



Trend of Technological Evolution by Innovation in Hard Disk Industry

HGST Japan

Platform Development

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HGST
a Western Digital company

What is the Innovation?

The purpose of the enterprise is a creation of the customer. Therefore, the enterprise has only 2 and 2 basic functions. It is marketing and an innovation. Only marketing and the innovation bring forth fruit.

from “Management” . Written by P.F.Drucker

The technology is a process where manpower, the capital, the raw material, and information on the organization are changed into a high product and the service of value.

The innovation is to change the technology.

from “The Innovator’s Dilemma” . Written by C.M.Christensen

What is the Innovation?

Disruptive Innovation and Sustaining Innovation

Definition of Dr.Christensen

■ Disruptive Innovation

A quite different idea from a past and standard is brought in the market.

It is supported by a new minor user who is not the main current of the industry.

Cost competitiveness is high because it is born in the low-end market.

■ Sustaining Innovation

Pursuit of performance requested in high-end market

It aims at the performance gain of an existing product by a new technology.

Because the performance gain is continued, customers' needs might be exceeded.

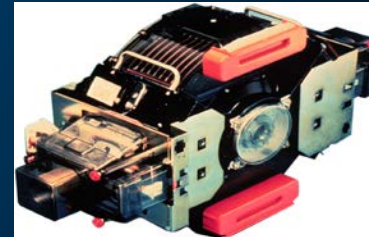
History of Storage Disk Drive

1956 RAMAC

- 5 Mbytes
- Fifty 24" disks, 1200 RPM
- 2000 bits/in²



30 years ago



1986 3380

- 1.2 GB >1000W
- Nine 14" disks, 3600 RPM
- 12 Mb/in²

Total weight 58Kg

2014 Now



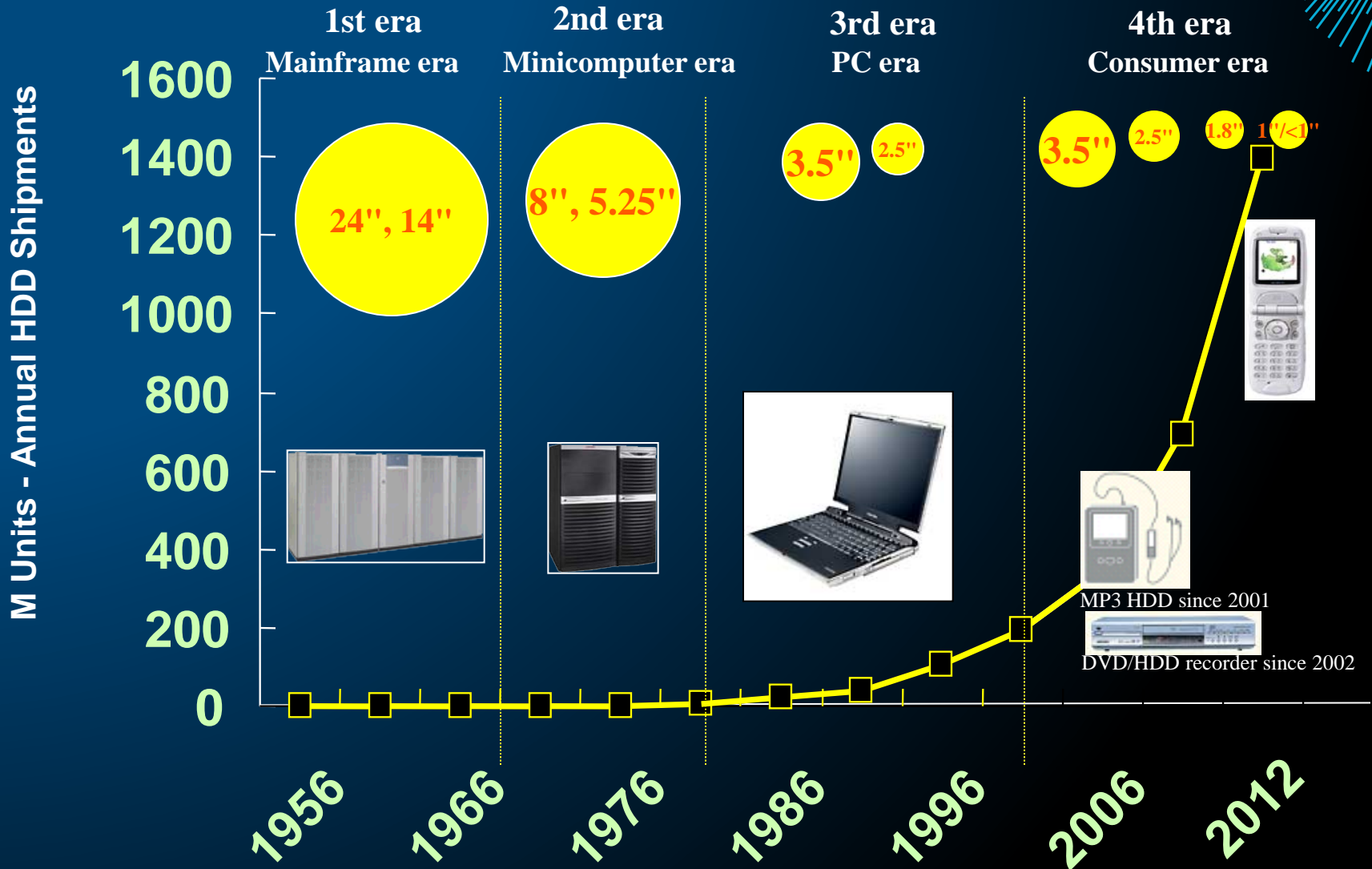
2.5" 1TB
5400RPM



3.5" 8TB
7200RPM

Device HDD that head flies on disk, records, reads data on disk, and plays. This structure has been succeeded without changing.

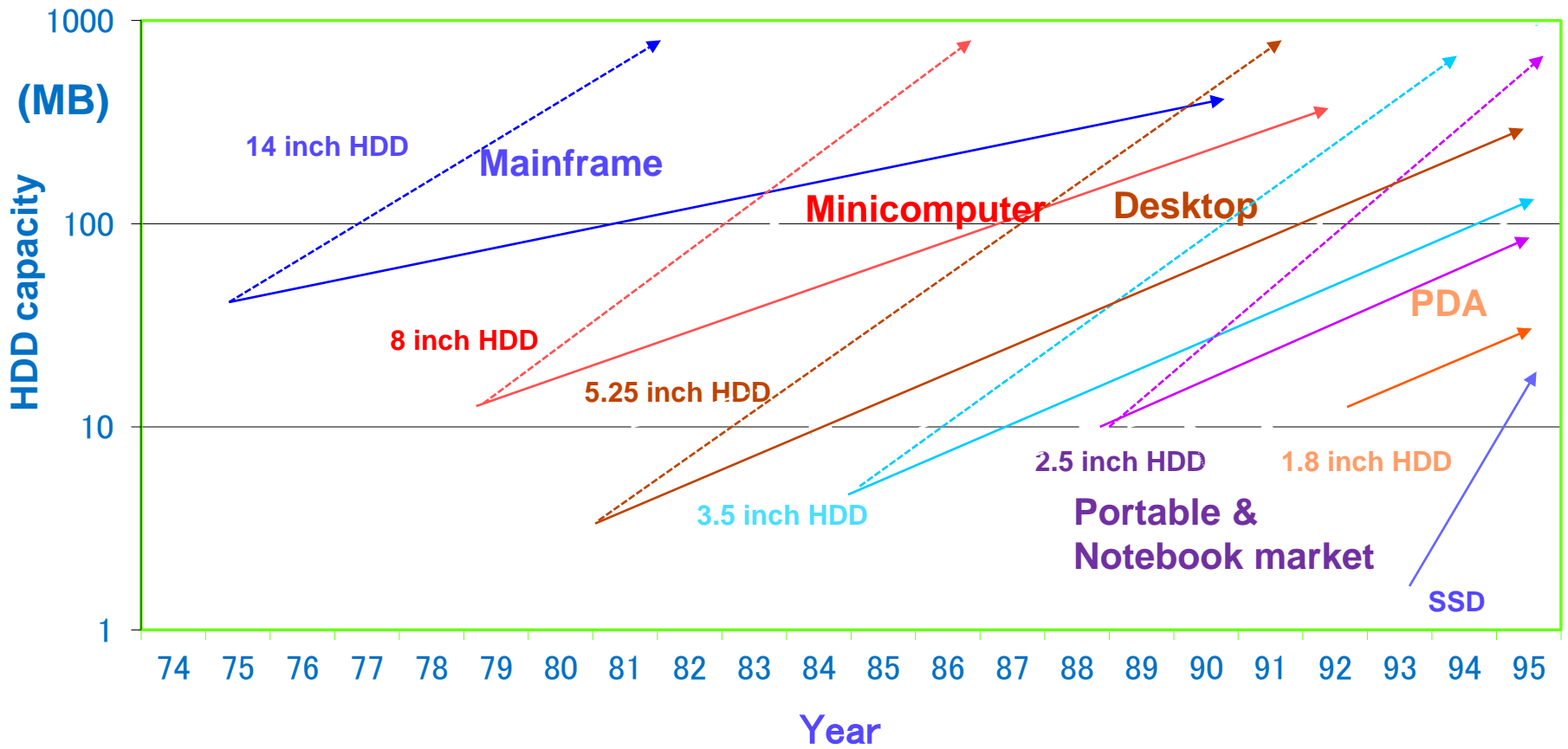
History of Storage Disk Drive



Trend of Demand Capacity and Supply Capacity

Short dashed line: Capacity practice of product

Solid line : Demand capacity of market



C.M from "Dilemma of innovation" . Written by Christensen

Disruptive Innovation

Disruptive Innovation: Architecture that miniaturizes HDD size

Innovator in each HDD industry

HDDサイズ	イノベーター	開発年度	初期顧客市場
14 inch	IBM	1975	メインフレーム
8 inch	シュガー、マイクロボリス、プライアム	1978	ミニコンピューター
5.25 inch	シーゲート	1980	デスクトップパソコン
3.5 inch	コナー	1984	ポータブル・パソコン
2.5 inch	プレーリーテック、コナー	1989	ノートブック・パソコン
1.8 inch	多数	1992	PDA

Trend of Evolution (written by D.Mann from "Systematic Technical Innovation")

Focus of Purchase of Customer

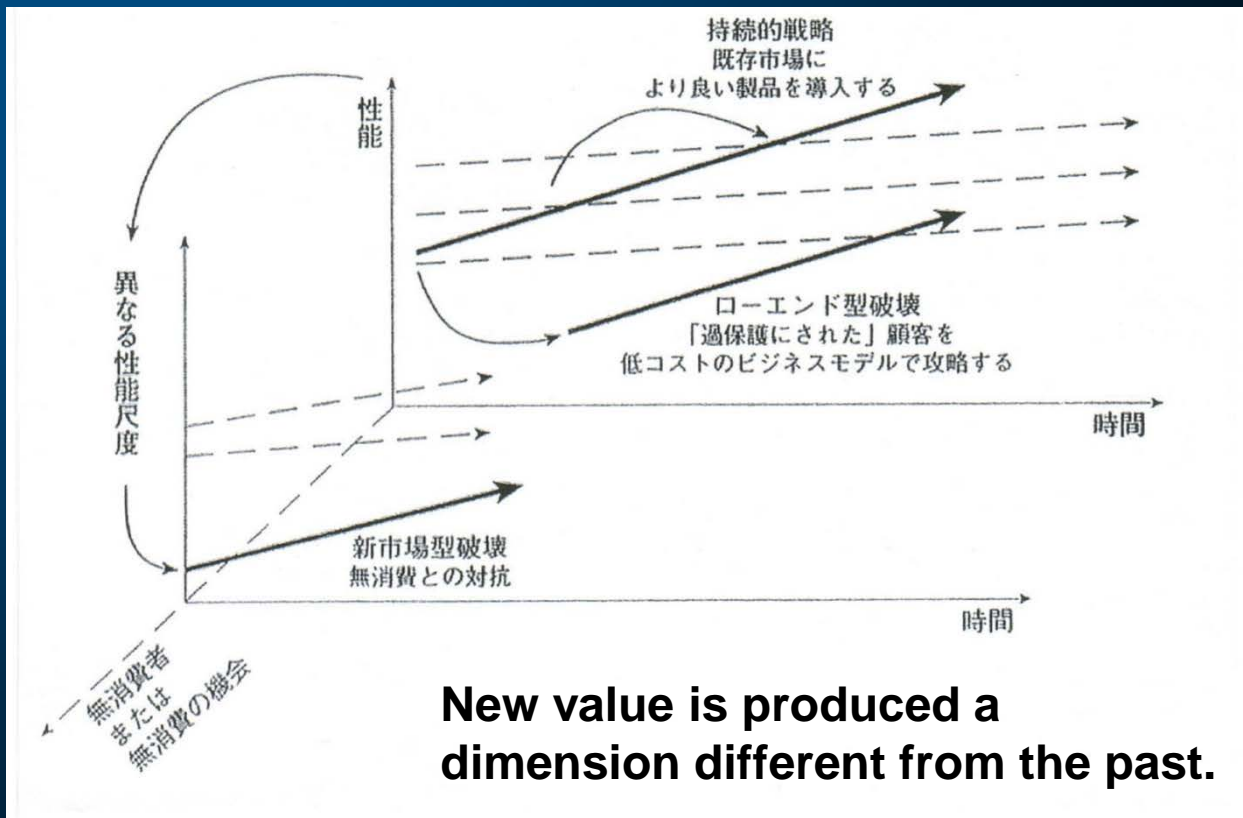
Performance -> Reliability -> Convenience -> Price

In HDD, a large-scale Disk size was always advantageous from the viewpoint of performance each other.

However, when a subordinate position model met the demand of the customer with a constant, the focus of the selection of the customer was shifted to reliability, convenience, and the price, and a small Disk model came to occupy the market.

Disruptive Innovation

- In a present HDD industry, the miniaturization more than this is impossible. That is, the low-end type disruptive innovation cannot be hoped for.
- Is it a road where the shift to the new market type disruptive Innovation to survives?



From "Solution to the innovation"

Written by
C.M.Christensen

Sustaining Innovation

Sustaining Innovation: Improvement technology of recording density

1. Slider technology

Ferrite head > Thin film head > MR head > GMR head > TMR head

2. Disk technology

Magnetic disk > Thin film magnetic disk > Vertical magnetic disk

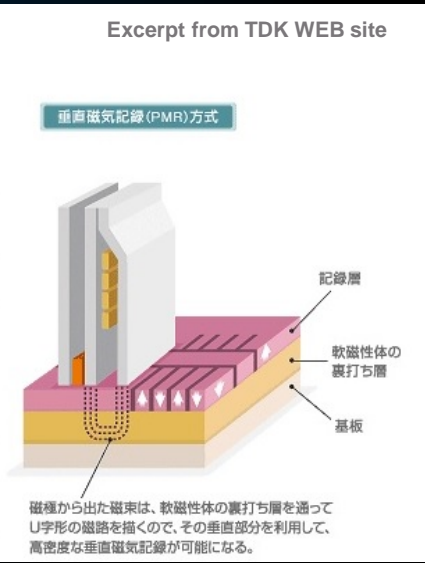
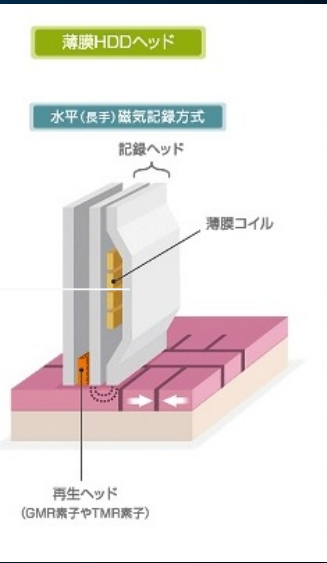
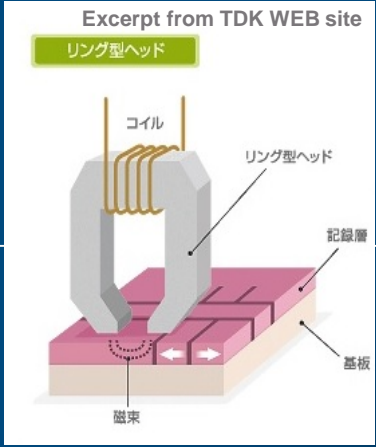
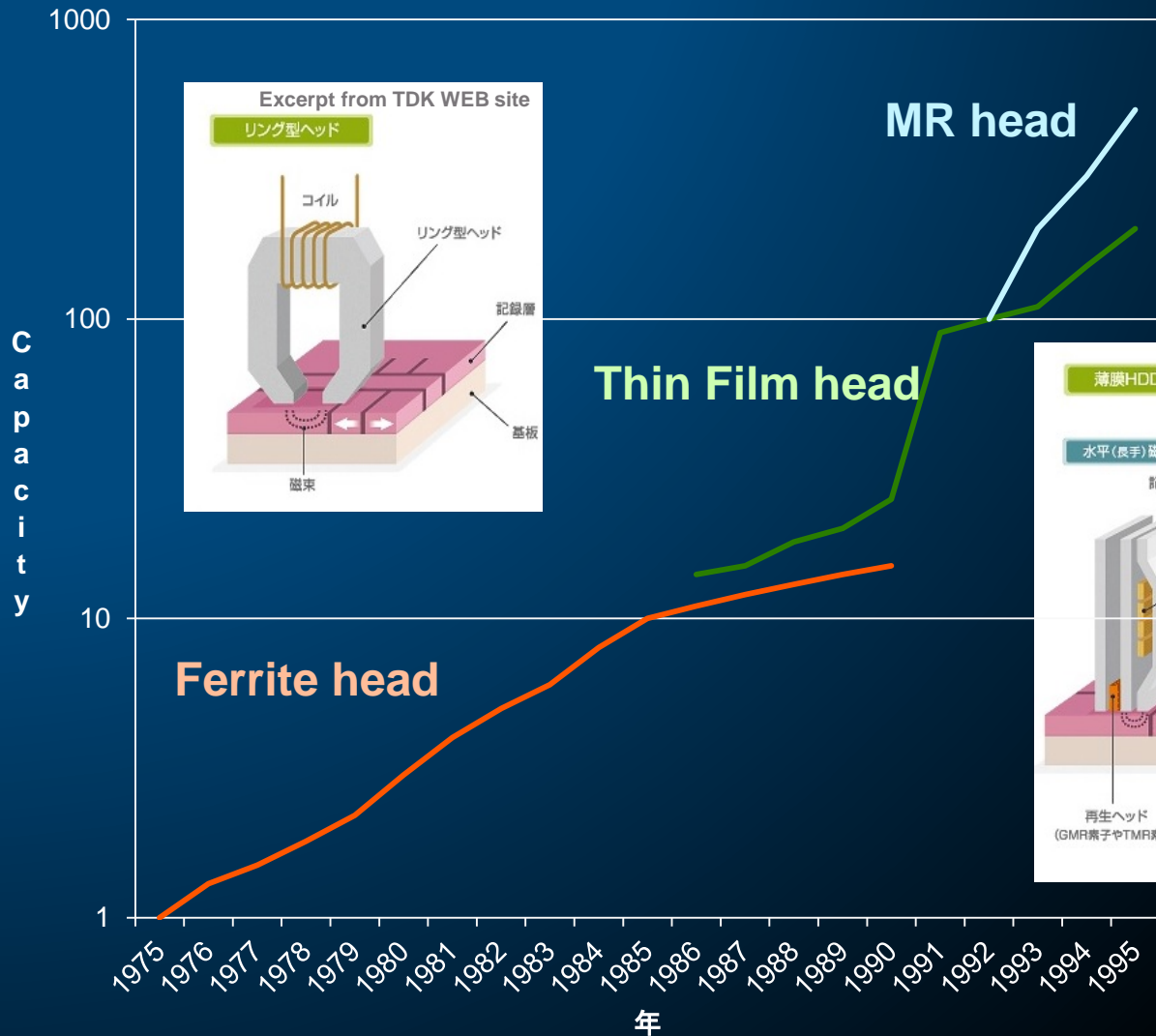
3. Clearance between slider and disk

Micron > Submicron > Nano > 1 nm or less

The trend of common evolution to these technologies is "Evolution from the macro to the Nano scale. "

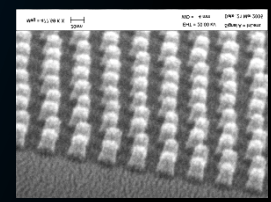
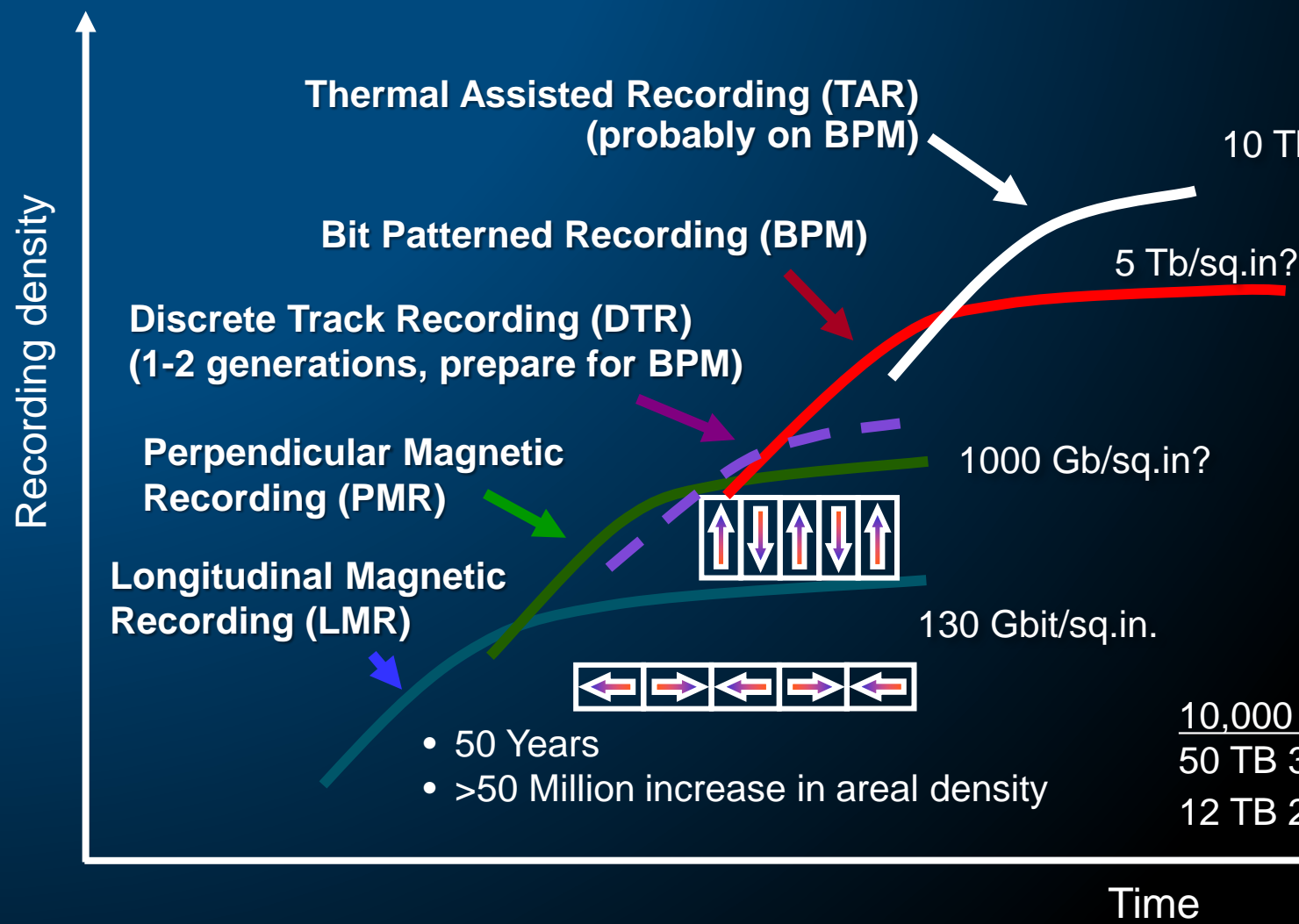
It aims at making minutely about the recording density and the FH clearance further.

Improvement of Recording Density by Slider (Mb/in²)



Improvement of Recording Density with Disk

Each technology of the disk draws S curve severally.



10,000 Gb/in² = 10 Tb/in²
 50 TB 3.5-inch drive
 12 TB 2.5-inch drive

Improvement of Recording Density by Flying Height

The trend of further evolution is used for a decrease in the clearance between recent slider disks.

Because the clearance has approached at a molecular level, the control technology of more advanced of flying height (FH) has become indispensable.

To always adjust to a complex user environment, it came to be able to manage.

Trend of evolution: Control

Straight line control action

> When producing, FH is managed.

Control action that uses mediation

> The user environment is assumed and FH is set.

Introduction of feedback

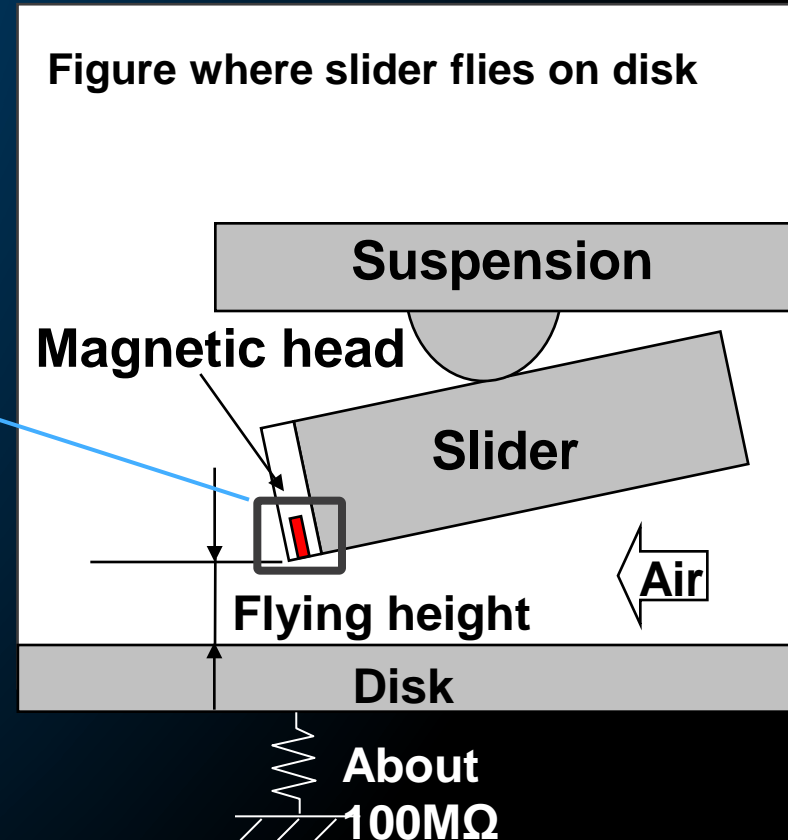
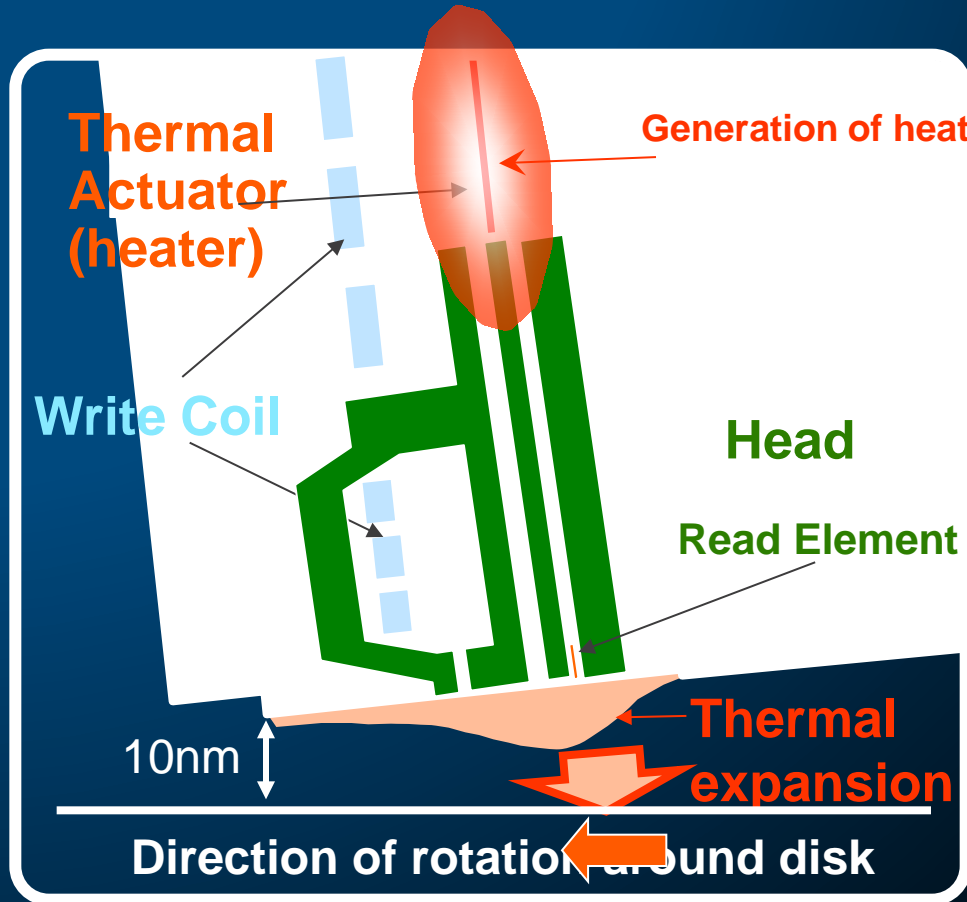
> FH adjustment that uses TFC in user environment

Intellectual feedback

> The temperature, the atmospheric pressure, gravity, and potential are perceived and it feeds back.

Principle of Thermal Flying Height Control (TFC)

Structure of head and disk in HDD



Diagrammatic illustration of head and disk in HDD

Conclusion

1. The disruptive Innovation in the HDD industry was a simple miniaturization according to the downsizing of the system. However, this low-end type disruptive Innovation comes to the limit. Groping for the next, disruptive Innovation starts.

Trend of evolution: Focus of purchase of customer (performance -> convenience -> reliability -> price)

2. Maintain tracks of the performance gain always established to high-tech development. In a word, it has aimed to improve the performance, and to get to the area where the rate of profit is high. It did not destroy such a technology though there were a lot of difficult one. The development, the target that the customer suggested was pursued.

Trend of evolution: Evolution from macro to Nano scale / Control

3. The manufacturer where results existed had technology that led the innovation that continued. However, it was an upstart that it took the lead, it developed, and had adopted destroyed technology. However, the upstart did not necessarily survive in the HDD industry. As for this, a part of technology to improve the recording density is thought that it is a reason that one company (IBM) was leaving others far behind until about 2000.

Aiming at the future



■ Approach 1 in HGST Japan

Innovation Harvest

- The fence in the development field is exceeded and the idea in-house is recruited.
- Regular review of specialist and executives
- An excellent idea is an object of the commendation.
- Securing of budget frame for idea achievement

Aiming at the future

■ Approach 2 in HGST Japan

Aiming at further high reliability

- Trend of Evolution: Design Methodology

1. Trial and error (mainframe market in the 1950's)
2. Design that thinks about stationary state (mainframe minicomputer market in the 1960-1980's)
3. Design to which transitional effect is taken (desktop portable market in the 1980-2000's)
4. Design to which slow effect of deterioration is taken (desktop portable market after 2000)
5. Design to which cross coupling is taken (future tasks)
6. Design to which Murphy's law is taken (future tasks)



Aiming at the future

Trend of Evolution : Design Methodology

Design by Murphy's law

Consideration "When something can be foolish the customer, they will surely do so about this product" is included in the design process.

=> It aims at the improvement of the design margin by a guard band examination thorough of HALT(Highly Accelerated Life Test) etc.

Written by D.Mann from "Systematic technical innovation"

Thank you for listening.

HGST Japan

<http://www.hgst.com/>

