

## APPLE LISA COMPUTER MOUSE DEVELOPMENT INFO

### SOURCE

Stanford University Apple Computer Inc Achives  
<http://library.stanford.edu/mac/primary/docs/index.html>  
15 December 2000

### SPECIAL NOTES

Documents scanned and OCR-ed with some errors (e.g. "F Baker" instead of "P Baker"). Scanned figures not scanned well (too low of resolution for good printing and reading).

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Bill Lapson, **Lore of the Mouse**. Retrospective essay written 8 July 1982, and distributed to members of the mouse development group. "The Mouse project has matured to the point where many others will be involved in its evolution. This collection of facts should ensure that some of the important lore about the Mouse is neither lost or distorted as time goes on."

Rickson Sun, **Testing the Mouse**. Memo from Rickson Sun to Bill Lapson, 16 October 1980, describing Hovey-Kelley's tests of the mouse.

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Jim Yurchenco, **Choosing Molding Vendor**. Letter from Jim Yurchenco to Bill Lapson, 5 December 1980, recommending "Micro Molding for producing the mouse ribcage and detector block tooling ." The tools would be used to

manufacture the mice, so it was critical to work with a company that could do precise work.

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## Lisa Mouse Package Design

Source: Memo from Bill Dresselhaus to Lisa mouse designers, 30 May 1980.

Location: Dean Hovey papers (reproduced courtesy of Dean Hovey).

Date: May 30, 1980

Subject: Lisa Mouse Packaging and Appearance Design

To: Distribution

From: Bill Dresselhaus

As I understand it, the charter for the Lisa product design team is essentially the responsibility for the appearance and mechanical package design for the Lisa product. Since the Lisa mouse is integrally part of the Lisa product, I am assuming that the responsibility of its package design is ours. With this in mind, I propose the following as a solution to implementing the mouse package design:

Douglas Dayton, a consultant employee with Hovey-Kelly Design (product design consultants to Apple), is presently a member of the Lisa product design team and is the design leader for the Lisa keyboard. The keyboard is presently in documentation and final detailing phases. I propose, as Douglas manages these last phases of the keyboard design, that he also becomes design leader for the mouse package and appearance design. Douglas already has experience in joystick design and mouse packaging and will have documentation and product design assistance available to him from Hovey-Kelly Design for both the keyboard and the mouse. I feel this is a very advantageous and appropriate situation to implement the mouse package.

As a member of the Lisa packaging team and as the design leader for the mouse package, Douglas would be responsible for:

1. Close interface with the Lisa packaging team members concerning all mouse product design aspects, reporting to me;
2. Appropriate interface with the mouse mechanical (mechanism), hardware and software engineering designers for proper parameter definition;
3. Development of appearance and mechanical package concepts via sketches, drawings and models;
4. Detail design and documentation of the package;
5. Appropriate reviews, scheduling and interaction to facilitate the design.

The task allocation for the Lisa packaging team would thus be:

Ken Campbell - chassis, card cage, interconnection and PCB blank design

Clive Twyman - documentation, materials control and costing, plastic part detailing, and miscellaneous detail design

Doug Dayton - keyboard and mouse package design

Bill Dresselhaus - project leader, over all appearance and enclosure plastic part design

Distribution: CC: Jerry Manock Doug Dayton Tom Hong Dean Hovey Bill Lapson

Document created on 6 July 2000;

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Mouse Cable and Connector

Source: Memorandum from Dave Evans to Bill Lapson, n.d. (after 20 January 1981).

Location: Jim Yurchenco Papers, file "Mouse Cord," private possession.

MEMORANDUM

To: Bill Lapson

Cc: P. Baker, B. Bull, K. Campbell, D. Dayton (H-K), B. Dresselhaus, J. Giese, T. Hawkins, W. Rosing

From: Dave Evans

Re: Mouse Cable and Connector - Specification Responsibility.

This memo documents our recent discussions on mouse cable issues. (ref. Mouse Cable memo by DJE of 1/20/81)

SUMMARY

Full responsibility for the requirements definition, supplier identification, and detailed parts specification for the mouse cable and connectors (as well as all other components) rests with you as the Engineering Project Manager. In completing this responsibility, the specific needs for these parts should be obtained from the appropriate parties in the POS Division, as the primary mouse customers.

RFI

The final answer is not known yet, and must be defined from test data some day soon. Paul Baker in the Lisa Hardware group is your contact for getting Lisa information regarding any PCB trace re-routing etc., and Dave Hantula is

still the main contact for RFI testing. The total RFI from a fully configured Lisa system is the responsibility of the POS Division; however, since the cable will be part of a Peripherals product, it is your responsibility to insure that you have all the data needed to correctly specify the cable and connector parts (e.g. shielding).

Please work with Paul in obtaining test information to confirm or disprove the present hypothesis that shielding is unnecessary.

#### CONNECTORS

The cable strain relief at the mouse end is fairly well defined and the mold is apparently underway at Tri-Tec. The connector to be used at the Lisa end of the cable is still undefined. The connector being used for the P3 mouse is unacceptable since it does not have a restraining clamp. A connector must be located which will clamp to the Lisa chassis. Preferably, this connector will be as clean looking and compact as the present unit, inexpensive to purchase and assemble, and provide excellent right or left handed strain relief.

The Product Design group in POS has responsibility for assuring the system integration and aesthetic acceptability for all connectors used with Lisa. Please work with Ken Campbell in gaining their approval for the connector unit you specify. Ken has already looked at some alternatives by Cannon, AMP, etc. You should get together with Ken at the earliest possible time to discuss connector requirements and look at, the physical space limitations on the back of Lisa, etc. Please advise me of the result of your discussions with Ken.

Document created on 24 May 2000;

This version published on Sep 18 18:02:31 2000



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Mouse Report, December 1980

Source: Mouse Project Team Report for December 1980 and January 1981, 2 February 1981.

Location: Jim Yurchenco Papers, untitled folder, private possession.

#### MOUSE PROJECT TEAM REPORT DECEMBER 1980 AND JANUARY 1981

##### PROJECT NUMBERS

Hardware: none

Packaging: 122

##### TEAM MEMBERS

Dave Evans, Bill Lapson, Dean Hovey, Doug Dayton, Bill Dresselhaus

##### KEY CONCERN

There are no great worries about the mouse at this time. The greatest risk is in the manufacturability of some very intricate parts from hard tool injection molding; however, the current schedule still looks very doable.

The RFT characteristics of the cable cannot be firmly identified prior to specifying materials for the first production run. The unshielded cable is expected to be fine but could be found to cause problems in future testing.

##### ACCOMPLISHMENTS

1. Completed assembly and test of 25 prototype units per schedule.

2. Defined and completed the "P3" interim mouse design with soft tooled exterior for February delivery.
3. Completed detailed production review of mouse project with POS Engineering and Production groups, Peripherals, and Hovey-Kelley.
4. Finalized all exterior shape design modifications (including aesthetic confirmation model).
5. Completed confirmation model of production mouse internals (ribcage etc.).
6. Initiated manufacturing engineering review of production mouse design; one improvement in case anchoring already implemented.
7. Formed production team in Peripherals Division for P3 and Production mouse manufacturing.
8. Reviewed P3 design and reduced total parts cost from approximately \$100 to \$50.
9. Selected molding vendors for exterior and ribcage.
10. Initiated training of Peripherals production team in assembly procedures.
11. Completed initial draft of mouse testing procedure.
12. Began coding of prototype quality assurance test program on Apple II.
13. Developed detailed schedule for development and build schedule.
14. Received commitment from Peripherals to meet or beat Lisa build rate.
15. Completed preliminary discussions regarding shielded cables; predicted unnecessary.

16. Identified new source for clamping connector for cable.

17. Qualified TRW as supplier for emitters and detectors.

#### OVERVIEW

It all came together for the mouse in the last two months. A tremendous amount of focus was brought to bear from POS engineering and materials, and the response from Peripherals and Hovey-Kelley has eliminated the large majority of uncertainties.

In order to meet the predicted Lisa build schedule, a production plan had to be put in place and the design had to be solid with all drawings ready for construction. These tasks were all accomplished, and the P3 design occurred as a necessity to provide volume production of "saleable" mice prior to the June/July timeframe. Since the P3 mice will be made from soft tooled parts, a new design checkpoint has been introduced to further confirm the mouse design.

All purchasing and assembly of mice will be done out of the Bubb Rd facility by Apple Peripherals people with initial supervision from Hovey-Kelley. Once assembly is completely debugged, second sources for manufacture will be evaluated. POS will maintain design review and acceptance responsibility.

There was a good deal of discussion regarding the need for a shielded mouse cable for RFT purposes. No test data is currently available since the RFT group is overloaded with Apple II, III issues. The consensus was that by regrouping the traces on the motherboard, the need for shielding could be avoided. The cable for the P3 mice will be unshielded; however, actual test data is needed to confirm this point prior to releasing the production design and Bill of Materials.

The possibilities for a logo on the mouse are also being worked on.

## OBJECTIVES

1. Finalization of all production design drawings.
2. Production of 50 acceptable P3 mice.
3. Completion of logo design in the Lisa "logo system".
4. Publish test specification for review.
5. Complete final tests of confirmation model to release drawings to vendors.
6. Design a label for bottom of mouse.

## CRITICAL DEPENDENCIES

At this stage, virtually all the custom pieces are single sourced by small suppliers who each represent a "critical" resource should they go down for any reason. No such problems are presently foreseen.

All necessary resources are currently in place at Apple to meet the near-term objectives.

## SCHEDULE

(see attached)

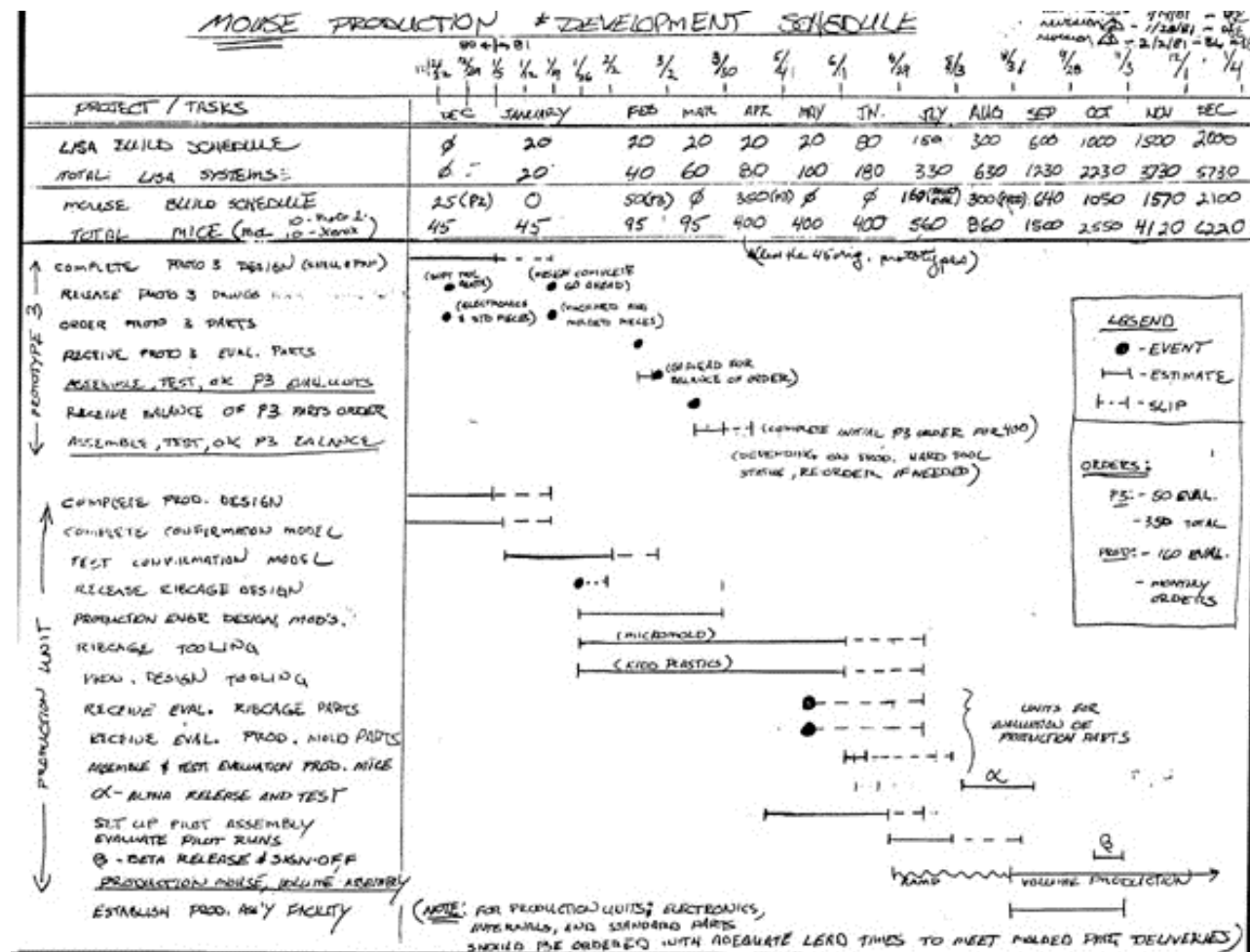
## COST ESTIMATE

P3 Design: \$100.00 (includes amortization of soft tooling, may be lower)  
Production Mouse: \$37.00

## SCHEDULE

[Note: These two pages were attached to the original memo.]

<div> <div>LISA - MOUSE</div> <div>NO. 122</div> <div>PROJECT SCHEDULE</div> </div>												
MILESTONE	JAN 1981	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
MRD PUBLICATION	9/80											
MRD APPROVAL	8/80											
ERS PUBLICATION	N/A											
ERS APPROVAL	N/A											
POST ERS DESIGN REVIEW	N/A											
PROTOTYPE COMPLETION	9/80											
ALPHA RELEASE	8/1											
BETA RELEASE	10/15											
ERO	11/1											
FIRST CUSTOMER SHIP	12/1 - PROD 9/1 - PS											
COMPLETE (PS) INTERIM MOUSE DESIGN	1/82											
RECEIVE (PS) INTERIM MICE	2/27											
COMPLETE PRODUCTION DESIGN	2/15											
PRODUCTION ENGR. REVIEW	4/15											
RELEASE PROD. DESIGN FOR HARD TOOL	2/20											
FIRST HARD TOOL MICE (EVAL)	7/1											
DESIGN REVIEW	8/15											
APPROVED PRODUCTION MICE	8/30											
SECOND MFG SOURCE	1/82											



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Mouse Connector

Source: Memorandum from Dave Evans, 6 March 1981.

Location: Jim Yurchenco Papers, untitled folder, private possession.

MEMORANDUM

To: Ken Campbell, Bill Lapson  
cc. B. Dresselhaus, D. Dayton, J. Giesea, R. Insane  
From: Dave Evans  
Re: Mouse Connector  
Date: 6 March 1981

This memo serves only to document the agreement reached 2 weeks ago regarding the mouse connector.

We all accepted that the mouse connector had to be secured at the Lisa mainframe and should be a compact simple device. The connector selected was a standard DB-9 (AMP, and others) using screw securing posts.

Ken is working on a way to design in a custom thumbwell affair that would make the hook-up tool-less. However, if this doesn't work out or requires too much effort, then we will accept the standard off-the-shelf product.

I leave the final selection of the part supplier, model number up to you two. Responsibility for getting the details specified (hopefully within a week or so) lies with Bill as before, but Ken must still approve for the Lisa system

I hope this can put the connector issue to bed once and for all. Be sure and let me know if any questions or problem remain.

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P3 Mouse Deliveries

Source: Memorandum from Dave Evans, 17 March 1981.

Location: Jim Yurchenco Papers, untitled folder, private possession.

MEMORANDUM

To: Larry Tesler and Distribution

From: Dave Evans

Re: P3 Mouse Deliveries

Date: 17 March 1981

MEETING IN PASCAL IN DE ANZA AT 3:00 PM ON FRIDAY MARCH 20  
FOR DELIVERY AND PRESENTATION OF LATEST BATCH OF MICE.

BRING YOUR OLD MOUSE AND TRADE IT IN ON THE MOST CURRENT  
MODEL!!!

The long awaited P3 improved interim mouse is here. It has an injection  
molded case and button. The insides are somewhat different from the final  
production units, but only in design, not output.

There are a few differences in feel and appearance between the P3 mouse and  
the final unit which will be discussed. Please come to hear about the mouse  
status and our interest in gaining final input from you all through your  
experience with your new P3 mouse.

We will have mouse designers there to answer your question and the one and  
only complete confirmation model of the final unit, so you can see what the  
future  
holds.

Don't it or you'll be the only one on your block without the latest in Apple Mouse Technology.

3:00 to 3:30 Mouse Review and Demonstration of production mouse confirmation model

3:30 to 4:00 Questions and Mouse Distribution (trade-ins only please)

#### DISTRIBUTION

Lisa and Lucy Software Lab Members

F. Baker  
P. Lapson  
D. Hovey  
D. Dresselhaus  
D. Dayton  
T. Hawkins  
W. Rosing  
G. Marten

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Completion of 50 P3 Mice

Source: Memorandum from Dave Evans, 23 March 1981.

Location: Jim Yurchenco Papers, file "Mouse Cord," private possession.

MEMORANDUM

To: Distribution

Fm: Dave Evans

Re: SUCCESSFUL COMPLETION OF 50 P3 MICE BY PERIPHERALS DIVISION

Date: 23 March 1981

On Friday March 20, Bill Lapson delivered 50 P3 mice to the POS Division for testing and use with the software development machines.

These mice represent a major step toward production, on schedule.  
Congratulations and thanks to those who contributed to getting the job done well:

Dean Hovey, and Jim Sachs in finalizing the design and assisting in setting up the pilot assembly line at Apple.

Chris Christofier in getting the vendors lined up and the soft tooling completed.

Denise Bruno and Bill Bull for providing production management for Peripherals Division.

Bill Dresselhaus and Doug Dayton for enduring all the minute modifications required to design the exterior.

Jim Giesea, Gary Marten, Daniella Carver, Rod Holt, Ken Abell, Paul Baker, Rich Williams, and others for help along the way.

Bill Lapson - Special thanks for managing the entire project to bring it to this point.

I am hopeful and confident that this milestone provides a positive indicator toward completing the final design and manufacture of the production mouse on time and within budget.

Thanks again to all of you.

#### DISTRIBUTION

P. Baker  
D. Bruno  
B. Bull  
K. Abell  
D. Carver  
C. Christofier  
J. Couch  
B. Daniels  
D. Dayton  
B. Dresselhaus  
J. Giesea  
T. Hawkins  
R. Holt  
D. Hovey  
G. Marten  
R. Montgomery  
W. Rosing  
J. Sachs  
J. Scott  
L. Tesler  
R. ToWane  
J. Vennard

Document created on 24 May 2000;  
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Mice race

Source: Dave Evans, "Mouse OEM Vendors (Whetstone)," internal memorandum (4 March 1982), n.p.

Location: Jim Sachs personal papers. Reproduced courtesy of Jim Sachs.

To: T. Hawkins, R. Tompane, L. Garvey, W. Lapson, P. Swearingen, L. Tesler, J. Scott, B. Yarkoni, W. Rosing, D. Hovey (Hovey-Kelley Design)

From: Dave Evans

Re: Mouse OEM Vendors (Whetstone) Response and Confidentiality

Date: 3/4/82

Today, Steve Kirsch of Whetstone (baby start up) came in to make a presentation to some POS Marketing and Peripherals Div. Engineering staff regarding his new optical mouse (as opposed to a mechanical mouse). Apple attendees included P. Swearingen, W. Lapson, R. Tompane, L. Garvey, and D. Evans.

We listened and said virtually nothing, but looked semi-interested. Needless to say, Steve would like to sell billions of mice to Apple, or at least license his design to us. He is going to develop some proposal to us for potential evaluation of the device for product opportunity analysis.

Steve's device is definitely inferior to ours. It is more expensive (\$100/ea. at 10,000 units/yr.) and requires the use of a reflective grid pad as its sliding surface. It could determine rotation as well as translation, but the value of that is hardly obvious (except for aiming while playing tank)-- especially at 3X our current costs. We never confirmed or denied anything whatsoever regarding our mouse. We also did not confirm or deny the existence of a mouse or the desire to use a mouse for any current or future products.

I strongly recommend that we kindly receive Steve's proposal, then respond that Apple is impressed with his technology, has investigated pointer technologies such as mice, but is not presently in a position to further discuss any OEM or co-development arrangements for pointing devices with any groups or individuals.

It may seem that "everyone knows" about Lisa and the mouse, but they don't really. They for the most part are going on rumors. Steve indicated that a mechanical mouse required a pad under it in order to work properly (e.g.: the Alto mouse), clearly showing that he does not know anything about the universal surface mouse that we have in the Hovey-Kelley design. The Apple mouse is state-of-the-art in terms usability and cost of manufacture. We should retain our uniqueness by not giving these guys the time of day.

SO.... even though it may be interesting to talk about new technologies, lets not use our valuable time educating these entrepreneurs and others like them in a technology area that we spent over a year (2 years!) developing to its current state. Please do not speak to anyone about our mouse. All future inquiries should receive a kind "Thank you, we are looking at pointing technologies but cannot talk with any 3rd parties at this time-- period."

Please be sure people in your areas follow these instructions and remind any knowledgeable suppliers that their work with Apple on this product remains fully confidential regardless of what they see in the media.

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## Hovey-Kelley and the Mouse

Source: Memo from Dean Hovey to Tom Whitney re: mouse development, 4 June 1980.

Location: Dean Hovey personal papers. Reproduced courtesy of Dean Hovey.

To: Tom Whitney

From: Dean Hovey

Re: Mouse development project

Cc: Bill Lapson, Jerry Manock, Tom Hong

This memo's intent is to establish H/K's perception, to this date, of its involvement with Apple's Mouse development program.

## BACKGROUND

In early January 1980, I discussed the possibility, with Steve Jobs, of H/K working on a small, complete product for Apple. At that time, the Mouse was mentioned as a potential product. After that discussion, H/K began to collect literature and discuss with vendors various possibilities of Mouse design.

Early in April, news surfaced, Lisa would require a Mouse at introduction and a development project was being opened. Tom Hong would be in charge of this project. I discussed with Mr. Hong the possibility of H/K working on the development project. After a minor misunderstanding about the course of the project, Mr. Hong suggested I discuss with Tom Whitney H/K's specific working relationship on the Mouse project.

## MOTIVATIONS



H/K is interested in the Mouse project for these reasons:

- 1.We would like to demonstrate a broader level of technical expertise to Apple. To this point we have only had the opportunity to express our mechanical packaging and industrial design abilities.
- 2.The ability to add a manufacturing base to our company would add stability to a potentially volatile consulting business
- 3.Individuals at H/K think the Mouse is an exciting, fun product to work on.

#### PRODUCT SPECIFICATIONS/DESIGN PARAMETERS

From the inception, H/K's understanding of the design specs are the following:

- 1.Resolution of 1/100 of an inch
- 2.Three control buttons would be located on the Mouse
- 3.Will not require a special pad to roll on
- 4.Inexpensive to manufacture
- 5.Reliable and manufacturable

#### WHITNEY/HOVEY MEETING

The remainder of this memo elaborates on our discussion. I stated the following:

- 1.H/K has a Mouse concept which can satisfy the design criteria.
- 2.The estimated manufacturing cost is less than \$20,000.
- 3.The estimated required tooling budget is \$50,000.
- 4.The estimated cost of design time is \$25,000.

#### APPLE'S DEVELOPMENT PLAN

Because a Mouse is an important part of the Lisa concept, a dual development

is strategic to Apple.

Another design consultant and H/K would work on the development in parallel on different concepts. Each firm will work independently under the guidance of Bill Lapson.

The first design effort would be to build a breadboard prototype to establish concept feasibility. When both development projects reached this point, the designs would be compared rating advantages and disadvantages. If possible, attractive features of both designs might be integrated into a final design direction.

#### TERMS OF THE DESIGN DEVELOPMENT

Tom Whitney asked how much it would cost to build this first prototype. I estimated between \$7,000 and \$12,000. At this point I received a go-ahead on the development project. My assumption was these funds were authorized, and were to be billed under our already established contractual relationship.

It was also agreed H/K might have the opportunity to manufacture Mice for Apple. Why?

- 1.H/K would like to manufacture a product for reasons already stated.
- 2.H/K might provide Apple a second source of Mouse manufacture.
- 3.H/K might show more enthusiasm and speed for the development program, knowing it may have the opportunity to manufacture the product.

Finally, regardless of whose design proved most attractive, H/K would probably work on the Industrial Design and potentially still have the opportunity to manufacture Mice for Apple.

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Hovey-Kelley Mouse Billing

Source: Memo from Dean Hovey to Bill Lapson, 4 August 1980.

Location: Dean Hovey papers (reproduced courtesy of Dean Hovey).

To: Bill Lapson

From: Dean Hovey

Re: Mouse billing to date

Date: 4 August 1980

The following is a description of the phases and monies allocated for the Mouse development program.

There are five distinct phases of the Mouse project: They are:

- 1.Original research
- 2.Feasibility prototype
- 3.First prototypes
- 4.Pilot production of 10 units
- 5.Production design

The following chart describes the transactions for each phase:

## PHASE

Phase	Date Begin	Date End
1	4/1	4/13
2	4/14	6/1
3	6/2	7/15
4	7/14	Not completed

5

7/29

Not completed

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Mouse Parts

Source: Memorandum from Bill Lapson, 10 April 1981.

Location: Jim Yurchenco Papers, untitled folder, private possession.

## MEMORANDUM

To: Tim Soho

From: Bill Lapson

Subject: Summary of discussion regarding Mouse parts

Date: April 10, 1981

1. Discussion involved Tim Soho, Larry Kelly, Chris Christophier, Bill Lapson, Dean Hovey, Bill Dresselhaus, and Steve Balog. Topics were materials, colors, and textures for the case and keybutton, logo, and centering of the keybutton.
2. The keybutton shall be molded of ABS, the same material used by the Keyboard Co. for Lisa keycaps. Texturing of mold shall be done by same vendor used by the Keyboard Co. (Raywald, Chicago).
3. The top cover is to be made of Noryl N-190 with MT`055 texturing as noted on drawing SK 2175-00.
4. The base is to be made of polycarbonate with color matching the keybutton as closely as possible. Texturing shall be MT1055 as noted on drawing SK 2177-00.
5. Apple keybutton will provide color reference chips and keycaps.
6. The artwork for the logo will be revised by Bill Dresselhaus. A new logo insert is to be made which will be tried by shooting a few parts with the P3 mice mold.
7. Dean Hovey will check that the above points regarding materials are indicated on the drawing. Dean will also mark case and keybutton drawings showing the critical dimensions determining keybutton

centering. Christophier will have P3 Mouse parts measured to establish the correct dimensions to be shown on the drawings to assure keybutton centering.

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State of the Mouse, 4 August 1981

Source: Memo from Bill Lapson, 4 August 1981.

Location: Jim Sachs personal papers. Reproduced courtesy of Jim Sachs.

#### APPLE MOUSE DROPPINGS

Date: August 4, 1981

To: Distribution

From: Bill Lapson

Subject: What's Going on and Who to Contact on the Mouse Project While  
Bill Lapson is on Vacation

WHAT'S GOING ON?

CASE AND KEYBUTTON

The mold for the case has been re-worked. This is what needs to be done at  
this point:

1. Assemble a complete Mouse and see if the parts go together properly (Paul Swearingen\*, Jim Sachs, and Jim Yurchenko).
2. Check case parts for conformation to print (Chris Christophier\* and Stan Lassley).
3. Submit case parts, including logo, to Bill Dresselhaus for aesthetics approval (Chris Christophier\* and Bill Dresselhaus).
4. Send molds for case and button to Rawal for texturing ( Chris Christophier\* and Bill Dresselhaus).



## RIBCAGE

The ribcage mold is just about finished. At this point, a detail has to be machined into the mold to stiffen the fingers positioning the LEDs. The mold is then ready to go. I recommend ordering no more than 500 parts since this is a very new item. (Chris Christophier\*, Paul Swearingen, Jim Yurchenko, and Jim Sachs).

## CABLES FOR P3 MICE

Up to 100 P3 Mice have to be retrofitted with connectors conforming to the current Lisa pin-out requirements. (Paul Swearingen\*, Denise Bruno, and Paul Baker).

## ELECTRONICS TESTING

Several Mice have to be assembled to determine the best scheme for controlling LED current and signal timing. An order must then be placed for the required PC board (Paul Swearingen\* and Jim Sachs).

## MANUFACTURING PROCEDURES

There are several items in this category:

1. Assemble LED and detector test rig and use it for incoming inspection of these items.
2. Develop procedures for assembling Mice and checking them out at various stages of assembly.
3. Build checkout equipment, adapt presently available software. (Paul Swearingen\*)

## PARTS ORDERING

Check that orders have been placed for all parts. At the moment we have enough cases for engineering purposes (about 50) but lack just about every other part. Parts will not be ordered b manufacturing until they are released by document control (Bill Bull\*, Jim Stewart, and Bob Maas).

\*Indicates person with principal responsibility

## WHO'S IN CHARGE?

The above asterisks show who is responsible for or working on each activity.

The focal point for all issues in my absence is Bill Bull.

## DISTRIBUTION

Paul Swearingen  
Jim Sachs  
Jim Yurchenko  
Chris Christophier  
Stan Lassley  
Bill Dresselhaus  
Denise Bruno  
Paul Baker  
Jim Stewart  
Bob Maas  
Bill Bull  
John Scott  
John Manousos  
Ray Yokoyama  
Bob Montgomery

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## Lore of the Mice

Source: Bill Lapson, "Lore of the Mice," typed ms. (28 July 1982).

Location: Jim Sachs personal papers. Reproduced courtesy of Jim Sachs.

The Mouse project has matured to the point where many others will be involved in its evolution. This collection of facts should ensure that some of the important lore about the Mouse is neither lost or distorted as time goes on.

### WAS THERE A SPECIFICATION FOR THE MOUSE AT THE BEGINNING OF THE MOUSE PROGRAM?

The original specification was in the form of a piece of hardware, that is, an expensive species of Mouse which used lots of ball bearings, was susceptible to clogging from eraser fragments, cost around \$400, slipped on a formica surface, and wore out after not too many hours of use (the brushes disappeared!). The specification was for a Mouse with the same sensitivity, having none of the problems just mentioned, and costing a maximum of \$35. Because of the high degree of interaction between the teams developing Lisa and the Mouse, this was a quite adequate specification for a start. As time went on a document was drafted called "Mouse Specification" which described the device that people seemed to like.

### WHO WERE THE KEY PEOPLE INVOLVED IN THE DEVELOPMENT OF THE MOUSE?

The project manager was Bill Lapson. He stayed with the project as many others came and went, keeping the project moving as the organization about it went through drastic changes, in addition to being a technical contributor. Some real heroes were Dean Hovey, Jim Sachs, and Jim Yurchenco of Hovey/Kelley Design. Inspired to be part of the Apple team and hoping to be

the possible manufacturers of the Mouse, these guys really used some imagination to produce a Mouse concept overcoming all the operational faults of previous Mice, and which had great promise of meeting cost objectives. Because of an urgent need for Mice for Lisa system development, Hovey/Kelley manufactured our historical Lucite Mice (only 50 were made, so hold on to those antiques). Several hundred P3 Mice were next manufactured by the Peripherals Division. These were Mice externally similar to the present Mice, but having very different innards. The heroes at this point were Bill Bull, Denise Bruno, and Esther Brunner who produced these interim Mice with virtually no fuss, delivering them on time. Chris Christophier helped with the tooling for the P3 Mice as well as the present production version.

We can attribute the present state of quasi-perfection to Paul Swearingen who (working with Bill Lapson) figured out a way to eliminate adjustments, what mechanical details affected signal timing, suggested ways of cutting costs, and Supported the production line run by ta ta! Jim Hsu, who did a fine job of planning and helping to de-bug the Mouse.

There are several names in the Lisa group which must be mentioned. The styling of the Mouse was done under the direction of Bill Dresselhaus with color and texture control by Bill Dresselhaus and Clive Twyman. Dresselhaus and Twyman should also be cited for the logo on the Mouse which is asymptotically approaching perfection. Functional performance of the Mouse was directed by Larry Tesler. Overall Lisa/Peripherals coordinator was Dave Evans who had a very substantial influence in keeping the project alive and in moderate health. A cast of anonymous secretaries performed the ergonomic (this is a clean word!) evaluation of the Mouse.

At this time a new kind of hero is involved with the Mouse. First is Peggy Hummel who is getting the Mouse released (until now all Mice have been kept in stock-room cages or tied to a computer!). This task has, without exaggeration, required the equivalent mental and emotional energy of designing the Mouse Next is Bob Mihalus who has discovered that mice are too

mortal. They lose their tails (cables break) and whiskers (springs wear out) and develop palsy (friction of the balls and shafts). Some live to be ancient but others die after a weekend beating.

WHAT SHOULD BE DONE WITH P3 MICE THAT HAVE FAILED?

Failed P3 mice should be scrapped... they've served their purpose as an interim product for in-house use. The principle failure modes, namely loose rollers and popped springs have been eliminated on the production version of the Mouse. P3 Mice can be distinguished from production Mice by looking for the black ball-retainer which is used only on the production Mouse.

WHAT'S THE DIFFERENCE BETWEEN THE LISA AND MAC MICE?

Both Mice have the same ball tracking mechanism and PC board. The cases and connectors are different. Adaptation of the Lisa Mouse to Mac was done by the Mac group.

WHAT IS AN ALPS MOUSE?

The Alps Corp independently developed a Mouse looking just like a Lisa Mouse but using mechanical brushes sliding on a disk with a radial pattern of conductors. Very clever, but too much friction and potential for wearing out as compared to the photo-optical Mouse now being produced in Peripherals. However, Alps claims they can produce the Mouse at extremely low cost (\$3-10) so the concept should be given a fair evaluation and as much engineering as it takes to make it work right.

HOW MUCH DOES A LISA MOUSE COST?

Shhhh! This may be confidential! The objective was to produce a Mouse costing under \$35. Since Mice have never been produced in large volume, it is only possible to estimate that they'll cost \$25-30, which includes about 10-15

minutes of assembly labor.

#### WHERE WILL THE MOUSE BE MANUFACTURED?

Until recently the plan was to manufacture Mice at the Accessory Products Division and start up a parallel manufacturing operation in Singapore. The present plan is to continue to manufacture Mice in the Peripherals Division. This may go on for three to six months while large scale testing of the Mouse is in progress. This will assure that any changes necessary will be executed by the group most familiar with the Mouse.

At various times there has been talk of "pulling the molds" and sending them to some other site, e.g., Singapore, APD, or some other vendor. Assuming there are good reasons for such a transfer, this should be done carefully. For example, the ribcage, a delicate and complex part, may not be moldable in an ordinary shop.

#### WHAT KIND OF CHANGES MIGHT BE NECESSARY ON THE MOUSE?

Changes!?!??? What kind of ----- changes? Indeed, large scale testing is likely to reveal the need for changes. For example, there is a suspected problem with cable breakage near the grommet. Possible causes are too much heat and pressure in the grommet molding process which damages the cable during manufacture. Another possible but unlikely cause is insufficient annealing of the wire after drawing. A likely cause is subjecting the cable to an unrealistically sharp bend. Some cures for a problem of this type are better control of the grommet molding process, adding another segment to the grommet, and using fatigue-resistant tinsel or copper-clad, stranded steel wire. Tinsel wire is used in telephone cords. It's been considered for the Mouse but was not used because it's stiffer and more difficult to terminate than the present stranded copper wire. Copper-clad wire wasn't used because it's custom made and may also be more difficult to terminate than stranded copper wire. Naturally, all of these cures are pursuable at this time.

An easily cured, real problem has just been found involving slippage of the idler spring on the idler wheel shaft which wears out the spring. This slippage is not supposed to occur. The cure is to put flats on the idler shaft ... almost certain to cure the problem without causing another. In fact, a small flat has been put on an idler wheel shaft and the result was to stop the unwanted slippage.

Another problem may be with signal timing. This problem affects production yield and should not affect the reliability of a tested Mouse. The important contributing factors here are consistency in the performance of the photo-optics and tolerances in the "detector block". As Mice are produced, the required performance limits for the photo-optics will emerge. This type of data can also be obtained by performing some methodical engineering tests. The present detector block tolerances are border-line. A second go at a detector block mold would result in more favorable signal timing. It would take about two months and \$10,000 to make another mold, a safe course of action since an attempt to alter the present mold may destroy it.

Introducing the bounce resistance of a gerbil into the present Mouse may be the most difficult problem ... if it is a problem. The Mouse can leap off a desk like an Aztec warrior proving his courage, dangling a fraction of an inch off the floor from its cable. That's pretty good since many Mice will be required to perform this act one or more times during their life. A more serious problem ... if it is a problem, is that Mice, as they now are, Will probably never survive the Queen of SM, a direct drop on the floor from waist height. Shafts bend and cases crack. If it's really important, Mice can be made which will survive! First the shafts can be made of a stronger steel. Next, the bearing supports can be moved to provide better support. The case can be improved to resist breaking. A more extreme modification would involve stepped shafts, that is, heavy in the center where it contacts the ball and smaller at the ends.

IS ENGINEERING OF THE MOUSE FINISHED?



The intensive life test program about to be carried out by Ed Houston of Corporate Services has a good chance of revealing weaknesses. I've tried to anticipate these weaknesses and their cures above. Yup! There may be more engineering.

On the other hand, why shouldn't there be more engineering on the mouse? If it is such an important part of the new computer systems, why not assign a bona-fide engineering team not only to maintain and sustain this products but to develop improved versions of Mice?

Bill Lapson  
July 28, 1982

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## Testing the Mouse

Source: Memo from Rickson Sun to Bill Lapson, 16 October 1980.

Location: Dean Hovey papers (reproduced courtesy of Dean Hovey).

To: Bill Lapson

From: Rickson Sun

Date: Oct. 16, 1980

Subject: Mouse Life Testing Memo

After an effective three years of running in circles on formica, the mouse has shown only minor degradation in performance.

The testing machine runs at the rate of 2473 ft/hour. With a usage estimate based on the following assumptions: 1.5 feet per edit, 1 edit per 10 seconds, 2 hours per day of editing activity, and 300 working days per year. This gives 324,000 ft/year, or 119 hours/year. With 385 hours total, the mouse has run for 3.24 years.

To check performance of the mouse a fixture was made up that constrained the mouse motions to up-down, left-right, diagonal lower left (LL)-upper right (UR), and lower right (LR)-upper left (UL). Hysteresis was monitored qualitatively by watching the resulting cursor motion on Lisa.

Document created on 6 July2000;

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Hovey/Kelley Work on Mouse

Source: Memo from Tom Whitney to Jerry Manock and Tom Hong, 14 May 1980.

Location: Dean Hovey papers (reproduced courtesy of Dean Hovey).

Date: May 14, 1980

To: Jerry Manock, Tom Hong

From: Tom Whitney

Subject:

CC: Dean Hovey (Hovey/Kelley), Steve Jobs

I have discussed with Dean Hovey his continued relationship with Apple. We agreed his firm will continue to work on a prototype "mouse", spending no more than \$X in the process. His efforts will be coordinated with Bill Lapson, Project leader for Mouse activities. His firm is interested in the possibility of being the (or one of the) manufacturers of the mouse. This we can discuss at some future time.

Hovey's work on the mouse will be independent of our other outside consultant....

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## Choosing Molding Vendor

Source: Letter from Jim Yurchenco to Bill Lapson, 5 December 1980.  
Location: Dean Hovey papers (reproduced courtesy of Dean Hovey).

December 5, 1980

Mr. Bill Lapson  
Apple Computer, Inc.  
10260 Bandley Drive  
Cupertino, CA 95014

Dear Bill,

I would like to recommend using Micro Molding for producing the mouse ribcage and detector block tooling for the following reasons:

- 1) Once the conceptual design was complete, I discussed with Laszlo Zsidek the parts to be molded in detail. Our discussion concerned both moldability and possible vendors. He recommended Micro Molding at that time.
- 2) I Agreed with Laszlo because:
  - a. Micro Molding is located conveniently to both Hovey/Kelley and Apple Computer.
  - b. Hovey/Kelley has a good working relationship with Micro Molding based on past services rendered.
  - c. Micro Molding has successfully produced difficult parts for Apple Computer in the recent past, including the disk frog and disk clamp.

d. Micro Molding has delivered tooling on time which has not required rework.

e. Micro Molding has extensive experience with intricate small parts and can be expected to produce parts to spec. Mouse parts must be to print or the mouse may be non-functional.

In any event, if Apple chooses another vendor for the job, I will cooperate completely and amicably with the vendor selected.

Sincerely,

[signed Jim Yurchenco]

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