THE ROLE OF THE STATE IN RESEARCH AND DEVELOPMENT FUNDING

A REPORT PREPARED FOR

THE CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

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1. The Scope of the Paper

California spent $317,751,344 for research and development (R&D) in 1995-1996 (including federal funds given to the state for R&D). This was about .5 percent of the state budget and represented about $9.10 per person. The focus of this paper is how the State of California agencies allocate funds for research and development (R&D). The funds that the agencies allocate primarily come from state and federal sources (with the federal sources coming to the state which then, in turn, reallocates the funds to specific state programs).[1] The paper will describe the results of an extensive survey of state departments that allocate R&D money, and will present several tables of summary data that can be used to describe partially the R&D atmosphere in California with respect to public funding.

The paper will be divided into three sections: a section on the methodology of the data collection, a section on the justification for government intervention in the R&D arena, and a section that analyses the data that were collected. The first two sections will be quite brief and introductory; the third section will comprise nearly all of the paper. These results will be presented as a series of 13 topics.

This paper examines only one aspect of the role of government in the R&D field--the role of the state spending money directly on R&D. It does not include any analysis of the state or federal government stimulating R&D through tax incentives (sometimes called tax expenditures). Other papers in this project will be examining these other aspects of the public sector's role in stimulating R&D.

Because there are thirteen topics, each of which contains several findings, the paper tends to be dense. Different readers should find some results more appropriate to their particular interests than other results. The following are examples of three very powerful conclusions:

- Accurate data are difficult to obtain because R&D expenditures are not covered by specific statutory codes and there is no consistent accounting format for departmental allocation.
- There are many times in which there is an apparent skewness in the funding. For example, from Form 1, two-thirds of the total research function funding goes to education and science and technology base; 78 percent of the total stage of funding goes to either basic or applied research, and 63 percent of the total performer funding goes to academic institutions. This concentrated pattern, which may reflect the idea of a "champion" for a particular type of R&D, is approximately continued in many of the other forms.
- In nearly all cases, basic and applied research categories receive more money than the development and commercialization categories. The "R" tends to be better supported than the "D".
- From Topic 7, the community and economic development research functions allocate only three percent of their funding to the social sciences.

2. General Comments on Methodology

In order to successful obtain the best possible data set, an extensive collection effort was undertaken for this project. A detailed analysis of the methodology assumptions is undertaken in Appendix A, which was written by Victoria Koeheler Jones. This brief section summarizes her points.

1. Plant (capital) expenditures equal zero in this analysis

2. Based on the analysis of the 1997 Battelle study which collected data for the 1994-1995 fiscal year, (see below), it is clear that it makes no sense to do a longer term longitudinal study at this time. The Battelle numbers may be off by as much as 25 percent.

3. The fiscal year terminology is sometimes confusing. California refers to a fiscal year ranging from July 1, 1995 to June 30, 1996 as FY 1995. The federal government and the other states would refer to that fiscal year as FY 1996. The data for this analysis is for the 1995-1996 fiscal year, with the tables entitled FY 1995. The tables used for California in the previous year, in the Battelle report, however, are also called FY 1995, although they reflect the 1994-1995 year. Whenever there is a potential for confusion, this paper will write out the entire fiscal year.

4. It should be noted that aggregate state R&D expenditures remained almost constant between 1994-1995 and 1996-1997. The lowest coefficient of correlation between any two years in this period is .989.

3. The Role of Government in Financing R&D Expenditures[2]

The role of government in R&D is a very complex issue, and could easily include a wide variety of examples, ranging from training programs, program evaluation research, fiscal planning research, and data collection. Appendix B, which gives definitions of the relevant variables, also provides guidelines for what R&D expenditures should be included in the study. This section will only address government and R&D

[1] As Form 1 indicates, federal sources contribute about 11 percent and industry and other non-state sources contribute less than 2.6 percent of the total that the state allocates.

[2] Dirk Vanderloop provided many of the citations for this section.

expenditures in the light of this definition and is meant to give only a brief overview of the literature.

The principal justification for government intervention into the private market for R&D is that there are uncompensated externalities associated with successful R&D. This leads to an under-investment in R&D activities. Reugg (1998) and Jaffe (1996) further argue that not only are there market, but knowledge and network spillovers that also lead to under-investment in R&D activities. Similarly, Goolsbee (1998) argues that there is substantial evidence that the social rate of return to R&D spending significantly exceeds the private rate of return. Thus, its public good nature tends to support private R&D spending at a lower than the socially optimum rate.[3]

A second justification, closely related to the first, is that there is too little R&D with respect to optimal rates of growth. Jones and Williams (1998) argue that their conservative estimates indicate that optimal R&D investment is at least two to four times actual investment, and that the extant literature understates the necessary amount of R&D to generate optimal growth rates. Davis and Carden (1998) apply a similar argument in analyzing R&D in developing countries, although they caution that the ability to do evaluation research on the impacts of R&D is an elusive skill.

A third justification for government intervention revolves around international competitiveness. Howells and Michie (1998) argue that the competitive advantage of firms and their underlying economic institutions is achieved by both conscious (and unconscious) strategies and decisions of governments (as well as other institutions and agents). They ultimately argue that governmental policy action is necessary to exploit innovation, and thus implicitly endorse an activist government R&D policy. Although the framework for the Howells and Michie analysis is at the national level, much of what they say would be appropriate at the State level, where interstate competition is at least as intense as international competition

It should be noted that the literature is not totally supportive of all types of governmental R&D expenditures. Davidson and Segerstrom (1998), using an endogenous growth model that discriminates between innovative R&D) and imitative R&D, find that while consumers benefit from the knowledge created by both types of R&D, only subsidies to innovative R&D activities lead to faster economic growth, while stimulating imitative R&D may actually retard growth. They conclude that imitative R&D should be minimized. Goolsbee (1998) as noted above, believes that there is a role for government involvement to increase R&D spending. However, he also believes that most R&D spending goes to pay the salaries of R&D workers (whose supply is quite inelastic). Goolsbee ultimately argues that a significant fraction of any increase in R&D spending goes directly into wage increases (an increase in price rather than quantity). Including this distinction into his model, Goolsbee argues that the conventional literature overstates the effects of government R&D spending by 30-50 percent. An implication of this is that government R&D funding, by increasing the costs of R&D through its effects on wages, may crowd out private inventive activity.

Finally, the U.S. GAO (1996), in its evaluation of the Advanced Technology Program (ATP) of the National Institute of Standards and Technology of the Department of Commerce, tended to be somewhat skeptical of the efficacy of federally supported R&D. Using a survey of "near winners" of ATP funding, GAO determined that half had continued their projects without ATP money. Of the "winners" (recipients) of ATP funding, 63 percent did not look for funding from other sources first.

A second set of questions revolving around the appropriate role of government in R&D is which level of government should be undertaking the funding. One potential rule might be based on Oates' (1972) decentralization theorem, which argues that under a set of assumptions relating to costs, public good attributes, and geographic dimensions of the scope of the good, it is more efficient for small units of government to provide some services while larger units should provide others. In particular, the national government should provide goods that affect the nation, while smaller units should provide goods that affect the locality. In terms of R&D, and the categories that follow, the state should vary in its importance according to this rule.

Most of the analysis of the importance of R&D spending has been at the national level. In order for analysis to be done at the state level, the basic state level data has to be collected and discussed. The remained of this paper will examine the data for California and attempt to draw some conclusions as to how the State is allocating its R&D expenditures. Definitions of the terminology are included in Appendix B.

4. Data Analysis

There was a large volume of data collected for this study, which is available in Tables 1, 2 and 3. These tables are in separate files but will not be printed for this analysis. In order to make sense of this large volume of data, summary forms 1 through 4 will constitute the basis for the study. Each of the basic forms is a disaggregation of the previous form: Form 1 includes all sources, research functions, fields, stages and performers of R&D, Form 2 allocates the same total dollars, but suppresses the source category, Form 3 allocates the same total dollars but suppresses the source and field categories, and

[3] Note that Goolsbee uses a public good argument rather than an externality argument to reach the same conclusions.

Form 4 again allocates the same dollars, but suppresses the source, field, and performer categories.

In this presentation, each of the basic forms is followed by a subsidiary form, which was calculated, from the basic form. Thus, Form 1A follows Form 1 and was calculated from Form 1, Form 2A (Parts 1 and 2) follows Form 2 and was calculated from Form 2, etc. The terminology "Form" is used in order to be consistent with the Battelle study--Form and Table are used as synonyms in this paper. In addition, the term category refers to the function, field, stage or performer descriptor. Sub-categories refer to the individual line items under each category.

The process followed by this analysis is to sequentially move through each of the forms and discuss the results. As this is done, thirteen topics are addressed as a device to highlight the important findings. Note that because of the successive disaggregations, results must be carefully interpreted.

4.1 Form 1

Form 1 is the summary table that displays expenditures by source and use. It is the most disaggregated of the four summary tables and includes all sources of funding as well as all functions, fields, stages and performers. Similar to all of the forms, it is directly linked to the basic data tables, which are not printed for this analysis but are available as separate files.

4.1.1 Topic 1: Who does the giving for R&D expenditures and how much money is given?[4]

Nearly $318 million is given by various sources for R&D activities, with about $274 million coming from state sources and $35 million coming from federal sources. This translates to approximately 86 percent of the funding coming from the state, with federal sources contributing about 11 percent. The remainder comes from industry and other non-state sources. About 71 percent of the state money (about $223 million) comes from direct appropriations--that is through the political process.

The research functions, fields, stages, and performer R&D categories will be more extensively analyzed under the Form 2 discussion. However, some brief comments are possible at this point.

The distribution of total R&D funding by research function is clearly skewed. About 66 percent of the funding goes to science and technology (57 percent) and education (nine percent). The other eleven categories share the remaining third of the funding. Further, of those eleven, six receive about one percent or less. Food, fiber and other agricultural products gets the smallest share.

45 percent of the total spending in the category of fields of science and engineering is consumed by biological (28 percent) sciences or engineering (20 percent. Other sciences (13 percent), social sciences (11 percent), physical sciences (nine percent), environmental sciences (nine percent), and medical sciences (seven percent) receive approximately equal shares, while psychology and mathematics receive almost nothing.

When the stage of R&D group is examined, it is evident that research side of the research and development expression is heavily favored, in the aggregate. Nearly 77 percent of the funding goes to basic or applied research, with basic research receiving nearly half of the total funding. Commercialization is favored over development.

Academic institutions receive nearly 63 percent of the funding when the performer category is disaggregated. The within state government category follows, with about 13 percent of the total. Other performers receive about one percent,[5] and private individuals receive about two percent as examples of performers who receive only a token amount.

Because these are aggregate data, it is worthwhile to begin to disaggregate the data set. The rest of the topics address the issues of this disaggregation.

4.1.2 Topic 2: What are the patterns of distribution of R&D funds by provider?

It is noteworthy to compare the funding patterns of the federal and state governments.[6] In some cases they closely match, while in others, there are minimal overlaps. If these are conscious decisions, they may imply an assumption of agglomeration effects when they overlap and an assumption of a different set of priorities when they do not overlap. It might also be observed that the state tends to concentrate its funding in specific areas. It is unlikely that any marginal analysis of R&D gains per dollar of investment is calculated, and this should call into question whether resources are being used efficiently.

When allocation patterns by research function or use are examined, the patterns do not match. The federal government allocates 39 percent of its money (about $30 million) to education; 20 percent (About 26 million) to transportation; and about 19 percent ($23 million) to health. Thus, about 78 percent of federal R&D money goes to these three functions. There is minimal overlap with the state's decisions. The state allocates 65 percent (about $178 million) of its R&D expenditures to science

[4] While detailed data appear in the table, percentages and dollar amounts will be rounded in the text.

[5] Other performers is a "catch-all" category that was not defined in the survey instrument.

[6] Industry and other non-state sources will be combined with federal sources throughout the analysis unless otherwise noted.

and technology, with the environment ($19 million), education ($13 million), and transportation ($18 million) each getting about five to seven percent. About 83 percent of the state aid goes to these four functions. Although both education and transportation appear in the top rankings of both units of government, the federal government clearly believes that they are more deserving than the state does. Science and technology base gets less than five percent of the federal funds.

There is a slightly closer relationship when allocation patterns by field of science or engineering are analyzed. 84 percent of the federal funds goes to engineering (24 percent or $11 million), social sciences (24 percent or $10 million), other (22 percent or $10 million) and medical sciences (14 percent or $6 million). The top four from the state receive 70 percent of the state's funding: biological sciences receive 32 percent ($89 million), engineering receives 19 percent ($53 million), physical sciences receive ten percent ($27 million) and the social sciences receive nine percent ($26 million). Engineering and social sciences appear on both lists, with the differences in importance being slightly less than in the previous category.

Since there are only four potential stages of R&D, it would be anticipated that there would be some overlap. 57 percent of the federal dollars went to applied research ($25 million) and 29 percent ($13 million) went to development giving a total of 86 percent of the funds going to these two categories. The state expenditure patterns show less concentration. 55 percent ($151 million) of the state money went to basic research while 264 percent ($86 million) went to applied research, resulting in a total of 79 percent going to the top two categories. On the margin, it appears as if the state is more interested in the research component of R&D while the federal government is more interest in the development components.

Finally, the federal government distributes the R&D funds more broadly across performers that the state. 27 percent ($12 million) of the federal R&D money goes to state agencies, 24 percent ($11 million) goes to academics and 16 percent ($7 million) goes to non-profit agencies. This total of 67 percent going to three different performers can be contrasted to the state's allocation pattern which gives 80 percent to only two performers--academic institutions receive 69 percent ($190 million) of the funds while state agencies receive 11 percent ($30 million). While there is some overlap, the initial distribution of the funds indicates quite different patterns.

For three of the four categories, the state appears to be slightly more concentrated than the federal government, at least examining the distribution to the top of each category. In particular, the state seems to have strong preferences in the "by function" and "by performer" categories. Although additional information and study is needed, the implication may be a skewed allocation of the available resources because of this strong concentration. It is clear that a marginal analysis of the power of the last R&D dollar on specific criteria should be undertaken.

4.2 Form 1A

Form 1A, derived from Form 1, shows the relative importance of each funding source to the specific research function, field of science, stage, and performer categories. For example, about nine percent of the total R&D funds received by community development, housing, and public services comes from federal sources, while about 69 percent comes from the state. Since the state provides about $9 of R&D funding for every $1 that the federal government provides, it is clear that the state dominates all of the categories. However, there are useful insights that can be gained by examining these various dependency ratios.

4.2.1 Topic 3: What is the relative importance of the federal money to the various recipients?[7]

This topic concerns on the specific federal money that is funneled through the state. It appears that there is a great deal of variation in its importance to the various components of the resource functions or uses. Four categories--education, income security and social services, natural resources, and transportation receive about 23 percent or more of their R&D money from federal sources. However, four categories receive no more than 1.7 percent of their R&D funds from the federal government--economic development, energy, food and fiber, science and technology, and other. It is clear that there is only a moderate following of Oates' decentralization principle. Income security and social services and natural resources are arguably national in scope; however, energy as well as science and technology certainly have country-wide benefits. For these five examples, the importance of the state versus the federal government funding patterns should be reversed. Further research is indicated to determine why this pattern of resource allocation exists.

There is slightly less variation among the field of Science and Engineering sub-categories, although there are three categories that receive less than 1.5 percent of their R&D funding from the federal government--biological sciences, psychology, and mathematics and computer science. However, the two high categories--social sciences and medical sciences receive only between 27 and 24 percent of their funding from the federal government. These might imply a less intense preference pattern at the federal level compared to the results of the research function analysis.

Basic research (one percent) and commercialization (four percent) are not dependent upon federal government

[7] The state's role will be intensively analyzed, beginning with Topic 4.

support. However, applied research (21 percent) and development (41 percent) seem to be more dependent.

Finally, with respect to performers, with the exception of academic institutions which are only 5 percent dependent on federal dollars, there is not a great deal of variation. At the bottom, industry or business is about 13 percent dependent on federal money, while non-profits and private individuals are about 44 and 42 percent, respectively, dependent. It is interesting to note that each of the institutions of our society should exhibit the same degree of dependence on federal funds.

4.2.2 Topic 4: Does the ratio of restricted to unrestricted state funds vary by category?

This topic examines the percentage of state funds that are restricted in each of the four analytic categories. Although only about four percent of the total state funds are restricted, there are some interesting differences among the four categories.

There is a large variation in the percentage of restricted funds among the 13 research functions. For example, four of the functions (community development, crime prevention, income security, and other) have no restrictions placed on their funding. Further, education, food, science and technology, and transportation have less than three percent of their state funding restricted. However, economic development, energy, and the environment all have more than 16 percent of their state funds being restricted. There may be two possible explanations for these results: the first is that the state agencies responsible for the allocation of funds are staffed by different people and the degree of restriction is merely a function of the personalities of the staff of the agency and thus there is no pattern; the second, which is less likely, is that there is a conscious effort to balance some of the functions. For example, since community development, crime prevention, and economic development are all closely related, and since the first two research functions have no restrictions, the large amount of restrictions on the third may be interpreted as a conscious balancing of the total amount restricted. The combining of energy and science and technology would give the same results. Not surprisingly, the standard deviation of about seven percent is larger than the average, about 5.9 percent, which gives rise to a coefficient of variation of nearly 124 percent, which is quite large compared to most of the other findings.[8]

There are only two fields of science or engineering that face virtually no restrictions on their funding: mathematics, medical sciences and social sciences both have less than one percent of their state funds restricted. However, unlike the research function discussion, there is little variation among the rest of the fields. At the high end, about nine percent of engineering funds are restricted while, at the low end, about 1.5 percent of biological sciences funds are restricted. In this group, the standard deviation is slightly above the average, so the coefficient of variation is about 83 percent.

With the exception of basic research, which receives over 99 percent of its state funds without restrictions, there is little variation in the stage of R & D category. About 14 percent of development research R&D funding from the state comes with restrictions (the high end) while about eight percent of state applied research funding comes with restrictions (the low end). this pattern makes sense, since restricting how funds should be used for basic research does not make a good deal of sense. The standard deviation is less than the average, and therefore the coefficient of variation is about 73 percent.

Recipients within the R&D performer category discover that about ten percent of state funds come with restrictions. This covers a range of about two- percent (academic institutions) to about 26 percent for private individuals. Perhaps not surprisingly, the state only minimally restricts itself in the R&D category, with less than four percent of the funds of the within state sub-category being restricted. Non-profit organizations (16 percent) and industry or business (11 percent) also receive a relatively large share of funds with restrictions. A potential explanation for this pattern is that the state, acting as a principal, has determined that the private and non-profit sector recipients of its R&D funding have the potential to act as opportunistic agents, and thus must be monitored more closely.[9] Again in this category, the standard deviation is less than the average.

4.3 Form 2[10]

Form 2 disaggregates the state expenditures on R&D into nine sub-categories of science or engineering. This is about $274 million out of the $318 million total, which was discussed in Form 1.

4.3.1 Topic 5: What are the patterns of distribution of R&D Funds by fields of science or engineering?

Biological sciences receives the largest allocation, $89 million, and is about 36 million greater than the next highest, engineering, which received about $53 million. Half of the total funding goes to these two categories. Psychology receives the smallest level of support, less than one percent. Perhaps most interestingly, mathematics and computer sciences, the areas in which

[8] The averages referred to in the text are those found by averaging the relevant entries in each column. For example, 10.9 percent of R&D funds come from the federal government. The average importance of federal funds in this research function category is 16.9 percent.

[9] See Milgrom and Roberts, chapters 5 and 6 for a discussion of the applicable agency theory.

[10] The rest of the analysis in the body of the text is focused on only state funds.

rapid growth is forecasted, receive only two percent of total funding. The allocations to the remaining categories are closely clustered, ranging from about seven percent for the medical sciences to about nine percent for the social sciences (with the other category being about 12 percent).

The final column of Form 2 indicates that there exists a sharp differentiation among resource function sub-categories. Nearly two-thirds of the funds (65 percent) go to the science and technology base sub-category. There is a second cluster of education (five percent), transportation (six percent), health (five percent), environment (seven percent) and economic development (five percent). The remaining seven functions share the seven percent that is left over.

The funds are also concentrated in the stage of R&D categories. Fifty-five percent go to basic research, with an additional 24 percent going to applied research. Commercialization receives about $25 million more than development, or about ten percent more.

Total funding by R&D performer indicates a very high concentration in the academic institution category, with more than 69 percent going to this category. The second largest category is the within state government, which obtains more than eleven percent of the total. The other five categories share the other 21 percent, with private individuals receiving the least at about one percent and others receiving about one percent).

4.4 Form 2A (Part 1)

Part 1 of Form 2A assumes that the state first allocates to the research function, stage of R&D, or performer category. These categories then subdivide the funds into the various fields of science or technology. Each field sums to 100 percent.

4.4.1 Topic 6: Another examination of the sources of funds for the categories of fields of science or engineering.

This topic is concerned with the relationship between the three other categories (function, stage, or performer) and the fields of science or engineering category. For example, it indicates that over 94 percent of the biological science function's funds come from the science and technology base. This is a relatively consistent pattern: over half of the funds for medical science, psychology, physical science, mathematics and computer sciences, social science, and other come from this research function. Only in engineering (where transportation funding contributes about 29 percent)[11] and environmental sciences (where the environmental function contributes about 33 percent), does a non-science and technology base dominate.

[11] Probably because of the importance of CALTRANS.

The pattern of one dominant relationship is basically the same, although with perhaps slightly less concentration, when the stage of R&D is utilized as a funding classification. Basic research is dominant in seven of the nine categories and is relatively unimportant only in engineering (13 percent) and environmental sciences (four percent).

Again, the pattern of one dominant source appears when the category is performer. In this case, academic institutions are usually the dominant source of funds for the various fields of science or engineering. Academic institutions are the principal source of funds for seven of the nine fields. Only in environmental sciences, in which within state government provides 35 percent compared to the academic base source of 20 percent, and in engineering in which business provides 32 percent (and academic institutions provide 27 percent), are they considerably less important.

Environmental sciences and engineering consistently differ from the other fields. Regardless of function, stage, or performer, their dominant source of funding is usually not the same as the others.

4.5 Form 2A (Part 2)

The second part of Form 2A analyzes the data horizontally. It divides the total funding of each research function, stage, and performer into the ten fields of science and engineering.

4.5.1 Topic 7: The patterns of allocation to fields from functions, stages, and performers.

Topic 6 examined the source of funding for each field of science or engineering by utilizing the function, stage, or performer categories as the source of funds. This topic examines the manner in which a specific function, stage or performer sub-category allocated its funds to fields. For example, community development devoted about three percent of its funds to biological sciences, while giving environmental sciences 45.8 percent of its funds. Further, it virtually ignored medical sciences, psychology, and other.

Analyzing by function generates few surprises. It is logical to assume that the environmental function would put most of its resources into environmental sciences, health would put its resources into medical sciences, transportation would allocate 87 percent of its resources to engineering, and so on. Nearly all of the functions devote a very large majority of the resources to only one or two fields. There are, however, several particularly interesting patterns of distribution which are not necessarily intuitive.

- As noted above, the community development function allocates the highest percentage of its funds to environmental sciences, with an additional 20

percent going into physical sciences and 23 percent going to engineering. Meanwhile the social sciences receive only three percent of the allocation. This might imply that the human element of community development is in the process of being ignored.

- Economic development might be following the same pattern. This function allocates nearly 75 percent of its funding to engineering with another 19 percent going to environmental sciences. Again, the social science element of economic development is ignored.
- Education only allocates funding to environmental sciences, engineering, social sciences, and other. The rest of the fields get nothing or virtually nothing.
- Energy devotes over 80 percent of its funding to engineering and environmental science.
- Science and technology base gives over 70 of its resources to biological science, physical science, and other.
- The allocation pattern from "other" appears to come from a decision rule that says give each field, with the exception of mathematics and computer sciences (which gets 30 percent), eight or nine percent of its total.[12] For example, the biological science, physical science, medical science, and environmental science categories have allocations that are virtually identical.

The stage category of R&D shows a less concentrated pattern of funding. Basic research allocates nearly half of its resources to biological sciences, and then gives about 14 percent to both physical sciences and other. Applied research allocates between 10 and 20 percent to six different fields, with biological sciences receiving the largest share at 20 percent. Development gives 42 percent to engineering and then allocates 16 percent to sciences and 18 percent to other, The commercialization stage is the most concentrated, allocating about 60 percent of its resources to engineering and another 28 percent to environmental sciences.

Finally, the R&D performers also tend to give most of their funding to only a few groups. The within state government favors environmental sciences and engineering, local government gives 55 percent of its resources to engineering with another 26 percent to environmental sciences. Industry or business shows the most extreme allocation, giving 64 percent of its resources solely to engineering. Other performers give over two-thirds of their resources to biological sciences and mathematics and computers. Only academic institutions and non-profits show slightly more diversification, with the largest specific allocation among all of their allocations being the 46 percent from academic institutions to biological sciences.

[12] This is fortunate for mathematicians and computer scientists, since the other functions allocate this field very small percentages of their budgets.

4.6 Form 3

This form, which is nested within Form 2, presents the relationships between state funding sources by performer and the research function and stage descriptors.[13] The row across the top allocates state R&D expenditures by performer; the column at the far right allocates R&D expenditure by either research function or stage. This latter column is a subsection of a similar column that appeared on Form 1 and was analyzed in that section.

4.6.1 Topic 8: The patterns of allocation between performers and research functions or stages.

In this disaggregation, academic institutions utilize the major share of R&D funds (over 69 percent). When the within state government (about 11 percent) funding is added to academic institutions, about 80 percent of the spending is accounted for. The remaining 20 percent is divided among the remaining five categories, not necessarily in an equitable manner. For example, industry or business utilize about four times as much as non-profit organizations. The magnitudes of the dollars of the differential are quite large. Academic institutions utilize nearly $190 million, while private individuals utilize less than $4 million.

4.7 Form 3A (Part 1)

Form 3A examines two different ways of examining the data in Form 3. The first is a disaggregation (by percent) of each performer's funding by research function and stage of R&D. For example, the within state government performer allocates about seven percent of its resources to community development, five percent to crime prevention, eight percent to economic development, etc.

4.7.1 Topic 9: How do performers allocate their funding?

Each of the performers allocates their funds in a different manner. The state government generally allocates its funds in roughly equal shares. The health function receives the largest share of state funding, but it is only 19 percent of the total. Transportation, education, environment, and science and technology receive between eight and fourteen percent. Only other and income security receive virtually nothing. In terms of allocation to the stage of R&D, the state puts over 60 percent of its funding into applied research, but less than two percent into basic research. The development stage receives less than half the percentage allocation as the commercialization stage.

[13] The fields of science and engineering descriptors are is suppressed in this form. However, the final total funds remain as before in Forms 1 and 2.

Local governments' allocations appear to be less equitable, with four of the research function sub-categories receiving nothing and natural resources receiving almost nothing.[14] Education receives about 16 percent of the local funds, while transportation receives 26 percent. However, when the stage of R&D funding is examined, the allocation seems to be slightly more equitably distributed, with applied research and development both receiving about 20 percent of the funding, with commercialization receiving about 51 percent. Similar to the state government findings, basic research receives a very small percentage of county or local funds.

The rest of the performers' sub-categories seem to allocate resources in a more concentrated manner. Industry or business focuses on economic development, (33 percent), transportation (16 percent) and environment (17 percent). Community development, crime prevention, food, income security, and other receive either nothing or trivial amounts. Perhaps not surprisingly, industry or business allocates over 65 percent of their funds to commercialization, and continue the pattern of giving virtually no support to basic research.

Academic institutions are the most concentrated in their allocation patterns. Nearly 90 percent of their funding is associated with the science and technology base, with environment being the next most important recipient at three percent. Further, as would be anticipated, academic institutions allocated over 95 percent of their funds to either basic research (79 percent) or applied research (17 percent). Development and commercialization get very little.

Private individuals allocate 50 percent of their funds to education, with nothing (or virtually nothing) going to community development, crime prevention, food, income security, natural resources and other. The other five functions receive about the same percentage (seven or eight percent). Private individuals also follow the general pattern of allocating virtually nothing to basic research.[15] Applied research and commercialization each receive about the same percentage, approximately 30 percent, while development receives about 40 percent,

About 75 percent of the non profit resources to education (27 percent), health (28 percent) and science and technology base (22 percent). The highest percentage any other function receives is about six percent. It is interesting to note that, similar to the state funding pattern, non-profits allocate a super-majority (54 percent) of their funds to applied research, with commercialization and development being the next two important categories, in that order.

Other performers champion the environment, allocating 54 percent of their funds to that function. Another 31 percent goes to the other functional area, and food receives ten percent. Since this leaves only four percent to be distributed among the ten other functions, most of them receive nothing from this last performer category. These other performers allocate about 90 percent of their funds to applied research and development.

Once outside of government, and perhaps industry and business, it appears as if performers choose a function (or perhaps 2 functions) to support and concentrate their resource allocation pattern towards that group. This probably results from the interdependencies of performer and function, and although this topic has been written in a sense that performers allocate, this causality may not always follow this pattern, and function may, at times, be allocating money to performer. For example, it may be that the economic development function receives the money, and then allocates it to industry and business. Obviously, more study is needed.

4.8 Form 3A (Part 2)

Part 2 of Form 3A examines each sub-category of research function or stage of R&D and determines which performer is most important to the sub-categories' total funding. It is a horizontal disaggregation, similar to Part 2 of Form 2A.

4.8.1 Topic 10: How important are the different performers to different research functions and stages in R&D?

The second half of Form 3A identifies the source of funding for each research function or stage of R&D. For example, community development receives 96 percent of its funding from the state government performer, with another three percent coming from academic institutions. Most, but not all, of the research functions follow this general pattern of receiving most of their money from one or two sources. Thus, crime prevention receives 100 percent of its funding from the state, economic development receives 62 percent of its funds from business and industry (with another 18 percent from the state), food receives 63 percent from the state and 15 percent from academic institutions, income security receives 81 percent of its funds from academic institutions, natural resources receives 73 percent from the state, science and technology receives 95 percent from academic institutions, and other functional areas receive 78 percent from academic institutions. But education, energy, environment, health, and transportation are much less dependent on sole source funding, with the greatest degree of dependence on any one source being about 39 percent (health and state government).

[14] This is particularly puzzling since two of these "zero" functions are community development and crime prevention, which are essentially local responsibilities.

[15] Academic institutions is the only performer that does not follow this pattern.

The basic research stage is the most heavily dependent upon one source--over 99 percent of its revenue is derived from academic institutions. The other three stages are generally more diversified, although applied research gets 47 percent of its R&D revenues from academic institutions and commercialization receives about 41 percent of its R&D funds from business or industry.

4.9 Form 4

Form 4 and its ancillary forms represent the final decomposition of the basic R&D data. It portrays the relationships between the stage of development and the research function.

4.9.1 Topic 11: What are the patterns of allocation among stages?

Form 4 illustrates that of the R&D funds, the research functions (both basic and applied) receive 79 percent of the allocation, with the development and commercialization functions unequally splitting the rest, with commercialization receiving nearly three times as much as development. In addition, basic research receives about 31 percent more than applied research in the fund allocations. This translates into nearly $85 million more for basic research than for applied research, with the total of these two stages being about $160 million more than the development and communication stages.[16]

4.10 Form 4A

This re-working of Form 4 follows the same pattern utilized in the forms following Forms 1, 2 and 3. The top half of Form 4A disaggregates the stage of research funding by research function. The bottom half illustrates how each research function spends its funds on the stage of R&D.[17]

4.10.1 Topic 12: What are the patterns of allocation by function for each stage of research?

There is some variation in the way the funds are allocated by stage of research. Ninety-eight percent of the basic research funds are allocated to the science and technology function. Crime prevention, economic development, education, energy, food, and income security get below one-tenth of one percent. Environment, health, transportation, and other share the remaining funds. Applied research allocates about 37 percent of its funds to science and technology, but then education, environment, health and transportation all receive approximately equal shares of between 8 and 16 percent. The other research functions receive trivial amounts from this source. Thirty-three percent of the development research funds goes to education, with another 26 percent going to transportation. With the exception of income security, all of the other research functions receive some funding (albeit a very small amount) that is devoted to development. Commercial research is the least skewed in its distribution of funds, with the highest amount, about 26 percent) going to economic development. Crime prevention, economic development, and income security receive no money from the commercial research stage. Generally, with the exception of the basic research allocation pattern, there is not much concentration illustrated in this format.

4.10.2 Topic 13: What are relative importance of the research functions to the stage of R&D?

The bottom half of Form 4A displays the percentage of funding each research function contributes to the stage of R&D, for example, community development applies about 97 percent of its funds to the applied research stage, while giving virtually nothing to the development and commercial stages. Crime prevention (95 percent) and food (89 percent) also give over 80 percent of their funds to the applied research stage. Note that income security gives 100 percent of its R&D funds to the applied research stage. Science and technology gives over 83 percent of its funds to the basic research stage, with another 14 percent going to the applied research stage. Only health and other give more than nine percent of their funds to the basic research stage. Income security gives nothing the basic research stage, with education and transportation giving only trivial amounts to basic research. In addition to giving nearly 42 percent of its funds to the applied research stage, education gives nearly 40 percent of its funds to the development stage. No other research function gives anywhere near that amount in the development stage, although transportation gives almost 23 percent.

Economic development (79 percent) and energy (73 percent) give the majority of funding to the commercial stage. Environment, natural resources, transportation, and other give between 16 and 35 percent or more of their funding to the commercial stage. Crime, food, and income security give nothing to the commercial stage.

4.10.3 Some final additional comments

1. The results among the tables give a robust picture of resource allocation patterns. However, they must be interpreted carefully, since they reflect different slices of the same set of data.

2. There are extreme concentrations of funding patterns in most of the categories. This seems to be especially true in the research funding and field relationships. Further study is needed to determine why

[16] The final column of Form 4, the disaggregation of expenditures by function, is identical the relevant column of Form 3, and was discussed in that section.

[17] An alternative interpretation might be that this top half illustrates the source of funding for each research function. This might change some of the implications.

this is occurring. In particular, it would be useful to determine if any sort of marginal analysis might improve resource allocation decisions. Allocation decisions may be more of a function of the political process than of economic analysis.

3. There are typically (but not always) different supporters of different functions. Overall, there may be some rough equality in the system, since there are different champions of different activities.

4. If funding is the evaluative criteria, it appears as if there is stronger support for the research activities of R&D than for the development and commercialization activities.

Form 1. Fiscal Year 1995-1996 Non-Plant Expenditures by Source

	Federal Sources (A)	Industry (B)	State Sources					Other Non-state Sources (H)	Total (I)	% of Total
			Direct Appropriation (C)	Bonds (D)	Lotterv Proceeds (E)	Restricted Funds (F)	Other (G)			
	10.90%	0.22%	70.09%	0.17%	0.00%	3.48%	12.58%	2.55%	100.00%	
Research Function or Use										
1. Total	34,647,581	691,262	222,713,434	545,400	0	11,070,763	39,983,534	8,099,371	317,751,344	100.00%
1a. Community Development, Housing & Public Services	265,845	0	1,143,031	9,666	0	0	949,238	693,150	3,060,930	0.96%
1b. Crime Prevention and Control	170,081	0	1,498,507	0	0	0	0	0	1,668,588	0.53%
1c. Economic Development	258,386	2,500	6,838,462	0	0	2,277,157	4,919,017	870,173	15,165,694	4.77%
1d. Education	15,022,938	2,500	6,530,989	301,400	0	335,971	5,884,631	2,010,800	30,089,229	9.47%
1e. Energy	21,333	0	539,413	0	0	1,372,223	5,439,393	736,027	8,108,388	2.55%
1f. Environment	2,172,278	0	9,484,135	0	0	3,254,540	6,586,167	738,291	22,235,410	7.00%
1g. Food, Fiber, Other Agricultural Products	0	0	727,481	0	0	2,870	278,332	126,000	1,134,683	0.36%
1h. Health	5,723,965	686,262	6,331,180	0	0	1,466,046	6,729,798	1,760,690	22,697,940	7.14%
1i. Income Security & Social Services	1,108,500	0	1,312,000	0	0	0	0	0	2,420,500	0.76%
1j. Natural Resources	434,242	0	862,048	224,666	0	135,049	255,090	0	1,911,094	0.60%
1k. Science & Technology Base	1,238,334	0	171,388,865	0	0	1,949,501	4,457,508	697,995	179,732,202	56.56%
1l. Transportation	8,192,611	0	13,513,676	0	0	277,408	3,822,464	466,245	26,272,404	8.27%
1m. Other functional areas, not elsewhere classified	39,069	0	2,543,649	9,668	0	0	661,900	0	3,254,286	1.02%
Field of Science or Engineering										
2. Total	34,647,581	691,262	222,713,434	545,400	0	11,070,763	39,983,534	8,099,371	317,751,344	100.00%
2a. Biological Sciences	256,833	0	86,990,839	0	0	1,354,599	379,887	344,154	89,326,312	28.11%
2b. Medical Sciences	5,239,549	686,262	15,367,558	0	0	19,000	0	197,916	21,510,285	6.77%
2c. Psychology	29,401	0	2,178,952	0	0	58,619	0	0	2,266,972	0.71%
2d. Physical Sciences	1,075,604	0	25,150,857	0	0	887,250	1,295,806	1,153,500	29,563,016	9.30%
2e. Environmental Sciences	1,871,223	0	8,615,946	0	0	2,112,158	15,240,094	1,473,589	29,313,009	9.23%
2f. Mathematics & Computer Science	64,707	0	4,458,432	0	0	166,041	1,622,733	545,458	6,857,370	2.16%
2g. Engineering	8,831,395	0	30,764,394	244,000	0	4,600,721	17,153,102	1,700,369	63,293,981	19.92%
2h. Social Sciences	9,259,676	5,000	22,112,389	150,700	0	232,464	1,500,400	1,133,525	34,394,154	10.82%
2i. Other Sciences, not elsewhere classified: _____	8,019,194	0	27,074,070	150,700	0	1,639,911	2,791,513	1,550,859	41,226,246	12.97%
Stage of R&D										
3. Total	34,647,581	691,262	222,713,434	545,400	0	11,070,763	39,983,534	8,099,371	317,751,344	100.00%
3a. Basic Research	1,962,429	0	150,695,824	0	0	319,584	171,000	2,263	153,151,099	48.20%
3b. Applied Research	19,342,716	691,262	51,621,256	150,700	0	5,238,546	8,837,851	4,764,458	90,646,789	28.53%
3c. Development	11,403,015	0	8,569,755	180,700	0	2,119,390	4,646,027	1,203,316	28,122,202	8.85%
3d. Commercialization	1,939,421	0	11,826,601	214,000	0	3,393,243	26,328,657	2,129,334	45,831,255	14.42%
R&D Performer										
4. Total	34,647,581	691,262	222,713,434	545,400	0	11,070,763	39,983,534	8,099,371	317,751,344	100.00%
4a. Within State Government	7,445,751	2,500	15,485,364	294,233	0	1,158,899	13,491,621	4,272,459	42,150,827	13.27%
4b. Local or County Government	3,944,707	0	4,928,499	50,233	0	1,127,127	9,684,673	867,466	20,602,705	6.48%
4c. Industry or Business	3,997,585	2,500	13,549,624	50,233	0	2,751,761	9,842,195	884,967	31,078,865	9.78%
4d. Academic Institution	9,343,343	0	182,621,074	50,233	0	3,902,094	2,968,098	1,160,948	200,045,790	62.96%
4e. Private Individual	2,911,201	0	1,149,610	50,233	0	921,069	1,407,943	452,396	6,892,451	2.17%
4f. Non-profit Organization	6,046,012	686,262	3,641,956	50,233	0	1,087,573	1,863,773	335,133	13,710,942	4.31%
4g. Other Performer: _____	958,982	0	1,337,308	0	0	122,242	725,233	126,000	3,269,765	1.03%

Form 1 (continued). Fiscal Year 1995-1996 Non-Plant Expenditures by Source – Breakdown State vs. Other Sources

	All State Sources	% of Total	All Other Sources	% of Total	Total
		86.33%		13.67%	
Research Function or Use					
1. Total	274,313,131	100.00%	43,438,213	100.00%	317,751,344
1a. Community Development, Housing & Public Services	2,101,935	0.77%	958,995	2.21%	3,060,930
1b. Crime Prevention and Control	1,498,507	0.55%	170,081	0.39%	1,668,588
1c. Economic Development	14,034,636	5.12%	1,131,059	2.60%	15,165,694
1d. Education	13,052,991	4.76%	17,036,238	39.22%	30,089,229
1e. Energy	7,351,028	2.68%	757,360	1.74%	8,108,388
1f. Environment	19,324,841	7.04%	2,910,569	6.70%	22,235,410
1g. Food, Fiber, Other Agricultural Products	1,008,683	0.37%	126,000	0.29%	1,134,683
1h. Health	14,527,023	5.30%	8,170,917	18.81%	22,697,940
1i. Income Security & Social Services	1,312,000	0.48%	1,108,500	2.55%	2,420,500
1j. Natural Resources	1,476,852	0.54%	434,242	1.00%	1,911,094
1k. Science & Technology Base	177,795,873	64.81%	1,936,329	4.46%	179,732,202
1l. Transportation	17,613,548	6.42%	8,658,856	19.93%	26,272,404
1m. Other functional areas, not elsewhere classified	3,215,217	1.17%	39,069	0.09%	3,254,286
Field of Science or Engineering					
2. Total	274,313,131	100.00%	43,438,213	100.00%	317,751,344
2a. Biological Sciences	88,725,325	32.34%	600,987	1.38%	89,326,312
2b. Medical Sciences	15,386,558	5.61%	6,123,727	14.10%	21,510,285
2c. Psychology	2,237,571	0.82%	29,401	0.07%	2,266,972
2d. Physical Sciences	27,333,912	9.96%	2,229,104	5.13%	29,563,016
2e. Environmental Sciences	25,968,197	9.47%	3,344,812	7.70%	29,313,009
2f. Mathematics & Computer Science	6,247,206	2.28%	610,165	1.40%	6,857,370
2g. Engineering	52,762,217	19.23%	10,531,764	24.25%	63,293,981
2h. Social Sciences	23,995,953	8.75%	10,398,201	23.94%	34,394,154
2i. Other Sciences, not elsewhere classified: _____	31,656,194	11.54%	9,570,053	22.03%	41,226,246
Stage of R&D					
3. Total	274,313,131	100.00%	43,438,213	100.00%	317,751,344
3a. Basic Research	151,186,408	55.11%	1,964,692	4.52%	153,151,099
3b. Applied Research	65,848,353	24.00%	24,798,436	57.09%	90,646,789
3c. Development	15,515,871	5.66%	12,606,331	29.02%	28,122,202
3d. Commercialization	41,762,500	15.22%	4,068,755	9.37%	45,831,255
R&D Performer					
4. Total	274,313,131	100.00%	43,438,213	100.00%	317,751,344
4a. Within State Government	30,430,117	11.09%	11,720,710	26.98%	42,150,827
4b. Local or County Government	15,790,532	5.76%	4,812,173	11.08%	20,602,705
4c. Industry or Business	26,193,813	9.55%	4,885,052	11.25%	31,078,865
4d. Academic Institution	189,541,498	69.10%	10,504,292	24.18%	200,045,790
4e. Private Individual	3,528,854	1.29%	3,363,597	7.74%	6,892,451
4f. Non-profit Organization	6,643,535	2.42%	7,067,408	16.27%	13,710,942
4g. Other Performer: _____	2,184,783	0.80%	1,084,982	2.50%	3,269,765

Form 1A. Fiscal Year 1995-1996 – Relative Importance of Each Funding Source to the Specific Research Function, Field of Science, Stage and Performer Categories

	% of Total Federal Sources	% of Total Industry	% of Total Non-State	% of Total State	Sum	Restr. Funds/ Total State Funds
1. Research Function or Use – Total	10.90%	0.22%	2.55%	86.33%	100.00%	4.04%
1a. Community Dev., Housing & Public Services	8.69%	0.00%	22.65%	68.67%	100.00%	0.00%
1b. Crime Prevention and Control	10.19%	0.00%	0.00%	89.81%	100.00%	0.00%
1c. Economic Development	1.70%	0.02%	5.74%	92.54%	100.00%	16.23%
1d. Education	49.93%	0.01%	6.68%	43.38%	100.00%	2.57%
1e. Energy	0.26%	0.00%	9.08%	90.66%	100.00%	18.67%
1f. Environment	9.77%	0.00%	3.32%	86.91%	100.00%	16.84%
1g. Food, Fiber, Other Agricultural Products	0.00%	0.00%	11.10%	88.90%	100.00%	0.28%
1h. Health	25.22%	3.02%	7.76%	64.00%	100.00%	10.09%
1i. Income Security & Social Services	45.80%	0.00%	0.00%	54.20%	100.00%	0.00%
1j. Natural Resources	22.72%	0.00%	0.00%	77.28%	100.00%	9.14%
1k. Science & Technology Base	0.69%	0.00%	0.39%	98.92%	100.00%	1.10%
1l. Transportation	31.18%	0.00%	1.77%	67.04%	100.00%	1.57%
1m. Other functional areas, not elsewhere classified	1.20%	0.00%	0.00%	98.80%	100.00%	0.00%
Average for Category	15.95	0.23	5.27	78.55		5.88
Standard Deviation	0.175	0.008	0.065	0.177		0.073
Coefficient of Variation	1.099	3.574	1.237	0.225		1.242
2. Field of Science or Engineering - Total	10.90%	0.22%	2.55%	86.33%	100.00%	4.04%
2a. Biological Sciences	0.29%	0.00%	0.39%	99.33%	100.00%	1.53%
2b. Medical Sciences	24.36%	3.19%	0.92%	71.53%	100.00%	0.12%
2c. Psychology	1.30%	0.00%	0.00%	98.70%	100.00%	2.62%
2d. Physical Sciences	3.64%	0.00%	3.90%	92.46%	100.00%	3.25%
2e. Environmental Sciences	6.38%	0.00%	5.03%	88.59%	100.00%	8.13%
2f. Mathematics & Computer Science	0.94%	0.00%	7.95%	91.10%	100.00%	2.66%
2g. Engineering	13.95%	0.00%	2.69%	83.36%	100.00%	8.72%
2h. Social Sciences	26.92%	0.01%	3.30%	69.77%	100.00%	0.97%
2i. Other Sciences	19.45%	0.00%	3.76%	76.79%	100.00%	5.18%
Average for Category	10.80	0.36	3.10	85.74		3.69
Standard Deviation	0.106	0.011	0.025	0.111		0.031
Coefficient of Variation	0.980	2.985	0.808	0.129		0.828
3. Stage of R&D – Total	10.90%	0.22%	2.55%	86.33%	100.00%	4.04%
3a. Basic Research	1.28%	0.00%	0.00%	98.72%	100.00%	0.21%
3b. Applied Research	21.34%	0.76%	5.26%	72.64%	100.00%	7.96%
3c. Development	40.55%	0.00%	4.28%	55.17%	100.00%	13.66%
3d. Commercialization	4.23%	0.00%	4.65%	91.12%	100.00%	8.13%
Average for Category	16.85	0.19	3.55	79.41		7.49
Standard Deviation	0.181	0.004	0.024	0.195		0.055
Coefficient of Variation	1.074	2.000	0.676	0.246		0.738
4. R&D Performer - Total	10.90%	0.22%	2.55%	86.33%	100.00%	4.04%
4a. Within State Government	17.66%	0.01%	10.14%	72.19%	100.00%	3.81%
4b. Local or County Government	19.15%	0.00%	4.21%	76.64%	100.00%	7.14%
4c. Industry or Business	12.86%	0.01%	2.85%	84.28%	100.00%	10.51%
4d. Academic Institution	4.67%	0.00%	0.58%	94.75%	100.00%	2.06%
4e. Private Individual	42.24%	0.00%	6.56%	51.20%	100.00%	26.10%
4f. Non-profit Organization	44.10%	5.01%	2.44%	48.45%	100.00%	16.37%
4g. Other Performer:	29.33%	0.00%	3.85%	66.82%	100.00%	5.60%
Average for Category	24.29	0.72	4.38	70.62		10.23
Standard Deviation	0.149	0.019	0.031	0.168		0.085
Coefficient of Variation	0.612	2.637	0.715	0.238		0.827

Form 2. Fiscal Year 1995-1996 Non-Plant Expenditures by Field of Science or Engineering (State Funding Only)

	Biological Sciences (A)	Medical Sciences (B)	Psychology (C)	Physical Sciences (D)	Environmental Sciences (E)	Mathematics & Computer Sciences (F)	Engineering (G)	Social Science (H)	Other (I)	Total (J)	% of Total
	32.34%	5.61%	0.82%	9.96%	9.47%	2.28%	19.23%	8.75%	11.54%	100.00%	
Research Function or Use											
1. Total	88,725,327	15,386,559	2,237,571	27,333,915	25,968,204	6,247,206	52,762,221	23,995,954	31,656,193	274,313,150	100.00%
1a. Community Dev. Housing & Public Services	71,253	1,182	7,210	418,429	962,642	79,043	480,541	65,768	15,869	2,101,937	0.77%
1b. Crime Prevention and Control	0	0	4,288	0	62,500	72,338	62,500	1,224,444	72,437	1,498,507	0.55%
1c. Economic Development	124,580	0	0	221,483	2,697,386	80,844	10,481,254	128,363	300,727	14,034,636	5.12%
1d. Education	234	0	0	2,064	1,318,487	62,500	1,918,498	4,863,771	4,887,437	13,052,991	4.76%
1e. Energy	7,036	283	0	0	2,545,790	472,148	3,519,340	131,035	675,396	7,351,028	2.68%
1f. Environment	2,689,381	966,757	0	1,008,792	8,508,740	468,305	4,830,773	201,709	650,390	19,324,847	7.04%
1g. Food, Fiber, Other Agricultural Products	243,807	0	0	24,526	506,487	62,500	89,646	81,717	0	1,008,683	0.37%
1h. Health	989,954	3,465,611	211,263	454,682	3,763,080	445,648	3,760,743	553,916	882,129	14,527,025	5.30%
1i. Income Security & Social Services	0	0	0	0	62,500	62,500	62,500	1,124,500	0	1,312,000	0.48%
1j. Natural Resources	152,876	5,631	0	114,147	550,364	62,500	499,069	92,268	0	1,476,855	0.54%
1k. Science & Technology Base	84,161,714	10,669,319	1,707,585	24,752,871	2,995,852	3,309,140	11,447,906	15,161,855	23,589,633	177,795,875	64.81%
1l. Transportation	6,714	0	22,110	59,143	1,716,598	113,228	15,322,003	85,505	288,248	17,613,548	6.42%
1m. Other functional areas, not elsewhere classified	277,777	277,777	285,116	277,778	277,778	956,514	287,446	281,104	293,927	3,215,217	1.17%
Stage of R&D											
2. Total	88,725,326	15,386,559	2,237,571	27,333,913	25,968,200	6,247,206	52,762,220	23,995,954	31,656,192	274,313,142	100.00%
2a. Basic Research	75,078,532	8,351,287	1,652,068	21,019,953	1,037,341	2,931,605	7,115,538	13,339,221	20,660,863	151,186,409	55.11%
2b. Applied Research	12,995,722	6,701,574	424,566	6,036,988	11,353,638	1,433,531	13,269,055	7,923,888	5,709,399	65,848,361	24.00%
2c. Development	558,412	99,294	91,493	89,849	2,083,958	783,413	6,442,893	2,550,227	2,816,335	15,515,873	5.66%
2d. Commercialization	92,661	234,403	69,445	187,123	11,493,264	1,098,658	25,934,733	182,618	2,469,595	41,762,499	15.22%
R&D Performer											
3. Total	88,725,325	15,386,559	2,237,571	27,333,913	25,968,200	6,247,206	52,762,219	23,995,953	31,656,191	274,313,137	100.00%
3a. Within State Government	643,429	2,498,720	78,239	1,663,828	9,023,223	1,237,270	10,683,588	2,840,223	1,761,599	30,430,120	11.09%
3b. Local or County Government	162,452	283,350	0	4,888	4,061,745	243,646	8,626,537	860,531	1,547,382	15,790,531	5.76%
3c. Industry or Business	63,858	432,084	0	421,667	5,659,719	326,677	16,725,978	943,878	1,619,952	26,193,814	9.55%
3d. Academic Institution	86,919,219	10,063,743	2,135,672	25,201,330	5,135,314	3,758,813	14,080,630	17,363,593	24,883,183	189,541,498	69.10%
3e. Private Individual	15,558	394	0	0	726,849	0	1,104,220	794,456	887,378	3,528,854	1.29%
3f. Non-profit Organization	112,676	2,049,111	23,660	0	942,659	0	1,445,063	1,129,502	940,864	6,643,535	2.42%
3g. Other Performer: _____	808,132	59,156	0	42,200	418,690	680,798	96,203	63,770	15,833	2,184,783	0.80%

Form 2A – Part 1. Percentage of Fiscal Year 1995-1996 Non-Plant Expenditures by Field of Science or Engineering (State Funding Only)

	% Biological Science Derived From	% Medical Sciences Derived From	% Psychology Derived From	% Physical Sciences Derived From	% Environmental Sciences Derived From	% Mathematics & Computer Sciences Derived	% Engineering Derived From	% Social Science Derived From	% Other Derived From
1a. Community Dev., Housing & Public Services	0.08%	0.01%	0.32%	1.53%	3.71%	1.27%	0.91%	0.27%	0.05%
1b. Crime Prevention and Control	0.00%	0.00%	0.19%	0.00%	0.24%	1.16%	0.12%	5.10%	0.23%
1c. Economic Development	0.14%	0.00%	0.00%	0.81%	10.39%	1.29%	19.87%	0.53%	0.95%
1d. Education	0.00%	0.00%	0.00%	0.01%	5.08%	1.00%	3.64%	20.27%	15.44%
1e. Energy	0.01%	0.00%	0.00%	0.00%	9.80%	7.56%	6.67%	0.55%	2.13%
1f. Environment	3.03%	6.28%	0.00%	3.69%	32.77%	7.50%	9.16%	0.84%	2.05%
1g. Food, Fiber, Other Agricultural Products	0.27%	0.00%	0.00%	0.09%	1.95%	1.00%	0.17%	0.34%	0.00%
1h. Health	1.12%	22.52%	9.44%	1.66%	14.49%	7.13%	7.13%	2.31%	2.79%
1i. Income Security & Social Services	0.00%	0.00%	0.00%	0.00%	0.24%	1.00%	0.12%	4.69%	0.00%
1j. Natural Resources	0.17%	0.04%	0.00%	0.42%	2.12%	1.00%	0.95%	0.38%	0.00%
1k. Science & Technology Base	94.86%	69.34%	76.31%	90.56%	11.54%	52.97%	21.70%	63.19%	74.52%
1l. Transportation	0.01%	0.00%	0.99%	0.22%	6.61%	1.81%	29.04%	0.36%	0.91%
1m. Other functional areas, not elsewhere classified	0.31%	1.81%	12.74%	1.02%	1.07%	15.31%	0.54%	1.17%	0.93%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2. Stage of R&D									
2a. Basic Research	84.62%	54.28%	73.83%	76.90%	3.99%	46.93%	13.49%	55.59%	65.27%
2b. Applied Research	14.65%	43.55%	18.97%	22.09%	43.72%	22.95%	25.15%	33.02%	18.04%
2c. Development	0.63%	0.65%	4.09%	0.33%	8.03%	12.54%	12.21%	10.63%	8.90%
2d. Commercialization	0.10%	1.52%	3.10%	0.68%	44.26%	17.59%	49.15%	0.76%	7.80%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
3. R&D Performer									
3a. Within State Government	0.73%	16.24%	3.50%	6.09%	34.75%	19.81%	20.25%	11.84%	5.56%
3b. Local or County Government	0.18%	1.84%	0.00%	0.02%	15.64%	3.90%	16.35%	3.59%	4.89%
3c. Industry or Business	0.07%	2.81%	0.00%	1.54%	21.79%	5.23%	31.70%	3.93%	5.12%
3d. Academic Institution	97.96%	65.41%	95.45%	92.20%	19.78%	60.17%	26.69%	72.36%	78.60%
3e. Private Individual	0.02%	0.00%	0.00%	0.00%	2.80%	0.00%	2.09%	3.31%	2.80%
3f. Non-profit Organization	0.13%	13.32%	1.06%	0.00%	3.63%	0.00%	2.74%	4.71%	2.97%
3g. Other Performer	0.91%	0.38%	0.00%	0.15%	1.61%	10.90%	0.18%	0.27%	0.05%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Form 2A – Part 2. Percentage of Fiscal Year 1995-1996 Non-Plant R&D Expenditures by Field of Science or Engineering (State Funding Only)

	Biological Sciences	Medical Sciences	Psychology	Physical Sciences	Environmental Sciences	Mathematics & Computer	Engineering	Social Sciences	Other	Total
1. Research Function or Use										
1a. % Community Development devoted to	3.39%	0.06%	0.34%	19.91%	45.80%	3.76%	22.86%	3.13%	0.75%	100.00%
1b. % Crime Prevention and Control devoted to	0.00%	0.00%	0.29%	0.00%	4.17%	4.83%	4.17%	81.71%	4.83%	100.00%
1c. % Economic Development devoted to	0.89%	0.00%	0.00%	1.58%	19.22%	0.58%	74.68%	0.91%	2.14%	100.00%
1d. % Education devoted to	0.00%	0.00%	0.00%	0.02%	10.10%	0.48%	14.70%	37.26%	37.44%	100.00%
1e. % Energy devoted to	0.10%	0.00%	0.00%	0.00%	34.63%	6.42%	47.88%	1.78%	9.19%	100.00%
1f. % Environment devoted to	13.92%	5.00%	0.00%	5.22%	44.03%	2.42%	25.00%	1.04%	3.37%	100.00%
1g. % Food, Fiber devoted to	24.17%	0.00%	0.00%	2.43%	50.21%	6.20%	8.89%	8.10%	0.00%	100.00%
1h. % Health devoted to	6.81%	23.86%	1.45%	3.13%	25.90%	3.07%	25.89%	3.81%	6.07%	100.00%
1i. % Income Security & Social Services devoted to	0.00%	0.00%	0.00%	0.00%	4.76%	4.76%	4.76%	85.71%	0.00%	100.00%
1j. % Natural Resources devoted to	10.35%	0.38%	0.00%	7.73%	37.27%	4.23%	33.79%	6.25%	0.00%	100.00%
1k. % Science & Technology Base devoted to	47.34%	6.00%	0.96%	13.92%	1.68%	1.86%	6.44%	8.53%	13.27%	100.00%
1l. '% Transportation devoted to	0.04%	0.00%	0.13%	0.34%	9.75%	0.64%	86.99%	0.49%	1.64%	100.00%
1m. % Other functional areas devoted to	8.64%	8.64%	8.87%	8.64%	8.64%	29.75%	8.94%	8.74%	9.14%	100.00%
2. Stage of R&D										
2a. % Basic Research devoted to	49.66%	5.52%	1.09%	13.90%	0.69%	1.94%	4.71%	8.82%	13.67%	100.00%
2b. % Applied Research devoted to	19.74%	10.18%	0.64%	9.17%	17.24%	2.18%	20.15%	12.03%	8.67%	100.00%
2c. % Development devoted to	3.60%	0.64%	0.59%	0.58%	13.43%	5.05%	41.52%	16.44%	18.15%	100.00%
2d. % Commercialization devoted to	0.22%	0.56%	0.17%	0.45%	27.52%	2.63%	62.10%	0.44%	5.91%	100.00%
3. R&D Performer										
3a. % Within State Government devoted to	2.11%	8.21%	0.26%	5.47%	29.65%	4.07%	35.11%	9.33%	5.79%	100.00%
3b. % Local or County Government devoted to	1.03%	1.79%	0.00%	0.03%	25.72%	1.54%	54.63%	5.45%	9.80%	100.00%
3c. % Industry or Business devoted to	0.24%	1.65%	0.00%	1.61%	21.61%	1.25%	63.85%	3.60%	6.18%	100.00%
3d. % Academic Institution devoted to	45.86%	5.31%	1.13%	13.30%	2.71%	1.98%	7.43%	9.16%	13.13%	100.00%
3e. % Private Individual devoted to	0.44%	0.01%	0.00%	0.00%	20.60%	0.00%	31.29%	22.51%	25.15%	100.00%
3f. % Non-profit Organization devoted to	1.70%	30.84%	0.36%	0.00%	14.19%	0.00%	21.75%	17.00%	14.16%	100.00%
3g. % Other Performer devoted to	36.99%	2.71%	0.00%	1.93%	19.16%	31.16%	4.40%	2.92%	0.72%	100.00%

Form 3. Fiscal Year 1995-1996 Non-Plant Expenditures by Performer

	Within State Govt (A)	Local or County Govt (B)	Industry or Business (C)	Academic Institution (D)	Private Individual (E)	Non-Profit Organization (F)	Other Performer (G)	Total (H)	% of Total
	11.09%	5.76%	9.55%	69.10%	1.29%	2.42%	0.80%	100.00%	
Research Function or Use									
1. Total	30,430,125	15,790,533	26,193,815	189,541,500	3,528,854	6,643,535	2,184,783	274,313,146	100.00%
1a. Community Development, Housing & Public Services	2,017,576	3,595	22,175	57,233	218	1,139	0	2,101,936	0.77%
1b. Crime Prevention and Control	1,498,507	0	0	0	0	0	0	1,498,507	0.55%
1c. Economic Development	2,539,876	1,544,823	8,761,535	432,173	298,752	393,707	63,770	14,034,636	5.12%
1d. Education	2,629,187	2,493,549	2,570,842	1,805,181	1,749,624	1,804,609	0	13,052,991	4.76%
1e. Energy	1,938,913	1,857,585	2,128,469	717,062	297,128	390,761	21,111	7,351,029	2.68%
1f. Environment	4,439,807	2,063,097	4,611,589	6,287,076	307,232	430,882	1,185,162	19,324,844	7.04%
1g. Food, Fiber, Other Agricultural Products	634,139	0	2,411	153,985	1,115	0	217,033	1,008,683	0.37%
1h. Health	5,612,090	2,106,403	1,940,830	2,710,723	291,046	1,841,121	24,811	14,527,025	5.30%
1i. Income Security & Social Services	250,000	0	0	1,062,000	0	0	0	1,312,000	0.48%
1j. Natural Resources	1,083,623	70,369	52,051	252,266	4,350	14,195	0	1,476,854	0.54%
1k. Science & Technology Base	2,941,088	1,603,711	1,979,776	169,530,647	306,106	1,434,548	0	177,795,875	64.81%
1l. Transportation	4,792,002	4,047,401	4,124,137	4,033,155	273,283	332,574	10,996	17,613,548	6.42%
1m. Other functional areas, not elsewhere classified	53,317	0	0	2,500,000	0	0	661,900	3,215,217	1.17%
Stage of R&D									
2. Total	30,430,119	15,790,533	26,193,815	189,541,499	3,528,854	6,643,534	2,184,784	274,313,137	100.00%
2a. Basic Research	464,476	245,817	85,010	150,236,923	6,959	83,454	63,770	151,186,408	55.11%
2b. Applied Research	18,639,078	3,222,387	5,471,156	32,878,578	1,044,643	3,589,562	1,002,951	65,848,354	24.00%
2c. Development	3,264,119	3,243,851	3,494,218	2,300,762	1,074,716	1,164,700	973,507	15,515,873	5.66%
2d. Commercialization	8,062,445	9,078,478	17,143,431	4,125,237	1,402,535	1,805,819	144,556	41,762,501	15.22%

Form 3A – Part 1. Disaggregation (by Percent) of Each Performer's Funding by Research Function and Stage of R&D

	% of State Government that goes to	% of Local or County Gov't that goes to	% Industry or Business that goes to	% Academic Institution that goes to	% Private Individual that goes to	% Non-Profit that goes to	% Other Performer that goes to
1. Research Function or Use							
1a. Community Development, Housing & Public Services	6.63%	0.02%	0.08%	0.03%	0.01%	0.02%	0.00%
1b. Crime Prevention and Control	4.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1c. Economic Development	8.35%	9.78%	33.45%	0.23%	8.47%	5.93%	2.92%
1d. Education	8.64%	15.79%	9.81%	0.95%	49.58%	27.16%	0.00%
1e. Energy	6.37%	11.76%	8.13%	0.38%	8.42%	5.88%	0.97%
1f. Environment	14.59%	13.07%	17.61%	3.32%	8.71%	6.49%	54.25%
1g. Food, Fiber, Other Agricultural Products	2.08%	0.00%	0.01%	0.08%	0.03%	0.00%	9.93%
1h. Health	18.44%	13.34%	7.41%	1.43%	8.25%	27.71%	1.14%
1i. Income Security & Social Services	0.82%	0.00%	0.00%	0.56%	0.00%	0.00%	0.00%
1j. Natural Resources	3.56%	0.45%	0.20%	0.13%	0.12%	0.21%	0.00%
1k. Science & Technology Base	9.67%	10.16%	7.56%	89.44%	8.67%	21.59%	0.00%
1l. Transportation	15.75%	25.63%	15.74%	2.13%	7.74%	5.01%	0.50%
1m. Other functional areas, not elsewhere classified	0.18%	0.00%	0.00%	1.32%	0.00%	0.00%	30.30%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2. Stage of R&D							
2a. Basic Research	1.53%	1.56%	0.32%	79.26%	0.20%	1.26%	2.92%
2b. Applied Research	61.25%	20.41%	20.89%	17.35%	29.60%	54.03%	45.91%
2c. Development	10.73%	20.54%	13.34%	1.21%	30.46%	17.53%	44.56%
2d. Commercialization	26.49%	57.49%	65.45%	2.18%	39.74%	27.18%	6.62%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Form 3A – Part2. Disaggregation (by Percent) of Each Performer's Funding by Research Function and Stage of R&D

	State Government	Local/County Government	Business or Industry	Academic Institution	Private Individuals	Non-Profit	Other	Total
1. Research Function or Use								
1a. % Community Development Derived from	95.99%	0.17%	1.05%	2.72%	0.01%	0.05%	0.00%	100.00%
1b. % Crime Prevention and Control derived from	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1c. % Economic Development derived from	18.10%	11.01%	62.43%	3.08%	2.13%	2.81%	0.45%	100.00%
1d. % Education derived from	20.14%	19.10%	19.70%	13.83%	13.40%	13.83%	0.00%	100.00%
1e. % Energy derived from	26.38%	25.27%	28.95%	9.75%	4.04%	5.32%	0.29%	100.00%
1f. % Environment derived from	22.97%	10.68%	23.86%	32.53%	1.59%	2.23%	6.13%	100.00%
1g. % Food, Fiber, Agricultural derived from	62.87%	0.00%	0.24%	15.27%	0.11%	0.00%	21.52%	100.00%
1h. % Health derived from	38.63%	14.50%	13.36%	18.66%	2.00%	12.67%	0.17%	100.00%
1i. % Income Security & Social Services Derived from	19.05%	0.00%	0.00%	80.95%	0.00%	0.00%	0.00%	100.00%
1j. % Natural Resources derived from	73.37%	4.76%	3.52%	17.08%	0.29%	0.96%	0.00%	100.00%
1k. % Science & Technology Base derived from	1.65%	0.90%	1.11%	95.35%	0.17%	0.81%	0.00%	100.00%
1l. % Transportation derived from	27.21%	22.98%	23.41%	22.90%	1.55%	1.89%	0.06%	100.00%
1m. % Other functional areas derived from	1.66%	0.00%	0.00%	77.76%	0.00%	0.00%	20.59%	100.00%
2. Stage of R&D								
2a. % Basic Research derived from	0.31%	0.16%	0.06%	99.37%	0.00%	0.06%	0.04%	100.00%
2b. % Applied Research derived from	28.31%	4.89%	8.31%	49.93%	1.59%	5.45%	1.52%	100.00%
2c. % Development derived from	21.04%	20.91%	22.52%	14.83%	6.93%	7.51%	6.27%	100.00%
2d. % Commercialization derived from	19.31%	21.74%	41.05%	9.88%	3.36%	4.32%	0.35%	100.00%

Form 4. Fiscal Year 1995-1996 Non-Plant R&D Expenditures by Stage

	Basic Research (A)	Applied Research (B)	Development (C)	Commercialization (D)	Total (E)	% of Total
	55.11%	24.00%	5.66%	15.22%	100.00%	
Research Function or Use						
1. Total	151,186,410	65,848,362	15,515,874	41,762,503	274,313,149	100.00%
1a. Community Development, Housing & Public Services	46,861	2,032,633	13,965	8,478	2,101,936	0.77%
1b. Crime Prevention and Control	6,059	1,422,260	70,188	0	1,498,507	0.55%
1c. Economic Development	18,408	2,121,725	845,429	11,049,075	14,034,636	5.12%
1d. Education	4,506	5,446,895	5,185,314	2,416,276	13,052,991	4.76%
1e. Energy	12,737	1,186,350	797,256	5,354,687	7,351,029	2.68%
1f. Environment	789,678	10,645,941	1,412,708	6,476,518	19,324,845	7.04%
1g. Food, Fiber, Other Agricultural Products	19,217	894,749	94,717	0	1,008,683	0.37%
1h. Health	1,317,859	7,209,253	761,545	5,238,369	14,527,026	5.30%
1i. Income Security & Social Services	0	1,312,000	0	0	1,312,000	0.48%
1j. Natural Resources	72,387	1,090,139	75,699	238,630	1,476,854	0.54%
1k. Science & Technology Base	148,229,688	24,553,583	905,409	4,107,194	177,795,874	64.81%
1l. Transportation	33,641	7,286,854	4,053,256	6,239,798	17,613,549	6.42%
1m. Other functional areas, not elsewhere classified	635,368	645,980	1,300,389	633,479	3,215,217	1.17%

Form 4A. Disaggregation by Stage of Research Funding by Function

1. Research Function or Use	% Basic Research Devoted to	% Applied Research Devoted to	% Development Devoted to	% Comm. Devoted to
1a. Community Development, Housing & Public Services	0.03%	3.09%	0.09%	0.02%
1b. Crime Prevention and Control	0.00%	2.16%	0.45%	0.00%
1c. Economic Development	0.01%	3.22%	5.45%	26.46%
1d. Education	0.00%	8.27%	33.42%	5.79%
1e. Energy	0.01%	1.80%	5.14%	12.82%
1f. Environment	0.52%	16.17%	9.10%	15.51%
1g. Food, Fiber, Other Agricultural Products	0.01%	1.36%	0.61%	0.00%
1h. Health	0.87%	10.95%	4.91%	12.54%
1i. Income Security & Social Services	0.00%	1.99%	0.00%	0.00%
1j. Natural Resources	0.05%	1.66%	0.49%	0.57%
1k. Science & Technology Base	98.04%	37.29%	5.84%	9.83%
1l. Transportation	0.02%	11.07%	26.12%	14.94%
1m. Other functional areas, not elsewhere classified	0.42%	0.98%	8.38%	1.52%
	100.00%	100.00%	100.00%	100.00%

2. Research Function or Use	Basic Research	Applied Research	Development	Commercial	
2a. % Community Development contribution to:	2.23%	96.70%	0.66%	0.40%	100.00%
2b. % Crime Prevention and Control contribution to:	0.40%	94.91%	4.68%	0.00%	100.00%
2c. % Economic Development contribution to:	0.13%	15.12%	6.02%	78.73%	100.00%
2d. % Education contribution to:	0.03%	41.73%	39.73%	18.51%	100.00%
2e. % Energy derived contribution to:	0.17%	16.14%	10.85%	72.84%	100.00%
2f. % Environment contributed to:	4.09%	55.09%	7.31%	33.51%	100.00%
2g. % Food contributed to:	1.91%	88.70%	9.39%	0.00%	100.00%
2h. % Health contributed to:	9.07%	49.63%	5.24%	36.06%	100.00%
2i. % Income Security contributed to:	0.00%	100.00%	0.00%	0.00%	100.00%
2j. % Natural Resources contributed to:	4.90%	73.81%	5.13%	16.16%	100.00%
2k. % Science & Technology Base contributed to:	83.37%	13.81%	0.51%	2.31%	100.00%
2l. % Transportation contributed to:	0.19%	41.37%	23.01%	35.43%	100.00%
2m. % Other contributed to:	19.76%	20.09%	40.44%	19.70%	100.00%

5. Works Cited

Davidson, Carl and Paul Segerstrom (1998). "R&D Subsidies and Economic Growth." *RAND Journal of Economics* 29(3): 548-577.

Davis, Charles and Fred Carden (1998). "Research Effectiveness and R&D Evaluation in Developing Countries." *Knowledge and Policy* 10(4): 7-31.

Goolsbee, Austan (1998). "Does Government R&D Policy Mainly Benefit Scientists and Engineers?" *American Economic Review* 88(2): 298-303.

Howells, Jeremy and Jonathan Michie (1998). "Technological Competitiveness in an International Arena." *International Journal of the Economics of Business* 5(3) (November): 279-291.

Jaffe, Adam B. (1996). "Economic Analysis of Research Spillovers: Implications for the Advanced Technology Program." Brandeis University and the National Bureau of Economic Research (December). http://www.atp.nist.gov/eao/gcr708.htm.

Jones, Charles I. and John C. Williams (1998). "Measuring the Social Return to R&D." *Quarterly Journal of Economics* 63(4):1119-1136.

Milgrom, Paul and John Roberts. 1992. *Economics, Organization and Management.* Englewood Cliffs, NJ: Prentice Hall.

Oates, Wallace (1972). *Fiscal Federalism.* New York: Harcourt Brace Jovanovich, Inc.

Reugg, Rosalie T. 1998. "The Advanced Technology Program, Its evaluation Plan, and Progress in Implementation." *Journal of Technology Transfer* 23 (2): 5-9.

6. Appendix A - Data Collection Methodology

A Brief Summary of RESEARCH METHODOLOGY for California R&D Expenditures 1995-1996, Koehler Jones, Ph.D., 10 March 1999.

This study follows an earlier one conducted by Battelle in 1997.[18] Conclusions drawn from the earlier study are subject to three major data problems: (1) several respondents misunderstood the request; (2) the population of respondents was incomplete; (3) data entry errors were impossible to identify or correct. Because of these validity and reliability problems the findings of this earlier study must be used cautiously when making longitudinal comparisons.

The current study has been sensitive to these issues and attempted to modify or overcome them, however the short time allocated, and a change in administration at the midpoint, made it difficult to ensure accuracy.

6.1 Respondents

The study began with the 31 respondents who participated in the initial 1997 Battelle study--26 of whom had reported R&D expenditures during the 1994-1995 time period.

After discussions with experts from the Department of Finance, Legislative Analysts Office, Office of Planning and Research, Senate Office of Research, and the California Research Bureau, the population was enlarged to include 38 additional government entities--14 of whom were discovered to perform R&D.

The total population for this study was 69 and the total number of respondents was 64 making the response rate 93%. The five government entities who did not respond may have little or no R&D activity to report.

Overall, 41 entities have been identified who regularly perform R&D. This study reports on 38 of them because one was a non-respondent (Resources, Dept. Boating and Waterways, Operations), and two said they had zero expenditures during the 1995-1996 fiscal year (CALTRANS Capital Outlay and Health & Human Services, Dept. of Mental Health).

Table A1 lists all respondents and total R&D reported by them for both time periods, 1994-1995 and 1995-1996.

Future work could ensure thoroughness by blanketing the field--sending hundreds of questionnaires directly to individual departments, sections and institutions.[19]

6.2 Survey Instrument

The Battelle instrument[20] was used without modification except to change fiscal year. It offered a standardized request, with standardized, business-oriented descriptions, but it was awkward for respondents to apply to government operations. Even though every effort was made to explain and give examples, responses are not necessarily based on uniform, standardized interpretations of the questionnaire. Problems centered around the meaning of "research" and the interpretation of categories describing research.

The Meaning of R&D. Many respondents interpreted our request as an attempt to identify money

[18] *Survey of State Research and Development Expenditures: Fiscal Year 199*5. Jointly authored by Battelle and State Science and Technology Institute (SSTI) and published in September 1998.

[19] To meet the request from Battelle and SSTI, Texas asked 274 agencies and academic institutions to respond (above report p. 24).

[20] Section four, agency/institutions survey instrument, *Survey of State Development Expenditures: Fiscal Year 1995.*

spent for "scientific" research only. When we had an opportunity to explain that social science research, applied public policy research, financial analyses, and some program evaluations also qualify as research there were several upward adjustments in the data.

Other respondents felt that the request referred only to programs actually labeled as "research." The Energy Commission, for example, found another $6 million after taking time to examine individual programs to discover the intent of each activity . . . which often included a significant research element.

Activities fitting the "commercialization" category were particularly difficult for respondents to identify as legitimate R&D. The Energy Commission, for example had trouble with this even though a number of their programs are specifically dedicated to providing incentives for the commercialization of particular technologies.

Overall, most errors have been errors of omission, which means that many activities which are actually R&D may not have been perceived as R&D by the respondent. It is highly unlikely that the opposite happened to any great degree. All activities reported seem to qualify for inclusion in this study.

Interpretation of Categories. We received very few phone calls asking for clarification of the five categories used to describe R&D expenditures.[21] Apparently there were very few questions asked during the earlier, Battelle study as well. But, while Battelle investigators interpreted this to mean that respondents had little confusion about how to use the categories, we found--while making phone calls to validate and clarify data--that people often had serious questions about how to interpret and apply them.

For example, both government and academic institutions had problems with the category called "Stage." For university people in particular there is much overlap among stages.

Government entities appeared to have no real trouble with the category "Function or Use." State agencies usually know what their dollars are used for. But academic institutions may have had some problems since university work often has the potential for multiple applications. Mark Skinner,[22] principal investigator of the Battelle study, argues that academics are not accustomed to thinking in these terms because "function or use" is not required by NSF. He supports his view with the observation that one category, "Science and Technology," was overused in the 1994-1995 study.

R&D "plant" money was especially difficult for many respondents to identify and report. In some cases the budgets for facilities and equipment are handled in a different way than other contracts. Battelle/SSTI data for 1994-1995 is short on these dollars[23] and they are understated in the present study too.

6.3 Data Collection Process

The data collection process combined a top-down approach with a direct contact campaign. A questionnaire packet and cover letter, signed by the Executive Director of CCST, was sent to each of the agency chiefs and main bodies of government. The need for high priority was emphasized. Rather than waiting for responses, budget offices, comptrollers and contract offices were immediately called and faxed copies of the request. Telephone follow-ups and personal visits were most effective at gaining cooperation.

Issues with fiscal year. The data collection process brought to light a number of cases where people had confused fiscal years when responding to the earlier Battelle request. As we attempted to collect 1995-1996 data, we found several people who claimed data for those years had already been mistakenly submitted (for the 1994-1995 study). This pointed out the need to clarify the term "fiscal year." Eventually the term was dropped entirely in favor of the less ambiguous labels, "1994-1995" and "1995-1996."

Because of this confusion, the current study requested data for both 1994-1995 and 1995-1996 fiscal years so the earlier data base can be amended. When time grew short toward the end of the study, and in cases where cooperation was minimal, the latter time period (1995-1996) was emphasized. This means some data for 1994-1995 is still missing.

In the best case, respondents retrieved data from three-year-old files. It's not clear what effect this historical search may have had on overall results. One discussion with the Energy Commission, for example, focused on a $540 million program which was being examined at length to determine whether it qualified as "research." Eventually it became clear that the issue was moot since the program didn't even start until 1997. This example shows that, to the extent that data discovery depends on recollection, elapsed time increases the chance of error.

6.4 Description of Data

1995-1996 Data. As mentioned earlier, the total number of surveys distributed was 69. Of this number, 38--over half--reported R&D expenditures during the

[21] The five categories are: Source, Function, Field, Stage and Performer. See page 7 of the Survey Packet.

[22] E-mail 1/14/99.

[23] Phone conversation 1/12/99 with Mark Skinner, an author of the Battelle study. Skinner recommends dropping the plant category because it was so underutilized in the Battelle study.

period 1995-1996. Twenty-six reported zero expenditures and five did not respond.

The magnitude of dollars reported ranged from $24,945 (Office of Statewide Health Planning and Development) to $168,367,000 (University of California). Often entities with small expenditures were more detailed and precise in their responses than those with large budgets. But the commitment to respond thoughtfully did not always vary with size. Several entities gave rough estimates based on overall budgets (the Department of Education and the California Research Bureau and examples).

1994-1995 Data. The current study uncovered an additional $51,017,980 in R&D expenditures made during the 1994-1995 time period. When this number is reduced to account for newly identified over-reporting in the amount of $13,657,202, the overall total for this time period is $37,360,778.

This new data brings the total reported by Battelle ($274,033,603 for both plant and non-plant) up to $311,394,381. An increase of almost 14%.

Inspection shows data is missing for 26 entities. If the missing data for 1994-1995 were found to be similar to that submitted for the following fiscal year (1995-1996), an additional $6.7 million could be added to the above figure ($311 million).

6.5 Data Entry

The previous study used an additive data entry technique where data from individual respondents were obliterated by the automatic aggregation of data.

The current data entry technique[24] created records for each reporting entity so individual totals could be checked against hand calculated records. This ensures accuracy of data entry and makes changes and modifications possible. It also permits special studies. Future data should be encoded and kept this way.

6.6 Recommendations for Improving Future R&D Expenditure Surveys

The actual total of R&D may be higher than reported in this study.[25] The following recommendations focus on getting more data by: 1) improving identification of organizations that might be doing research; and 2) making the data collection instrument easier and less intimidating to understand and use. The simpler it can be, the faster and more accurate the responses will be.

A. Send hundreds of questionnaires directly to individual departments, sections and institutions rather than depending on expert opinion.
B. Reduce the number of categories. Make them more meaningful and easier to understand.
    1) Omit or reduce the number of stages.
    2) Clarify and reduce the number of functions. Or report findings from academic institutions separately from state agencies.
    3) Omit the category for Plant, or find better ways to assess it.
C. Shorten the questionnaire
D. Put definitions and examples on a web site.
E. Encourage respondents by giving them the option of computerized worksheets. Some may prefer it. Others may prefer working it out by hand.

[24] Thanks to Donna King of CCST Riverside.

[25] CCST initiated a follow-up study to increase the data validity and check the reliability of data reported herein. "Analysis of California R&D Funding from 1994-1995 to 1996-1997", Koehler Jones, Victoria.

Table A1. California R&D

AGENCY AND DEPARTMENT DIVISION OR OFFICE	TOTAL R&D REPORTED 1994-1995	TOTAL R&D REPORTED 1995-1996
Business, Transportation & Housing		
CALTRANS Capital Outlay	5,000,000	Zero
CALTRANS New Technology Program	11,388,464	14,017,824
CALTRANS Research Program	8,192,389	7,112,728
DMV	Should be: 632,385 (was 594,869)	664,107
Highway Patrol	92,000	88,000
Teale Data Center	-	Zero
Dept. of Transportation	-	-
California Research Bureau	-	3,000,000
Community Colleges, Board of Governors	Zero	Zero
Consumer Services Agency, Secretary of State and	Zero	Zero
Criminal Justice Planning, Office of	-	Zero
Education, California Board of	-	Zero
Education, Department of	25,329,800	28,363,800
EPA		
Air Resources Board	6,970,000	7,415,544
Office of Environmental Health Hazard Assessment	-	Zero
Pesticide Regulation, Dept. of	-	Zero
Water Resources Control Board, State	240,000	265,000
Toxic Substances Control, Dept. of	207,534	46,451
Waste Management Board, California Integrated	1,740,499	1,626,669
Food and Agriculture, Department of	3,194,224	1,820,562
Governor's Office		
Emergency Services - Administration	-	Zero
Emergency Services – Planning & Technical Assistance Branch	1,258,165	552,710
Planning and Research	-	Zero

Table A1 (continued). California R&D

AGENCY AND DEPARTMENT DIVISION OR OFFICE	TOTAL R&D REPORTED 1994-1995	TOTAL R&D REPORTED 1995-1996
Health and Human Services Agency		
Aging, Dept. of	-	Zero
Alcohol and Drug Programs, Dept. of	-	286,476
Community Services and Development, Dept. of	-	Zero
Data Center	Should be: 1,344,000 (was no data)	661,900
Developmental Services, Dept. of	-	355,000
Employment Development Dept.	-	340,000
Health Services, Dept. of AIDS	2,880,000 (should make changes in source)	2,308,000
Health Services, Dept. of Chronic & Injury	7,073,790	7,708,417
Health Services, Dept. of Communicable	1,064,779	3,327,000
Mental Health, Dept. of	1,218,000	Zero
Rehabilitation, Dept. of	-	Zero
Social Services, Dept. of	2,106,932	2,124,000
Statewide Health Planning and Development, Office of	Should be Zero (was 24,945)	24,945
Industrial Relations	Zero	Zero
Information Technology	-	Zero
Public Utilities Commission	-	Zero
Resources Agency		
Bay Conservation & Development Commission	-	500,000
CA Coastal Conservancy	-	-
Tahoe Conservancy	-	Zero
Fish and Game, Dept. of	5,048,665	3,599,564
Santa Monica Conservancy	-	Zero
Water Resources	-	-
Resources Agency – Dept. Boating & Waterways		
Facilities	1,020,500	1,489,750
Operations	26,671	-

Table A1 (continued). California R&D

AGENCY AND DEPARTMENT DIVISION OR OFFICE	TOTAL R&D REPORTED 1994-1995	TOTAL R&D REPORTED 1995-1996
Resources Agency – Dept. of Conservation		
Administration, Division of	-	Zero
Land Resource Protection, Division of	Zero	Zero
Mines and Geology, Division of	Should be: 5,197,093 (was 11,048,350)	11,048,350
Mine Reclamation, Office of	Should be 370,637 (was 228,884)	186,076
Oil, Gas & Geothermal Resources, Division of	Zero	Zero
Recycling, Division of	Zero	Zero
Technology Assessment Planning & Development	1,239,021	742,376
Resources Agency – Energy Commission		
Energy Efficiency Programs	Should be 9,024,000 (was no data)	6,212,000
Energy Information & Analysis Programs	Should be 856,000 (was no data)	223,000
Facilities Siting & Environ. Protection	Should be 503,000 (was no data)	200,000
R&D Office Programs	Should be 6,548,436 (was no data)	6,878,215
Transportation Technology & Fuels	Should be: 24,112,679 (was no data)	26,253,228
Resources Agency – Dept. of Forestry & Fire		
Fire Protection	1,176,000	488,000
Resource Mgmt. Program	755,454	676,752
California **State Lands Commission**	-	Zero
Secy. of State & Consumer Services Agency - **Teachers' Retirement System**	Zero	Zero
State Universities, Board of Trustees	Should be: 4,724,996 (was no data)	2,500,000
Trade and Commerce Agency	Should be: 4,724,996 (was no data)	7,040,000

Table A1 (continued). California R&D

AGENCY AND DEPARTMENT DIVISION OR OFFICE	TOTAL R&D REPORTED 1994-1995	TOTAL R&D REPORTED 1995-1996
California **Transportation Commission**	-	Zero
University of California, Board of Regents	Should be: 160,413,000 (was 168,194,031)	168,367,000
Youth and Adult Correctional Agency, Secy. of		
Dept. of The Youth Authority	Should be: 1,225,600 (was no data)	1,236,600
Narcotic Addict Evaluation Authority	-	-

Note:
These totals combine Plant and Non-plant.
Dashes mean no data.

7. Appendix B - Selected Definitions[26]

7.1 The Definition of Expenditures

There are two types of R&D expenditures for the purpose of this study: expenditures for R&D performed by or in support of state government agencies and R&D funding provided by the state agencies to external parties, typically through the form of grants. Academic institutions only report R&D expenditures from direct state appropriations to the institution from a Board of Regents, Council of Higher Education or a similar centralized agency. Academic institutions do not report industrial contributions, federal funds, grants or contracts that are awarded by other state agencies.

7.2 Sources of Funding

1. Federal Sources includes all funding for R&D which originated from any agency or branch of the federal government.

2. Industry includes R&D or R&D funding contracted, awarded, donated or granted to a state entity or academic institution by a private institution by a private industry, business, trade group or business-related association.

3. State sources include:

   A. Direct appropriations from state general revenues which are provided directly to the state agency or academic institution by the legislature as part of the agency's regular fiscal appropriation.

   B. State Bonds that generate funds dedicated to R&D.

   C. Lottery proceeds that are dedicated to R&D.

   D. Restricted funds that are generated by specific taxes, user fees, or revenue streams dedicated for R&D and the sole use of the agency or academic institution.

   E. Other state sources

4. Other sources are those sources not elsewhere classified, such as donations, endowments, and gifts.

7.3 R&D Function and Use

R&D Function refers to the broad categories included the intended use of the research results, whether used by the funding agency, the grant recipient, or a third party. If a research project has more than one fit within a functional category, then its expenditures may be split among categories or assigned to the functional category which most closely matches the primary purpose for the initial funding. Since much basic research within academic institutions have unknown potential applications at the time of the original research may be placed in the functional category entitled Science and Technology Base.

7.4 Fields of Science and Engineering

1. Biological Sciences: Those life sciences that deal with the origin, development, structure, function, and interaction of living things. This category includes agricultural sciences but does not include categories of medical sciences.

2. Medical Sciences: These are concerned with the causes, effects, prevention, or control of abnormal conditions in humans or their environment as they are related to health.

3. Psychology: This category deals with behavior, mental processes, and individual and group characteristics and abilities.

4. Physical Sciences: These are concerned with the understanding of the material universe and its phenomena.

5. Environmental Sciences: Those sciences, both terrestrial and extraterrestrial, that are concerned with the gross, non-biological properties of the areas of the solar system that directly or indirectly affect human survival and welfare. Studies of life in the sea or other bodies of water are reported in this category (they are linked to oceanography) rather than in the biological sciences category.

6. Engineering: This field is concerned with studies directed toward developing engineering principles or toward making specific principles useable in engineering practice.

7. Social Sciences: These are directed toward an understanding of the behavior of social institutions and groups and of individuals as members of a group.

8. Other Sciences: This category is used for multi-disciplinary and interdisciplinary projects that cannot be classified within one of the above broad fields.

7.5 Stages of R&D

1. Basic Research: the objective of the sponsoring agency is to gain fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.

2. Applied Research: the objective of the sponsoring agency is to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.

[26] These are summarized from the "Survey of State Research and Development Expenditures for Fiscal Year 1995", California Council on Science and Technology.

3. Development: the systematic use of knowledge or understanding gained from research, directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

4. Commercialization: the reduction to practice of a technical idea, its incorporation in the design or production process of a product or service, and initial introduction of the product or service into a commercial market.