

EXHIBIT B

WHAT IS EMAIL? AND, WHO INVENTED IT?

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Summary

Email is the electronic replica of the interoffice (inter-organizational) mail system – a system intended for enabling collaboration in the business office environment. Email, the system, is not to be confused with simple methods for the electronic exchange of text messages dating back to the Morse Code of the 1800s. Email was created in the late 1970s at the University of Medicine and Dentistry of New Jersey, located in Newark, NJ. Email, moreover, does not require the Internet. Prior to the creation of the World Wide Web (WWW) in 1993, email was utilized on intranets, local area networks (LANs) and wide area networks (WANS) for business office application. The invention of email in Newark, NJ demonstrates the possibilities for urban innovation when critical elements of an ecosystem for innovation are present.

It was within this backdrop that the LCN staff met Shiva Ayyadurai.

IV. "I've Got a Smart Son"

In 1977, Martin Feuerman, an accomplished applied mathematician and a Senior Systems Analyst and Biostatistician at UMDNJ, was acquainted with Ms. Meenakshi Ayyadurai, a colleague, who was also a mathematician, statistician and a Systems Analyst in UMDNJ's Data Processing Department. Ms. Ayyadurai and her family had moved to the United States from India seven years earlier in 1970. Ms. Ayyadurai sought advice from Feuerman on how to guide her precocious son, Shiva, who had already completed Calculus while attending 9th grade in the Livingston, New Jersey school system. The high school had no other mathematics courses to offer Shiva.

Feuerman shared with Ms. Ayyadurai, a news clipping of a special program at New York University's Courant Institute of Mathematical Sciences for a select group of 40 high school students to study computer science. He passed it on to her with a note, "Meena, I thought you'd be interested in this,"

The NYU program had been created by Professor Henry Mullish, a visionary computer scientist, who foresaw a need for skilled software engineers. Shiva was selected as one of 40 students to learn six programming languages -- COBOL, PL/1, ARTSPK, FORTRAN, BASIC, SNOBOL -- and to enroll in the NYU course on digital hardware and processing. Shiva was the only Sophomore in high school, and the

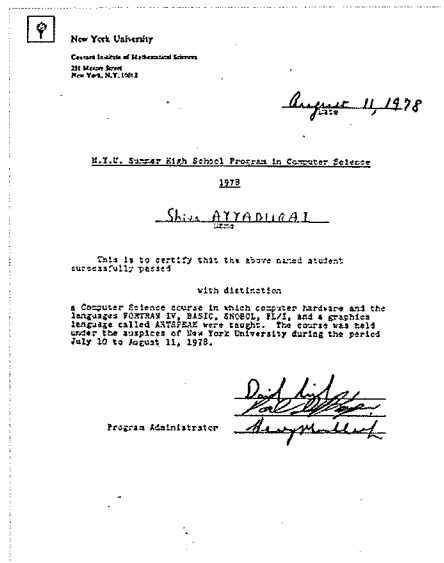
only student from New Jersey selected into in this program. The other students were either Juniors or Seniors.



Handwritten note from Martin Feuerman to Meenakshi Ayyadurai from Meenakshi Ayyadurai Estate (March, 1978)

Daily travel from New Jersey to New York City for a young teenager was not a normal occurrence. His mother drove him to Newark Penn Station in the early mornings, to catch the PATH trains to Manhattan. Shiva's schedule at NYU was intensive, typically from 8AM to 8PM. He graduated with Honors from the NYU program at the top of his class in the summer of 1978.

After Shiva completed the program, Feuerman and Ms. Ayyadurai introduced him to me. His mother said, "I've got a smart son." And, I thought to myself, every mother says that about her kid. But, the truth was this 14-year-old was really smart, in actuality, a prodigy.



Formal Letter Certifying Shiva Ayyadurai's Honors Graduation from Computer Science Program at NYU. Now at Smithsonian National Museum of American History (NMAH).

Discussions with Shiva developed into an exciting diversion from the major focus of LCN's work. He was hired to work in the laboratory at UMDNJ with the official title, initially as a Research Scholar, (and later as a Research Fellow, paid \$1.25 per hour). It was made clear to Shiva that he would be treated as every other employee, and professional behavior would be expected of him.

The hiring of a teenager was a first for UMDNJ at the time. The concept of a 14-year-old leaving Livingston High School (LHS) in the middle of the class day to travel to Newark was unconventional for the LHS school system. Shiva's independent study teacher, Ms. Stella Oleksiak worked with LCN leadership and petitioned Melvin Klein, the Superintendent of the Livingston School system, for approval. After significant lobbying by Ms. Oleksiak, the LHS school system agreed.

V. The Motivation for Email

At that time, a few were beginning to ponder the role minicomputers might play in general human interactions. The LCN staff was already familiar with simple interactivity between humans and machines. After all, much of the software being developed at LCN was to manage lab experiments that required this kind of interactivity. The LCN was also familiar with the methods and protocols by which computers could exchange messages with other similar types of computers. The minicomputers, used within the LCN, manufactured by the Hewlett Packard (HP) Corporation, were provisioned with subsystems that supported this type of communication.

Human interaction was mediated through teletypewriters and relatively primitive CRT-based display devices. Meanwhile, the interoffice mail system, the primary modality of workplace written communication and collaboration, remained in wide use at UMDNJ as it was everywhere else. Although beyond the scope of LCN's primary responsibility, there was an eagerness to explore the use of small computers beyond the sphere of numerical calculation and experiment control.

The notion of automating the entire interoffice, inter-organizational paper mail process was appealing for several reasons. It was a change that would benefit everybody, the mechanics of which, at least superficially, could be understood by anyone; automation could significantly reduce the timeframe of transactions; and,

there were multiple ways in which electronic automation could extend the utility of the interoffice memorandum.

As far as the LCN knew, no one else in 1978 had attempted to take on such a task.

So the creation of an electronic version of the interoffice, inter-organizational paper mail process became an object of LCN's attention and intention. Aware that Shiva was an exceptional student, he was offered what turned out to be one of most innovative (and fun) projects the LCN had ever to undertake. In return, it demanded that this fourteen-year-old teenager channel all of his energies into the project. It was made clear that he would be a full-fledged member of the LCN team, treated, as an adult, and that nothing less would be expected from him.

The lasting contribution of Shiva's work began with his systems analysis of the entire interoffice mail system that the LCN hoped would lead him to an implementation, beyond the mere automation of a manual process. In this regard, his mission was to develop a sustainable logical and functional framework that would add significant value and lead to further innovations over time.

Shiva's first task was to learn how the interoffice mail system was used at the UMDNJ. Who wrote them and to whom? What were all the functions they expected? What was their place in the hierarchy of written documentation? What was the sender's expectation of a reply? What volume of text could we anticipate? And, of

course, what could we do to improve the utility of this modality? Users surely would want more features. Could we be one step ahead of that demand?

Addressing and solving these questions were a genuine turning point in the history of communication – initially in business communication, but soon in a much larger universe. It was literally the invention of email, and a 14-year-old boy named Shiva Ayyadurai accomplished it in Newark, New Jersey, starting in 1978.

To provide some historical context, creating an electronic replica of the interoffice or inter-organizational mail system was of no interest to electronic messaging researchers of the Advanced Research Projects Agency Network (ARPANET) even as late as December 1977. In fact, ARPAnet experts, of the time, had concluded it was “impossible” to invent a full-scale electronic emulation of the interoffice mail system. Specifically, in the RAND Report, published on December 1977, which summarized the state of electronic messaging at the time, its author David Crocker - a leading member of the Advanced Research Projects Agency Network (ARPANET) community – described the impossibility of creating such a system:

*“...no **attempt** is being made to emulate a full-scale, inter-organizational mail system... The fact that the system is intended for use in various organizational contexts and by users of differing expertise makes it almost **impossible to build a system which responds to all users’ needs.**”*

Moreover, the ARPA brochure of 1978, and even the one of 1986 (eight years later) makes no reference to the word “email,” “e-mail” or “Electronic Mail” in the brochure or the index of their brochure.

The ARPANET community was focused on methods of simple exchange text messages. For example, researchers such as Ray Tomlinson, known for the use of the ‘@’ symbol, modified a pre-existing program SNDMSG, which was a local user command for appending text to a file, using borrowed code from CPYNET, a file transfer protocol, to allow a user on one computer to append text to a file on another computer. The user had to type in cryptic commands to make this happen. It was a rudimentary version of a networked “Post-It” note system, at best, for appending text messages on remote files, but not email.

The challenge to invent email, however, required Shiva to go far beyond simply creating a means to exchange basic text messages over the internal computer network. Instead, his challenge was to create an entire communications platform including a sophisticated database and workflow systems architecture. And this should be usable by anyone in the workplace – from upper level managers to entry-level office workers through an easy-to-use user interface. The goal was a fundamental transition from the world of typewriters and paper into a realm of pure electronic communication to replicate the entire *system* of interoffice mail. At the very least, this would be a full-fledged replacement for the long established and

seemingly indispensable interoffice mail system, and eventually it would be much more.

VI. The Invention of Email

As mentioned, at that time there was an internal computer network at UMDNJ, used mainly for business and healthcare data processing. It existed independently of any other networks, including the ARPANET

The components Shiva used to create email were:

- 1) computer hardware;
- 2) an operating system;
- 3) terminals and a keyboard;
- 4) a network;
- 5) a programming language; and,
- 6) a database system.

The software tools at UMDNJ were relatively primitive compared to today. A FORTRAN IV compiler with restrictive variable naming conventions and lacking intrinsic file system access; a non-relational, hierarchical database management system; and a simple networking environment that permitted static routing among nodes in a predetermined mesh. These tools ran on the HP1000 platform, a real-time environment not particularly optimal for the kind of development we envisioned.

These impediments turned out to be of little consequence, but certainly upped the complexity of the programmer's task and by some measure, Shiva's accomplishment. In fact, the inflexibility of the development and execution environment turned out to be somewhat serendipitous. The project combined the attributes of both the interoffice memorandum and paper mail systems. The FORTRAN IV compiler limited variable names to six characters. Moreover, the RTE/IVB operating system running on our HP1000 computers limited process names to five characters.

Did we hear "EMAIL?" That five-character limitation resulted in Shiva creating the word "EMAIL" to name his system of computer programs – a word that was non-existent in 1978, and not so obvious.

By late 1978, the first version of email had been designed and implemented with a few users, and by 1979 hundreds of users across UMDNJ were using email. Shiva had written some nearly 50,000 lines of FORTRAN code across nearly 35 cooperating processes that communicated within a node and across the UMDNJ at LCN.

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11 C
12 PROGRAM EMAIL(3,90)
13 COMMON IBASE(7),IDCB(144),ICOM(40),ICLOS,MAIN,LU,JVAL(4),NODE,
14 ILEN,MBCRT,MBCSEC,MFLCRT,MFLSEC,ISTATE(2),KFILE(3),IDCBQ(144),
15 ZIPRMT1,IWHER1,IPRMT2,IWHER2,IWHOM,IPARAM,IFINIS,INODE
16 COMMON/LABL/ IPL,ISL,LUH,IRWAIT,IPWAIT,ISCAN,ICREAT,IPRINT
17 COMMON/REGS/ KERR,IFNAM(3),IVAR1,IVAR2,MFILE(3),NFILE(3),IRND,
18 1ICODE,MABL,MABL,IFORNT,ISNAME(13),IGRP
19 COMMON/RECV/ ISBUF(12),LBUF(25),ICONT,MACCPY,ISRIAL
20 DIMENSION ISTAT(10),ITABL(11),ISEGS(3,9)
21 DATA ITABL/2H??,2HGM,2HTH,2HCM,2HEM,2HDN,2HDG,2HLM,2HDM,2HRD,2HEX/
22 1,IMODE1/1/
23 DATA ISEGS/2HRE,2HCE,2HV ,2HTR,2HAN,2HS ,2HCM,2HPD,2HS ,2HCM,2HPD,
24 12HS ,2HNA,2HME,2HS ,2HCR,2HOU,2HP ,2HNE,2HMO,2HS ,2HDE,2HLE,2HT ,
25 22HRE,2HDS,2HT /
26 C
27 C
28 C*****
29 C*
30 C* ELECTRONIC MAIL SYSTEM
31 C*
32 C* THIS IS THE MAIL SYSTEM INTERFACE. ALL COMMANDS ARE PROCESSED
33 C* HERE AND APPROPRIATE SEGMENTS ARE LOADED. THE DATA BASE IS NOT
34 C* OPENED HERE BUT BY A STARTUP SEGMENT CALLED 'INITL'; HOWEVER, THE
35 C* DATA BASE IS CLOSED HERE. WHEN EMAIL IS INITIALLY INVOKED, A PARA-
36 C* METER IS ACQUIRED FROM THE INITIAL COMMAND STRING. IF THE PARAMETER
37 C* IS NON-ZERO, THEN THE USER IS INFORMED WHETHER HE/SHE HAS MAIL.
38 C*****
39 C

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First page of the computer program showing Shiva's naming the program "email," thus defining email to be the electronic interoffice mail system (c. 1978), now at the Smithsonian National Museum of American History (NMAH).

On a formal launch day, the LCN called a seminar and filled a large lecture hall at the New Jersey Medical School with technical staff and other parties that were fascinated by the work Shiva had done. Here were all of these people: IT professionals, administrators, academicians, medical students, family and friends to learn what Shiva had done. Multiple screens and white boards filled with charts, "screen shots" and flow diagrams kept everyone's attention, but the most astounding aspect was that the presenter was not a distinguished scientist or clinician from UMDNJ or some other vaunted institution, but rather a kid with a fascinating story of ingenuity and determination.

The new service, email, was electronic and it combined many if not all of the characteristics of paper mail. Email moved the secretary's desktop which forced

her to be tied to a physical office and desk to, what we now call the, "cloud." Her desktop became virtual and she could access it from anywhere as long as she could connect to any one of the three minicomputers on the network.

Shiva was the author of the entire EMAIL program code and system. The environment that fostered such innovation and development was an environment of collaboration and teamwork, in the heart of Newark, New Jersey. Such interaction expanded his Livingston High School educational experience not only to become an adept software programmer but also, to evolve his leadership skills, in becoming an engineering professional, which were an important foundation for his continued success as a scientist and inventor.

His interactions, for example, with Robert Field, a systems programmer, who was very proficient in FORTRAN and database systems, for example, provided him critical insights to overcome many of the memory limitations and constraints of the RTE-IVB operating system. The late Phil Goldstein, who was an early innovator in the educational use of time-sharing systems, and nearly 50 years his senior, provided all of us an example of a scientist-programmer, who worked in a disciplined and methodical manner to solve complex problems.

Shiva's discussions with Dave Ritacco, a wunderkind studying engineering at the Stevens Technical Institute, who began working with our laboratory to develop user interfaces for graphics systems, predecessor to modern day presentation graphics

products such as PowerPoint, provided Shiva insights on how to evolve EMAIL's user interface to address end user needs. Marilyn Bodow and Tina Brezenoff, statistical programmers in our group, were Shiva's early Beta users, and provided him critical feedback on the EMAIL User's Manual --- documentation necessary to train others at UMDNJ in using the first email system. They setup a wonderful training room to teach and educate hundreds of other personnel on the use of email.

VII. Formal Recognition for Email's Invention

The invention of email did not go unnoticed. Shiva won one of the prestigious Westinghouse Science Talent Honors Awards (today know as the Intel Awards) for his invention, and was lauded by various letters including from New Jersey's U.S. Senator. He received some local news recognition.

More importantly, he was officially recognized as email's inventor by the United States government. An important point needs to be made here concerning the United States laws for invention at the time. At the time of Shiva's invention in 1978, there were no laws for intellectual property protection of software: neither patents nor copyright allowed protection of software inventions. The U.S. Supreme Court was not recognizing software patents in 1978. Only in 1994 (sixteen years after email's invention) did the Federal Court of Appeals recognize software as a "digital machine" and allow it to be patented.

CERTIFICATE OF COPYRIGHT REGISTRATION

FORM TX
UNITED STATES COPYRIGHT OFFICE

REGISTRATION NUMBER
TX 111-775

TX 8 30 82
EFFECTIVE DATE OF REGISTRATION
Month Day Year

DO NOT WRITE ABOVE THIS LINE. IF YOU NEED MORE SPACE, USE A SEPARATE CONTINUATION SHEET.

1 TITLE OF THIS WORK
EMAIL

PREVIOUS OR ALTERNATIVE TITLES
COMPUTER PROGRAM FOR Electronic Mail System

PUBLICATION AS A CONTRIBUTION If this work was published as a contribution to a periodical, serial, or collection, give information about the collective work in which the contribution appeared. Title of Collective Work

If published in a periodical or serial give: Volume Number Issue Date On Pages

2 NAME OF AUTHOR
a Mr. SHIVA AYVADURAT

DATES OF BIRTH AND DEATH
Year Born 1963 Year Died

Was this contribution to the work a "work made for hire"?
☐ Yes ☐ No

AUTHOR'S NATIONALITY OR DOMICILE
Citizen of Domiciled in **UNITED STATES**

WAS THIS AUTHOR'S CONTRIBUTION TO THE WORK
Anonymous? ☐ Yes ☒ No
Pseudonymous? ☐ Yes ☒ No

NOTE Under the law, the "author" of a work is the person who creates the work and in whom copyright is claimed.
Nature of Authorship Briefly describe nature of the material created by this author in which copyright is claimed.
Created and wrote entire text of the computer program.

Official US Copyright Notice for "Email" Issued on August 30, 1982, now, in the Smithsonian Institution National Museum of American History (NMAH).

The Copyright Act of 1976 did not allow for the copyrighting of software. In 1980, however, this Act was amended to become the Computer Software Act of 1980, enabling software inventors to use Copyright to protect software inventions. Only after Shiva attended MIT in 1981 and after meeting with then MIT President Paul E. Gray did he receive some fortuitous advice to apply for a U.S. Copyright to protect the invention.

On August 30, 1982, Shiva received the first U.S. Copyright for "Email," officially recognizing him as the inventor of email. Had lawmakers in Washington, DC and public policy been in step with software innovation in 1978 and had patents been

allowed to protect the creation of a young 14-year-old immigrant inventor, beyond receiving recognition as email's inventor, he would likely have benefitted economically in an enormous way. Regardless, the rest became history. What is also another important to emphasize concerning the invention history is that there is no doubt, given the historical advances in office automation and computing, someone would have invented email (perhaps calling it something else). However, the fact remains, a 14-year-old teenager working in Newark, New Jersey was the first to do it.

VIII. The Triumph of Email

As it turned out, the great accomplishments of contemporary email – the triumphs of email, if you will – are multifaceted. First, it really does duplicate or exceed all the capabilities of the interoffice mail system. An original document in the form of a digital file can be circulated to one recipient or to hundreds, edited, commented upon, downloaded, printed, or even deleted. Moreover, the almost simultaneous nature of these functions – the fact that they can happen virtually at once, in real time, with many participants – means that email can be a truly collaborative medium.

Grant applications, for example, which frequently go through many versions, can be collaboratively executed in a time frame infinitely shorter than would be possible using hard copy documents. Manuscripts can be edited and circulated in hours