MEMORANDUM ON THE M.I.T. DIFFERENTIAL ANALYZER

by

F. M. Verzuh

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Memorandum on the M.I.T. Differential Analyzer

1.0 INTRODUCTION

This memorandum is prepared with two objectives in mind. First, a brief historical background of the Rockefeller Differential Analyzer (RDA) is presented together with specific comments pertaining to the development period and pertinent factors associated with its operation during the past twelve years. Second, the recent dismantling and disposition of the RDA is described in some detail. In the discussion of the above items, frequent reference will be made to several memoranda which have been prepared on the machine during the past decade.

I think it is important that the Rockefeller Research Foundation be properly informed of the disposition of the Differential Analyzer since they were so helpful with financial contributions during its formative years.

2.0 HISTORICAL BACKGROUND OF THE ROCKEFELLER DIFFERENTIAL ANALYZER

The original design and development of the Differential Analyzer was initiated early in 1936, and several of the basic features of the machine were determined at that time. Specifically, the design of the servomechanism system which was used to interconnect the components of the machine was developed during that period. This is mentioned simply to indicate that during recent years some of the maintenance problems associated with the RDA were occasioned by the particular servomechanisms which were employed. These were vintage 1936, and as such, were not competitive with post-World War II servomechanism design.

The original Center of Analysis was formally organized by Professor S. H. Caldwell in July, 1939 with the aid of a grant of $30,000 from the Carnegie Foundation. During its early, formative years, the Center existed largely on grants from the Rockefeller Foundation, Electrical Engineering Department, and other sources; and it was not until 1942 that the RDA was finally placed into operation. Beginning at that time, the RDA provided a source of financial revenue which assisted in the formulation of a self-supporting regime.

During 1941, the activities of the Center (under the direction of R. Taylor) were expanded to include a large battery of desk calculators and associated personnel who were well advanced in the use of numerical analysis techniques. At that time, the Center contained 3 principal types of facilities:

1. The Differential Analyzer facility consisting of 2 machines:

    a) The original 6-Integrator Differential Analyzer,
    b) The new Rockefeller 18-Integrator Electromechanical Differential Analyzer.

2. The IBM Punched-Card Section,

3. The Hand Computing Group (which employed desk calculators for computational purposes).

During the war years 1942-45, the staff of the Center was increased to approximately 50 people. Because of the large volume of war-time computational activity (3-shift operation, etc.), this self supporting type of operation resulted in the creation of a financial reserve fund of over $40,000.

Professor S. H. Caldwell returned from his NDRC assignment in 1945 and again assumed his former position as active Director of the Center. The post-war years 1946-47 had a devastating effect on the previously-mentioned financial reserve. The volume of computational work was sharply curtailed during this period, but the operating staff of the Center was not materially reduced. As a consequence, the two-year period 1948-49 were very trying years from the financial standpoint; and during this period, the IBM Group and the Hand Computing Group were separated from the Center.

In March, 1948, F. M. Verzuh was placed in charge of the punched-card group. After a period of reorganization, it appeared that the loss of one of the principal clients of the IBM services, the A. D. Little Company, would create a serious operating deficit in the punched-card section. As a result, a decision was made to discontinue the punched-card section, and a letter terminating the existing IBM machine rental contract was sent to the IBM Corp. in May, 1949. Fortunately, Dr. Stratton learned of the situation in time to prevent dissolution of the group, and at his direction, the IBM punched-card facility was reactivated on July 1, 1949, and the group began operation as a separate computing facility under D.I.C. sponsorship. Finally, on July 1, 1950, the Administration set up the IBM group as an Administrative Office -- the Office of Statistical Services.

It also became apparent that the original 6-Integrator Differential Analyzer was no longer required at M.I.T., and consequently it was presented to Wayne University in July, 1949 where it is still in operation. Early in 1949 the Differential Analyzer Group (the last remaining section of the Center of Analysis) was about to be dissolved because of financial difficulties. Fortunately, in June, 1949, a contract was initiated with the U. S. Air Forces which provided the necessary financial assistance needed to continue its operation. In July, 1949, F. M. Verzuh was also placed in in charge of the RDA group and was faced with the problem of hiring a new operating staff. (The former group of Messers. J. L. C. Löf, H. Morash, G. Kunstadt, M. Coate, etc. had been released.)

A new operating staff consisting of Messrs. J. M. Ham, and H. E. Grossimon were hired and trained, and the new RDA group consisting of Professor Caldwell, Messrs. M. Forbes, L. E. Frost, J. E. Goos, H. E. Grossimon, J. M. Ham, F. M. Verzuh and Misses E. Collins, S. Conway, and E. Tamm experienced an effective year which resulted in the following major additions to the RDA:

1. Three new four-shaft units were constructed which increased the adder capacity of the RDA by 85%.[1]
2. The design and construction of two automatic curve followers was completed, and these were used as input units on the RDA.[2]
3. The design and construction of the Vector Unit was completed. This unit increased the functional capabilities of the RDA.[3]

Additional details of the work performed during this period under Air Force Contract are given in the Summary Reports which were submitted as part of this work.[4,5]

The official termination date of the Air Force Contract was September 30, 1950. However, it became apparent prior to July 1, 1950 that the operation of the Differential Analyzer would again be in financial difficulty. Consequently, the Institute decided to close down the Differential Analyzer as of June 30, 1950. Again the operating staff was released, and the E. E. Department permanently severed all responsibility for the Differential Analyzer. The machine was about to be scrapped when Dr. Draper, Director of the Instrumentation Laboratory expressed interest in its possible operation. When he learned that it only cost approximately $25,000 a year to operate the facility, he indicated that the Instrumentation Laboratory would assume full responsibility for all RDA operation as soon as the existing Air Force Contract was completed.

At this time, it was realized that the principal uncompleted work on the AMC contract was confined to the operational staff and not to the RDA Machine Shop. Consequently, the responsibilities of the RDA Shop were transferred to the Instrumentation Laboratory on July 1, 1950.[6] In this manner, the Laboratory was able to utilize the services of the 3 Instrument Makers and all of the shop facilities for the production of gyro and other delicate mechanisms for the Laboratory.

During the remaining three months of the AMC contract, namely July-September, 1950, the operating staff of the RDA was engaged in the completion of work requested by Wright Field, the preparation of final technical reports required under this contract, and the completion of outstanding Center of Analysis commitments requiring the use of the RDA. Hence, it was not until October 1, 1950 that the Instrumentation Laboratory assumed the responsibility of the operation of the entire RDA facility.

At this time, F. M. Verzuh agreed to supervise the operation of the RDA for the Instrumentation Laboratory. Since the Electrical Engineering Department staff assigned to this project had been reassigned to other projects within the E. E. Department, effective July 1, 1950, (Professor S. H. Caldwell, J. M. Ham, and H. P. Grossimon), it again became necessary to hire a new operating staff. Two new men (Messrs. I. Pfeffer and R. Fredrickson) were hired and trained in the techniques of the RDA operation, and in several months they were able to effectively utilize the RDA for the solution of Instrumentation Laboratory problems.

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1. Please refer to the Bibliography for the List of References.

3.0 INSTRUMENTATION LABORATORY UTILIZATION OF THE RDA

The Instrumentation Laboratory expressed a desire to assume the responsibility for RDA operation in order that it might carry on design and calibration studies for new computing sights and ammunition which were under current investigation in the Laboratory. Furthermore, certain Instrumentation Laboratory contractual commitments were concerned with the development of improved computing sights, and the solution of associated kinematic equations required the use of the RDA.

The Laboratory felt that the RDA was unique in its demonstrated capability for handling problems of that type. It must be remembered that at that time (1950) the status of present-day large-scale computers was not where it is at the present time, and as a result, these calibration studies could be carried out more effectively on the analog machine.

As it turned out, this was a most fortunate decision on the part of the Instrumentation Laboratory since it resulted in the design of new lead computing sights which were used most effectively in propeller and jet combat over Korea. In this regard, the Differential Analyzer again made a most valuable contribution to the war effort.

In the meantime, however, there were continuous rumblings in the background concerning the removal and disposition of the RDA. It was clearly realized that this machine was indeed a very old computing machine by existing standards. As a result, late in 1952, improved types of digital computing machines were obtained (CPC, etc.) and certain problems formerly solved on the Analyzer were transferred to the digital machines. During this period a determined effort was made to evaluate the performance of the Analyzer both on an economic and engineering basis. As the performance of the Whirlwind Computer improved and more interpretive subroutines, conversion programs, floating decimal subroutines, etc. were made available, it became increasingly apparent that a larger and larger portion of the work done on the Differential Analyzer could be handled on the digital equipment. Furthermore, as the RDA increased in age its maintenance costs naturally increased, and since the digital facilities had definitely become part of the M.I.T. computational program, it became apparent that serious consideration should be given to the removal of the RDA.

4.0 SURVEY OF THE APPLICATION OF THE DIFFERENTIAL ANALYZER

In retrospect, it is of interest to point out some of the principal contributions made by the Analyzer during its 12-year life at M.I.T. It must be remembered, of course, that its early applications were strongly influenced by World War II. Specifically, the machine was completed in 1942, and since the applications during the period 1942-1945 were almost entirely of a military character, the following types of problems were solved (in some cases thousands of times):

1) Evaluation of ballistic tables,
2) Guided missile stability and performance studies,
3) Lead computing sight calibration studies,
4) Studies of aircraft propeller performance equations,
5) Study of the design characteristics of submarines, torpedos, and other underwater craft,
6) Study of the design of catamarans employing the hydrofoil principle.
7) Study of the operations research problem dealing with submarine warfare.
8) Study, design and performance of antiaircraft missiles such as Nike, etc.

As a matter of fact, the contributions made by the Analyzer were considered to be sufficiently important that the Navy Department issued the Naval Ordnance Development Award in recognition of the work performed by the Differential Analyzers and associated computing staff.

In addition to such studies, the Analyzer was used to design new types of lead computing sights, tracking systems, aircraft component design, etc. This type of activity was carried on by the Instrumentation Laboratory during the years 1950-1954.

It is evident from the above partial list of problems that the Analyzer was primarily used for the solution of military problems. However, there were a number of industrial problems solved on this machine. For example:

1) Study of the performance of a supercharge,
2) Study of circuit solution of electrical networks,
3) Analysis of the dynamic performance of servomechanisms,
4) Studies associated with heat flow problems,
5) Study of a problem in enzyme kinetics,
6) Studies of the atmospheric oscillation of the upper atmosphere,
7) Studies of a boundary value problem associated with the design of an ultra centrifuge,

In addition to the above industrial problems, the machine was used to a limited extent for the solution of academic problems arising in M.I.T. thesis research. For example,

1) Investigation of aircraft performance and control,
2) Investigation of the performance of magnetic relay circuits,
3) Investigation of the stability of gyroscopes,
4) Investigation of the orbit of dynamically-loaded journal bearings,
5) Investigation of statistically-loaded machine bearings,
6) Study of magnetic amplifiers,
7) Investigation of the rolling characteristics of ship models,
8) Study of M.I.T. servomechanisms,
9) Study of differentiation with elements of the Differential Analyzer,
10) Investigation of Schrödinger's Wave Equation,
11) Bonneville power load allocation study.

It is evident from the above list of problems solved on the Differential Analyzer that it was used predominantly for military and D. I. C. sponsored

research. As a matter of fact, this was true to such an extent that the machine did not contribute as effectively to the academic research program as it might have done had it not been operated on a self-supporting basis. Specifically, I believe the operation of a machine computing facility of this type should be sponsored in such a manner that the financial revenue for its utilization not be the primary concern. The Analyzer was always operated under a self-supporting basis, and this of necessity limited its application to groups who had adequate means to pay for its use. A better plan, of course, is one in which the Administration would provide adequate financial support to permit the operation of these facilities for educational training and research.

5.0 DISPOSITION OF THE DIFFERENTIAL ANALYZER

The studies concerned with the possible utilization of the digital machines such as the CPC and Whirlwind, had progressed to such a stage that on February 1, 1954 the Institute decided that the Differential Analyzer should be closed effective July 1, 1954. Hence, in February, the present operating staff was notified of this decision in order that they might make other arrangements for personal employment. As a result, the operation of the Differential Analyzer was terminated on June 30, 1954.

During the spring and summer months a certain amount of negotiating was carried on with various Educational Institutions concerning the possible disposition of the machine. Only the following Universities:

a) Northwestern University, Evanston, Illinois,
b) Purdue University, Lafayette, Indiana,
c) University of Pittsburgh, Pittsburgh, Pa.,
d) The University of Connecticut, Storrs, Conn.

expressed a serious interest in the possible utilization of portions of this machine. After several visits by representatives, etc., it was mutually agreed that Purdue University would take the major portion of the machine. The remaining Universities expressed an interest in only a small part of the RDA.

Once it became apparent that the RDA was not to be removed and reinstalled as a complete working unit at some other location, plans were rapidly formulated for its actual removal. Specifically, early in September, Dr. Stratton arranged for an M.I.T. appropriation of $5000 (Operating Account 1979.41) to cover the cost of removing and dismantling of the RDA. On August 17, 1954, Prof. G. S. Brown officially notified various members of the M.I.T. family of the decision to remove the RDA and asked them to express their interest in possible use of machine components. Therefore, in approximately six weeks a definite decision was made regarding the distribution of the Analyzer. On October 4, a crew of 5 technicians began to dismantle the RDA.

Table I contains the names of sister Institutions, various M.I.T. projects, and the type and amount of RDA equipment which they received. Roughly speaking, Purdue University was given one-third of the RDA and other groups received the rest.

TABLE I

DISTRIBUTION OF THE ROCKEFELLER DIFFERENTIAL ANALYZER

Group	Individual	Equipment Received	Quan.
Purdue University	Prof. Geldmacher	Integrator, Setting Mechanism,	6
		Servo Panel & associated equip.,	
		Independent Variable Control Circuit	1
		4-shaft Adding Units & Servos	2
		Output Table & Servo Panels	1
		Digit-Decade Differentials	2
		Counters & Servomechanisms	5
		Main Power Supply, Oscillator, etc	4
Univ. of Connecticut	Prof. J. L. C. Löf	Integrator, Setting Mechanism	1
		Setting Mechanism Relays	4
		3-Shaft Differential	1
		Miscellaneous Relays	200
Museum of Science	Mr. Bradford Washburn	Integrators & Setting Mechanism	1
Franklin Institute	Mr. A. C. Carlton	Integrator & Setting Mechanism	1
		Four-Shaft Unit	1
Graphic Arts Research Foundation	Prof. S. H. Caldwell	Integrators	3
		3-Shaft Unit	1
		Western Electric Relays	432
		Multicontactors	10
Elec. Engg. Dept.	Prof. S. H. Caldwell	New Automatic Electric Relays	349
		Used Western Electric Relays	23
		Crossbar Switches (10 vert.6 pt)	10
		" " (20 vert.6 pt)	5
		Multicontactors	17

Group	Individual	Equipment Received	Quan.
Elec. Engg. Dept.	Prof. T. F. Jones	Integrator & Setting Mechanism	1
		Decade Differential	1
		Counters	5
		Tape reading mechanisms	3
Elec. Engg. Dept.	Prof. D. A. Huffman	Western Electric Relays	713
		Crossbar Switches(10 vert,6 pt)	8
		" " (20 vert,4 pt)	5
		Multicontactors (60 pt)	15
		Stepping Switches	6
		Motor Generator Set:	
		25 hp Induction Motor	1
		48v Generator	1
		250v Generator	1
		Main Power Control Panel	1
Elec. Engg. Dept.	Prof. E. H. Boehne	Western Electric Relays	70
		Crossbar	1
		Multicontactors	3
	Mr. H. M. Teager	Western Electric Relays	258
		Crossbars (10 vert, 3 pt)	6
		Crossbars (20 vert, 4 pt)	6
Servo Laboratory	Prof. G. Newton	Input Tables	2
	Mr. J. Ward	Vector Units	2
Feedback Control Lab.	Prof. P. E. Smith	Function Units	4
		Decade Differentials	2
Dynamic Analysis Lab.	Dr. W. Seifert	Integrators & Setting Mechanism	4
Elec. Engg. Dept.	Prof. C. E. Tucker	Western Electric Relays	590
		Crossbar Switches (10 vert,6 pt)	20
		Multicontactors	60
		Motors	12
		22 gauge Telephone Wire, 3200 ft. reels (color coded)	25
	Mr. H. E. Laurence	Digit Decade Differentials	6

Group	Individual	Equipment Received	Quan.
Instrumentation Lab.	Mr. C. L. Emmerich	Western Electric Relays	54
		Crossbars	2
		Multicontactors (10 vert.)	20
		Terminal Blocks	65
Flight Control Lab.	Mr. R. Phagan	Servo Panels	6
		Relay Control Panels	4
		Digit Decade Differential	1
Acoustics Lab.	Mr. T. K. Naylor	Tape Punch Unit	1
		Tape Reading Mechanism	2
		Rolls of 75 mm. Paper Tape	25
Naval Supersonic Lab.	Mr. S. Briggs	Digit Decade Differential	1
		Servo Panels	2
		Multicontactors (60 pt.)	26
		Crossbars (4 pt.)	9
		Western Electric Relays	93
Rocket Research Soc.	Mr. B. Woznick	Western Electric Relays	55
		Dunco Power Relays	41
		Multicontactors	8
		Terminal Blocks	10
		Panel Lights & Sockets	120
		Misc. Wiring and Panels	
Tech Model Railroad	Mr. W. J. Eccles	W. E. Type U Relays	950
		Mounting relay strips	60
		Multicontactors	45
		Terminal Blocks	77
		Slow Release 24v relays	100
		Telephone Jack Strips & Switches	30
		Misc. Components	

Group	Individual	Equipment Received	Quan.
Building and Power	Mr. J. Barraford	G. E. Transformer 37.5KVA 2300/115v single ø	1
		G. E. Transformer 85KVA 2300/115v Single ø	1
		G. E. Transformer 10KVA 2300/230/115v Single ø	3
		3 hp Motor and Compresser	1
		O-S Cubicle	1
		3 hp 230v Motor	1
		$15,000 Precipitron and associated equipment	

5.1 PURDUE UNIVERSITY NEGOTIATIONS

The Division of Engineering Sciences at Purdue University agreed to supply the necessary manpower to dismantle the components in which they were interested. Of course, they also agreed to pay all costs associated with the transportation of said equipment to Lafayette, Indiana. Accordingly, Professors Geldmacher, Anderson and Mr. Coon arrived at the Institute on October 7 to assist with this work. In approximately one week their portion of the machine had been dismantled and suitably packed and crated for trailor shipment to Indiana.

In connection with the work performed for Purdue University, Professor Geldmacher requested the expenditure of certain labor and materiel expenses. For example, the salaries of electrical technicians, carpentors, steel cutters, cost of lumber, etc., were expenses which were authorized with the definite understanding that Purdue University would reimburse M.I.T. Table II contains a breakdown of this type of expense and indicates the magnitude of the invoice ($923.42) which has been submitted to Purdue for payment.

TABLE II

RDA REMOVAL EXPENSES INCURRED BY PURDUE UNIVERSITY

	Hours		
Electrical Technicians	Reg.	Overtime	Total
Caufield, Joe	14	22	$ 92.12
Goos, John	46	23	176.41
Kay, Richard	13	4	38.00
Sears, Jack	10		21.90
Simms, Al	35		58.10
	118	49	$386.53
Carpenters			
Wages	56	24	345.51
Stock and Materials			116.98
Steel Workers			
Wages	0	8	74.40
TOTAL EXPENSE	174	81	$923.42

In passing, it may be well to mention that the entire DA was dismantled and largely removed from the premises during a two-week period covering October 4 - 16 inclusive. A later section of this report contains a detailed statement regarding the cost of the entire dismantling and removal operation.

Purdue University intends to utilize their portion of the RDA for educational training and research, and as such, they hope to have their machine installed and in operation at the beginning of the spring semester. In this connection, it is well to emphasize that although the physical machine components have been delivered to Purdue, it is still necessary to provide them with adequate circuit, machine component, etc. wiring diagrams which will enable them to reassemble the machine properly. This means that wiring diagrams, etc. have yet to be photostated and released to them for their use.

In addition to the RDA facilities, Purdue is procuring a fairly large installation of electronic analogue equipment. In fact, $30,000 worth of Goodyear equipment has been ordered. The Purdue Statistical Division (which operates a moderate-size punched-card installation) has recently received an intermediate size digital computer from the Consolidated Engineering Company. Professor Goldmacher made the following statement about their plans: ". . . Purdue does not intend to remain behind in the rapidly-expanding field of analog and digital computation. . ." It is evident that the University has a rather ambitious long-range plan.

5.2 OTHER INSTITUTIONAL NEGOTIATIONS

In addition to the major contribution to Purdue University, The University of Connecticut, The Franklin Institute (Philadelphia), The Museum of Science (Boston), The Graphic Arts Research Foundation (Cambridge) received various components from the DA which will be used primarily for educational training, teaching, and research. Since several of these groups are museums, certain choice portions of the Analyzer were released to them in order that they might serve as characteristic museum pieces illustrating the state of art prevalent on the RDA.

In addition to the above-mentioned educational institutions, a considerable amount of machine components, notably vacuum tubes, resistors, relays, etc. were donated to Belmont High School. This equipment is to be used as part of the Vocational Training Program in radio and electronics which is being presented at the high school level. This contribution should achieve a very useful educational purpose.

5.3 M.I.T. RESEARCH PROJECTS

It is also evident from Table I that a number of M.I.T. projects have received components from the RDA. In certain cases, e.g., Dynamic Analysis Control Laboratory (DACL), Flight Control Laboratory (FCL), Servomechanisms Laboratory (REAC), Acoustics Laboratory, etc., the components will be incorporated into other computing machines. In other cases, the equipment will be used for graduate thesis research. This is largely true for all the equipment released to various members of the Electrical and Aeronautical Engineering Projects.

In addition to the M.I.T. academic projects, a certain number of relays and minor machine components were released to several student organizations: The Rocket Research Society, The Tech Model Railroad, etc.

5.4 EXPENSES INCURRED IN THE REMOVAL OF THE RDA

Table III contains a detailed breakdown of the number of working hours, hourly rates, etc. for the personnel as well as other expenses which have been incurred on the RDA under Account No. 1979.41. When one considers some of the original estimates which were made concerning the cost of the removal of the RDA, the amount $2638.59 is indeed a relatively small sum.

It must be understood that operations of this type naturally require considerable time of certain administrative personnel which, of course, do not directly appear as expense items in the above Table III. Thus, the above-mentioned cost of RDA removal is slightly misleading.

TABLE III

TOTAL COST OF REMOVING THE RDA

	Hours Reg.	Hours Overtime	Sub Total	Total
Electrical Technicians				
Caufield, Joe	80	29.25	$242.80	
Goos, John	198	155.25	944.40	
Kay, Richard	70.62		141.24	
Sears, Jack	80		175.20	
Simms, Al	104		186.94	$1690.58
Carpenters				
Wages	56	24	$345.51	
Stock and Materials			116.98	462.49
Steel Workers				
Wages				74.40
Supervision				361.12
Miscellaneous				
Telephone, Telegrams, Materials				50.00*
TOTAL REMOVAL COST				$2638.59
Less Purdue Expenses				923.42
NET M.I.T. COST				$1715.17

*Estimated cost

6.0 DISPOSITION OF THE RDA MACHINE SHOP

When the Instrumentation Laboratory stopped using the RDA on July 1, 1954, it was no longer necessary to maintain the machine shop in 7-302 for RDA maintenance. Accordingly, all of the equipment in the RDA shop, which had been purchased during the 4-year interval that Instrumentation Laboratory operated the shop (1950-1954), was returned to the Instrumentation Laboratory.

Table IV contains a list of the equipment which was returned to Mr. T. J. Ryan, property officer, on July 1, 1954.

TABLE IV

RDA SHOP EQUIPMENT RETURNED TO INSTRUMENTATION LABORATORY

Quan.	Description	Equipment No.
1	4 Drawer Metal Letter File	783-1
1	Linley Vertical Milling Machine complete with standard equipment including criterion boring head with adapter and 6 collets	783-2
1	Floor-type Fan	783-3
1	Nichols Dividing Head (Serial #A-1536)	783-4
1	Nichols Swivel-base Vise	783-5
1	16" Desk-type Fan	783-6
1	Water Cooler	822-3516
1	Marchant Calculator	-13062
1	Marchant Calculator	822-287
1	IBM Typewriter	7139-110
1	IBM Typewriter	822-3673

6.1 MACHINE SHOP EQUIPMENT TRANSFERRED TO ELECTRICAL ENGINEERING

At a conference held on May 24, 1954, attended by Professor C. Floe, Dean Harrison and F. Verzuh, the disposition of the capital goods, machines, stock and materials, etc. available in the RDA machine shop was considered. It was decided that the RDA shop equipment was to be transferred to Room 10-481 where it will be reactivated as a shop to be used in connection with the computational activities which have been recently transferred to Building 10. Professor G. S. Brown expects to use a machinist from the Electrical Engineering Shop to organize the new shop.

Not all of the equipment available in the RDA Shop has been moved to Room 10-481. For example, an Allen Drill Press (Model No. 2) was given to Mr. Kallenbach of the Physics Shop (Room 6-014) at the direction of Dean Harrison.

Table V contains a list of the principal pieces of machine shop equipment which were moved to Room 10-481 on July 15, 1954. In addition to these capital goods, a considerable amount of metal stock and materiels ($1465) was also transferred at that time. The entire facilities of a 3-man shop (working benches, metal cabinets, tools, equipment, etc.) were also transferred intact to the new area.

TABLE V

RDA MACHINE SHOP EQUIPMENT TRANSFERRED TO ROOM 10-481

Item No.	Description	Model No.	Purchase Price
1	Van Norman Milling Machine	12	$1655.
2	South Bend Lathe 3/4 hp. 3 phase, 220v Motor Motor control unit Collet draw bar, center rest 6" 4-jaw independent chuck 5" 3-jaw universal chuck #2 Everede boring bar holder 3 boring bars 1/2" Jacobs drill chuck and arbor	187A	1152.
3	Pratt & Whitney Lathe	13"	?
4	Starke Lathe (10")	4 1/2	1300.
5	Johnson Cut off band saw	#3343	495.
6	Dumore Grinders	44	80.
7	Walker Turner Drill Press		110.
8	Floor-type Drill Press		45.
9	Bench Master Punch Press	4 ton	157.
10	Reed Surface Grinder		
11	Metal Cabinets		
12	Complete line of auxiliary equipment for above		

7.0 INSTITUTE SPACE REALLOCATION

The removal of the RDA will naturally serve to release a number of bays of space in Building 7. Specifically, 2450 sq. ft. of space have been released as a result of the removal of the RDA. The following breakdown indicates the space involved:

Bay	Area (sq. ft.)
7-302 (2)	700
7-303 (4)	1400
3-329 (1)	350
	2450

As a matter of fact, the machine shop which formally occupied the two bays in 7-302 has already been transferred to Room 10-481 and the two bays in 7-302 are currently occupied by the Educational Council.

The remaining 5 bays of space (1750 sq. ft.) are to be occupied by the Architecture Department. The receipt of this 2500 sq. ft. of space should certainly help to alleviate their space requirements.

8.0 CONCLUSION

This memorandum contains some of the facts associated with the removal of the RDA. A brief description of the historical background of the machine, a survey of its applications, and disposition of various components are described in considerable detail.

A breakdown of the expenses incurred in this operation isgiven, and it is of interest to note that only $2638.59 was required to remove this "200-ton giant" from the M.I.T. premises. Perhaps of equal interest is the fact that it only required 60-man days (over a 2-week period) to accomplish this removal.

It is hoped that this report contains sufficient information to properly acknowledge the financial assistance received from the Rockfeller Research Foundation. Furthermore, it should serve as a record of the disposition of the equipment contained on the machine. In this regard, it is perhaps well to mention that an entire power plant facilities, notably, power transformers, a motor generator set, an air compressor, a precipitron unit, etc., have been given to Buildings and Power for other M.I.T. use.

In closing, it is evident that the RDA has served a very useful purpose in the Institute. However, like all things, it had a limited life and certainly had become obsolete by existing standards of the large-scale computing equipment. It is therefore only proper that it should be removed and that other modern computing equipment be installed to serve in its place.

F. M. Verzuh
November 1, 1954

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