

# Cal TSS Archives

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December 14, 1991 reunion. Left to right: Redell, Gray, Vaughan, McDaniel, Lindsay, McJones, Simonyi, Lampson.

## 1 TSS design notes and documentation

### 1.1 “A basic time sharing system”

The first documents, by Howard Sturgis, take up various aspects of a time-sharing system (including process scheduling, a disk-based file system, low-speed terminal i/o, and capabilities), but don't mention subprocesses and (multilevel) operations. *Was Howard working alone, or with Butler?*

1. Sturgis. November 15, 1967. *“What follows is a description of a basic time sharing system, as seen by a knowledgeable user.”* [671115-hes](#)
2. Sturgis. February 27, 1968. *Early disk file system notes.* [680227-hes](#)
3. Sturgis. February 28, 1968. *More early disk file system notes.* [680228-hes](#)
4. Sturgis. February 29, 1968. *Capabilities, basic objects.* [680229a-hes](#)
5. Sturgis. February 29, 1968. *Calculations based on size of 6638 disk.*  
[680229b-hes](#)
6. Sturgis. March 3, 1968. *Notes on disk file representation.* [680303-hes](#)
7. Sturgis. March 4, 1968. *More notes on disk file representation.* [680304-hes](#)

## 1.2 Designing the ECS system

In the next series of documents, by Howard Sturgis, Butler Lampson, and Bruce Lindsay, Cal TSS begins to take shape: swapping controlled by a map, errors and interrupts, and more...

8. Sturgis. July 14, 1968. *Map, operation, capability, objects.* [680714-hes](#)
9. Sturgis. July 16, 1968. *Process, subprocess.* [680716-hes](#)
10. Lampson. July 18, 1968. *“Allocate ECS as follows: ...”* [680718-bwl](#)
11. Lampson. *“Scope compatibility for symbolic file.”* 1968? *Sample code and timing for conversion from eight seven-bit ASCII characters per word to ten six-bit Display Code characters per word. The estimate was nine microseconds per character.* [scope-compat-bwl](#)
12. Sturgis. July 18, 1968. *“Allocate fixed peripherals by list scheme ...”*  
[680718-hes](#)

13. Sturgis. August 22, 1968. *“For each subprocess ...”* [680822-hes](#)
  14. Sturgis. September 3, 1968. *“Sensitive code versus interrupt routines ...”* [680903-hes](#)
  15. Sturgis. “ECS System structure.” September 5, 1968. [680905-hes](#)
  16. Sturgis. “Modification of operation.” September 10, 1968. *“See 7/14/68.”* [680910-hes](#)
  17. Lindsay. “Subprocess error handler.” September 11, 1968. [680911-bgl](#)
  18. Lampson. “Swapping and charge for ECS.” September 11, 1968. [680911-bwl](#)
  19. Sturgis. “Error handling.” September 11, 1968. [680911-hes](#)
  20. Sturgis. “Process.” September 19, 1968. [680919-hes](#)
  21. Sturgis. October 3, 1968. *Event channel algorithms.* [681003-hes](#)
- I believe there must have been more design memos written by Howard and perhaps others. When did the idea of multilevel operations emerge?*
22. Sturgis. “Disk representation of file.” May 1, 1969. [690501-hes](#)
  23. Standiford? “Option bit assignments.” August 20, 1969. *Table of option bit assignments for the various object types.* [690820-opt-bit-assign](#)

### 1.3 The ECS system begins to run

When was the “two-teletype demo”?

24. Malbrain. “The Bead.” Circa Fall 1969. “*The Bead is the first subprocess created in every process when the system is initialized. Its function is to act as an interim monitor package to coordinate file activity and naming, elementary utilities, and be a command processor for the user.*” [bead-km](#)
25. —. TS Interrupt System September 2, 1969. *Typewritten documentation.* [690902-int-sys](#)
26. Lampson. An Overview of the CAL Time-Sharing System. October 10, 1969. Reprint of [[Lam69](#)], with a progress report (similar to Gray, October 11, 1969) appended. [691010-overview-bwl](#)
27. Gray. Progress Report on 6400 CAL Time-Sharing System. October 11, 1969. [691011-progress-jng](#)
28. —. CAL Time-Sharing System Users Guide. November 1969. *Actually, this is the programmers guide.* [6911-users-guide](#)
29. —. CAL-TSS Internals Manual. November 1969. [6911-internals](#)
30. —. Preliminary SCOPE Manual. November 5, 1969. *The SCOPE simulator made it possible to run programs designed for CDC’s SCOPE batch system.* [691105-scope-prelim](#)
31. —. TSS Printer Driver November 5, 1969. [691105-print-driv](#)
32. Standiford. “TSS Display Driver.” Late 1969?. [69-disp-driv-ks](#)
33. —. “S-device user interface.” November 5, 1969. *Specification of device interface to be used for tape drives, printers, card readers, card punches, and the console display.* [691105-s-dev](#)

34. —. The BEAD Users Guide. December 18, 1969. [691218-bead-ug](#)
35. —. SCOPE Manual. January 21, 1970. *“This document describes the SCOPE simulator under the interim system. A knowledge of the SCOPE 3.1 manual is assumed.”* [700121-scope](#)
36. Gray. (Lack of Visible) Progress Report: CAL-6400-TSS. January 15, 1970. [700115-progress-jng](#)
37. Malbrain. “SCOPE 3.0.” 1970? [scope-30-km](#)
38. Malbrain. “Proposal for batch system.” Early 1970?. *Early proposal for simple batch system: no tapes or job queuing; low-level disk system to be implemented below the Bead; SNOBOL program used for ?.* [batch-proposal-km](#)
39. Vaughan. “Interrupts.” 1970? *Notes for redesign.* [70-interrupt-redesign-vv](#)
40. Lindsay. 1970? *Proposal for interrupt priorities based on magnitude of high-order part of class code.* [70-interrupt-proposal-bgl](#)
41. Vaughan. “September system.” 1970. *Notes on content of September system: low-level disk system less swapping, pseudo-close, and space control; directory less subprocess descriptors, ECS goodies, global objects, and accounting; disk dump and load; command processor and subprocess descriptors (“a la bead”), line collector, login, logout, and accounting; Scope simulator; disk recovery.* [70-sept-sys-vv](#)
42. Gray. “[Addendum to] Systext standard.” 1970? [70-systext-changes-jng](#)
43. Vaughan. “User interface, command processor, human engineering.” 1970? *Sets down requirements for mechanism for user to control time used by sub-system, etc.* [70-user-interface-vv](#)

44. Sturgis. January 22, 1970. "*Objects in directories, note on ecs goodie, representation of files, directories, access keys, ecs goodies, directory structure for an entry, directory operations, subprocess descriptor.*" [700122-hes](#)
45. Sturgis. "Subprocess descriptor." February 19, 1970. [700219a-hes](#)
46. Sturgis. "Directory object descriptions." February 19, 1970. "*Implementation algorithms another time.*" [700219b-hes](#)
47. Sturgis. "Tentative changes to ECS system." March 5, 1970. *Design notes for return parameter authorization.* [700305a-hes](#)
48. Sturgis. "[Global] ECS objects implementation." March 5, 1970. *Design notes for representing ECS objects in disk system directories.* [700305b-hes](#)
49. Sturgis. "ECS goodie implementation." March 5, 1970. [700305c-hes](#)
50. Sturgis. "New ECS facility (version 3)." March 12, 1970. *Design notes for capability-creating authorizations.* [700312a-hes](#)
51. Sturgis. "New ECS facility." March 12, 1970. *More design notes for return parameter authorization and block data and capability parameters.* [700312b-hes](#)
52. Sturgis. "'Disk process' structure." March 19, 1970. [700319-hes](#)
53. Vaughan. "Evaluation of work yet to be done on the ECS system as of 30 March 70." March 30 and April 13, 1970. [700330-0413-vv](#)
54. Gray. "Disk meeting." April 1, 1970. [700401-jng](#)
55. Vaughan. "Interrupts." April 2, 1970. [700402-vv](#)
56. Gray. CAL Progress Report. April 15, 1970. [700415-progress-jng](#)

57. Sturgis. "General description of actions with respect to directories." April 17, 1970. [700417a-hes](#)
58. Sturgis. "Directory structure." April 17, 1970. [700417b-hes](#)
59. Sturgis. "Specific actions for directories." April 17, 1970. [700417c-hes](#)
60. Vaughan. April 20, 1970. *Notes on various ECS system redesign issues.* [700420-vv](#)
61. Sturgis. April 23, 1970. "*Open and close, general; directories; disk files; subprocess descriptors; access keys; global ECS object; ECS goodie.*" [700423-hes](#)
62. Richard Brautigan. All Watched Over by Machines of Loving Grace. April 27, 1970. *Photocopied and distributed to the staff by Vaughan.* [700427-brautigan-vv](#)
63. Sturgis. "Subprocess descriptors." April 30, 1970. [700430-hes](#)
64. Vaughan. "Reconstituted list of things to be done on the ECS level of Cal TSS." June 1, 1970. "*Stuff needed for the operation of the 'September System'*" [700601-vv](#)
65. Sturgis. "Dump-load." June 1, 1970. [700601-dump-load-hes](#)
66. McJones. "Operations." June 3, 1970. *Operation data structure diagram.* [700603-operations-prm](#)
67. McJones. "Directory." June 29, 1970. *Preliminary interface specification and internal data structure.* [700629-prm](#)
68. Standiford. "TSS Display Driver - Revision A." July 6, 1970. [700706-disp-driv-rev-a-ks](#)

69. Morris. "Editor Commands." 1970? *Handwritten.* [ed-cmmds-jhm](#)
70. Morris. "The Text Editor." July 9, 1970. [700709-ed-jhm](#)
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72. Redell and Lindsay. "Low Level Disk System Actions." July 9, 1970 [700709-low-level-disk-ddr-bgl](#)
73. Vaughan. "Change to indirect C-list specifications." July 20, 1970. [700720-new-indir-clist-vv](#)
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76. Sturgis. Interim Disk System: Preliminary Manual. 1970? [interim-disk-sys-hes](#)
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78. —. The Idiot's Guide to TSS. Fall 1970? [idiots-guide](#)
79. Sturgis? "How to make a new system tape for Bead 4.0." 1970? *All-caps listing on TTY; edited on the system.* [make-sys-tape-bead40](#)

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[700911-tent-basic-cmmd-hes](#)
81. Sturgis? "System and system part of user process initialization." Date?  
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*Diagram of file used to control editing of system tape? Also lists of module names.*  
[700922-editbin-spec-ddr](#)
83. Vaughan. "Observable states of a subprocess." November 18, 1970. *Proposal for a redesign of call stack entries?*  
[701118-observable-states-vv](#)
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[701124-bead41-panic-hes](#)
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[701130-hes](#)
86. Malbrain. "Peripheral Device Processor: Preliminary Specifications." December 1, 1970. *Proposal for a batch system handling card reader, printer, job queues, tape, and operator console.*  
[701201-pdp-km](#)
87. Sturgis. "Interrupt handling code at the command level in the new system." December 4, 1970.  
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88. Sturgis. "Syntax of parameters [for new command processor]." December 5, 1970.  
[701205-param-syntax-hes](#)
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92. Vaughan. "2 CP disaster sheet." Circa 1970?. *Also notes on speed phreaques, scheduling, and compactification.* [2-cp-disaster-vv](#)
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97. Sturgis. "Errors in BEADS." 1971? [beads-errors-hes](#)
98. Vaughan? "BEADS Errors." Year? [beads-errors-vv](#)
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100. Sturgis. About Cal TSS. January 6, 1971. *Sturgis' first status report as project director.* [710106-about-hes](#)
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104. Vaughan. "New stack logic." February 22, 1971. *Call stack manipulation changes; problem with maps and file unique name change; control of CPU time.* [710222-vv](#)
105. Sturgis. February 24, 1971. *Diagram of proposed subprocess structure; distributed with 710224a-hes?* [710224b-hes](#)
106. Sturgis. "Proposal for proprietary subprocesses." February 24, 1971. [710224a-hes](#)
107. Vaughan. "Facilities available." March 15, 1971. *Status report on readiness of various subsystems.* [710315-facilities-avail-vv](#)
108. Sturgis. "Immediate mopping up." March 15, 1971. [710315-mopping-up-hes](#)
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113. —. Time-Sharing System Users Guide. May 1971. *Planned as Part Three of Volume III (The 6400 Computer System) of overall Cal Computer Center Users Guide.* [7105-users-guide](#)
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118. Sturgis. “Preliminary proposal for testing system subprocesses of user processes.” June 8, 1971. [710608-hes](#)
119. Sturgis. “New commands in SERVICES.” June 11, 1971. *New commands: SHAZAM, CHAIN, UNCHAIN, and SOFTL.* [710611-new-services-cmmds-hes](#)
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132. Redell or Lindsay. “Declare Process Swapped-ECS Cross-Section.” 1971? *Description of disk file action.*  
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135. Hebert, Kenneth J. "Staff notice." December 8, 1971. "*Effective immediately, Vance Vaughan will assume the responsibilities of Chief Programmer. I hope that you all will give him your utmost support in this most trying position.*" [711208-promotion-kjh](#)
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## 2 Theses

Three of the participants based their Ph.D. theses on aspects of CAL TSS:

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[thesis-hes](#)
153. Redell. Naming and Protection in Extendible Operating Systems. September 1974. [thesis-ddr](#)
154. Lindsay. Exception Processing in Computer Systems. 1977? [thesis-bgl](#)

## 3 Papers

Several papers and technical reports were eventually published: [[Lam69](#)], [[LS76](#)], [[GLLS72](#)].

## 4 Hardware

155. Control Data Corporation. *Control Data 6400/6500/6600 Computer Systems Reference Manual. February 1967.*

[6400-cdc](#)

156. Control Data Corporation. *Control Data 6400 Systems Central Processor Monitor. 196?*

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157. Control Data Corporation. *Control Data 6400/6500/6600 Computer Systems reference card. Pub. No. 60164500*

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158. David Wheeler? “6400 Multiplexor Reference Manual.” 1967? [6400-mux](#)

## 5 People

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**Bruce G. Lindsay**

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**Paul R. McJones**

**James H. Morris**

**David D. Redell**

**Charles Simonyi**

**Keith Standiford**

**Howard E. Sturgis**

**Vance Vaughan**

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