Executive Summary

The National Institute of Standards and Technology's (NIST's) Advanced Technology Program (ATP) began in 1990 as a cost-sharing program to assist U.S. industry in pursuing high-risk, enabling technologies with potential for significant national economic benefit.

ATP conducts economic analyses of these technologies to assess the short- and long-run impact of ATP-funded projects on project participants and on others in the economy. As part of this effort, Research Triangle Institute (RTI), under contract to NIST, addressed the specific challenges of developing and employing a framework for estimating social and private returns on ATP-funded innovations used in medicine.

This executive summary provides an outline of the study's methodology and summarizes key findings. Chapter 1 of the report gives a complete overview of the study, describing objectives and methodology, the specific tissue engineering projects, and findings and conclusions. Chapter 2 explains the methodology in greater detail. Chapter 3 provides case by case analysis of each of the seven ATP-funded tissue engineering projects.

Our approach to modeling the social and private returns on ATP-funded projects in medical technologies is based on the methodology recommended by Mansfield (1996). We modify Mansfield's methodology for the specific case of medical innovations. In particular, we use nonmarket methods to value the benefits of new medical treatments. Nonmarket valuation methods are useful for valuing benefits of new technologies that are not priced in markets—cleaner water or air, reductions in crime, or, as in this case, improvements in health.

ATP-funded medical technologies may improve the long-run health outcomes of thousands of patients each year with acute and chronic diseases. They may also reduce the cost of health care. Valuing these effects requires extending conventional benefit-cost models and applying methodologies commonly used in health economics.

The economic burden of a disease is usually divided into three components: direct medical costs, indirect costs, and intangible costs. Direct medical costs are costs of medical treatment. Indirect costs are the societal costs associated with the loss in productivity due to illness and unpaid caregiver time. Intangible costs measure the patient's pain and suffering. Our methodology measures how ATP-funded technologies change both the direct medical costs and the intangible costs of a disease. Changes in indirect costs are generally not included in our estimates.

Social return on public investment quantifies the incremental improvement in social outcomes attributable to ATP investment.

The primary emphasis of the methodology developed and used in this study is to evaluate the *social return on public investment* for ATP projects. From a public policy perspective, this evaluation factor is central, because it quantifies the incremental improvement in social outcomes attributable to ATP's investment.

Our methodology allows ATP funding to affect the development of medical technology in three ways:

- **Accelerate the technology's benefits:** ATP funding can catalyze and accelerate the R&D phase, bringing benefits to the private sector, patients, and society sooner and for a greater number of years than without ATP funding. In some cases, ATP funding may persuade a company to conduct research in a technology that it otherwise would not pursue.
- **Increase the likelihood of success:** By reducing the cost of R&D to the companies developing the technology, ATP funding can increase the amount of R&D conducted and increase the likelihood that a project will be technically successful.
- **Widen the technology's applications:** ATP funding can also widen the scope of the project, enabling the company to apply its technology to additional diseases or patient populations.

To determine the social return on public investment, we constructed two scenarios for each project: one with ATP funding and one without ATP funding. The with-ATP scenario can differ from the without-ATP scenario through any of the three impact channels described above. We first calculated the social benefits and costs for each scenario and then calculated the difference in the stream of benefits and costs between the with-ATP and the without-ATP scenarios.

Social return on investment quantifies the net benefits to society resulting from public *and* private investment in ATP-funded technologies.

Private return on investment considers only the investment costs and revenues to the companies participating in the technology's development.

Social return on investment quantifies the extent to which the nation is better off as a result of public and private investment in the development of these technologies. The concept of social return considers the costs of public investment and the value of medical benefits to individuals in addition to private investment costs and private company profits.

Private return on investment is a component of social return on investment. The concept of private return considers only investment costs and revenues of companies carrying out the research, commercialization, and manufacturing of the new technologies and does not consider either costs of public investment or value of medical benefits to individuals.

Social return on public investment is based on a comparison between social return with ATP and social return without ATP; that is, between cell A and cell C in Figure E-1.

Figure E-1. Social and Private Returns With and Without ATP

	Social Returns	Private Returns
With ATP	A	B
Without ATP	C	D

To demonstrate the feasibility of the methodology, we examined one specific application for each of seven multiple-application tissue engineering projects funded from 1990 to 1996. Assuming that these technologies are developed and used for the specific applications we studied, our analysis shows the following expected benefits:

- The expected *social return on ATP public investment* in these technologies, or the increment to social returns attributable to ATP funding, is estimated at $34 billion in net present value.
- The expected *social rate of return on ATP public investment* in these technologies is estimated at an annual rate of 116 percent.
- The expected total *social return* on public and private investment in these technologies is estimated at $112 billion in net present value, or an annual rate of 115 percent.
- The expected total *private return* on investment in these technologies to ATP-award companies and their partners in commercialization and production is estimated at $1.6 billion in net present value, or an annual rate of 12 percent. Of the $1.6 billion in net present value of private returns, $914 million is estimated to be attributable to ATP funding.

These results illustrate two important points about ATP's role in funding these technologies:

- ATP plays a significant role in increasing the expected social and private returns on these projects.
- The social returns are far greater than the private returns. Private companies will therefore tend to underinvest in these technologies. The wide disparity between social and private returns indicates the importance of public incentives to the private sector to pursue these technologies.

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The study analyzed only the preliminary applications of these technologies. Because these technologies provide the scientific basis for a wide range of applications, their long-term impact may be much greater than suggested here, as companies apply their discoveries to a variety of medical applications. In addition, the knowledge generated by these initial applications may lead to advances in additional, unrelated areas by other companies.

Because none of these technologies has yet reached the commercial market—though several are in clinical trials—the results of this analysis are based on the expectations of the innovators and other informed individuals. Whether these expectations will be realized is uncertain. However, the methodology will allow us to update these results as data on the actual costs and benefits of the projects become available.