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Clerk, Supreme Court of Appeals
Richmond, Va.

214 Va. 161

IN THE

Supreme Court of Virginia

AT RICHMOND

RECORD No. 8182

COMMONWEALTH OF VIRGINIA,
Plaintiff in error,

v.

RESEARCH ANALYSIS CORPORATION,
Defendant in error.

APPENDIX TO BRIEF

ANDREW P. MILLER
Attorney General of Virginia

MRS. SALLY T. WARTHEN
Assistant Attorney General of Virginia

P. O. Box 6-L
Richmond, Virginia 23282
Counsel for Plaintiff in error.

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FILED
IN CIRCUIT COURT
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VIRGINIA:

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

RESEARCH ANALYSIS CORPORATION, A District of Columbia Corporation McLean, Virginia Plaintiff, vs. COMMONWEALTH OF VIRGINIA c/o State Tax Commissioner Department of Taxation Richmond, Virginia Defendant.	)	PETITION FOR CORRECTION OF ERRONEOUS TAX ASSESSMENT

TO THE HONORABLE JUDGES OF SAID COURT:

1. Petitioner is a District of Columbia corporation, duly qualified and doing business in Virginia at McLean, Fairfax County, Virginia. Petitioner brings this suit for correction of an erroneous sales tax assessment, pursuant to Section 58-1130, Virginia Code of 1950, as amended, such erroneous assessment having been made by the Department of Taxation of the Defendant, Commonwealth of Virginia.

2. Petitioner is a non-profit corporation, engaged primarily in the business of doing research and development work for the United States Army and others. Its Articles of Incorporation provide, Article Third:

> "The purposes of this corporation are exclusively scientific, educational and charitable within the meaning of Section 501(c)(3) of the Internal Revenue Code...including furnishing scientific research and advisory services to or for the government of the United States of America or the government of any state or of any county, municipality or other local subdivision thereof, and

otherwise undertaking, furthering and promoting scientific research in the public interest and for the public welfare and national security."

Article Fifth of Petitioner's Articles of Incorporation provides:

"The corporation shall have no shareholders and no part of the net earnings of the corporation shall ever inure to the benefit of any private shareholder or individual;...".

3. Petitioner leased certain equipment used in research and development. As a result of such lease, there was collected from Petitioner, and paid to the Defendant for the year 1968, under Section 58.441.1 et seq., Code of Virginia, a sales and use tax in the amount of $25,667.00.

4. Protest against the assessment and collection of the aforesaid tax and written application for relief therefrom were duly made to the Defendant, but it has failed and refused to refund such tax, and continues to collect it.

5. The assessment and collection by the Defendant of a sales and use tax on the equipment used by Petitioner in research and development was erroneous and illegal inasmuch as such equipment is exempt from imposition of the sales and use tax.

WHEREFORE, the premises considered, Petitioner prays that the Defendant be summoned to answer this Petition; that the assessment by Defendant of the tax set forth above, in the total amount of $25,667.00, be declared by this Honorable Court as erroneous, illegal and without warrant in law; and that judgment be entered for Petitioner against the Defendant for $25,667.00, together with interest thereon from the date of payment, and Petitioner's costs in this behalf expended.

RESEARCH ANALYSIS CORPORATION

By Research Analysis Corporation
Counsel

BAUKNIGHT, PRICHARD, McCANDLISH & WILLIAMS

By Carrington Williams
Carrington Williams, Counsel for Plaintiffs
3976 Chain Bridge Road, Fairfax, Virginia

2

V I R G I N I A :

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

FILED

JAN 15 1971

W. FRANK... ...DING
Clerk of the Circuit Court
of Fairfax County, Va.

Law 24180

RESEARCH ANALYSIS CORPORATION,
A District of Columbia Corporation
Plaintiff,

vs.

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TAXATION
Defendant.

A N S W E R

Now comes the defendant, Commonwealth of Virginia, Department of Taxation, and answers the petition filed against it herein and says:

1. The defendant admits the allegations of Section 1 of the petition, except that it denies that any sales tax assessment against the petitioner is erroneous.

2. The defendant admits the allegations of Section 2 of the petition.

3. The defendant denies the allegations of Section 3 of the petition. The defendant alleges that the plaintiff filed consumer use tax returns for the calendar year 1968, showing use tax liabilities for such period in the amount of $3,053.02, which amount was timely paid to the defendant. The defendant further alleges that the plaintiff has been assessed with an additional consumer use tax of $3,779.16, including penalties, for the calendar year 1968, which amount has not been paid. The defendant denies that either the $3,053.02 or the $3,779.16 was a tax upon equipment used in research and development <u>in the experimental or laboratory sense</u>.

4. The defendant says that it is without knowledge of any protest or written application for relief as alleged by Section 4 of the petition and neither admits nor denies such allegations but calls for strict proof of the same.

5. The defendant denies the allegations of Section 5 of the petition.

And now, having fully answered, the defendant prays to be hence dismissed with its costs in its behalf expended.

THE COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TAXATION

By _____
Assistant Attorney General

Andrew P. Miller
Attorney General of Virginia

Lee F. Davis, Jr.
Assistant Attorney General
P. O. Box 6-L
Richmond, Virginia 23215

CERTIFICATION

I hereby certify that the original of the foregoing Answer has been mailed to the Clerk of this Court for filing and a true copy thereof has been likewise mailed to Carrington Williams, Esquire, 3976 Chain Bridge Road, Fairfax, Virginia, counsel for plaintiff, on this 13th day of January, 1971.

_____
Assistant Attorney General

IN CIRCUIT COURT OFFICE
CLERK'S OFFICE
JAN 1 1 1977
W. FRANKLIN GOODING
CLERK FAIRFAX COUNTY, VA.
WRIT TAX PAID
DEPOSIT

V I R G I N I A :

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

RESEARCH ANALYSIS CORPORATION, a District of Columbia Corporation McLean, Virginia Plaintiff, vs. COMMONWEALTH OF VIRGINIA c/o State Tax Commissioner Department of Taxation Richmond, Virginia Defendant.	PETITION FOR CORECTION OF ERRONEOUS TAX ASSESSMENT

TO THE HONORABLE JUDGES OF SAID COURT:

1. Petitioner is a District of Columbia corporation, duly qualified and doing business in Virginia at McLean, Fairfax County, Virginia. Petitioner brings this suit for correction of an erroneous sales and use tax assessment, pursuant to Section 58-1130, Virginia Code of 1950, as amended, such erroneous assessment having been made by the Department of Taxation of the Defendant, Commonwealth of Virginia.

2. Petitioner is a non-profit corporation, engaged primarily in the business of doing research and development work for the United States Army and others. Its Articles of Incorporation provide, Article Third:

> "The purposes of this corporation are exclusively scientific, educational and charitable within the meaning of Section 501(c)(3) of the Internal Revenue Code...including furnishing scientific research and advisory services to or for the government of the United States of America or the government of any state or of any county, municipality or other local subdivision thereof, and

otherwise undertaking, furthering and promoting scientific research in the public interest and for the public welfare and national security."

Article Fifth of Petitioner's Articles of Incorporation provides:

"The corporation shall have no shareholders and no part of the net earnings of the corporation shall ever inure to the benefit of any private shareholder or individual;...".

3. Petitioner leased certain equipment used in research and development. As a result of such lease, there was assessed against Petitioner, on or about December 28, 1970, under Section 58.441.1 et seq., Code of Virginia, sales and use taxes, penalties and interest as follows:

Period of Audit	Type of Tax	Amount
Dec 66 June 68	State Use Tax	$331.64
Dec 66 Jun 68	State Use Tax Pen or Int	82.91
July 68 Apr 70	State Use Tax	16,919.30
Jul 68 Apr 70	State Use Tax Pen or Int	3,415.43
July 68 Apr 70	Local Use Tax	9,616.92
Jul 68 Apr 70	Local Use Tax Pen or Int	2,132.77

This Petition is a companion proceeding to a suit filed against the Defendant in this Court on December 31, 1970 on the same grounds, but does not duplicate that suit.

4. Protest against the assessment of the aforesaid taxes, penalties and interest and written application for relief therefrom were duly made to the Defendant, but it has failed and refused to abate or refund the same.

5. The assessment and/or collection by the Defendant of sales and use taxes, penalties and interest on the equipment used by Petitioner in research and development were erroneous and illegal inasmuch as such equipment is exempt from imposition of the sales

and use tax.

WHEREFORE, the premises considered, Petitioner prays that the Defendant be summoned to answer this Petition; that the assessment by Defendant of the taxes, penalties and interest set forth above, in the total amount of some $6,831.97, be declared by this Honorable Court as erroneous, illegal, and without warrant in law; and that judgment be entered for Petitioner against the Defendant for so much thereof as has been paid to the Defendant, together with interest thereon from the date of payment, and Petitioner's costs in this behalf expended.

RESEARCH ANALYSIS CORPORATION

By_____
Counsel

BAUKNIGHT, PRICHARD, McCANDLISH & WILLIAMS

By_____
Carrington Williams, Counsel for Plaintiffs
3976 Chain Bridge Road, Fairfax, Virginia

V I R G I N I A :

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

RESEARCH ANALYSIS CORPORATION, A District of Columbia Corporation Plaintiff, vs. COMMONWEALTH OF VIRGINIA DEPARTMENT OF TAXATION Defendant.	LAW 24336

A N S W E R

Now comes the defendant, Commonwealth of Virginia, Department of Taxation, and answers the petition filed against it herein and says:

1. The defendant admits the allegations of Section 1 of the petition, except that it denies that any sales tax assessment against the petitioner is erroneous.

2. The defendant admits the allegations of Section 2 of the petition.

3. The defendant admits the allegations of Section 3 of the petition.

4. The defendant says that it is without knowledge of any protest or written application for relief as alleged by Section 4 of the petition and neither admits nor denies such allegations and calls for strict proof of the same.

5. The defendant denies the allegations of Section 5 of the petition.

And now, having fully answered, the defendant prays to be hence dismissed with its costs in its behalf expended.

CERTIFICATION

I hereby certify that the original of the foregoing Answer has been mailed to the Clerk of this Court for filing and a true copy thereof has been likewise mailed to Carrington Williams, Esquire, 3976 Chain Bridge Road, Fairfax, Virginia, counsel for plaintiff, on this 22nd day of February, 1971.

Assistant Attorney General

V I R G I N I A :

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

RESEARCH ANALYSIS CORPORATION Plaintiff, v. COMMONWEALTH OF VIRGINIA Defendant.	Law No. 24180 and Law No. 25336

O R D E R

These cases were consolidated and came on for trial to the Court sitting without a jury on May 4, 1972. Counsel designated by the State Tax Commissioner appeared on behalf of the Commonwealth.

Upon consideration of the Plaintiff's claim that its payments for lease of a computer used in its business are exempt from imposition of the Virginia Sales and Use Tax under the provisions of § 58-441.6(q), Code of Virginia, which exempts property purchased for use or consumption directly and exclusively in research and development in the experimental or laboratory sense, and the contention of the Virginia Department of Taxation that such sales and use tax exemption does not apply to the computer; and the court having heard the testimony of the witnesses, and being of the opinion that the exemption applies, it is

ADJUDGED, ORDERED AND DECREED that the assessment by the Virginia Department of Taxation of the Sales and Use Tax for the period between December 1, 1966, and April 30, 1970, in the amount of $26,937.82, with penalty of $5,348.11, be and it hereby is declared to be erroneous and illegal.

The transcript of the proceedings of May 4, 1972, shall become a part of the record of this case.

This Order is final.

July 17, 1972 Bernard J. Jennings
Judge

I ASK FOR THIS:

Carrington Williams
Carrington Williams

SEEN AND OBJECTED TO:

Sally T. Warthen
(Mrs.) Sally T. Warthen

FILED

JUL 21 1972

W. FRANKLIN GOODING
Clerk of the Circuit Court
of Fairfax County, Va.

V I R G I N I A :

IN THE CIRCUIT COURT OF FAIRFAX COUNTY

RESEARCH ANALYSIS CORPORATION Plaintiff, v. COMMONWEALTH OF VIRGINIA Defendant.	LAW NOS. 24180 and 25336

NOTICE OF APPEAL AND
ASSIGNMENT OF ERROR

Pursuant to Rule 5:6 of the Rules of the Supreme Court of Virginia, the Defendant, Commonwealth of Virginia, by the Attorney General, hereby gives notice that it will apply to the Supreme Court of Virginia for an appeal from the final order entered herein on July 17, 1972.

Counsel for Defendant gives further notice that in the application to the Supreme Court of Virginia, the Defendant assigns and will rely upon the following error:

1. The court erred in its conclusion that the Virginia retail sales and use tax assessment against Research Analysis Corporation was erroneous.

The transcript of the hearing, referred to in the Order of July 17, 1972, will be filed in the office of the Clerk.

Dated this 19th day of July, 1972.

COMMONWEALTH OF VIRGINIA

By _____
Assistant Attorney General

Andrew P. Miller
Attorney General of Virginia

Mrs. Sally T. Warthen
Assistant Attorney General
P. O. Box 6-L
Richmond, Virginia 23215

1 EXTRACT OF PROCEEDINGS

2 Whereupon

3 DANIEL CAWGILL

4 a witness, was called for examination by counsel on
5 behalf of the plaintiff, and, after having been
6 previously duly sworn, was examined and testified as
7 follows:

8 DIRECT EXAMINATION

9 BY MR. WILLIAMS:

10 Q Would you state your name, residence, and
11 occupation, please, sir.

12 A My name is Daniel Cawgill, C-a-w-g-i-l-l, I
13 live at 7228 Middlewood Road, Bethesda. My occupation,
14 I am the head of the Computer Sciences Center at Research
15 Analysis Corporation in McLean.

16 Q How long have you been with Research Analysis
17 Corporation?

18 A I've been out there a little over eight years,
19 since November '63.

20 Q Would you tell the Court your background briefly,
21 Mr. Cawgill, beginning with your education and subsequent
22 experience in the scientific or computer field, up until
23 the time -- if Your Honor please, Research Analysis

1 Corporation is customarily referred to as RAC, it's a
2 lot easier to say. We will use that term with your
3 permission.
4 A My education starts with a Bachelor's Degree
5 in Mathmatics from Oberlin in 1943, subsequently a Master's
6 Degree in Mathmatics at Boston University in 1948. It
7 was at that time that I had decided to enter the computer
8 field, which was quite new then, and I did, indeed,
9 start in the fall of 1948 at the Aberdeen Proving Ground
10 in Maryland, working on the, incidently, world's first
11 electronic computer, the ENIAC. The applications made at
12 that time ranged all the way from firing tables to
13 support of what was the beginning of nuclear research,
14 theoretical studies of computations.
15 Subsequently, I joined the Burroughs Research
16 Division, worked there for seven years, primarily, in
17 the, as part of a project team developing digital
18 computers, and some special purpose business machines.
19 Q This is the Burroughs Machine Corporation
20 that you refer to?
21 A Yes, you could call it, it was called Burroughs
22 Adding Machine Corporation in those days. Subsequently,
23 I worked for the American Bosch Arma Corporation in

1 Long Island for a period of, approximately, four years.
2 The principal objection there of my employment and,
3 indeed, of the company was of the development of the
4 inertial guidance system for the Atlas ICBM. Specifically,
5 my activities related to the development of the on-board
6 guidance computer that, fundamentally, analyzed the
7 measurements as to position and acceleration of the
8 vehicle, and described what steering commands should be
9 given to guide it to its target.
10 The kinds of things I did there were primarily
11 associated with the logical design of the computer for
12 that purpose. I was at one stage of the development,
13 head of what was called the logical design group, these
14 are the people, fundamentally, who say where what kind
15 of parts should go in the computer in order that it be
16 able to do its job.
17 One of the major problems in a project of that
18 type, since I guess everybody knows an Atlas ICBM is a
19 vehicle designed to carry nuclear warheads over many
20 thousands of miles, is the big problem in that kind of
21 thing is the reducing the response time, once the
22 customer knows what kind of a system he wants, getting a
23 design and getting it built. There was, for example,

1 there a problem of minimizing the size of the on-board
2 computer, minimizing its weight, because there's very
3 little room, certainly back in those days, the late
4 fifties, for having much in the way of equipment aboard
5 the missile.
6 Q Excuse me, you're saying there was a computer
7 on the missile itself?
8 A Yes, sir.
9 Q As it would be launched into space?
10 A Yes, indeed, and one of my jobs was to find
11 ways to minimize the size and the weight of this
12 particular part of the on-board equipment, and also to
13 reduce the length of time that it took to reach those
14 design decisions. An example is the design of layout
15 or circuit cards which composed the computer.
16 Typically, it took on the order of two to three
17 months per card for people, designing draftsmen they're
18 called, to figure out where to put the parts on the
19 card, so that we would achieve something of the goal of
20 minimum size and minimum weight.
21 If you don't care where the parts are put,
22 there is no problem, but you use up a lot of space and
23 you use up a lot of wiring and increase the size and

1 you increase the weight of the thing. To my knowledge
2 there was no such capability existing at that time to
3 automate these design draftsmen, and the decision
4 processes that they went through.
5 My group, I as one of these people, did develop
6 such a computer scheme. That was one of my successes,
7 and our end result and leaving out all the details,was
8 a procedure which designed a card, a matter of 30 minutes
9 on a computer which was of the quality result, as
10 measured by the design draftsmen superior to anything
11 that they could come up with.
12 This anticipates a bit, but it is a, certainly
13 it's an example of what I would call research to devise
14 the technology that can solve a problem of this type.
15 Subsequently, I worked, somewhat briefly, for IBM for
16 a period of two years on Project Mercury.
17 My responsibilities there were to develop the
18 test procedures by which all the ground equipment, the
19 radars, the computers, that we use to control what was
20 called the launch phase, the time the vehicle is powered
21 flight, until the capsule is separated.
22 My computer programs checked out the ground
23 communications equipment, radars, communication links

1 that control that phase of that flight Subsequently,
2 joining Research Analysis Corporation, and after about
3 two years, I became head of this Computer Sciences Center
4 in 1966.
5 Q You're head of the Computer Sciences Center
6 at the present time?
7 A Yes.
8 Q Would you describe briefly your duties as head
9 of the Computer Sciences Center?
10 A The real problem since we have learned by
11 historical events and passage of time that we need a
12 computer in our kind of research work to make certain
13 that the computer that we have is adequate to support
14 that work. The computer is a well known adjunct in many
15 areas of endeavor and the person who undertakes to do
16 research and advance development work, whatever you may
17 call it, with a computer as a central activity in that
18 research or advance development cannot perform if he
19 does not have the proper equipment, the equipment which
20 is most up-to-date in terms of his functional capabilities
21 in its capacity.
22 Number one job is to make sure and that resides
23 in my office that the computer which RAC has is adequate

1 for its kind of research capability, as far as research
2 work. Second, once it's there, since typically the
3 users of the RAC computer are on the fringes of what
4 people know how to do and on the fringes of what they
5 know how to do on a computer, is to provide the technical
6 interface, the human technical interface between the
7 purely computer technician as a man who knows how to
8 push the buttons and put the tapes on, and the users of
9 that computer
10 In our case, when I say users of the computer,
11 I'm talking about the members of the RAC technical staff
12 who are an in the process of figuring out what their
13 problems are and how they can be solved on a computer.
14 Let me give a little bit of example of the kind of thing
15 I'm talking about. RAC had a project back in the days
16 when it was the operation research office of Johns
17 Hopkins called --
18 Q Excuse me, RAC was the successor to the
19 Observation Research Lab of Johns Hopkins, was it not?
20 A Yes, this project used a computer at that time.
21 Successive versions of it had been used, and there is
22 one today which is, has grown and kept pace with the
23 growth in size and capabilities of computers. The

1 simulation and the model that our computer now contains
2 is somewhere between a hundred and two hundred times as
3 large, in terms of the number of logical or arithmatic
4 decisions or computations that are made.
5 This particular model has gotten to be so large
6 now that it cannot be contained in a single episode on
7 the computer, but has to be partitioned at several pieces.
8 Q Can you describe that in a little more detail
9 so it is more understandable to a layman like me when
10 you talk about the model and the partitioning process?
11 A It is a model of ground combat, that is two
12 opposing sides shooting at each other, and the number of
13 types of decisions that the combatants can be in is very
14 large, the amount of computation and what I would call
15 reasoning is very large. I'll give an example, one of
16 the things we simulate is the fact that one of the
17 opponents notices the other in this simulated battle.
18 The initial question to be asked is does side A
19 see side B. The answer is yes. How well can he see him,
20 and for this we resort to a table of terrain data which
21 is incorporated within the computer to see whether, with
22 respect to hills, trees, bushes, this kind of thing,
23 side A has a clear view of side B, or an obscured view.

1 Whatever the outcome of that is, the next question is
2 what kind of weapons does side A have in view of his
3 visibility and what he has seen of his opponent. Does
4 he have the necessary ammunition, does he have people
5 with which to operate these weapons. Finally, after all
6 these questions are asked and answered on the basis of
7 data are stored according to the rules of the model which
8 the designers had built into this thing, there is a
9 statement as to what action took place, a certain kind
10 of weapon was used, or certain kinds of weapons and so
11 many rounds of certain kind of ammunition were used.
12 The probable outcome is then computed. That is,
13 he either made direct hit or a near hit, and inflicted
14 damage of this as such type of value, the amount of value
15 on the opposition. If it was a simulated night fall, the
16 side doing the attacking may not have had a good under-
17 standing of the extent of the damage inflicted on his
18 opponent, so there is a model to simulate his intelligence
19 for the terrain visibility conditions that apply at the time.
20 Obviously, the battle is an exchange of such
21 events and to return to question earlier, there is so
22 many of these questions and so much of the kind of data
23 referred to as terrain data, weapons data, ammunition

1 data, several of them that the computer cannot contain
2 them all at one time, so the programmer or the person
3 who organizes the sequence of computations and decisions
4 that are used to arrive at the result has got to figure
5 out how he can partition what is to him, logically a
6 whole thing into pieces and get it into the computers.
7 That's where my people come in, because it is -- it didn't --
8 it's hardly ever obvious how you can cut these things up
9 and how you can get them into the computers, and frequently
10 there is the problem of time. Even if you could get it
11 in, you have to be aware of the fact that there are a
12 variety of ways in which you can cut a problem into
13 pieces to make it fit.
14 If he runs out of time, obviously, it's an
15 ineffectual undertaking, so people in my department
16 provide the expertise, the knowledge of how computers
17 put together, how it works, and how those facts of
18 design of the computer can be exploited in the partition,
19 the optimum partitioning of the problem to fit it.
20 Q Do I take it that most of the work which RAC
21 has done has been on contract for the United States Army?
22 A That's right, most of it.
23 Q In characterizing the work, such as the battle-

1 field example, what is your primary purpose then under
2 the order which you have entered into, on the contract
3 which you've entered into with the army, in broad terms?
4 A. I would say that by far the bulk of the
5 motivation has been to find ways in which to measure,
6 to analyze, to discover, what has happened and how to
7 measure it. There is a classical parable, as I understand
8 these things, in battles that frequently the side that
9 wins doesn't know why it won, yet knows it won if they
10 have come to that point. But, what exactly did they do
11 that was related to the fact of having won, and this is
12 the kind of thing that frequently takes place at RAC and
13 the kind of thing that a computer does participate in,
14 in the attempt to be able to answer more accurately this
15 question. That is we will perform experiments with a
16 variety of different decision type of models. That is on
17 the assumption that certain types of activity have taken
18 place in the battle and this particular side has won.
19 We'll attempt to establish, in computer man's
20 word charistically experimentally by guess and gut trying
21 the relationship between the events that took place and
22 the outcome, so given one model of forecasting the out-
23 come of battle , there may be attempts, there will be

1 attempts to validate that by getting similar data from
2 a variety of battles in testing that particular model.
3 Q Can you give us examples of other work which
4 you have done at RAC, other than military models,
5 battlefield strategy, other types of work?
6 THE COURT: Before you leave this phase of it,
7 Mr. Williams, I wonder if you would, Mr. Cawgill, I
8 wonder if you could give us a specific example, not one
9 that has actually taken place, but one problem of the
10 actual question, the problem that has been posed to you
11 by the military, and tell us, specifically, what you do
12 in order to solve it and what results you -- in a few
13 words?
14 THE WITNESS: I missed some of your words, a
15 specific what?
16 THE COURT: Let me ask the question again.
17 Before we leave the subject that Mr. Williams has been
18 pursuing, so far as the military is concerned, I wonder
19 if you could give us a specific problem that might have
20 been posed to you so far as the details of it are
21 concerned, and the procedure you went through in order
22 to properly analyze the problem and give us the solution
23 you arrived at. I don't necessarily mean a specific

1 example, or an actual problem as such, but something
2 that could be hypothetical, that would be typical of
3 the type of work that you do that would exemplify the
4 type of work that you do in this field?
5 THE WITNESS: Just a bit of clarification, my
6 company or my department?
7 THE COURT: The Department we're concerned
8 with is Exemption of Taxation.
9 THE WITNESS: I refer to the partitioning
10 activity there and I think that is in the technical area
11 is typical of problems that confronts me and my department
12 in our computer work. And, if I generalize that any, I
13 would say that it's a question of where we are undertaking
14 what turned out to be computationally very large problems.
15 The question is how do we use the computer to
16 handle that, or recast the statement of the problem of
17 the inquiries so that it can exploit the characteristics
18 and capabilities of our equipment.
19 THE COURT: Let me interrupt you, let me take a
20 piece of your, suppose you would, if you would give me an
21 example of a particular question, or a particular problem
22 that would be posed to you by the military, or whoever
23 would submit the problem to you?

1 THE WITNESS: Find out what the characteristics
2 of the problem are and how to analyze and evaluate them,
3 when I say that I wish to be able to respond effectively,
4 militarily to the possibility of an outbreak of large
5 scale conflict, simultaneously, in several parts of the
6 world.
7 THE COURT: Do they give you a number of factual
8 situations that you would consider in connection with
9 that or do they leave that up to you to perform those
10 things?
11 THE WITNESS: That's left up to us, the problem
12 being for us to find out the ones which are of greater
13 significance. The only restriction being, we're in this
14 world, we live in this pretty much today as we understand
15 it might be in the future.
16 THE COURT: Could you tell me, very briefly,
17 then the things you are considering setting up
18 the program which you would put into your computer?
19 THE WITNESS: Setting up --
20 THE COURT: Tell me very briefly the things
21 that you would consider in setting up the program that
22 you would submit to your computer, or the information
23 that you would give to your computer.

1 THE WITNESS: That's a hard one to be brief
2 about. Organizing the, all of the data that are involved
3 about men, equipment, transportation capabilities,
4 weapons effectiveness, both ours and the prospective
5 enemy's, the amount of computation that probably has to
6 be performed in going from one point to the next on the
7 pathway to a statement of outcome, to see whether these
8 computation steps can be accommodated within the computer,
9 whether the data can be contained within it, and where
10 this partitioning phenomenon, that I spoke about earlier,
11 has to be applied or it should be applied in order to
12 assure us, and still achieving an answer at some point
13 in time.
14 BY MR. WILLIAMS:
15 Q. Mr. Cawgill, let me, perhaps, suggest this or
16 ask this question to clarify again with what Judge
17 Jennings was putting. Do you make the assumption or does
18 the army make the assumption that they have one division
19 composed of a regimental combat team and so many tanks,
20 so many machine guns, do you make that assumption, does
21 the army make the assumption, and what assumption is made
22 about air power, artillery, and so forth?
23 A. Typically, neither one of us make that assumption.

1 We know that these kinds of things would be considered.
2 What we do is come up with a reasoning processes, the
3 computation processes by which they can answer that
4 question for themselves.
5 THE COURT: In other words, you, in effect,
6 work out a formula for them, is that correct?
7 THE WITNESS: Yes, a formula which is usable,
8 that's typically a problem.
9 THE COURT: Do I understand it, once you have
10 assembled all this information that would go into the
11 computer, then the computations are made by the computer
12 and you, in turn, arrive at the formula and furnish
13 that back to the military or whoever submitted the problem
14 to you, is that correct?
15 THE WITNESS: After the formula is developed,
16 they operate, themselves.
17 THE COURT: But you submit the formula back to
18 them and --
19 THE WITNESS: Yes.
20 THE COURT: That would be the end result of your
21 work?
22 THE WITNESS: Yes.
23 THE COURT: Do I, further, understand that it

1 wouldn't be just a simple matter, and I'm sure that I'm
2 over simplifying it in this question and answer, but do
3 I understand that there would be a number of different
4 alternatives that you could submit to the machine which,
5 in effect, take an average, thus arrive at your formula
6 as such, or some type of interpretations as far as that's
7 concerned?
8 THE WITNESS: Yes, but I think more to the
9 point is the question of what are the alternatives, what
10 are the questions that are of greatest relevance to the
11 army, to be asked and answered. It's fundamental dilemma
12 is the possibility of conflicts as I've described.
13 THE COURT: I think I understand what you're
14 saying now. Do they ever, on occasion, submit a problem
15 to you and say that, on the 10th day of June we are going
16 to have a battle at such and such a location, what should
17 we do and how should we handle that situation, do they
18 ever ask you a specific question such as that?
19 THE WITNESS: No.
20 THE COURT: In other words, what you're doing
21 is to formulate a general sort of policy for them, or
22 general sort of formula for them that would be adaptable
23 to a number of situations, is that correct?

1 THE WITNESS: Yes.

2 THE COURT: Excuse me, Mr. Williams, you can go

3 ahead.

4 BY MR. WILLIAMS:

5 Q Mr. Cawgill, another example, have you had any

6 experience with aircraft characteristics, fuel load,

7 that sort of thing?

8 A Yes, indeed, there was in the early day of the,

9 days of the SST, for example, an inquiry made as to how

10 one would answer the question, is the SST economically

11 and functionally, from the point of view of the users of

12 this service, the right approach. The problem that we

13 looked at was to devise the methodology by which people

14 could answer that question.

15 This required doing such things as, well,

16 determining the obvious kinds of factors that you have

17 to have, air reports, and that you have to have fuel

18 supplies, and maintenance facilities, and you have to

19 have crews to operate the equipment, to maintain. The

20 question is suppose you had a well designed aircraft

21 system consisting of airplanes, airports, people, supplies,

22 all these good things.

23 The ultimate question is what would it look

1 like, where would the airports be, how would they operate,
2 how would the crews be assigned, and so on. This being a
3 new type of aircraft, the methods for arriving at these
4 answers were not known, well, they didn't exist. People
5 knew that, pretty well how to approach them. What we
6 did there was to devise the methodology by which these
7 questions could be answered. In that case, incidently,
8 the alternative course is conventional jet aircraft and
9 we did the analogist thing for them, that is devised the
10 methodology that will enable somebody to compute the
11 amount of fuel, at each of several locations, the amount
12 of spare parts needed, the number of crew personnel
13 required at several locations, develop this methodology,
14 test it with actual data sufficient to verify practically
15 that our formula would work.
16 Q Have you done any work in the field of health?
17 A Yes, there are a couple there. One was a
18 computerized system we used as a diagnostic tool, some
19 people called it as an aid to diagnosis, but it actually
20 did some diagnosis. The question is whether since a --
21 in diagnosing illnesses or injuries, a vast amount of
22 data have to be in the head of the person doing the
23 diagnosis. A computer could not be contrived or made to

1 handle these data and to intrepret them and give them
2 situations, so our inquiry was to establish whether we
3 could, as proven by a actual demonstrational operation,
4 come up with a computerized procedure for doing this.
5 We did undertake, we achieved some success
6 there. The resulting capability consisted of several
7 kinds of things -- you could type at a keyboard which
8 gave you a written record of what you asked the computer.
9 It would then go into the computer and say, a piece of
10 glass is in an automobile example, this is an actual case
11 that took place, of such and such dimension so long,
12 pointed, shaped like a long skinny triangle and hurt the
13 accident victim's body at such and such a point, and
14 exited from some other point, define by just erromatic--
15 question, what organs were, and what organs
16 probably were impacted by this piece of glass.
17 The computer did two things, number one, it
18 interpreted the sequence of words composing that question,
19 and from that inferred the location within the computer's
20 memory of the data which constituted the answer to the
21 question. That is, in that case, it's a matter of
22 searching anatomical encyclopedias stored within the
23 computer to find out, first of all, what is at the place

1 where the glass entered the body, and then to trace a
2 geometrical line or a plane since a cut with a sliver of
3 glass through the body, check off which blood vessels,
4 and which other parts in there were cut. Since you have
5 to deal with an average body, because its content
6 vary from individual to individual, the question has to
7 be answered, in part, probablistically, and you say, well
8 it may or may not have hit such and such a major blood
9 vessel, or the stomach, or depending on the pecularities
10 of the individual.
11 It could also respond to such questions as the
12 patient has a greenish palor about his face, his forehead
13 is sweating, he lacks consciousness, his respiration is
14 so and so, his heart rate is elevated to 120 per minute
15 or something like that, list the things that could be
16 wrong with him.
17 Q With the patient?
18 A Yes, with the patient. So again the thing
19 that this particular inquiry is the ability to infer from
20 the question what is the location of the information that
21 is relevant to it, to the extent that we exercise this
22 particular end result. We demonstrated that we have the
23 ability to let a machine do the interpretation of these

1 words, and go to the right place to look up the information.
2 A doctor does the same thing, if he knows about the
3 information. What we simulated was that part of -- the
4 doctor making his diagnosis. We had another one which dealt
5 with crib deaths, infants, as I understand it, frequently
6 will, just unexplainedly, die in their cribs.
7 They don't smother, they haven't been strangled,
8 they just suddenly die. The question is why, even more
9 to the point, what can be done about this. So, the
10 starting point was a couple of tape recordings of
11 breathing and heart beats of two infants taken down to
12 the hospital in Washington.
13 The question put to the RAC researcher was,
14 can you find, perhaps in these two recordings, which are
15 a sample of this phenomenon, some indication of the
16 possibility of some cardiac failure or impending death
17 by that infant
18 Second, if you can do that, can you come up
19 with a suggestion as to a characteristic of the device
20 that you could afford to build and sell the people,
21 which would enable them to monitor any individual baby
22 to see whether he is, perhaps, about to die.
23 Presumably, there is in the recordings of the

1 heart and breathing record of the infant, an indication
2 of impending cardiac failure. Can we detect it, could
3 we minimize it. The computer got to that one because of
4 the obvious need for speed. It does no good eight hours
5 after the baby has died for somebody to say, yeah, I can
6 tell that that particular point in his breathing and heart
7 rate, that he is going to expire soon. It has to be
8 timely, you have to give a warning. That one, like a
9 lot of research has yet to be implemented in an economical
10 of feasible device.
11 Q Mr. Cawgill, what part of the operations, if
12 any, would be classified in the terms operations research,
13 first of all, can you define the term, operations
14 research?
15 A I can't, it's a -- a lot of people do it, it's
16 a matter of looking at the mental or physical activities
17 of processes or procedures employed by people in their
18 attempt to reach decisions or judgments, and to discover
19 the aspects, the individual details of those processes
20 or procedures which are relevant to the decision. When
21 a voter decides for a particular candidate, the question
22 might be well, what does he really use as his decision
23 making mechanism.

1 Q. The question was raised by the Court earlier
2 relating to the question of business decisions, and
3 what you have testified here, today, as to what RAC
4 does. My question is this, is what RAC does more related
5 to methodology, or is it more related to the actual
6 decisions?
7 A. It's related to the methodology, in my
8 experience, they hardly, if ever, get involved in an
9 actual decision. That's done by our client, his problem
10 is he doesn't know how to answer his own questions, so
11 we show him how to use those answers for himself.
12 Q. Mr. Cawgill, does the term research and
13 development have any general connotation within the trade
14 in which you are engaged, so to speak. I call it a trade,
15 that might not be a fair categorization but that's the
16 shortest way to say it.
17 A. As in the kind of work RAC does, or the kind
18 of uses that are made of computers?
19 Q. Both.
20 A. Well, as a matter of fact, it's the same answer
21 applies to both.
22 Q. What is that?
23 A. Research or research and development consists

1 of finding out what new, useful questions are worth
2 answering and how do you answer them. I mean, you have
3 found out how to answer the question, well, then some-
4 body else can do that. With the example I used earlier,
5 for example the military wishes to know what is relevant
6 about, or what is our posture militarily, if certain
7 multiple, major conflicts break out across the face of
8 this earth.
9 The question in that case is, we know the end
10 result, or the end question is how do we survive. But
11 between that statement of the situation of its -- that
12 effects survival of the decision is to whether you can
13 survive it or not, there is a multiplicity of detailed
14 questions that have to be identified which he will then
15 have to answer. And, our research in that case is
16 mainly finding what questions are of relevance to the
17 end objective that should be answered and where there is
18 not a methodology or a knowledge of how to answer them
19 to supply that as well.
20 Q Would you state whether, in your opinion, as
21 an expert, whether the work which is being done by RAC
22 constitutes the research and development work as applied
23 to this computer?

1 (Objection.)

2 * * *

3 BY MR. WILLIAMS:

4 Q Mr. Cawgill, based on your training and
5 experience within the scientific community, and with the
6 use of computers, will you state whether or not you have
7 formed an opinion as to whether or not the use of these
8 computers at RAC, as you have described it, is research
9 or development within the commonly accepted usage of
10 that term. My question is have you formed an opinion?

11 A Yes, indeed.

12 Q What is that opinion?

13 A That it is predominantly research or research
14 and development.

15 Q My next question is with the same premises, your
16 broad background and experience, do you have any opinion
17 as to what constitutes research in the laboratory sense,
18 or in the experimental sense?

19 (Objection.)

20 * * *

21 BY MR. WILLIAMS:

22 Q Mr. Cawgill, will you define the term laboratory
23 as applied to the use of the computer?

THE COURT: So far as its ordinary meaning, as

1 far as Mr. William's expression in the trade.

2 THE WITNESS: I would say it denotes a, a

3 facility, established design for, with certain capabilities

4 and characteristics selected for the conduct of some

5 kind of inquiry or investigation, the conduct of research.

6 By way of contrast, I can point out, that many computer

7 facilities are set up so that they are ideally arranged

8 to handle the user's accounting problems. They are

9 located near the comptroller's office, doors and windows

10 are designed to enable appropriate security monitoring

11 for this type of application to facilitate the transfer

12 of data which they control and use on the computer to

13 facilitate return paychecks, invoices, reports, et cetera,

14 to him.

15 A computer laboratory, on the other hand, to

16 return to my original narrative, is going to be located,

17 designed, facilitated to the use by people who are

18 doing research. It will have attributes, characteristics

19 which are appropriate for that which --

20 Q You have partially answered this question

21 before, but I want to make it clear. I understand in

22 comparing the laboratory in the conventional sense of

23 the word, and the computer about which you have

1 testified, can you state briefly the advantages and
2 disadvantages of each?
3 A. Would you say that again.
4 Q. In comparing conventional laboratory on the one
5 hand, scientific laboratory on the one hand, with the
6 computer and it's use on the other, can you tell us
7 briefly the advantages and disadvantages of the
8 computer versus the conventional laboratory?
9 THE COURT: That's the computer by itself?
10 MR. WILLIAMS: Yes, sir, the characteristics
11 and the way they operate.
12 THE WITNESS: The disadvantages, if it had any, w
13 would be that it impeded the inquiry of people attempting
14 to the inquiry in research. I don't think I get you yet.
15 BY MR. WILLIAMS:
16 Q. For instance, do you -- in the laboratory, you
17 customarily build a model, do you not?
18 A. Yes, indeed.
19 Q. In an ordinary conventional laboratory, if you
20 want to conduct an experiment, you will build a model,
21 will you not?
22 A. Yes.
23 Q. A physical model?

1 A Yes.

2 Q Do you do that with a computer?

3 A I think that's fair to say, of course, it's

4 not a tangible model, a creation of thought and reasoning

5 that can be implemented by arithmetic and logical

6 decisions, and once this has been done, then --

7 Q Which would be the better model if you had

8 your druthers?

9 A If I could build it, I'd always be impressed,

10 but one cannot build an SST to see whether it can -- how

11 it will perform, economically and functionally. It has

12 to proceed this with some sort of, if you will, paper

13 description of how it would work if it existed.

14 Q Are you saying that the computer model of the

15 SST is a more accurate reflection of what will happen

16 than a physical model in a laboratory?

17 A No, it's --

18 THE COURT: I think he said the opposite, did

19 you not? That is the physical model itself would be

20 more desirable than the situation, if you use that term

21 properly.

22 THE WITNESS: I think it is more desirable in

23 the sense that most people will prefer to trust the

1 actual, tangible thing, if they have a choice. The
2 person designing the model is a competent man and his
3 competence is understood, will find the model perfectly
4 acceptable and, in any case, it's much faster and much
5 cheaper.
6 BY MR. WILLIAMS:
7 Q Mr. Cawgill, to what extent would you say, if
8 any, the use of the computer at RAC would constitute basic
9 research, for example?
10 A I wouldn't mind saying that it's mostly, it
11 seems to me, that it is, it participates in inquiry of
12 that quality of novelty and intellectual difficulty.
13 THE COURT: I assume your question, in effect,
14 is what percentage is used in basic research?
15 MR. WILLIAMS: In broad terms, yes, Your
16 Honor. What percentage, if you could say that percen-
17 tage?
18 THE WITNESS: Three quarters.
19 THE COURT: As distinguished from what?
20 MR. WILLIAMS: As distinguished from any other
21 kind of use, I haven't asked him that.
22 THE COURT: Basic research as compared to
23 advance type research.

1 MR. WILLIAMS: I was going to ask him about
2 advance technology as the next question.
3 (Objection.)
* * *
4 BY MR. WILLIAMS:
5 Q Next, Mr. Cawgill, what about the usage within
6 the trade, to what extent would you classify the use
7 of the computer at RAC, as advanced thechnology?
8 THE COURT: As distinguished from basic
9 research.
10 MR. WILLIAMS: As distinguished from basic
11 research, yes.
12 THE WITNESS: It would be relatively minor.
13 BY MR. WILLIAMS:
14 Q Relatively minor?
15 A Yes.
16 Q Could you state a percentage arbitrarily or not?
17 A In reflection I would probably regret it.
18 There are some examples, but I'd regret trying to quantize,
19 it's bound to be small.
20 Q Can you state to what extent, if any, the
21 computer at RAC is used for research and development for
22 improving existing products?
23 A I couldn't quantize that, but it's very small.

1 Q To what extent, if any, is it used for research
2 and development for new uses for existing products?
3 A That's going to be fairly sizable. Actually
4 the first thing was probably understated. The case -- I
5 can recall a case in which the question was trucks. The
6 army has an enormous fleet of trucks of many, many
7 different types, and it's a big financial, and functional
8 problem with them to know how many of what type to have,
9 and we did make, construct it, if you will, a model of
10 the army use of trucks for the kinds of function
11 and the amount of function, and were able to participate
12 in the -- thereby in their evaluation of the kind of a
13 new truck that they required.
14 This vehicle, for example, the trailer could
15 articulate not only bend this way, relatively with the cab,
16 but rotate, and it could swim, so it's small but not -- let
17 me say not very small,
18 Q Your answer was in answer to my question about
19 research and development of new uses for existing
20 products that that was quite extensive, did I understand
21 you correctly?
22 A Yes, that's fairly sizable, yes.
23 Q Lastly, what about the research and development

1 on the RAC computer of new products, as opposed to new
2 uses or improving existing uses?
3 A. If we are talking there about this concept of
4 methodology, it's the enormous bulk of our activity.
5 Q. That is the what?
6 A. The enormous bulk of the use of the computer
7 is on behalf of that kind of work.
8 MR. WILLIAMS: No further questions, Your
9 Honor.
10 CROSS EXAMINATION
11 BY MR. DAVIS:
12 Q. Mr. Cawgill, Mr. Williams asked the question
13 that we pulled up short and answered, but would you
14 characterize the basic nature of your work as operations
15 research?
16 A. The company's is -- my work as head of the
17 computer department is --
18 Q. This is a distinction you're making you perform
19 or you get the computer to perform its service as
20 required by other people in the company, is this a
21 correct statement?
22 A. I would prefer the word assist, it's theirs to
23 use. The problem is of filling in the occasional gaps of

1 knowledge, and of course at the end of that operation,
2 there are people that are pushing the buttons that make
3 it go.
4 Q But you're making a distinction, for example,
5 that your function is distinct, the last day of function
6 to the line, if the line of the company is deemed to be
7 operation research, you are staff assistant to the -- are
8 you the staff assistant?
9 A Yes, sir.
10 Q When the company is approached with an
11 operations research problem, it will utilize the computer
12 in resolving the problem or in defining the problem,
13 perhaps --
14 A This is not necessarily known in the beginning,
15 it frequently turns out to be the case which is why it is
16 there, of course. There is nothing in the beginning of
17 that process that says we're going to use a computer.
18 Q We discussed the situation with the army and
19 the game theory, or competitive strategy situation, in
20 which you constructed a model or theoretical model and
21 tried, I guess, boxed it in so that you could figure out
22 what the variables were, is this the same type of
23 process that General Motors might go through as an example

1 in trying to decide its competitive market?

2 A. There is a similarity there, but the thing that

3 we do is develop the mechanism by which the user can

4 make those decisions for himself. As I think I said

5 earlier, we extremely seldom are involved in the use of

6 the device beyond demonstrating with practicality

7 that it performs the assigned task, and I would say

8 therefore that the similarity with the situation you cite

9 is slight.

10 Q. You could perform the same service for

11 General Motors to tell them how to evaluate their auto-

12 mobile market?

13 A. Yes, indeed, I could, I could, and this is based

14 on the fact that I have some experience in devising

15 procedures by which he is going to make his decisions.

16 Q. So the development of the procedures for

17 General Motors to make the decision, the type of thought

18 process that goes--the intellectual endeavor that go into

19 your creation of the program for the army is the same

20 type of --

21 A. No, you're getting tangled up over the matter

22 of how you answer a question, how do you go about answer-

23 ing a question and then what other activities you engage

1 in in answering the question. The General Motors
2 situation, the analogy is there's some kind of a gaming
3 theory that is relevant to the concept decisions that
4 I have to make. If they were to come to RAC with this
5 kind of question and say will you work on it for us, the
6 answer would be yes, if what they are after is an answer
7 to the question of what is the procedure by which you
8 can answer these questions, can you come up with the
9 procedure. If they were to ask us to answer the questions
10 on marketing strategy so their design strategies,
11 production strategies, we almost certainly would not
12 have anything to do with it.
13 Q You mention with the SST, the work you did on
14 the airports, and this type of work, how about financial
15 planning involved in the whole SST operation, were you
16 involved in this?
17 A We were involved in financial planning in this
18 way, -- that it is recognized that the financial aspects
19 of that program are of great importance to the yes or
20 no decision, and the model by which money aspects can be
21 measured had to be devised, and we did, indeed, devise
22 that model.
23 Q What is advanced linear programming?

1 A. Advanced --

2 Q. Linear programming.

3 A. I hate to dwell on advanced, but I can tell

4 you that linear programming is the term used to describe

5 the mathmatical procedure which has a characteristic

6 that you have many mathmatical, algebraic equations, just

7 as one might have in high school, algebra II equations,

8 and two unknowns, X plus Y equals two, X minus Y equals

9 five, find the value of X and Y.

10 Linear programming deals with many

11 such equations, but with the important distinction that

12 there are far more unknowns than there are equations, in

13 our place, for example, the typical challenging linear

14 programming problem may have two or three thousand

15 variables in it, and five hundred to a thousand equations,

16 and the problem is that those equations define the

17 relationships among the variables, such as a man might

18 have a relation between his bank account and solvency.

19 His wife may be taking money out, and people

20 putting money in, and so on. Then there's a final very

21 important equation which discribes the value or signi-

22 ficance of the values of all these unknowns, and one

23 seeks to find a set of values for the unknowns, whose

1 inner-relationships are defined by these many equations.
2 Those equations must hold such that this final evaluation
3 equation, if I many call it that, has a maximum or
4 minimum, some sort of optimum value. I think if I may
5 slide away from what is linear program, now, I would say
6 that advanced is an emotional term used to suggest some
7 partitioning between very difficult computationally and
8 logically, and not so difficult computationally and
9 logically.
10 Q. I'm trying to again draw the distinction between
11 your particular work and the company's work, whether the
12 company, itself, is doing operations research, would you
13 utilize often on your computer, advanced linear programming
14 in the solving of a problem, or again in the setting up
15 of an equation situation?
16 A. Yes, indeed, it's a major technology exploited
17 by our model builders. It was a fee motivation causing us
18 to change from our previous computers to our present
19 ones three and a half years ago. The fact that the kinds
20 of models we were getting into required a far greater
21 capability of this type than the computer we had at the
22 time could handle. The problem is to find one that
23 could handle it. My problem was to find it.

1 Q I want to clarify the meaning of the terms
2 you used, or Mr. Williams used, in asking you questions
3 earlier when he referred to basic research, you were
4 construing this to include the development of mathmatical
5 formuli?
6 A Yes.
7 MR. DAVIS: That's all.
8 THE COURT: Any further questions, Mr. Williams?
9 MR. WILLIAMS: No further questions, Your
10 Honor.
11 THE COURT: You may step down.
12 (Witness excused.)
13 Whereupon
14 GEORGE A. MCALPINE
15 a witness, was called for examination by counsel on behalf
16 of the plaintiff, and, after having been previously duly
17 sworn, was examined and testified as follows:
18 DIRECT EXAMINATION
19 BY MR. WILLIAMS:
20 Q Would you state your name, residence, occupation,
21 and title, please?
22 A My name is George A. McAlpine, I live at 120
23 Overlook Drive, Charlottesville, Virginia, my position

1 is associate professor, Electrical Engineering and
2 Directing of Research Laboratories for Engineering
3 Sciences, University of Virginia.
4 Q. As the director of that office, that encompasses
5 not only the School of Engineering but all of the sciences
6 involved in that title, the University?
7 A. No, it's limited to the School of Engineering
8 and Applied Science.
9 Q. Can you tell the Court briefly, Dr. McAlpine,
10 your education, and training, and experience to date,
11 please?
12 A. I received my Bachelor of Electrical Engineering
13 Degree at the University of Virginia in 1957, Masters of
14 Electrical Engineering at Stanford, 1961, Doctor of Elec-
15 trical Engineering at the University of Virginia 1967.
16 From 1957 to 1964 I worked in various industries,
17 primarily, the aerospace industries, and from February
18 1964 to date, I have been at the University.
19 Q. When you speak of the aerospace industries,
20 can you tell briefly what you did in those industries?
21 A. I was known as a systems engineer which is
22 sort of a catch-all title, working for the Martin Company
23 in Orlando, Florida; Sylvania Electronic Defense Laboratories

1 in Mountain View, California, the Sperry Piedmont
2 Company, which is now the, Sperry Marine Division at
3 Charlottesville, working primarily in the area of
4 electronic systems, design and analysis.
5 Q. Would you describe your experience, if any,
6 with the use of computers?
7 A. My experience with computers has been strictly
8 using them as a tool in my own research in the field of
9 electrical engineering. I have studiously avoided
10 learning too much about how they operate or anything else
11 so I could remain objective about their use, so I am not
12 a computer expert as such, but I do know how to use
13 them and when not to use them.
14 Q. Would you clarify that a little bit as to why
15 you made that point?
16 A. Just in many situations the computer is not the
17 applicable tool to use. For example, if you had a
18 calculation to make and you didn't want an accuracy of
19 seventeen decimal places, use a slide rule, or count on
20 your fingers, or punch an adding machine.
21 Q. You're saying that the computer does have
22 limitations?
23 A. Very definitely.

1 Q. Can you describe those briefly?

2 A. Well, there are, I suppose, two fundamental

3 types of limitations. One is where the computer is just

4 too powerful a machine for the use you want to put it to,

5 such as using it as an adding machine, and this is one

6 of my objections to it, people tend to forget how to

7 think for themselves when they use the computer too much.

8 The other thing is applying it in situations

9 where the nature of the computer itself inhibits the

10 revealing of the truth about the problem you're involved

11 with, and just many instances where you have to be very

12 careful about how you use the computer and that the

13 results, the computer itself affects the results and

14 you have to know that beforehand.

15 Q. What about the advantages, if any, of the

16 computer as a tool?

17 A. The primary advantage of the computer, of

18 course, is it's great speed in which it can do fairly

19 simple operations, and that is the primary advantage of

20 the computer since the computer, itself, is a man made

21 device. Obviously, I think man can do everything if

22 given enough time, but the computer can do -- the main

23 advantage of the computer is that it can do these things

1 maybe a million times or ten million times faster than a
2 human can do them.
3 Q. Can you draw a comparison between the computer
4 and the use of the computer in the building of physical
5 models, for example, in a laboratory?
6 A. Yes, in the University setting we have come to
7 the point where the use of the computer as a laboratory is
8 beginning to become an accepted practice. Many years ago
9 engineering thesis and disertations, for instance, required
10 the actual experimental production of a piece of hardware,
11 and measurements made in the laboratory on it and so forth.
12 I would say in the past ten years, this has
13 changed drastically and except in very rare instances
14 where we are actually dealing with physical devices in those
15 areas where we are dealing from, primarily with systems.
16 The systems are no longer built and tested in the labor-
17 atory, but they are simulated on the computer and the
18 computer becomes the laboratory for the testing of the
19 theory, developed, and so forth.
20 Q. How would you compare the accuracy of the
21 computer where that is done, for example, with a model?
22 A. Well, there are certain trade-offs, of course,
23 the model has some advantages, in that it has reality.

1 The computer, on the other hand, has a great deal of
2 flexibility. Once you build a piece of hardware, build
3 a physical model, you're stuck with the way it was
4 designed and put together. The computer, on the other
5 hand, can be readily programmed to put in changes after
6 the fact, you can fiddle with it and tune it and play
7 with it and get different results. And, by proper
8 programming you can, in effect, bring about the same
9 laboratory conditions as if you built many, many physical
10 models, rather than just one by simply repeating the
11 experiment with different programs.
12 Q. What you're saying is with proper application
13 of the computer with these refinements can be more
14 accurate than one physical model can be?
15 A. It can give you more information about the
16 physical situation you're interested in, or the system that
17 you're interested in designing.
18 Q. You mentioned something about the use of
19 computers at the University of Virginia, is this exten-
20 sively or not extensively used amongst the students
21 there and the faculty?
22 A. We have three fundamental computers at the
23 University which the engineering school is involved with,

1 two at the Computer Science Center, one being the CT 460400
2 the same as at RAC.
3 Q CD 460400 at the University, is that the same
4 type as at RAC?
5 A It's the same manufacturer.
6 Q The so called 65?
7 A We also have the Burroughs 5500 which is the
8 predecessor of the CDC 6400. We also have the small unit-
9 packer time sharing system that is contained in the Engineering
10 School, itself. And, all undergraduates are taught to
11 program and solve problems on this machine, and it is
12 becoming, to some extent, a replacement for the slide rule
13 in the operation. However, we hope that people will not
14 get to the point where they will use $100,000 computer
15 every time they could use a $15.00 slide rule.
16 Q Can you give us some examples of the use of
17 the computer at the University of Virginia?
18 A Well, I can give you some examples from my own
19 experience and my knowledge of other parts of things that
20 goes on, things that go on in other parts of the school.
21 Start with my own personal experience with the
22 computer, we had, a couple of years ago, a research task
23 from General Electric in Lynchburg to do some research in

1 digitalization of the touch tone telephone which is
2 the Bell Labs, they wanted us to do the necessary research and
3 development, digital, completely digital design and to
4 perform some tests. So, we did the design using the
5 computer in the design process. We then took the design
6 and implemented it on the computer, with the assimilation
7 of the equipment that we would have built in the labora-
8 tory, simulated the telephone channels and the words and
9 signals on the telephone channel and then tested the
10 device under certain conditions to see how well our design
11 functioned in a realistic situation.
12 In other areas that I'm not personally
13 involved in, we have people in the bio-medical engineering
14 field which is -- who are using the computer to model the
15 oxygen transport system within the human body as a
16 transportation system.
17 They are taking operations research approach to
18 this problem to try to determine how oxygen gets trans-
19 ported through the body, and what we can do to critically
20 ill patients to improve their oxygen transport and
21 so forth.
22 Also, in the medical field we have done much
23 the same type of thing that Mr. Cawgill talked about,

1 about the monitoring the critically ill patients and
2 the diagnosis of those patients from computer data. We
3 have also done some studies in terms of transportation
4 systems. The Village Tiel and Dye preparation in
5 Charlottesville asked us to look at the problem about how to
6 optimically fly a tanker from one point to another.
7 carrying gasoline, in such a way that would minimize
8 the fuel use.
9 This is a problem of optimization which one
10 of our electrical engineering faculty members checked
11 and used the computer and coming to conclusions
12 about optimal ways in doing this, and in essence, this
13 would result eventually in the design and production, I
14 suppose, of a flight computer which would probably be
15 on board the tankers themselves to put in the
16 use of the situation, tell them what other optimal
17 projectories.
18 Q Has it been used in connection with cancer
19 research?
20 A Yes, I'm not familiar with that research
21 personally, but I understand it is being used though.
22 A recent issue of the Alumni News, talked about it a
23 little bit.

1 Q Do you know whether or not the computer was
2 used in connection with the Apollo project?
3 A I'm certain it was, both in the design and the
4 hardware, itself, and plotting the projectories for the
5 flight to the moon, and, as I'm sure you're aware of,
6 they run simulations on computers here in the United
7 States of the entire flight while it is in progress so
8 that when something goes wrong, like it has on the last
9 couple of times, they can tell through simulations exactly
10 where the problems are and give advice to the astronauts
11 as to how to circumvent the problems.
12 As a matter of fact, that happened on the most
13 recent flight of Apollo.
14 Q Based on your training and experience, would
15 you give the Court, please, a definition of the term
16 research and development?
17 A I have to give you definition from my perspective,
18 as to actuve research in the School of Engineering.
19 It is part of my job to make sure we stay within the
20 area of research and development, so we don't infringe
21 on industrial activities. Basically, we look on
22 research and development, research, first of all, in
23 about three stages, pure research, applied research and

1 development. Pure research is just the search for
2 fundamental truths about nature and the relationship
3 between things in nature, with no real motivating
4 force behind it, other than the search for truth.
5 Applied research, on the other hand, is the
6 same type of intellectual activity, but usually motivated
7 by the need for the answers to the questions.
8 Development, on the other hand, is taking the store of
9 scientific knowledge that exists today, the results of
10 research if you will, and through intellectual
11 activities developing solutions to problems. I must
12 keep the problem in there because I'm an engineer, that's
13 the difference between the scientist and an engineer.
14 An engineer is concerned with solving problems
15 so the development is the activity where we take the
16 basic scientific information that exists and apply it to
17 the solution to the problems. If it--what we don't do
18 is the product development type work or the product
19 improvement type thing, we don't build more than one of
20 anything, and so forth, and we try not to make a profit.
21 Q Would you define, please, for the Court the
22 word, experimental?
23 A In my view experimental or an experiment is one

1 where an engineer or a scientist takes a result of this
2 purely intellectual activity, and then tries to put it
3 into the real world, the physical world which may be a
4 computer. An experiment, if I may use the word, in
5 defining the word in the application of the results of
6 his intellectual activity to the particular situation
7 that he's concerned with, that's the running of a
8 solution or a problem to see if it really is a solution
9 to the problem.
10 Again, I have made that problem oriented, that
11 is not entirely necessary, and for instance, in it's
12 scientific endeavors, an experiment may be carried out
13 to prove the fundamental knowledge of the experimenter
14 and what he is working with. This may also be done in
15 what problems that are worked on with a computer.
16 Q At my request, did you go and make a visit,
17 make an examination of the operation at Research Analysis
18 Corporation, particularly of the computer there, as it's
19 described?
20 A Yes, I did. I must say, though, it was not
21 extensive. I was there one afternoon and I had read a
22 report on the activities of RAC with the army, and so I
23 have a--thus my industrial experience leads me to think

1 that I have a pretty good characterization of the kind of
2 organization they are and what they do.
3 Q Based on your experience and training,
4 Dr. McAlpine, have you formed an opinion as to whether
5 or not the operation of that computer at Research and
6 Analysis Corporation constitutes research and
7 development?
8 (Objection.)
9 * * *
10 BY MR. WILLIAMS:
11 Q The question, Dr. McAlpine, is, does the operation,
12 in your opinion, based on your experience and training,
13 operation at RAC on the use of the computer constitute
14 research or development?
15 A Yes.
16 Q Aside from your opinion as an expert, would you
17 say whether or not that use at RAC of that computer would
18 constitute research or development within the trade
19 usage of the term research or development?
20 A Yes, I would characterize RAC's operation as
21 being primarily in the field of operations research,
22 which is, in my view, a valid enterprise in the research
23 and development field.

1 Q. In your opinion as an expert, would the use
2 of the computer at RAC constitute either research or
3 development in the experimental sense or the laboratory
4 sense?
5 A. Yes, in the same sense that we use the
6 computer in the experimental and laboratory sense at the
7 University. Instead of doing physical experiments, we do
8 simulated experiments with the computer.
9 Q. Does the same answer apply to trade usage,
10 that is the use of the computer RAC in research or
11 development in the experimental or laboratory sense,
12 aside from your opinion as an expert?
13 A. Yes, I would say this is the case.
14 MR. WILLIAMS: No further questions.
15 CROSS EXAMINATION
16 BY MR. DAVIS:
17 Q. Dr. McAlpine, excuse me for starting at the
18 beginning, but you left me. I don't know what a system is.
19 A. That's a hard thing to define in accurate
20 terms of -- a system is any group of things, people,
21 materials, resources, brought together to accomplish a
22 purpose, I would say. For instance, your body is a
23 system, the telephone system is a system, the P.A. system

1 is a system, the judicial system, and so forth.

2 Q Intellectual concept?

3 A Is a system an intellectual concept?

4 Q No, is intellectual concept a system?

5 A Perhaps a logical system.

6 Q You testified that you use operations research

7 techniques in your research and development which you do

8 carry on, you are then familiar, generally, with

9 operations research?

10 A Very generally, but do not claim to be an

11 expert in operations research.

12 Q But, you view operations research as a technique

13 which may be implied in this context or that context?

14 A Yes, in the same way that I view mathmatics

15 as a technique that may be applied in a given situation.

16 It is a discipline, in the University sense. It is a

17 discipline which is coming to its own the last twenty

18 years or so.

19 Q So a physicist may use mathmatics in performing

20 an experiment in physics, although mathmatics is not of

21 itself a physical science?

22 A I don't know whether I'd agree with that or

23 not. You'd have to define what you mean by physical

1 sciences. I would include mathmaticians in the physical
2 sciences.
3 MR. DAVIS: I think I'd better stop then, no
4 further questions.
5 REDIRECT EXAMINATION
6 BY MR. WILLIAMS:
7 Q Dr. McAlpine, an objection was made by the
8 Attorney General's Assistant to my use of the term of
9 research and development, but I find my friend, using
10 precisely the same terms. I want to go back one more
11 time, I put the question to you in perhaps an equivical
12 way about your opinion of what constitutes research and
13 development at RAC and I may have said research or
14 development. Would your answer be the same if it were
15 research and development, the plural of the relating
16 to the operation at RAC, as you have testified earlier?
17 A As you say in the trade research and develop-
18 ment has become one word. However, there are distinctive
19 differences between research and development, but in the
20 general context of what people think of when they ask
21 you what field you're in, usually it's research and
22 development all one word, so it's hard to differentiate
23 between the two in the general meaning of the word.

However, there is a difference. For instance, most of the faculty researchers at the University would not like to be called developmental engineers, they would like to be known as research engineers.

Q The questions that I asked you related to specifically, the operation of RAC, what in your opinion whether that constituted research and development. Your answer was research or development, and your answer was yes,-- whether it's research and development or research or development?

A My answer would be the same.

MR. WILLIAMS: Thank you.

RECROSS EXAMINATION

BY MR. DAVIS:

Q Do you think that some of the-- your associates at the University of Virginia to whom you have just referred who do this type of work, might not like to be called, engaged in development work?

A I don't understand your question.

MR. DAVIS: I withdraw the question.

THE COURT: Any other questions? You may step down.

(Witness excused.)

* * *

SALES AND USE TAX RULES AND REGULATIONS

§1-92. Research and development.—The tax does not apply to tangible personal property purchased for use or consumption *directly and exclusively* in research and development *in the experimental or laboratory sense.* Such research and development does not include efficiency surveys, management studies, consumer surveys, economic surveys, advertising, promotions, or research in connection with literary, historical or similar projects.

The exemption set out in this section does not apply to equipment and supplies used for production line testing and quality control, but in the case of a manufacturer or processor these items are classified as exempt production items under § 1-63.

All costs involved in research and development are not exempt. Only tangible personal property used or consumed directly and exclusively in research and development in the experimental or laboratory sense is exempt. Laboratory equipment and repair parts are exempt. All expenses in building and maintaining facilities used in research as well as clerical desks, typewriters, etc., used in administering research work are taxable.

Types of projects which qualify as research and development include: (a) Research and development of new products; (b) research and development of new uses for existing products; (c) research and development for improving existing products; (d) research and development in advanced technology; (e) basic research.