MEMORANDUM

September 15, 1982

TO: Bill Turner

COPY TO: Bill Sick

SUBJECT: TI-88 White Paper

SUMMARY

The decision has been made to cancel the TI-88 program and pursue the market currently addressed by sophisticated keystroke programmable calculators with a competitively priced programmable language portable computer, the ALC. Our previous strategy, as exemplified by the dual development programs of the ALC and the TI-88, was to penetrate the programmable language personal portable computer market with the ALC product while attempting to maintain our share of the programmable calculator market with the TI-88 program. Due to difficulties with the TI-88 program, the costs and the risks of producing this product have grown significantly over the past year. During that time, the acceptance of programmable language portable computers has accelerated the decline of the keystroke programmable market. We are now in the position with the TI-88 of spending more money at increasing risk to enter a declining market at a later timeframe. This tactic not only decreases the probability of a fair return on our investment in a keystroke programmable product, but it subtracts effort and energies from the long range strategic product, the programmable language portable computer. Key to success in either market is applications software. Focus on getting third parties to do packages on only one product will significantly increase the rapidity with which we build up an applications library.

The decision has been made to concentrate our energies in the long range strategic area, the programmable language portable computer, and to accelerate our effort in that space by adding to the BASIC language programmable product a Pascal and FORTRAN language programmable product. These latter languages are especially attractive to the market space that is currently occupied by the keystroke programmable calculators.

This white paper details the data considered, and strategic thinking behind that decision. Included are:

- Current TI-88 status.
- History.
- Alternatives for problem resolution.
- Market requirements and impact.
- Impact of TI-88 cancellation.
- Decision.
- Programmable Language Portable Computer Strategy.

## CURRENT TI-88 STATUS

The metal gate CMOS parts (display drivers, RAMS and ROMS) are qualified and in good shape. The silicon gate CMOS process, which is used for the 485 microprocessor chip, is now in good shape. Until recently, the process development problems masked the logic/circuit design problems. We have, over the last six months, identified and fixed a number of circuit problems. Most recently, a logic problem in the divide-by-three counter has been identified, which makes the current chip pass obsolete, but which explains a large number of the problems we have been experiencing. There are, however, a number of other known failure mechanisms which are not solved. In addition, there are indications which give concern about the overall adequacy of the chip design where significant compromises were made to keep the chips small to maintain the low cost. Changing the 485 mask to correct the currently identified logic problem will solve the most significant problems, but there is still considerable question as to whether the product would be of acceptable quality to ship. There is a high probability of additional mask changes being required.

## HISTORY

The TI-88 development was an exceedingly ambitious program which attempted to push forward the state-of-the-art in three dimensions: semiconductor process, architecture, and complex custom chip design. In retrospect, it was unrealistic to assume that the significant risks inherent in each of these technology areas could be isolated and managed separately without confusing interactions. As a result, it became impossible to isolate the problems in each of the areas and problem solution became an iterative process. There is ample precedent for similar problems occurring on other equivalently ambitious digital systems programs.

## ALTERNATIVES FOR PROBLEM RESOLUTION

Two major alternatives were identified to bring the TI-88 or an equivalent product to market place.

1) Continue the current TI-88 program. This would include fixing the current logic problems in the 485 chip set, producing new samples, and then further analyzing additional problem symptoms to ascertain whether or not the logic fix made the product sufficiently reliable to ship. Current projections are that the logic fix cures the most significant and obvious multiple problem symptoms we have experienced. There are a number of less frequent problem symptoms which it probably does not fix. Fixing these further problems would require further diagnosis and additional chip mask changes, resulting in additional shipping schedule delays. If we elect to

ship the next mask version of the product, first shipment would occur January of 1983. If, as a calculated assumption, it takes two additional mask changes to product a shippable product, shipment date would be in June of 1983. The January 1983 production schedule would require an additional expenditure of OST and Tooling of $1.3M. The June shipment schedule would require additional spending in OST and Tooling of $1.75M. In addition to these sums, OST would have to be expended next year to enhance the TI-88 product from a peripheral and application software standpoint.

2) Produce a keystroke programmable calculator by modifying the ROM code in the ALC-A product so it would be programmable in keystroke language rather than the BASIC language. This effort would also include changing the key top graphics and would provide slightly different and slightly lower functionality than the TI-88 product. However, it would still be a significant functionality and performance improvement over the TI-59 with product cost equal to the TI-88. The critical path for this project would be the software development of the keystroke language ROM and the current schedule estimate using EPROMS would be a July ship date. Incremental OST and tooling to accomplish this program would be $725K, including the modifications of currently coded TI-88 applications software to run on this new product.

## MARKET REQUIREMENTS AND IMPACT

There are a number of indications that the market for sophisticated keystroke programmable calculators has plateaued and is, in fact, declining. Recent 1982 surveys were conducted with ALC target customers and have identified that three BASIC language computing devices (the TI ALC, Sharp 1500, and Panasonic HHC) were overwhelmingly preferred over keystroke programmable HP-41CV and TI-88 devices. Seventy-one percent of the respondents interviewed preferred the BASIC Language computing device. The major points of preference are: the language is perceived to be easier to use than keystrokes; and the keyboard layouts provide easier entry of alphanumeric information.

These findings are consistent with a historical technology view of the keystroke programming market place. Keystroke programmable calculators were originally positioned as a bridge between calculators and computers. Cost considerations dictated implementations and programming languages be developed to provide highly efficient use of registers in order to control the cost of memory. The costs of memory and storage are dropping at such a rate that it is no longer necessary to restrict programmable calculators to highly efficient register oriented languages and architectures. Instead, user friendly, well-understood, higher level languages along with computer type architectures can be applied to these products with little, if any, sacrifice in cost.

The user preference for BASIC as opposed to keystroke programming is a direct result of the computer orientation of most sophisticated programmable calculator users. In fact, BASIC is probably one of the least acceptable computer programming languages for this class of customer. Much more desirable is Pascal and, to a lesser extent, FORTRAN. Pascal is particularly attractive due to its structured nature, transportability to personal and minicomputers, and relatively low memory requirements.

These factors have caused the total available market in the keystroke programmable space to have peaked at 600K units in 1981 (up from 500K units in the two previous years) and to decline to a projected 500K units during 1982. The introduction by HP of the HP-75, which is a BASIC Language programmable computer, is confirmation of their recognition of this market trend. HP has been forced to introduce that product at a significantly higher price point ($995) to protect the 41CV's entrenched sales position. The 41CV and the TI-88 are particularly vulnerable to a competitively priced programmable language portable computer such as the ALC. This vulnerability would be amplified by the availability of Pascal as a language on that computer.

## IMPACT OF TI-88 CANCELLATION

The three major impact areas are: TI's reputation in the market place, specific obligations to customers that we have incurred, the financial write-offs required by the cancellation.

The impact of the cancellation in the market place can be turned into a positive by the announcement of the ALC programmable language portable computer, and the highlighting of our strategy of replacing keystroke programmable calculators with programmable language portable personal computers. While this will still have a short-term negative impact, in the long run we will be better off protecting our user base by not bringing out a dead-ended product, and then not enhancing it and yanking the rug out from under in a year. We are protecting our customers from this disruptive strategy and will handle the announcement in such a fashion that we receive credit for it, while making the appropriate points with regard to the long term viability of the HP-41CV.

We have identified 23 specific customers who are in the process of developing applications for the TI-88. All but one or two of those are switchable to the ALC. In addition, there are 6 retailers who have the TI-88 in their catalogs. Half of those have been stopped. We believe there is no major liability in the remaining catalogs.

As a result of stopping the TI-88 program, we will incur a write-off of $3M. This includes:

TI-88 PHASEOUT COST

| | $M |
|---|---|
| Inventory | 1.1 |
| Commitments to Vendors | .8 |
| Capital | .9 |
| Expense | .2 |
| | 3.0 |

While this is a significant impact on our bottom line, it is not clear that, given the risks, continuing the TI-88 until next year would avoid the write-off. There is a possibility of further technical problems causing cancellation in the middle of next year, increasing the current write-off. Even after we announce the product, there is the possibility of significant further investment in inventory and promotion, without effective sales volume to amortize the costs.

DECISION

The following alternatives were considered:

1) Continue the TI-88.

2) Cancel the TI-88 and replace it with the ALC keystroke program.

3) Cancel the TI-88 and not produce a keystroke program device and attempt to capture the market with the BASIC Language ALC.

4) Expand the ALC product family to include Pascal program language to capture the scientific keystroke program user.

The decision is to abandon the keystroke programmable calculator market, and expand the ALC family to provide a Pascal program product to re-capture the keystroke user.

The Pascal version of the ALC would include three significant new product features:

1) The alteration of the case work of the ALC to accept plug-in ROM cartridges with different language processors, enabling multiple language options on the same programmable portable computer.

2) The coding of the Pascal compiler.

3) The cost reduction of the current ALC design with the objective of the product cost of the new machine with the plug-in ROM feature being no greater than the current ALC product cost.

OST and tooling for this effort is $550K with a ship time of September 1983. In addition to the Pascal program, a plug-in ROM cartridge for FORTRAN would be implemented. OST and tooling for this is $150K and it will be shippable in September 1983.

It was concluded that the risks associated with the TI-88 would represent significant future investment in what is a declining market space. While the ALC keystroke version represented slightly lower risk and smaller investment, it still represented too large an expenditure to capture a short-term market. Both of those would have a time to market much later than acceptable to capture a significant portion of a declining market against the entrenched competition of the HP-41CV. The addition of the Pascal language to the ALC line provides a product that is extremely attractive to keystroke programmable users at an equal price point. It represents an investment in an expanding technology and market segment, and has the advantage of providing additional leverage when the ALC family of products is expanded to higher and lower functionality/price points.

PROGRAMMABLE LANGUAGE PORTABLE COMPUTER STRATEGY

We are finalizing plans for a family of programmable language portable computers based upon extensions of the ALC-A and a library of applications programs and language compilers to be used in this family. There follows a brief description of the new members of the family and the software offering.

ALC-LC - SRP $119 (1K RAM, 18K ROM, BASIC)

The ALC-LC will be a 16-character LCD display computer with 1.0KB of memory, and a reduced functionality BASIC language. The unit will have no plug-in module capability, but will have full ALC I/O bus (peripherals) compatibility.

ALC-A2 - SRP $250 (2K RAM, 32K BASIC Plug-in ROM)
SRP $270 (2K RAM, 64K Pascal Plug-in ROM)
SRP $270 (2K RAM, 64K FORTRAN Plug-in ROM)

A multi-language version of the ALC-A. The major differences between the A and A2 are 1) 1/4" thicker, 2) addition of a plug-in (flat pack) programming language module, 3) expansion of the language ROM space from 32KB to 64KB, and 4) expansion of internal RAM capacity from 18KB to 34KB. Each of these modifications is provided in order to obtain the multi-language capability required:

- 64KB ROM is required in order to house more extensive languages such as Pascal or FORTRAN.

- o 32KB RAM expandability is required to 1) run the more sophisticated programs expected to be developed from higher level languages, and 2) aid in the compilation speed of compiled programs.

- o Plug-in languages on flat pack modules provide the ability to exchange languages on the machine.

- o Additional thickness is required to house the additional memory and plug-in module.

ALC-C/T - SRP $550/$650 (8K RAM, 32K BASIC Plug-in ROM)

An expansion of the ALC-A2 to enhance the product for use in higher utility applications, specifically high level professional and managerial support. The ALC-C will be an ALC-A2 in a larger case (notebook size) with a 6X40 LCD display, full travelling typewriter keyboard, and built-in tape mass storage. Critical to the product will be an applications module containing a word processing and spreadsheet package. The ALC-C will be able to run any ALC-A2 application or language modules.

The ALC-T is a variation of the ALC-C and provides the added feature of a built-in 300 baud modem and telecommunication software. With this added feature, the executive/manager can do remote teleprocessing involving file exchanges, private database access, public database access and electronic mail, all in a single package.

SOFTWARE OFFERINGS

A minimum of three language processors: BASIC, Pascal and FORTRAN will be offered. In addition, we will investigate the usefulness of other languages such as C, FORTH and a microsoft BASIC language to provide compatibility with the personal computer space. Each of these languages will run on the ALC-A, A2 and C/T.

APPLICATIONS PACKAGES

Horizontal Applications - Currently under development are applications in Math, Finance and Statistics areas. In addition, we will add developments for spreadsheet (VisiCalc), formula solver, personal word processing, graphics, project management, financial investment, and games.

Vertical Applications - Currently under development are applications in electrical engineering, photography, inventory, QA sampling, fluid dynamics, profitability analysis, mechanical engineering, physics, nonparametric statistics, production planning, regression analysis, QA control. Being investigated and planned are: real estate analysis, industrial engineering, banking, civil engineering, operations research, heating and ventilation analysis.

Plans are being put in place to do the majority of applications via third party vendors on a royalty basis.

[redacted] C. B. Wilson

MEMORANDUM

September 20, 1982

TO: Bill Turner

COPY TO: Bill Sick

FROM: Herb Shanzer

SUBJECT: TI-88 White Paper

SUMMARY

The decision has been made to cancel the TI-88 program and pursue the market currently addressed by sophisticated keystroke programmable calculators with a competitively priced programmable language portable computer, the ALC. Our previous strategy, as exemplified by the dual development programs of the ALC and the TI-88, was to penetrate the programmable language personal portable computer market with the ALC product while attempting to maintain our share of the programmable calculator market with the TI-88 program. Due to difficulties with the TI-88 program, the costs and the risks of producing this product have grown significantly over the past year. During that time, the acceptance of programmable language portable computers has accelerated the decline of the keystroke programmable market. We are now in the position with the TI-88 of spending more money at increasing risk to enter a declining market at a later time frame. This tactic not only decreases the probability of a fair return on our investment in a keystroke programmable product, but it subtracts effort and energies from the long range strategic product, the programmable language portable computer. Key to success in either market is applications software. Focus on getting third parties to do packages on only one product will significantly increase the rapidity with which we build up an applications library.

The decision has been made to concentrate our energies in the long range strategic area, the programmable language portable computer, and to accelerate our effort in that space by adding to the BASIC language programmable product a Pascal and FORTRAN language programmable product. These latter languages are especially attractive to the market space that is currently occupied by the keystroke programmable calculators.

This white paper details the data considered, and strategic thinking behind that decision. Included are:

- Current TI-88 status.
- History.
- Alternatives for problem resolution.
- Market requirements and impact.
- Impact of TI-88 cancellation.
- Decision.
- Programmable Language Portable Computer Strategy.

## CURRENT TI-88 STATUS

The metal gate CMOS parts (display drivers, RAMS and ROMS) are qualified and in good shape. The silicon gate CMOS process, which is used for the 485 microprocessor chip, is now in good shape. Until recently, the process development problems masked the logic/ circuit design problems. We have, over the last six months, identified and fixed a number of circuit problems. Most recently, a logic problem in the divide-by-three counter has been identified, which makes the current chip pass obsolete, but which explains a large number of the problems we have been experiencing. There are, however, a number of other known failure mechanisms which are not solved. In addition, there are indications which give concern about the overall adequacy of the chip design where significant compromises were made to keep the chips small to maintain the low cost. Changing the 485 mask to correct the currently identified logic problem will solve the most significant problems, but there is still considerable question as to whether the product would be of acceptable quality to ship. There is a high probability of additional mask changes being required.

## HISTORY

The TI-88 development was an exceedingly ambitious program which attempted to push forward the state-of-the-art simultaneously in three dimensions: semiconductor process, architecture, and complex custom chip design. In retrospect, it was unrealistic to assume that the significant risks inherent in each of these technology areas could be isolated and managed separately without confusing interactions. As a result, it became impossible to isolate the problems in each of the areas and problem solution became an iterative process. There is ample precedent for similar problems occurring on other equivalently ambitious digital systems programs.

If we were to do this again, we would divide the program into three specific phases. First, a top-down system design with a clear definition of the interface requirements and performance requirements for both the process and each of the architectural entities. Secondly, each of those high risk technology efforts would be broken apart and managed separately. That is, the process would be developed independently, while the microprocessor and support chips are designed, on paper, and checked using software simulation. Thirdly, only after each of these technology achievements had reached a satisfactory level of completion, would they be re-combined, to complete the TI-88. The proven architectural design could then be implemented as an ambitious custom design on the proven process.

The product was announced in late May at CES as a calculated risk driven by the desire to maintain TI's image and position in the keystroke programmable market. An attempt was made to minimize the risk by holding the ship date until Fourth Quarter 1982. The time table required for successful announcement at CES required that extensive preparation be done prior to the receipt of the latest version functioning calculators. A working prototype calculator was available only shortly before the CES and burn-in data was not available and understood at the time of CES. It was only during burn-in that a number of subtle problems were discovered, these caused the re-design cycle prior to the current set of problems.

## ALTERNATIVES FOR PROBLEM RESOLUTION

Two major alternatives were identified to bring the TI-88 or an equivalent product to market place.

1) Continue the current TI-88 program. This would include fixing the current logic problems in the 485 chip set, producing new samples, and then further analyzing additional problem symptoms to ascertain whether or not the logic fix made the product sufficiently reliable to ship. Current projections are that the logic fix cures the most significant and obvious multiple problem symptoms we have experienced. There are a number of less frequent problem symptoms which it probably does not fix. Fixing these further problems would require further diagnosis and additional chip mask changes, resulting in additional shipping schedule delays. If we elect to ship the next mask version of the product, first shipment would occur January of 1983. If, as a calculated assumption, it takes two additional mask changes to product a shippable product, shipment date would be in June of 1983. The January 1983 production schedule would require an additional expenditure of OST and Tooling of $1.3M. The June shipment schedule would require additional spending in OST and Tooling of $1.75M. In addition to these sums, OST would have to be expended next year to enhance the TI-88 product from a peripheral and application software standpoint.

2) Produce a keystroke programmable calculator by modifying the ROM code in the ALC-A product so it would be programmable in keystroke language rather than the BASIC language. This effort would also include changing the key top graphics and would provide slightly different and slightly lower functionality than the TI-88 product. However, it would still be a significant functionality and performance improvement over the TI-59 with product cost equal to the TI-88. The critical path for this project would be the software development of the keystroke language ROM and the current schedule estimate using EPROMS would be a July ship date. Incremental OST and tooling to accomplish this program would be $725K, including the modifications of currently coded TI-88 applications software to run on this new product.

## MARKET REQUIREMENTS AND IMPACT

There are a number of indications that the market for sophisticated keystroke programmable calculators has plateaued and is, in fact, declining. Recent 1982 surveys were conducted with ALC target customers and have identified that three BASIC language computing devices (the TI ALC, Sharp 1500, and Panasonic HHC) were overwhelmingly preferred to $100 or greater keystroke programmable HP-41CV and TI-88 devices. Seventy-one percent of the respondents interviewed preferred the BASIC Language computing device. The major points of preference are: the language is perceived to be easier to use than keystrokes; and the keyboard layouts provide easier entry of alphanumeric information.

These findings are consistent with a historical technology view of the keystroke programming market place. Keystroke programmable calculators were originally positioned as a bridge between calculators and computers. Cost considerations dictated implementations and programming languages be developed to provide highly efficient use of registers in order to control the cost of memory. The costs of memory and storage are dropping at such a rate that it is no longer necessary to restrict programmable calculators to highly efficient register oriented languages and architectures. Instead, user friendly, well-understood, higher level languages along with computer type architectures can be applied to these products with little, if any, sacrifice in cost.

The user preference for BASIC as opposed to keystroke programming is a direct result of the computer orientation of most sophisticated programmable calculator users. In fact, BASIC is probably one of the least acceptable computer programming languages for this class of customer. Much more desirable is Pascal and, to a lesser extent, FORTRAN. Pascal is particularly attractive due to its structured nature, transportability to personal and minicomputers, and relatively low memory requirements.

These factors have caused the total available market in the keystroke programmable space to have peaked at 600K units in 1981 (up from 500K units in the two previous years) and to decline to a projected 500K units during 1982. The introduction by HP of the HP-75, which is a BASIC Language programmable computer, is confirmation of their recognition of this market trend. HP has been forced to introduce that product at a significantly higher price point ($995) to protect the 41CV's entrenched sales position. The 41CV and the TI-88 are particularly vulnerable to a competitively priced programmable language portable computer such as the ALC. This vulnerability would be amplified by the availability of Pascal as a language on that computer.

## IMPACT OF TI-88 CANCELLATION

The three major impact areas are: TI's reputation in the market place, specific obligations to customers that we have incurred, the financial write-offs required by the cancellation.

The impact of the cancellation in the market place can be turned into a positive by the announcement of the ALC programmable language portable computer, and the highlighting of our strategy of replacing keystroke programmable calculators with programmable language portable personal computers. While this will still have a short-term negative impact, in the long run we will be better off protecting our user base by not bringing out a dead-ended product, and then not enhancing it and yanking the rug out from under in a year. We are protecting our customers from this disruptive strategy, and will handle the announcement and any initial unfavorable press and customer reactions in such a fashion that we receive credit for doing so.

We have identified 23 specific customers who were in the process of deciding to develop applications for the TI-88. Of the 23, 7 have prototype TI-88's. Of the 7, only one has started on a specific development program. Our liability to this one developer was $2K per man month development for 3 months or $6K. The other 6 that had TI-88's have been told to halt development. Each one was questioned as to the problems this would cause them. All 6 indicated no cost/problems. All 7 customers have agreed to switch their application efforts to the ALC. The balance of the group (16 people) were early in their decision cycle. We plan to contact each of them individually to manage a transition to the ALC. Given their lack of detailed involvement and the large number of customers, we cannot start to do this until after public announcement.

In addition, there are 6 retailers who have the TI-88 in their catalogs. Half of those have been stopped. We believe there is no major liability in the remaining catalogs. The detail run-down is as follows:

TI-88 RETAILER LIABILITY

| | |
|---|---|
| ACI | o Running in catalog now through Fall 1983.<br>o Liability is understood and no repercussions are expected. |
| SPEIGEL'S | o Running in the current catalog until March 1983.<br>o No major repercussions. |
| BENNET BROTHERS | o Running in the current catalog until September 1983.<br>o No problem expected. |
| OLYMPIC SALES | o Going to print this week on catalog.<br>o Have been told to pull the copy and will know on 9/15.<br>o No problem expected. |
| PENNEY'S | o Pulled from Spring catalog. |
| BLOOMINGDALE'S | o Pulled from Christmas catalog. |

As a result of stopping the TI-88 program, we will incur a write-off of $3M. This includes:

TI-88 PHASEOUT COST

| | $M |
|---|---|
| Inventory | 1.1 |
| Commitments to Vendors | .8 |
| Capital | .9 |
| Expense | .2 |
| | 3.0 |

In an attempt to minimize the write-off and gain maximum utilization of the investment in the TI-88, we have looked at the possibilities of re-using the chip designs, chip inventory, and the test equipment developed for the TI-88. The VATS test equipment can be salvaged with software and hardware modifications, and be re-usable as ALC test equipment, when volume on that product reaches the point where a second test set is required. This will recover approximately half of the $180K invested in that equipment.

There is no existing design which can utilize the custom ROM and RAM chips developed for the TI-88. Since these are more expensive than equivalent commodity RAM and ROM chips, any new design should not plan on using them. The display driver was customized for optimum communications with the 485 microprocessor and, based on cost considerations, not a good choice versus commodity chips for a new design. The 485 microprocessor is not usable in its current state. Additional design passes are necessary in order to fix the currently identified problems and other potential problems. The risks in doing this have been discussed in other sections of this paper and are not justifiable. The 485 would be a calculator processor that works on 3V, not the more conventional 5V, and requires sufficiently high power that it is not appropriate for use in solar calculators which are the wave of the future in the calculator market. The conclusion is that the chip designs and chip inventory are not productively re-usable.

While this write-off is a significant impact on our bottom line, it is not clear that, given the risks, continuing the TI-88 until next year would avoid it. There is a possibility of further technical problems causing cancellation in the middle of next year, increasing the current write-off. Even after we announce the product, there is the possibility of significant further investment in inventory and promotion, without effective sales volume to amortize the costs.

Our investment in the TI-88, CA800 and PC800 peripherals, and the TI-88 portion of the LCDIII process, exclusive of the write-off, is as follows:

| MANPOWER (MY) | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | TOTAL |
|---|---|---|---|---|---|---|---|
| CPG | .5 | 6 | 14 | 30 | 30 | 20 | 100.5 |
| SC | - | 1 | 2 | 25 | 20 | 9 | 57.0 |
| TOTAL-MY | .5 | 7 | 16 | 55 | 50 | 29 | 157.5 |
| OST & TOOLING-$K | 50 | 533 | 1157 | 3413 | 3661 | 2326 | 11,140 |

DECISION

The following alternatives were considered:

1) Continue the TI-88.

2) Cancel the TI-88 and replace it with the ALC keystroke program.

3) Cancel the TI-88 and not produce a keystroke program device and attempt to capture the market with the BASIC Language ALC.

4) Expand the ALC product family to include Pascal program language to capture the scientific keystroke program user.

The decision is to abandon the over $100 keystroke programmable calculator market, and expand the ALC family to provide a Pascal program product to re-capture the keystroke user.

The Pascal version of the ALC would include three significant new product features:

1) The alteration of the case work of the ALC to accept plug-in ROM cartridges with different language processors, enabling multiple language options on the same programmable portable computer.

2) The coding of the Pascal compiler.

3) The cost reduction of the current ALC design with the objective of the product cost of the new machine with the plug-in ROM feature being no greater than the current ALC product cost.

OST and tooling for this effort is $550K with a ship goal of April 1983. In addition to the Pascal program, a plug-in ROM cartridge for FORTRAN would be implemented. OST and tooling for this is $150K and with a ship goal of April/June. These dates are based upon use of outside software resources to improve the normal development schedule.

It was concluded that the risks associated with the TI-88 would represent significant future investment in what is a declining market space. While the ALC keystroke version represented slightly lower risk and smaller investment, it still represented too large an expenditure to capture a short-term market. Both of those would have a time to market much later than acceptable to capture a significant portion of a declining market against the entrenched competition of the HP-41CV. The addition of the Pascal language to the ALC line provides a product that is extremely attractive to keystroke programmable users at an equal price point. It represents an investment in an expanding technology and market segment, and has the advantage of providing additional leverage when the ALC family of products is expanded to higher and lower functionality/price points.

PROGRAMMABLE LANGUAGE PORTABLE COMPUTER STRATEGY

We are finalizing plans for a family of programmable language portable computers based upon extensions of the ALC-A and a library of applications programs and language compilers to be used in this family. There follows a brief description of the new members of the family and the software offering.

ALC-LC - SRP $119 (1K RAM, 18K ROM, BASIC)

The ALC-LC will be a 16-character LCD display computer with 1.0KB of memory, and a reduced functionality BASIC language. The unit will have no plug-in module capability, but will have full ALC I/O bus (peripherals) compatibility.

ALC-A2 - SRP $250 (2K RAM, 32K BASIC Plug-in ROM)
SRP $270 (2K RAM, 64K Pascal Plug-in ROM)
SRP $270 (2K RAM, 64K FORTRAN Plug-in ROM)

A multi-language version of the ALC-A. The major differences between the A and A2 are 1) 1/4" thicker, 2) addition of a plug-in (flat pack) programming language module, 3) expansion of the language ROM space from 32KB to 64KB, and 4) expansion of RAM capacity from 18KB to 34KB. Each of these modifications is provided in order to obtain the multi-language capability required:

- 64KB ROM is required in order to house more extensive languages such as Pascal or FORTRAN.
- 32KB RAM expandability is required to 1) run the more sophisticated programs expected to be developed from higher level languages, and 2) aid in the compilation speed of compiled programs. External plug-in ports will be provided for RAM expansion.
- Plug-in languages on flat pack modules provide the ability to exchange languages on the machine.
- Additional thickness is required to accommodate the plug-in modules.

ALC-C/T - SRP $550/$650 (8K RAM, 32K BASIC Plug-in ROM)

An expansion of the ALC-A2 to enhance the product for use in higher utility applications, specifically high level professional and managerial support. The ALC-C will be an ALC-A2 in a larger case (notebook size) with a 6X40 LCD display, full travelling typewriter keyboard, and built-in tape mass storage. Critical to the product will be an applications module containing a word processing and spreadsheet package. The ALC-C will be able to run any ALC-A2 application or language modules.

The ALC-T is a variation of the ALC-C and provides the added feature of a built-in 300 baud modem and telecommunication software. With this added feature, the executive/manager can do remote teleprocessing involving file exchanges, private database access, public database access and electronic mail, all in a single package.

## SOFTWARE OFFERINGS

A minimum of three language processors: BASIC, Pascal and FORTRAN will be offered. In addition, we will investigate the usefulness of other languages such as C, FORTH and a microsoft BASIC language to provide compatibility with the personal computer space. Each of these languages will run on the ALC-A, A2 and C/T.

## APPLICATIONS PACKAGES

Horizontal Applications - Currently under development are applications in Math, Finance and Statistics areas. In addition, we will add developments for spreadsheet (VisiCalc), formula solver, personal word processing, graphics, project management, financial investment, and games.

Vertical Applications - Currently under development are applications in electrical engineering, photography, inventory, QA sampling, fluid dynamics, profitability analysis, mechanical engineering, physics, nonparametric statistics, production planning, regression analysis, QA control. Being investigated and planned are: real estate analysis, industrial engineering, banking, civil engineering, operations research, heating and ventilation analysis.

Plans are being put in place to do the majority of applications via third party vendors on a royalty basis.