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T. Gardner December 2008

HYBRID DISC CACHE (HDC) PROGRAM

COMMERCIAL SPECIFICATION

EQUIPMENT PRODUCTS GROUP - MEMOREX CORPORATION

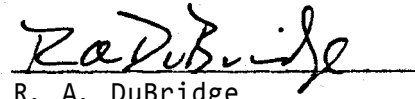
FEBRUARY, 1978

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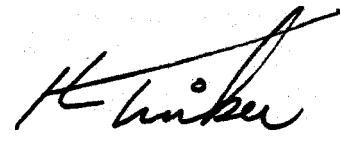
COMMERCIAL SPECIFICATION

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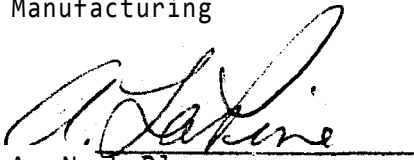
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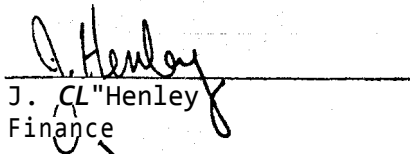
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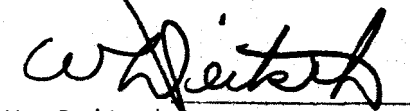
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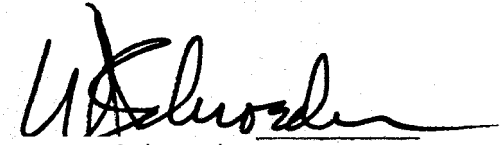
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INTRODUCTION

Memorex will be faced with an evergrowing discontinuance rate of 367X products, beginning in 1978. A product life enhancement is required to provide additional revenue, cash, and profit through remarketing of these units.

Of several marketing/planning programs under study to create this product life extension, the HYBRID DISC CACHE (HDC) Program has been identified as a key program to:

- Provide maximum potential to keep 367X products on-rent by maximizing our customers' investments in 367X products and application programs.
- Provide new markets for off-rent 367X products by introducing unique product differentiation and added function into the 367X line, while retaining 370 CPU and software compatibility.
- Obtain maximum additional revenue, cash, and profit by providing this differentiation through function capability of vastly improved "virtual" disc drive performance, while aiding the user in improved disc/storage management.
- Providing this required enhancement at moderate development risk through the use of well known, solid state memories and memory caching techniques.
- Providing product differentiation with minimal drive modification.
- Allow Memorex to introduce its first "hierarchical type" data management system before IBM sets a product standard for S/370, S/303X and S/380 CPU's.
- Create additional secondary market application of 367X products into the BUNCH program and OEM sales programs by providing further product differentiation.

As users have expanded, and continue to expand system utilization through increased expansion into data base/data communications applications, many of these users are, or will soon reach, system performance capacity. To most, the only alternative is to acquire a larger model CPU, more main memory, or both. Since the lease/sale ratio of 370 (and 303X) CPUs has been shifted by IBM to favor sale, this change often is financially difficult for the user, or cannot be accomplished.

Since the performance and management of disc storage is vital to total system performance and capacity, the HDC, providing vastly improved disc performance while maintaining plug compatibility, will be very appealing. This will be especially important to the user as conversions to the OS/VS2 -- MVS operating system, puts further strain on total system performance and capacity.

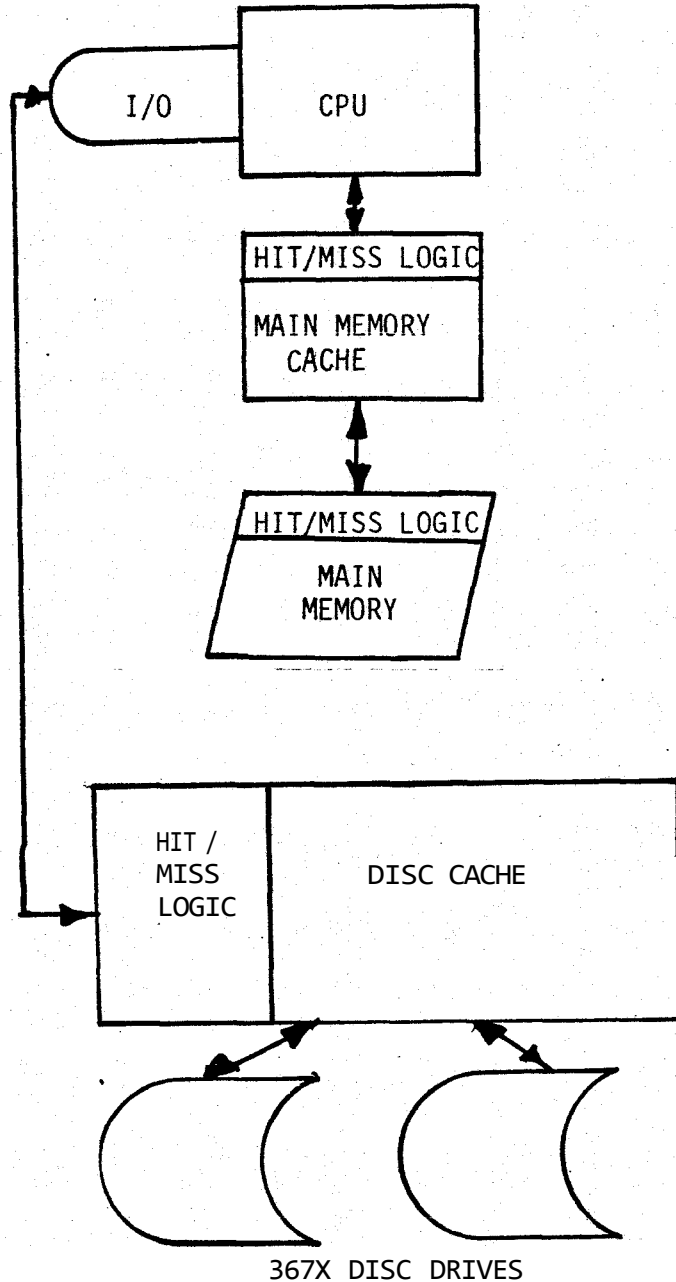
While the extended market for 367X products appears bright, this same improved performance will be required for 365X disc drives in the future. This commercial specification also includes cascading the HDC into the "3650 disc drive program.

The following sections of this commercial specification will outline:

1. Product Description and Application
2. MarketDefinition/CompetitorAssessment
3. Market Strategy
4. Preliminary Program Financials
5. Key Issues and Risks
6. Interim funding requirements until a business plan is prepared.
7. Program Schedule

1. PRODUCT OVERVIEW

The Hybrid Disc Cache (HDC) provides the capability of improving the cost/performance ratio on Memorex disc products by applying memory caching concepts, well-known in IBM 370 Large Scale and Amdahl computer systems, to disc drives



The HDC is described in this section in terms of its functional description, product structure, product differentiation/family relationships and other considerations.

FUNCTIONAL DESCRIPTION

The HDC attaches to Memorex disc string controllers and provides the capability for high performance access to data using a caching concept. Utilizing low-cost, charge coupled device (CCD) memories in a three-level hierarchy with high-speed RAM memories, it can allow for disc access requests to be serviced out of this high-speed memory rather than from the disc itself. As in traditional caching concepts, there is a probability that the data requested, from the System 370 CPU will either be in the cache memory or will be required to be read from the disc. If the request is contained within the cache memory, the access time to the CPU will, on the average, be, approximately one millisecond. If the access request is to be obtained from disc, it will be obtained at disc speeds (e.g., 30-40 ms.).

This concept of disc caching has not been implemented or produced in the past, because low-cost solid state memories to use in the cache have not been available until the recent introduction of CCD and Bubble Memories.

CCD memories have been chosen for this application since:

1. CCD memories are significantly lower in cost as compared to MOS RAMS.
2. CCD memories are just becoming commercially available while commercial availability of Bubble Memories is estimated to be 2H79.

Based on preliminary simulation testing conducted by Engineering, it has been determined that the probability that a disc access request will be in the cache memory based on a least-recently-used algorithm, will be between 80 and 98%. Based on this, the expected "virtual" access times for requests discs fitted with the HDC, are as follows:

Expected Average Access Time (MS)	
3650	367X
0.15 - 1.4	0.35 - 4.0

In addition, the HDC utilizes state-of-the-art technology in terms of both software and hardware. The use of CCD memories has been made possible by declining pricing structure for these slower performance solid state memories (but fast in relation to disc products). Also, new concepts will be utilized in the microprocessor application which will control the caching memory. Many of the functional features of the hybrid disc will include:

1. Initial attachment to 367X Disc Drive String Controllers and later application to 367X drives with the 3674 SCU to provide 1.20 MB data rates, and to 365X String Controllers to provide HDC performance improvements for 365X disc drives. *
2. Complete "write through" capability to guarantee data integrity upon power failure. This is required so that normal recovery procedures may be used to recover write errors.
3. Optional track "lock" capabilities to allow user requested tracks to be locked specifically rather than automatically into the cache for high-speed access.
4. Optional sequential file access capability to allow the cache to provide a "look-ahead feature," which will in sequential accessing bring the next blocks into the cache in an anticipatory scheme for high speed throughput in sequential file accessing.

The HDC will have separate cabinetry which physically resembles a 3673 cabinet, but made smaller (see Figure 1), this will contain both the 1.0 MB cache memory and the cache controller (microprocessor) as well as space for 6.0MB more cache memory. An additional memory cabinet will be available to allow the user to have up to 23 MB of cache memory per disc string. This particular architecture will allow attachment to those System/370 CPU's containing a MRX SCU.

PRODUCT DIFFERENTIATION/PRODUCT FAMILY RELATIONSHIPS

The hybrid disc subsystem provides several key benefits in providing product differentiation to the 367X product, thereby extending its life.

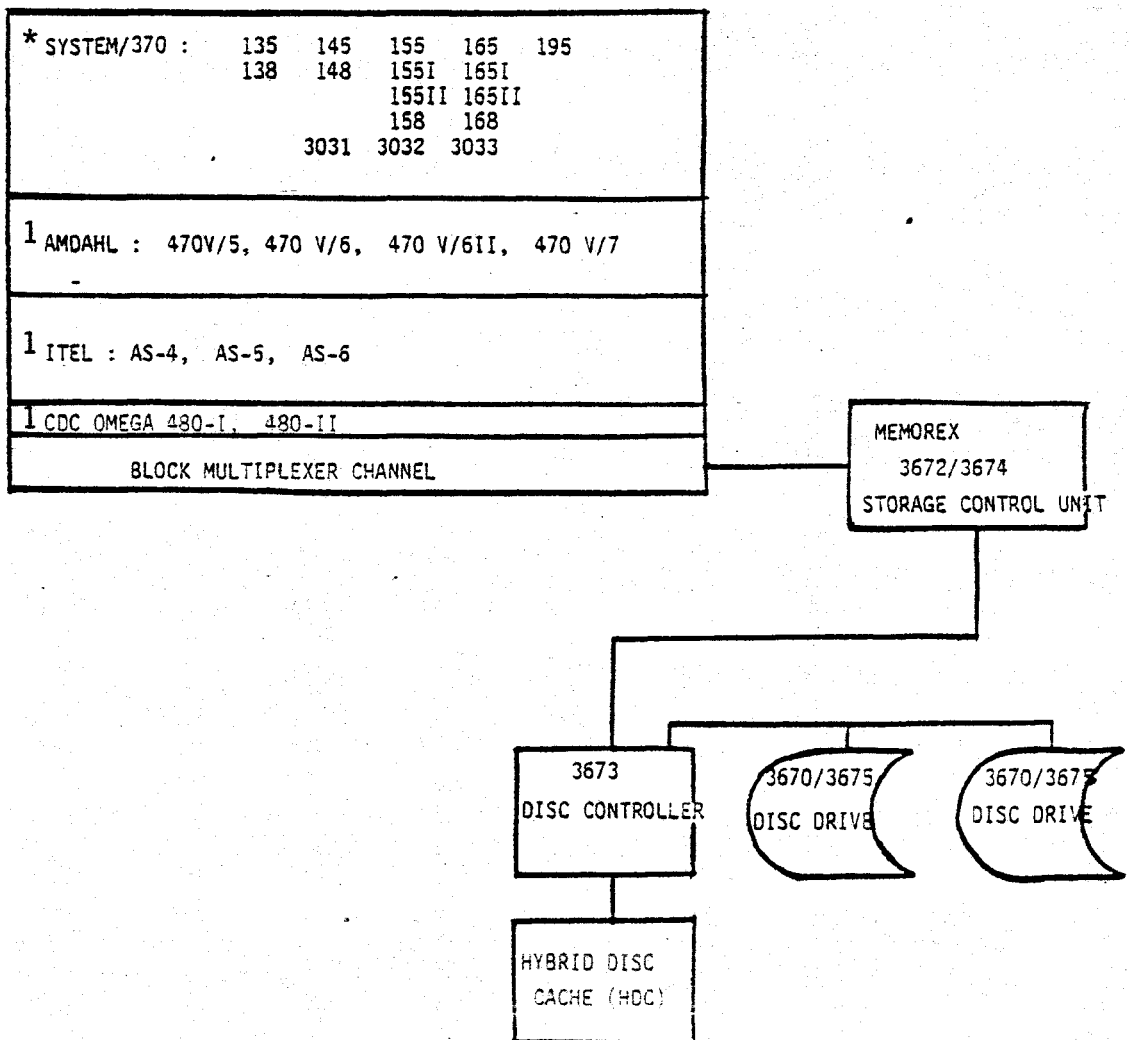
1. Provides for unique product differentiation while maintaining complete compatibility with current 367X products. Moreover, it can be applicable to 3650 products.
2. Extends the revenue life of all current installed 367X products, since the hybrid disc is completely field installable.
 - A. Enhances the user's current investment in 367X products by providing superior virtual performance than any other drive subsystem.
 - B. Provides replacement alternative to other data access performance improvements products (e.g., IBM 2305 FHSF) at considerably reduced cost.
3. Applicable to all System/370 CPU's because of complete hardware and software compatibility (i.e., will perform without any operating system or program changes).

5. An optional operators console to allow:

- A performance monitor capability to improve customer confidence in the HDC while allowing the user to "fine tune" disc performance.
- Tracks to be "locked" or "unlocked."
- Initiation of FE diagnostics

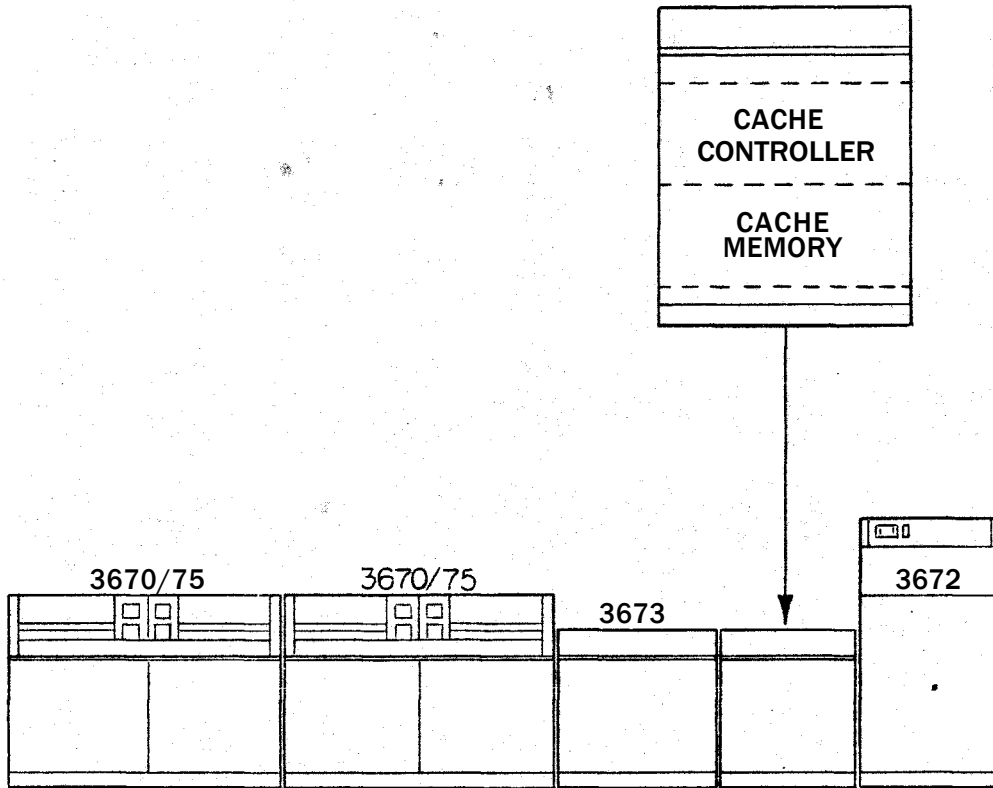
PRODUCT STRUCTURE

The HDC will be physically attached to a disc drive string controller as shown below:



* = Initial CPU Attachment

1 = Follow on CPU Attachments



PHYSICAL ATTACHMENT

FIGURE 1

Additionally, the hybrid disc subsystem will provide a performance enhancement improvement to other current and future Memorex disc products since its basic design is applicable to 3650 product line and its enhancements.

OTHER CONSIDERATIONS

1. Special Demands and Resources

Design Engineering manpower increases through 1977 and 1978 to implement the product, reaching a peak of 15 men in the fourth quarter of 1978.

New demands will be placed on manufacturing space, currently at a premium in Santa Clara. In addition, QA and Test Engineering resources will be strained by the introduction of new memory (CCD) technology into MRX test operations.

Demands for improved sales techniques and sales support will be greater with the introduction of this functionally oriented product. SE activity in presale, installation, and post installation activities will be greatly increased.

2. Patent/License Opportunities/Exposures

While the HDC concept may not be patentable, its implementation may be. A patent search has been initiated and patent applications will be filed before product announcement (June, 1978).

Patent laws prohibit granting of patents in countries where public disclosure of the patentable item has been made. Our greatest exposure is in publicly disclosing the HDC prior to patent application.