategies.

Financial models have been developed by consulting firms and others to assist in hospital budgeting and financial planning. These models, however, may not be particularly well suited for examining debt capacity associated with capital projects for one or more of the following reasons:

- Too much detail is incorporated in them, such as departmental budget breakdowns, to be of much use for aggregate planning.
- In the more aggregated models, the net income from operations is often taken as given, thus entirely avoiding the issues of census projection, patient mix assumptions, the future course of Federal and State reimbursement programs, and so forth.
- Even if the models include some structure for computing net income, they often lack the necessary feedback loops between capital investments and operating results.

The model described in this paper was formulated during the early stages of planning for a major renovation and construction program at Stanford University Hospital. It was specifically designed to project cash flow, the buildup of reserves, gift receipts, and debt requirements under a variety of alternative planning assumptions. Operating as an interactive forecasting

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device, this model specifically incorporates all the major effects of a substantial capital project on the hospital's net cash flow. It was used to examine the net financial impact of specified facility plans and, ultimately, to test whether, and under what circumstances, the institution could afford the amount of debt that would be required for such a project.

Historical Background

Stanford University Medical Center was established in 1959 when the Stanford University Medical School moved from San Francisco to a new home on the main university campus at Palo Alto. At Palo Alto, the architect Edward Durrell Stone designed a building that directly connected a hospital, clinics for the private clinical practice of the faculty, and the medical school under a single roof. This was the first hospital to be designed by Stone, and it manifests many of his noted characteristics, such as interior courtyards, exterior stonework filigree, and supporting columns. The building is situated in an area of the Stanford campus of striking beauty, with eucalyptus trees nearby and broad expanses of open meadow.

In the hospital portion of the building, wards emanate in a straight line from a central core, which houses offices, laboratories, elevators, and other central facilities. Each patient-care wing has a nursing unit on either side of a central work area with a connecting walkway in between. The sheer walls that were constructed on either side of the corridor and between some of the rooms precluded renovation of these wings in later years.

Over time, the basic workspace has become inadequate. The work areas of each nursing unit, too small from the beginning, have become further cramped as offices were built into the central area of each patient wing. Also, over time the patient care rooms were converted, without extensive remodeling, into intensive care units. Because the number of beds in the Stone building (approximately 450) also became insufficient, the center acquired the former Palo Alto City Hospital plant and reopened it as part of Stanford University Hospital. However, this facility, which has approximately 170 routine care patient beds, is located about 1 mile from the main hospital, and this separation has contributed to additional operational inefficiencies besides those arising from inadequate space and too few beds in the main center.

The tremendous regulatory pressures that built up in California during the 1970s forced hospitals to meet new spatial configurations that required a specific number of square feet for certain activities; to comply with new and more restrictive seismic codes; and to fulfill other miscellaneous life and safety requirements as well. Stanford University Hospital fell short in meeting many of the mandated requirements of the State licensing agency. Inadequacies that had been present in the hospital plant from its inception were compounded by the hospital's subsequent evolution into a tertiary care medical center. This center continued to add complicated clinical activities that had to be conducted in a structure built for a much simpler patient care environment. Over time, the Joint Commission on Accreditation of Hospitals (JCAH) and the California State Licensing Survey came together and cited the hospital for many spatial inadequacies. After the hospital had received only a 1-year accreditation 2 years in a row from the JCAH, hospital management made the decision to correct code-related deficiencies, both cited and citable. Since Stanford's management viewed these code-related deficiencies as serious functional deficiencies as well, this response was not driven by arbitrary codes.

An architectural firm was retained to address the hospital's major deficiencies and to see by what configuration of renovation and new construction a corrective job could be done at the least cost. The goal was to create the minimal facility that would be necessary to correct the major functional deficiencies in the physical plant and prepare the hospital to face the future. No attempt was made to engage in blue-sky forecasting of the way that medical care will evolve over the next 20 years or to try to predict how a tertiary care hospital directly affiliated with a heavily research-oriented medical school will move. The architectural planning focused on dealing with the glaring functional inadequacies, most of which had been cited or had potential for citation. These functional deficiencies included inadequacies in the size, arrangement, or location of hospital departments that currently affected patient care, constrained hospital capacity, or had an adverse impact on operating costs or revenues.

As the planning process moved forward, it became clear that the deficiencies could not be corrected merely by remodeling existing facilities. To meet the needs of many of the hospital's activities for new or reconfigured space, new construction would be necessary. The existing buildings could not be renovated to accommodate these activities because of the gross inadequacy of space (overall, Stanford University Hospital has a ratio of only 882 gross square feet per bed as contrasted with a range of 1,300–1,800 square feet per bed at comparable teaching hospitals), the physical limitations of the buildings themselves, and the drastic revenue cuts that would be experienced because of reduced patient care capacity. The major programmatic deficiencies of the hospital were found to be the following:

• There was an inadequate number of operating rooms to meet current and projected surgical demand.
• Intensive care and special coronary care could not be delivered optimally in the teaching and research setting in the existing units.
• A whole new pediatric unit was required because of the unworkable architectural configuration of the existing unit.

When these direct patient care needs were considered along with the more generalized needs for adequate space for central storage and for many of the support activities, a hospital modernization plan emerged whose major aims were:

1. To construct additional operating rooms based on current needs and projected demand;
2. To provide additional modern intensive care and coronary care units;
3. To establish a viable pediatric unit;
4. To achieve a reasonable balance among the various types of nursing units (routine care beds, intensive care units, and so forth) and between these and ancillary and central support functions (for example, materials management);
5. To move toward the consolidation of beds in a single hospital building;
6. As much as possible, to provide the flexibility to accommodate present and future developments in technology and medical care delivery.

What had to be clearly demonstrated was that the recommended options for facilities were affordable and cost effective, both in their short-term and long-term financial implications. In the light of the many significant risks and uncertainties involved in the hospital regulatory environment and cost-reimbursement programs, management had to ascertain whether or not it could afford the modernization plan under a variety of planning assumptions. For this purpose, a computer-based financial model was designed.

Description of Financial Model

It was necessary to answer questions raised by the Stanford University administration, the hospital's board of directors, and the university's board of trustees. Although the history of Stanford University Hospital had been one of financial soundness, the medical center as a whole (that is, the school of medicine, the faculty practice program, and the hospital) had not always been as financially secure as the university trustees would have liked. In particular, concerns existed because of cost overruns and the poor management in the early 1970s of a construction project in which a new wing had been added to the hospital. In the light of this past experience, the university's officers and trustees wanted to be sure that there would be no surprises concerning the financial viability and soundness of the proposed modernization plan. They were interested in taking a hard look at market and census projections, the impact of government reimbursement programs, the cost of borrowed money, and many other factors that would affect the viability of the hospital's modernization plan. The key question was: Would the hospital be able to support the cost of such a project, or might it become a financial burden to the university? A financial model of hospital expense, revenue, and cash flow was therefore devised that allowed projections to be made based on financial and other key variables. The purpose of this model was to determine the financial feasibility of the modernization plan and to verify that a positive net cash flow could be maintained throughout the project. Since, when planning began, it was not known whether the resulting cash flow would be positive or negative, it was decided not to base the model on supporting a specific dollar figure for construction, but rather to set it up so that it would show, for any given construction project, what amount of debt would be required and the projected impact of this new debt on net cash flow, given a set of independent, reasonable assumptions about key revenue and expense variables.

The model enabled management to simulate and examine financial outcomes under a variety of planning assumptions and to test the sensitivity of these outcomes to the key variables. It was designed to project revenues, expenses, and cash flows over a 10-year period beginning in 1980. The model was used to compute the total cost of the modernization plan with account taken of inflation and the amount of long-term debt that would be required for its implementation. The model also provided the information needed to derive the financial ratios (for example, debt-to-asset ratio, debt-service coverage, and so forth) that are essential in determining the feasibility of a debt package.

Several key features of our model that distinguish it from earlier efforts in hospital financial planning are as follows.

• Patient demand is projected by location (main building or the nearby facility), by type of care (routine, special, or pediatric), and by source of funding (Medicare-Medicaid or private pay). For each type of bed, patient volume (or average census) is computed as the minimum of projected demand and available capacity. In this computation, ordinary statistical variations in occupancy are taken into account as well as the ob-

Table 1. Financial model for Stanford University Hospital's modernization plan: variables and assumptions for basic runs

Variables	Assumptions: Base year (fiscal year 1980)	Assumptions: Subsequent years (fiscal years 1981–91)
1. Patient days	169,150	3 scenarios of demand through 1991: base case—6 percent increase; higher growth case—11.5 percent increase; no growth case—0 percent increase.
2. Basic inflation rate	12 percent.	11 percent 1981, 10 percent 1982, 9 percent 1983, and 8 percent 1984 and thereafter.
3. Revenue per patient day	At actual level.	Increases at CPI plus 3 percent.
4. Operating costs	do.	Increases at CPI plus 2.3 percent.
5. Ratio of variable to fixed costs	33 to 67 percent.	33 to 67 percent.
6. Construction inflation rate	CPI plus 2 percent.	CPI plus 2 percent.
7. Ordinary capital needs		Specifically projected, year by year through 1984.
Inflation rate on ordinary capital needs		CPI plus 1 percent beyond 1984.
8. Long-term debt interest rate		7½ percent.
9. Gifts for construction		$10 million total 1982–86.
10. Medicare and Medicaid changes:		
Growth in Medicare and Medicaid utilization		0.5 percent per year.
Medicare per diem routine nursing limitations	$1 million loss.	Increases at CPI plus 1.3 percent.
Loss from new Medicare and Medicaid limitations		$1 million inflated.

NOTE: CPI = consumer price index.

vious interaction between the number of patient days of intensive care and routine care.

• The model incorporates a detailed cost reimbursement formula for determining the net revenue from Medicare and Medicaid patients. In the absence of limitations on reimbursement for specific services, cost recoveries are computed, and then special losses due to known limitations, such as those imposed on routine nursing care, are deducted. The formula also provides for the effect of potential future government cost-containment efforts. It includes a term for the incremental depreciation and interest expenses resulting from the modernization plan that are reimbursable under current government regulations.

• The model incorporates the full incremental cost and revenue associated with each type of patient. That is, the relationship of hospital costs and revenues to patient volume was estimated and built directly into the forecasting model.

• The cost of the modernization plan project is computed on the basis of square-footage estimates, base-year construction costs per square foot, construction inflation rates, and the timetable for construction. The amount of new debt required is computed as the difference between the total project cost and the sum of gifts and accumulated capital reserves.

• A submodel is used to compute the depreciation and interest expense associated with the project and to estimate other space-related costs (for example, utilities) that will be incurred upon completion of the project, so that these costs can be fed back into the calculations of operating expenses and revenues. The submodel includes a calculation of the interest expense that will be accumulated during construction which must be capitalized and included in depreciation once the building becomes operational.

The projections made by the financial model are affected by the following 10 key variables: projected annual patient days, basic inflation rate, growth rate of revenue per patient day, growth rate of operating costs, ratio of variable to fixed costs, construction inflation rate, ordinary capital expenditures (for example, for equipment), long-term interest rate, availability of gifts for capital, and projected changes in Medicare-Medicaid reimbursement (that is, the projected growth in Medicare and Medicaid utilization, Medicare per diem routine nursing limitations, and the loss from new Medicare-Medicaid limitations).

Once the variables were identified and the equations relating them were calculated, we implemented the model on a computer, using the EDUCOM financial planning model (EFPM) system. The EFPM is a flexible interactive modeling language originally developed for planning by universities. The model was equally well suited, however, for our application; a group of three needed less than 2 months to code it and begin making live runs. We were assisted in this effort by an outside financial consulting firm whose main function was to validate the formulas and assumptions that were built into the model. [For brevity's sake, the detailed mathematical formulation is not included in this paper. Readers may contact Heath directly for such details.]

Results

For each of the key variables, assumptions were made regarding the magnitude of the variable in the base year (fiscal year 1980) and in subsequent years (fiscal years 1981–91). Table 1 shows the values assigned to each of these variables.

In general, the assumptions we used represent the most likely projection of future trends. The assumptions about the number of patient days of hospital care resulted from a separate study (*1*) and are worthy of special mention. Given the visibility and major impact of this variable on the financial projections, we decided to base the model runs on three patient-day alternatives labeled "base case," "higher demand case," and "no-growth case."

In the higher demand case, it was assumed that the total patient day demand would grow by an estimated 11.5 percent over the period 1979–91. This assumption was based on estimates of population growth, the aging of the population, and changes in Stanford's share of its service areas in future years.

Despite the designation "higher demand," the estimates on which this assumption is based actually reflect a reduction in the overall use of hospitals, in Stanford's share of the delivery of hospital care in its service-market area, or in both. Therefore "higher demand" may actually be a conservative estimate. It was not meant to represent an upper limit to the possible demand for patient days of hospital care at Stanford.

The most conservative assumption regarding the level of patient demand during the period 1979–91 was that patient days would not increase during the period. In view of the significant aging of the local population and the expected further development of Stanford University Hospital as a regional referral center for tertiary care over this period, this no-growth assumption represents a rather extreme lower limit on what is likely to occur.

In the "base case," a 6 percent increase in patient demand over the period 1979–91 was assumed. This percentage was chosen because it represents the midpoint between the higher demand and the no-growth assumptions.

Because the projected growth in patient days that was assumed in the higher-demand and base-case scenarios was phased in with the new construction, it was assumed that the major portion of this growth would occur late in the period being projected. Application of these three assumptions about the patient-day variable generated the three basic runs of the financial model that we carried out. These runs were used to project the financial outcomes from implementation of the modernization plan.

The estimated cost of construction plus applicable fees and other expenses associated with implementation of the modernization plan was $92.7 million. This figure was associated with achievement of the most preferred architectural configuration—a configuration arrived at through a lengthy process of interaction between management, planners, and the architect-consultants. The project was divided into three stages; construction was to begin in 1982 and be completed sometime in 1986. The following table shows the estimated costs of the modernization project in millions of dollars.

Construction stage	*Cost (1980 $)*	*Year of project's initiation*	*Cost (inflated $)*	*Square feet with new utilities*
Stage 1: completion of shell	$14.9	1982	$22.6	94,600
Stage 2:				
New construction	32.7	1983	56.0	133,000
Refill	6.5	1986	14.1	0
			$92.7	

Base case

The results of the base-case run of the model are shown in table 2. Cash flow projections are given in the top half of the table. Net revenue is broken down into patient revenue by payer class—"Title patients revenue" (Medicare-Medicaid) and "Private patients revenue"—and into "Nonpatient revenue." Expenses for direct patient care and overhead—including those incremental expenditures for utilities, housekeeping, maintenance, interest, and depreciation associated with the modernization plan—are aggregated on a single line of output labeled "Total expenses." The difference between total net revenue and total expenses represents net income. Net income computations provide for depreciation of capital assets, which is a noncash expense. To determine the total amount of cash generated by a given year's operations, depreciation expenses are added to net income. The ways that the cash generated is used are then accounted for. One significant use is for working capital. For example, hospital employees are paid 5 days after the end of a pay period, but accounts receivable are collected an average of 100 days after patient service is

Table 2. Results of the base case model run, February 28, 1980 (in thousands)

Item	1980	1981	1982	1983	1984	1985	1986	1987	1988
	Cash flow projections								
1. Revenue from title (Medicare-Medicaid) patients	$ 41,406	$ 46,888	$ 53,649	$ 60,955	$ 69,794	$ 81,750	$ 90,991	$100,958	$112,489
2. Revenue from private patients	56,675	64,726	73,272	82,211	91,415	102,198	112,316	123,424	137,944
3. Nonpatient revenue	2,184	1,877	2,087	2,051	2,451	2,844	3,127	2,855	3,209
4. Total net revenue	$100,265	$113,491	$129,007	$145,217	$163,661	$186,791	$206,434	$227,236	$253,642
5. Total expenses	$ 95,443	$109,184	$123,811	$139,158	$158,412	$183,534	$203,244	$223,268	$245,441
6. Net income	$4,822	$4,307	$5,197	$6,059	$5,249	$3,257	$3,189	$3,969	$ 8,202
7. Total depreciation	2,780	3,593	4,048	4,584	5,875	8,554	9,043	9,586	10,751
8. Other cash needs	—4,508	—1,982	—2,274	—2,423	—2,749	—3,729	—3,396	—3,697	—4,538
9. Total available cash	$3,095	$5,917	$6,971	$8,220	$8,375	$8,082	$8,836	$9,857	$14,415
10. Debt service on action plan	0	0	0	0	—240	—1,013	—1,089	—1,171	—1,315
11. Ordinary capital expenses	—9,127	—5,551	—6,357	—4,857	—5,409	—5,895	—6,426	—7,004	—7,635
12. Transfer to (or from) reserve	$—6,033	$367	$614	$3,363	$2,726	$1,174	$1,322	$1,683	$5,466
13. Reserve balance beginning of year	9,000	2,968	3,334	614	3,363	6,089	7,262	1,322	3,004
14. Outstanding debt	0	0	0	0	16,301	67,399	66,386	65,297	67,989
	Financial summary of modernization plan, February 28, 1980								
15. Total patient days	169,151	169,658	170,167	170,677	171,189	174,613	174,613	174,613	178,105
16. Total cost	0	0	$22,636	$55,951	0	0	$14,125	0	0
Sources of funds									
17. Reserve	0	0	3,334	614	0	0	7,262	0	0
18. Gifts	0	0	3,000	4,000	0	0	3,000	0	0
19. New borrowing	0	0	16,301	51,338	0	0	3,863	0	0
20. Reduction in operating costs due to efficiency	0	0	0	0	0	0	0	0	0
Operating cost increment due to modernization plan									
21. Operations and maintenance expense	0	0	0	0	1,269	3,374	3,729	4,120	4,553
22. Interest and depreciation	0	0	0	0	2,128	8,199	8,123	8,041	8,808

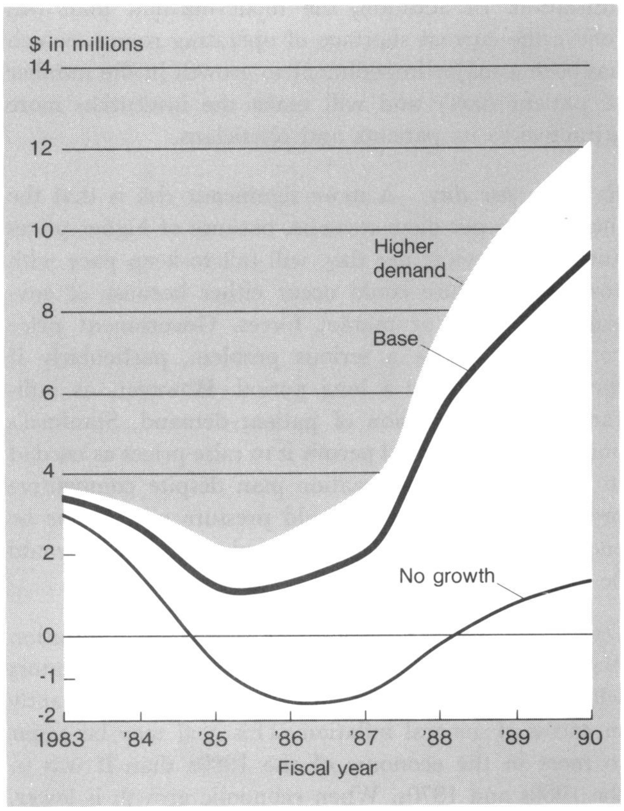
NOTE: In the base case, a 6 percent increase in the patient-day demand was assumed.

provided. This lag between outflow and inflow of cash is expressed as a working capital requirement. The model reflects the growth in working capital that will occur as patient revenues increase. This working capital increase is the main element of "Other cash needs," shown on line 8 of table 2.

The amount of modernization plan debt required is computed, and the amount needed for annual repayment of this debt is deducted from available cash ("Debt service on action plan"—action plan means modernization plan). Further deductions are made for expenditures for needed equipment and other capital needs not included in the modernization plan project ("non-action plan capital expense"). When all of these deductions have been made from available cash, the result is the net cash flow, which is treated as a transfer to or from capital reserves, as shown on line 12. The balance of debt remaining on the modernization plan is computed and displayed for each future year on line 14. (Note that the debt only shows up on this line after construction of each stage has been completed, since during construction interest is capitalized rather than charged to operations.)

The bottom half of table 2 is a financial summary of the modernization plan. The growth in patient days is phased in with the new construction, with the results shown on line 15. (Our base-case assumption was 6 percent growth in patient days in 1991; hence an approximate 5.3 percent increase is projected to occur by 1988). The next line (16) gives the total cost of each phase of the project; a breakdown of the sources of funds follows (lines 17–19). Once the cost of each new phase is computed, the model is instructed to draw down existing reserves, then to apply available gifts, and finally, to fund any remaining shortfall by new borrowing.

Net cash flows from basic runs of the financial model



The remaining lines in table 2 highlight the incremental operating savings and costs directly attributable to the modernization plan. Although the model was programed to allow for some increased efficiencies in operations achieved by the elimination of functional deficiencies, these potential increases in "productivity" (that is, positive changes in the ratio of services provided to operating costs) were conservatively assumed to be zero in the base-model runs (see line 20). The final two lines of table 2 show the incremental operating costs for the associated utilities and maintenance expense (line 21) and interest charges and depreciation (line 22).

According to table 2, the total debt requirement for the modernization plan is $71.5 million; the remaining $21.2 million of costs is provided in about equal shares from gifts and cash reserves. In spite of the approximately $8 million in additional interest and depreciation charges, plus $4 million in incremental operations and maintenance expense, the net cash flow remains positive in each future year and even begins to grow by the end of the 8-year period.

Alternative patient day assumptions. We have already discussed how critical the assumption is about the growth in the number of patient days. The financial model was run with each of the three basic alternatives to examine their impact on the hospital's "bottom line." The chart displays the sequence of net cash flows resulting from each run, from the time of borrowing through 1991. The middle curve represents the net cash flows for the base case in table 2 carried out to the year 1991. The upper curve represents net cash flows resulting from the higher demand case. The lower curve represents net cash flows associated with the no-growth case.

The results shown in the chart indicate that in both the base case and the higher demand case, the construction to be done in the modernization plan could be accomplished with positive cash flows throughout the duration of the project. In both cases, no negative cash flows would be experienced in any year. On the contrary, as revenues begin to increase in 1986, positive cash flows will increase rapidly, generating substantial additions to hospital reserves. This outcome has two implications. First, a substantial margin of safety would exist with respect to debt repayment. Second, once the construction called for in the modernization plan is completed, the rate of hospital price increases could be reduced and still leave adequate funds available to cover debt service. Thus, we concluded that in both the base case and the higher demand case, sufficient net cash flows would be produced to support the proposed modernization plan. It is interesting to note that in the higher demand case, several of the capacity constraints on beds would become operative, thereby preventing the full realization of the demand for patient days of care and limiting the hospital's profitability.

The no-growth case is the only one of the three basic runs that involves negative cash flow in any year. In the no-growth case, negative cash flows would be experienced in the years immediately following completion of stage 2 of the modernization plan. However, even in this case, the duration and intensity of negative cash flows are not significant. Totaling $3.7 million and lasting for 3 years, these negative cash flows would never extend below $1.5 million in any 1 year. Since the total amount of borrowing required would be well within the hospital's existing line of credit, these temporary cash shortfalls could be offset by short-term borrowing. Thus, even the conservative no-growth case was judged to be financially feasible.

Sensitivity to changes in other variables: analysis of risk. The base-case runs demonstrated that the proposed modernization plan is financially feasible under the most likely set of assumptions. The model was also used to identify and test the principal areas of risk.

The following table, which displays each of the 10 primary variables and related subvariables, indicates the relative degree to which the financial results are sensitive to changes in these variables. Each variable is classified as having high or low sensitivity. High sensitivity indicates that the results are especially sensitive to that variable and that changes in the assumptions regarding it will have a significant impact on the net cash flow outcomes generated by the model. Thus, these variables encompass areas of potential risk.

Variable	*Sensitivity of model*	
	High	*Low*
Patient days	x	
Basic inflation rate		x
Revenue per day	x	
Operating costs	x	
Ratio of variable to fixed costs		x
Construction inflation rate		x
Ordinary capital needs		x
Inflation on ordinary capital needs		x
Long-term debt interest rate		x
Gifts for construction		x
Medicare and Medicaid changes:		
Growth in Medicare and Medicaid utilization		x
Medicare per diem routine nursing limitations	x	
Loss from new Medicare and Medicaid limitations	x	

It should be noted that in ranking each variable according to high or low sensitivity, it was assumed that the variable was operating independently of any other variable. Clearly, if several low-sensitivity variables were operating together, their overall impact could equal, or even exceed, that of a single high-sensitivity variable.

The financial outcomes projected in the base runs of the model could be most affected by adverse changes in the patient-day demand, revenue per day, operating costs, and Medicare-Medicaid limitations and losses.

Reduction in patient demand. Although an outcome worse than no growth in patient days was considered unlikely, several factors that could potentially affect patient demand were analyzed. For example, the population growth underlying the demand forecasts could be overstated. However, recent trends indicate that the population projections reflected in the patient-demand levels are reasonable. Another area of risk is that Stanford's share of the existing service-market areas could be reduced more than anticipated. Decreased demand might occur if the costs of service at Stanford could not be maintained at a competitive level, or if there was an increased shift to use of nonhospital-based health care services. However, preservation of Stanford's position as a referral center offering highly specialized care should insulate it from serious declines in utilization. In addition, the modernization plan will relieve the current shortage of operating rooms (which has been a major impediment to growth in the number of patient days) and will make the institution more attractive to its patients and physicians.

Revenue per day. A more significant risk is that the increases in per diem revenue, because of higher prices and more services per day, will fail to keep pace with costs. This failure could occur either because of government action or market forces. Government price controls would be a serious problem, particularly if they persisted over a long period. However, as indicated in the discussion of patient demand, Stanford's unique services should permit it to raise prices as needed to finance the modernization plan despite competitive pressures. Nevertheless, should pressure on revenue be encountered, extraordinary cost-reduction efforts would be required.

Operating costs. It is implicit in the modernization plan's financial forecasts that hospital administrators will not permit increases in costs that are significantly in excess of general inflation. This goal may be easier to meet in the economy of the 1980s than it was in the 1960s and 1970s. When economic growth is lower, increases in wage rates tend to be lower relative to inflation. As many economists foresee reduced growth in the 1980s, labor-intensive industries like hospitals may experience less pressure on inflation-adjusted costs than in past years.

Future limits on financial support for Medicare and Medicaid programs. Federal and State governments probably will continue to limit the amount of funds reimbursed under Medicare and Medicaid programs. For this reason, an additional $1 million per year of such losses was included in the base-case financial projections, beginning in 1980–81. Assessing the likelihood of further limitations is somewhat speculative. Ultimately, such cutbacks would be constrained by economic realities, since many institutions would experience severe difficulties. Again, hospital administrators at Stanford would have to respond to any significant losses through further reductions in cost, as would all other institutions affected by such losses.

Given the analysis of the major areas of risk, additional runs of the model were made with specific changes in the assumptions affecting key variables. The net cash flows generated for the years 1984, 1987, and 1990 in the basic runs with three different patient-day assumptions are listed in table 3. The table also shows the amount of change—expressed in positive or nega-

Table 3. Impact of changes in key assumptions on financial forecasts (in thousands of dollars)

Basic runs with changes in key assumptions	1984	1987	1990
		Cash flows [1]	
Basic runs:			
Base case (patient-demand increase 6 percent through 1991)	$2,725	$1,685	$9,275
Higher demand case (patient demand increase 11.5 percent through 1991)	3,270	3,415	12,300
No-growth case (no patient demand increase through 1991)	1,940	(1,320)	1,470
		Amount of change [2] to be applied to basic cash flows [1]	
Changes in key assumptions:			
Inflation 1 percent higher per year	($300)	($475)	($225)
Gross revenue increase 0.7 percent less each year	(2,200)	(5,290)	(11,350)
Additional $1 million Medicare loss per year	(1,800)	(2,600)	(4,030)
Long-term debt rate 8½ percent (versus base run with 7½ percent)	(60)	(200)	(260)
1 percentage point increase per year in "efficiency" for 5 years	3,870	6,840	9,930

[1] Cash flow occurs after provision for working capital, debt service, and all anticipated capital needs.

[2] "Change" indicates amount to be added to (or subtracted) from basic runs to calculate adjusted cash flow.

tive cash flow—associated with variations in certain key assumptions. It indicates in dollar terms (net cash flow) the sensitivity of the model to changes in the assumptions associated with selected variables and clearly shows the risk associated with the variables of revenue per day, operating costs, and changes in Medicare-Medicaid.

In table 4, several variables to which the financial model is highly sensitive have been combined to show their collective impact on net cash flow. With the base-case growth in patient days, assumptions are made about the impact on net cash flow of the two variables of revenue per day and Medicare-Medicaid loss. These assumptions, which are far more negative than those used in the basic runs, are that (*a*) increases in gross revenues per patient day will be limited to the rate of increase in standard operating costs (that is, will not include any increment to offset the capital costs of the modernization plan) and (*b*) the hospital will be subjected to another $1 million (inflated) in Medicare-Medicaid losses each year in addition to the $1 million per year loss assumed in the basic runs of the financial model. Both of these more negative assumptions would likely affect most of the other hospitals in the nation as well if they affected Stanford, since they would result from national legislation, public resistance, or changes in governmental reimbursement regulations.

The combined effect of these two negative assumptions, when applied to the base case, would be to cause negative cash flows instead of the positive ones associated with the base case (table 4). In the example, they would produce a negative cash flow of $1.275 million in 1984, which would increase to $6.205 million in 1987 and drop to $6.105 million in 1990.

If the negative cash flows projected under these two more negative assumptions were to occur, the hospital would be required to respond by cutting costs. Table 4 indicates the cash flow impact of a response involving a 1 percentage point increase in operating "efficiency" for a total of 5 years. This increase would be generated by moderate reductions by the hospital in costs (and presumably in quality as well) to offset

Table 4. Example of combined impact of selected changes in key assumptions on financial forecasts (in thousands of dollars)

Impact	Cash flow or change [1]	Effects on cash flow [1]		
		1984	1987	1990
Base case	Cash flow.	$2,725	$1,685	$9,275
A. Gross revenue increase per day 0.7 percent less	Change.	(2,200)	(5,290)	(11,350)
B. Additional $1 million Medicare loss	Change.	*(1,800)*	*(2,600)*	*(4,030)*
Effect of A and B combined	Cash flow.	(1,275)	(6,205)	(6,105)
C. Response: 1 percentage point increase in "efficiency"	Change.	*3,870*	*6,840*	*9,930*
Effect of A, B, and C combined	Cash flow.	2,595	635	3,825

[1] Cash flow occurs after provision for working capital, debt service, and all anticipated capital needs. "Change" indicates amount to be added to (or subtracted) from basic runs to calculate adjusted cash flow.

the negative cash flows that would occur under the two more negative assumptions. When this response is entered into the financial model as an assumption, the combined effect of the two more negative assumptions and the assumed management response offsets the negative cash flows produced before the response. As table 4 indicates, the combined effect of the two negative assumptions and the positive response would change the net cash flow in all years from negative back to positive. The net cash flow would change from minus $1.275 million to plus $2.595 million in 1984, from minus $6.205 million to plus $0.635 million in 1987, and from minus $6.105 million to plus $3.825 million in 1990. This example demonstrates that even when more negative assumptions are made regarding two variables to which the financial model is highly sensitive, periods of significant negative net cash flow could be offset by a hospital response which, although it would almost surely lead to sacrifices in the quality of care, is certainly within the realm of possibility.

The preceding analysis was used to reassure the Stanford University administration, the Stanford University Hospital Board of Directors, and the Stanford University Board of Trustees that the hospital could undertake the proposed modernization plan without placing the university's other revenues and assets in serious financial jeopardy. Use of a model allowed for manipulation of key variables to project net income and cash flow. It provided a dynamic way of judging the financial feasibility of the construction project that would not have been possible by analysis of financial statements alone.

Postscript

Subsequent to the formulation and application of the financial planning model described in this paper, a somewhat more simplified version was designed by Arthur Andersen & Co., the financial consulting firm that assisted in the Stanford project. This firm is using the more simplified version, which runs on the Apple microcomputer, in projects for a number of its hospital clients.

It is worth noting that since the analyses reported in this paper were performed, several significant changes have occurred which unfavorably affect several of the key variables. First, the expected cost of the modernization project has risen to approximately $120 million because of further refinement of the model and the timing of the project, as well as sharply increased financing costs. Second, the interest rate on debt is currently estimated to be 12 to 13 percent per annum, rather than the 7½ percent rate assumed in the model runs. Third, the hospital already has experienced losses in Medicare and Medicaid funding far in excess of what was anticipated in the model runs, and even greater losses are projected for the future. Nevertheless, after we updated the model to take account of these new assumptions and reran it, the modernization plan still appeared to be financially feasible.

Reference

1. Dietrich, E., and Hopkins, D. S. P.: Patient volume at Stanford University Hospital: recent trends and future projections. Office of the Vice President for Medical Affairs, Stanford University Medical Center, Stanford, Calif., February 1980.

SYNOPSIS

HOPKINS, DAVID S. P. (Stanford University Medical Center), HEATH, DAN, and LEVIN, PETER J.: *A financial planning model for estimating hospital debt capacity. Public Health Reports, Vol. 97, July–August 1982, pp. 363–372.*

A computer-based financial planning model was formulated to measure the impact of a major capital improvement project on the fiscal health of Stanford University Hospital. The model had to be responsive to many variables and easy to use, so as to allow for the testing of numerous alternatives. Special efforts were made to identify the key variables that needed to be represented in the model and to include all known links between capital investment, debt, and hospital operating expenses. Growth in the number of patient days of care was singled out as a major source of uncertainty that would have profound effects on the hospital's finances. Therefore this variable was subjected to special scrutiny in terms of efforts to gauge expected demographic trends and market forces. In addition, alternative base runs of the model were made under three distinct patient-demand assumptions.

Use of the model enabled planners at the Stanford University Hospital (*a*) to determine that a proposed modernization plan was financially feasible under a reasonable (that is, not unduly optimistic) set of assumptions and (*b*) to examine the major sources of risk. Other than patient demand, these sources were found to be gross revenues per patient, operating costs, and future limitations on government reimbursement programs. When the likely financial consequences of these risks were estimated, both separately and in combination, it was determined that even if two or more assumptions took a somewhat more negative turn than was expected, the hospital would be able to offset adverse consequences by a relatively minor reduction in operating costs.