Precision Machine Design

Lecture 1 : Introduction

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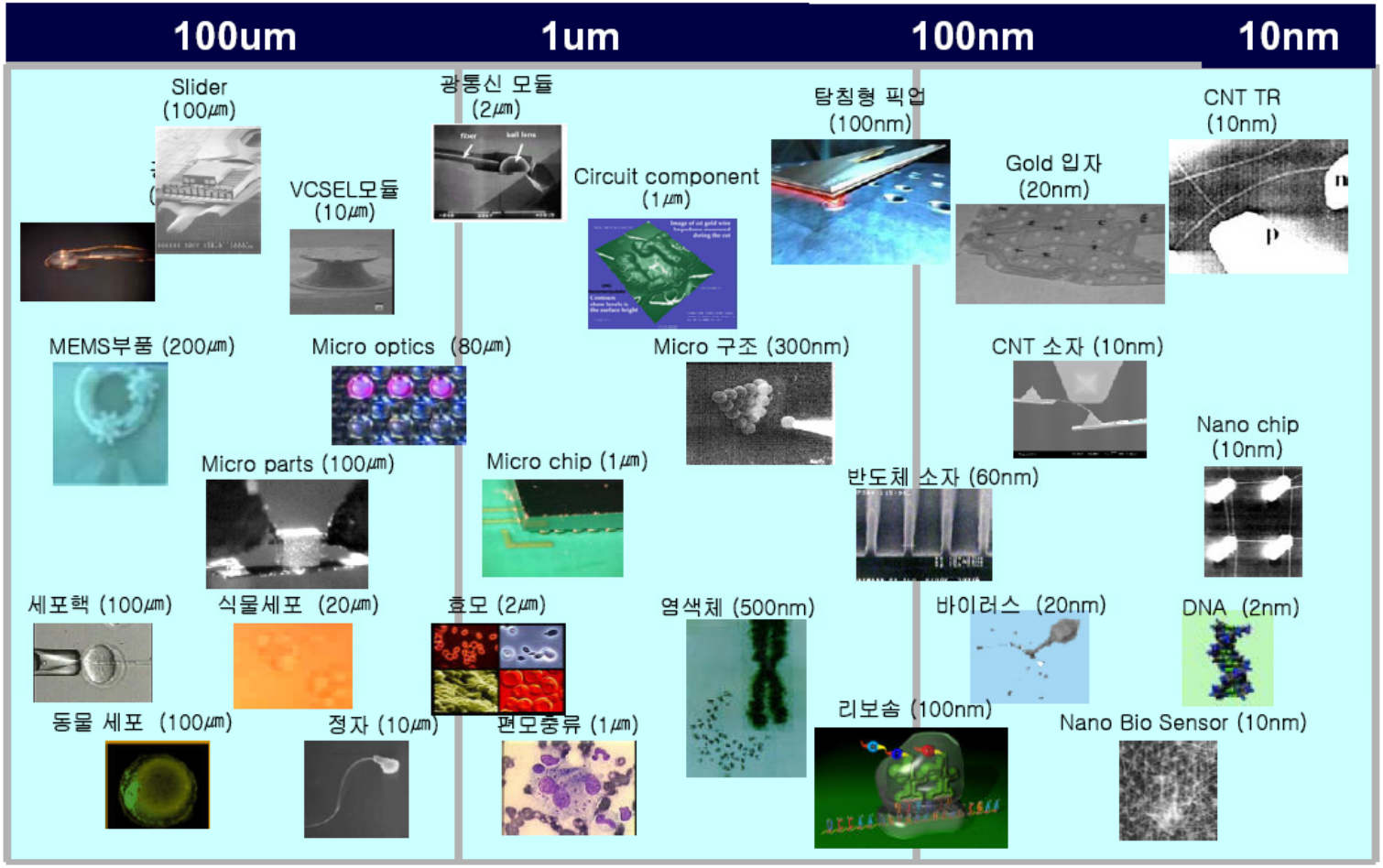
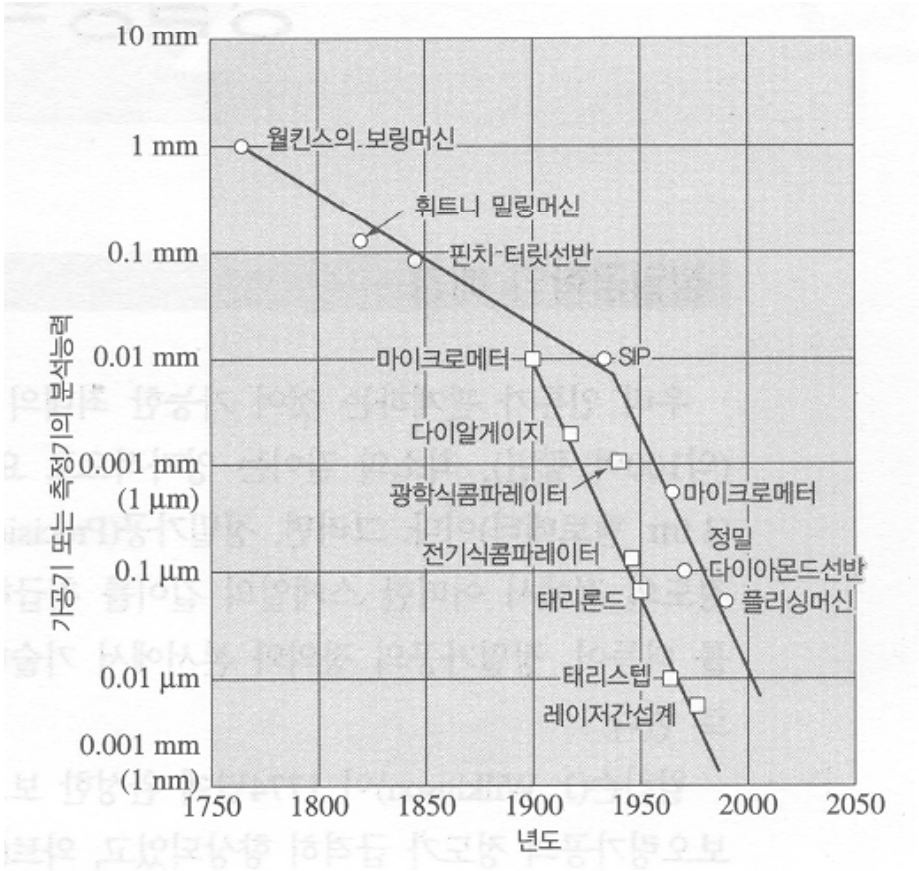
References : 1. Dae Gab Gweon, Precision Machine Design, KAIST
2. Alexander H. Slocum, Precision Machine Design, MIT

1. Objects of Precision Size Level

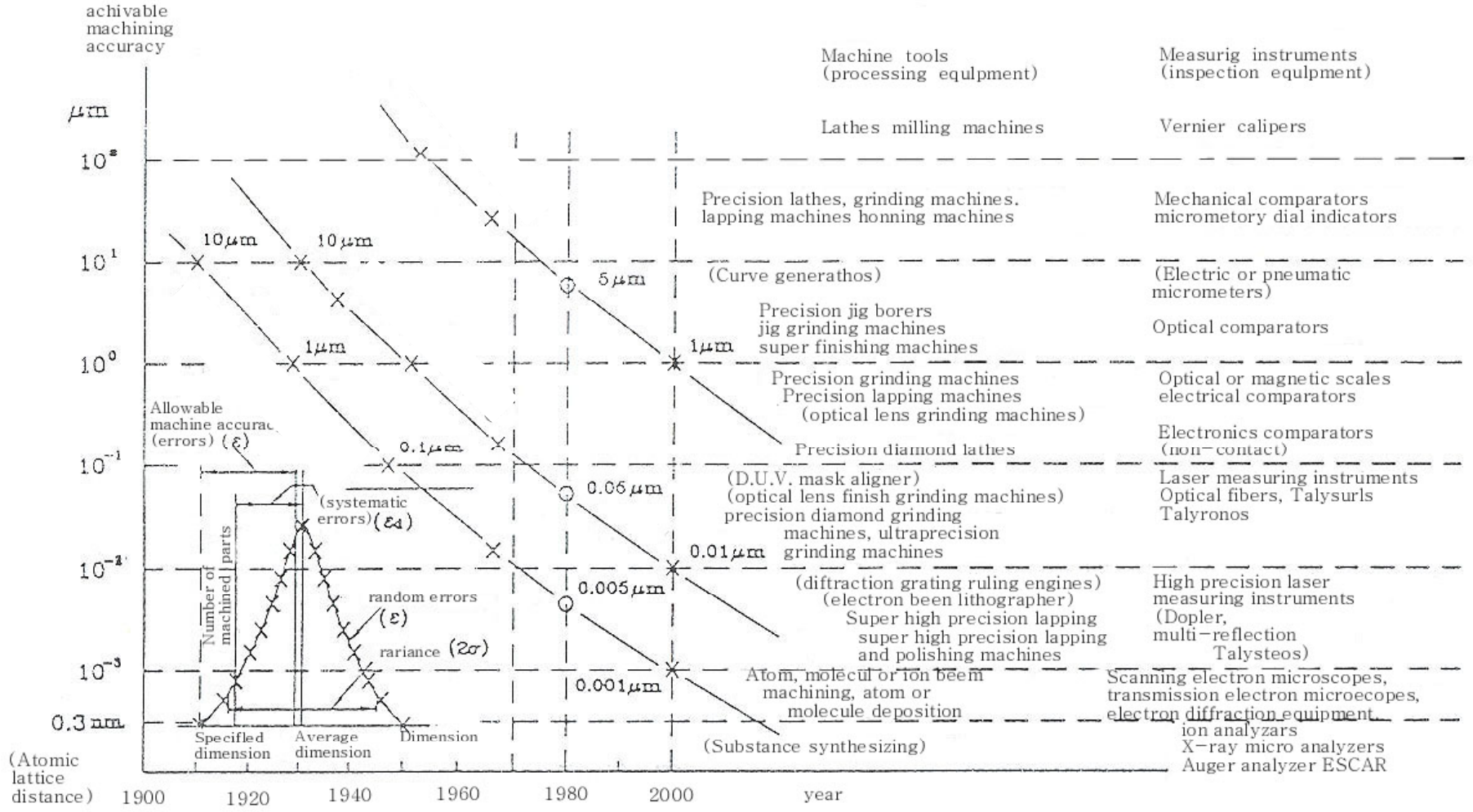


2. Development History of Precision Equipments



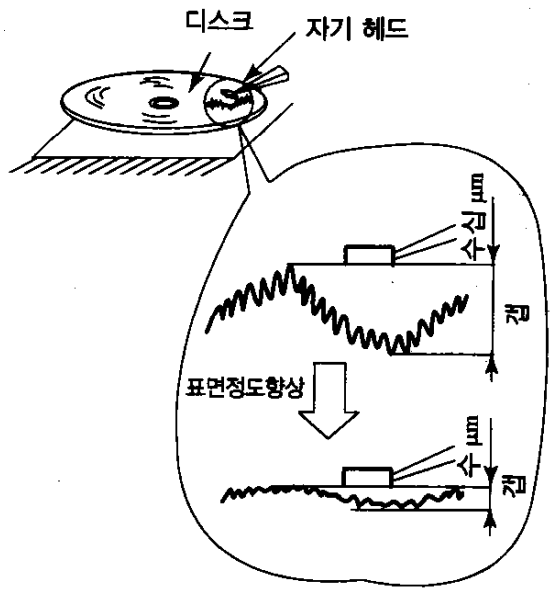
가공정도의 변천

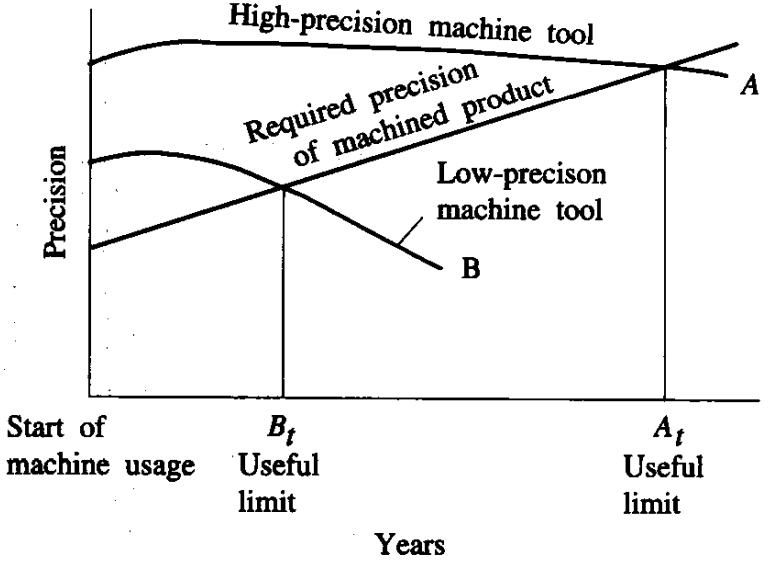
2. Development History of Precision Equipments



2. Development History of Precision Equipments

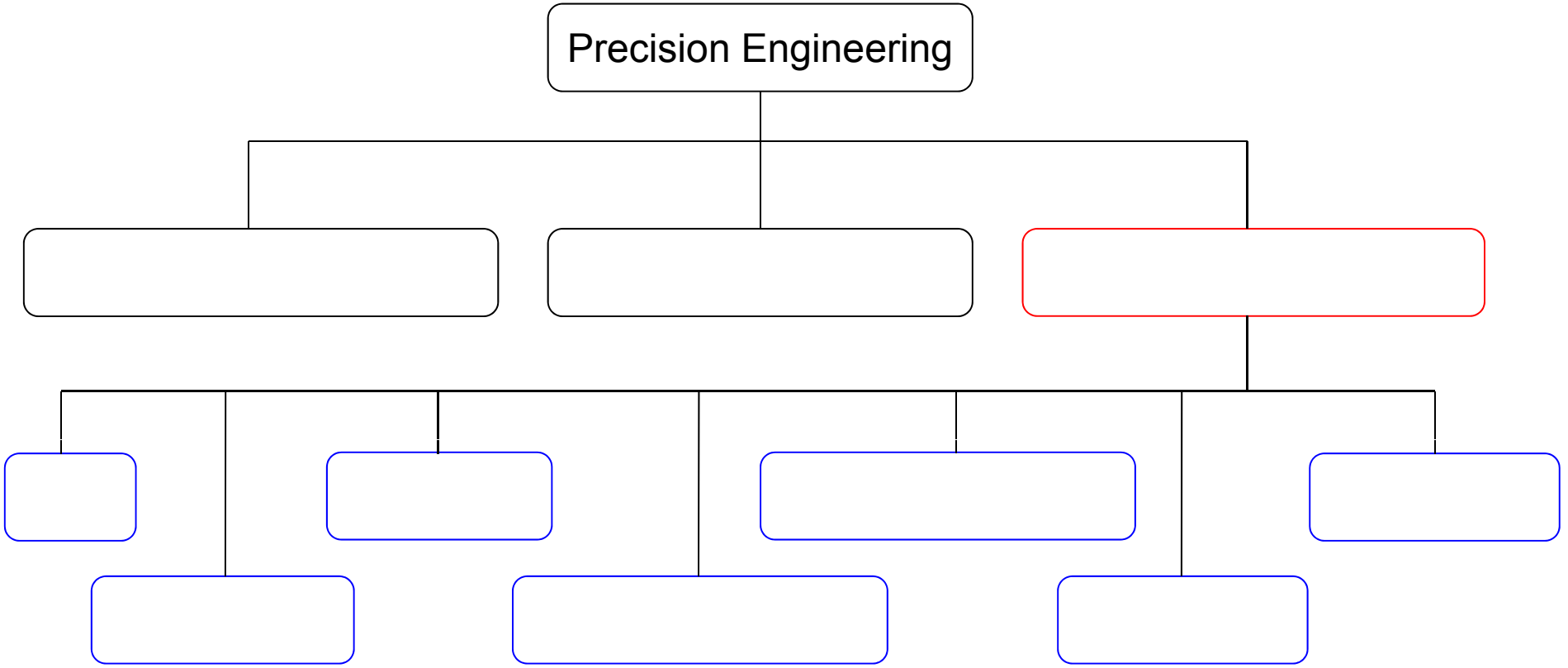
- 부품에 고정밀도를 부여하는 대표적인 이유 :



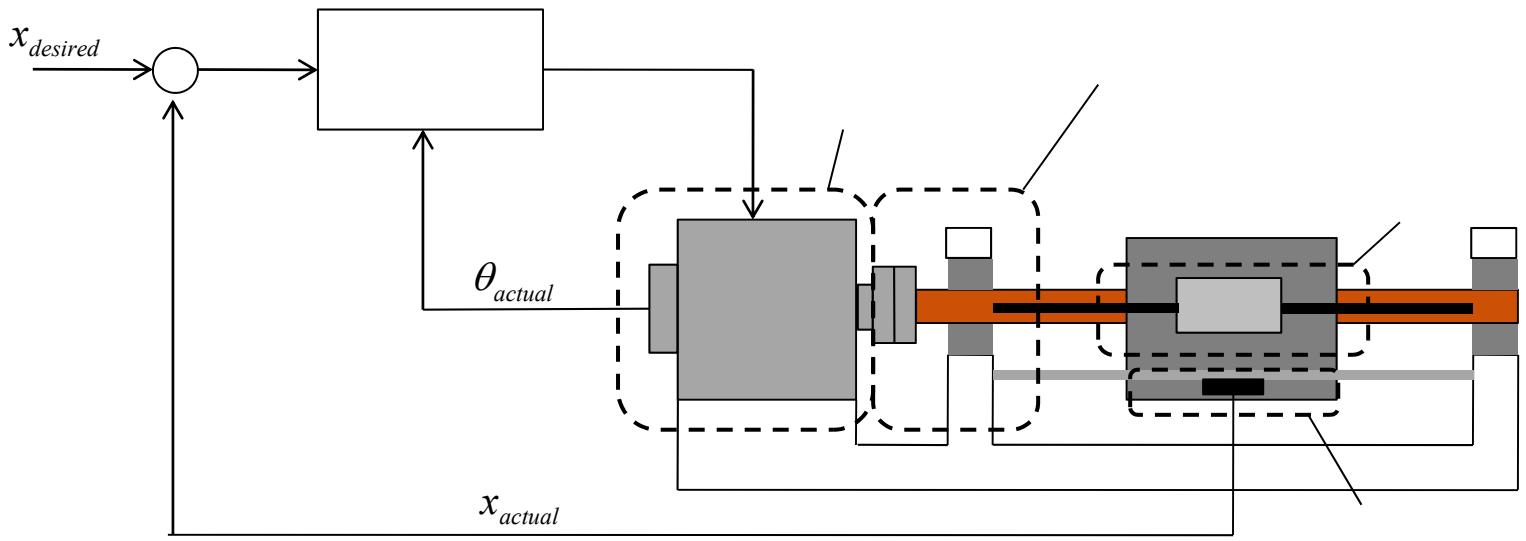


❖

3. Precision Engineering Tree



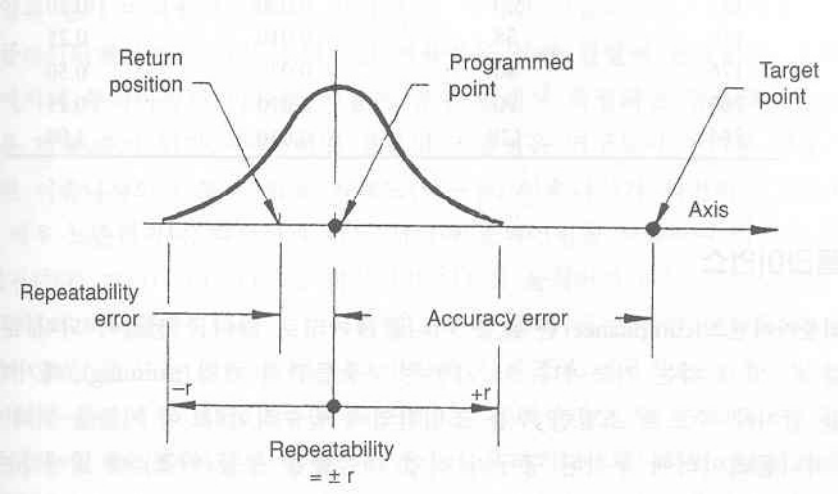
4. Configuration of Positioning Mechanism

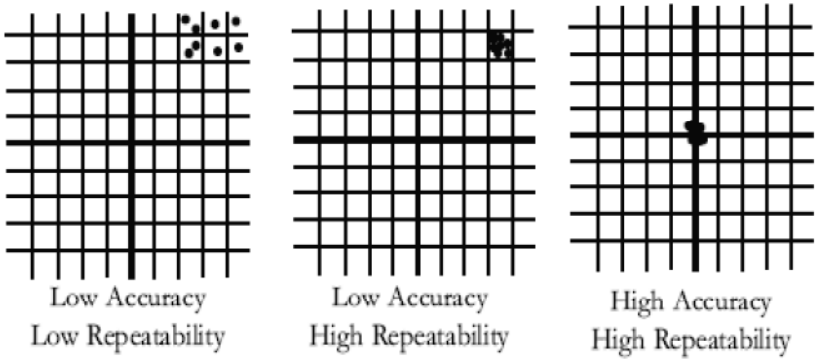


❖ The key to precision machine design is predicting [ ] will be and then designing the system to [ ].

5. Definition of Precision

1) [ ] is the ability to tell the truth :
   - How well a machine can move to an arbitrary point in space
   - compensable value
2) [ ] is the ability to tell the same story over and over again :
   - How well a machine can return to the same point.
   - Repeatability is often considered to be the most important parameter of a computer controlled machine(or sensor).
   - Minimize static friction and thermal variants to get better repeatability.
   - [ ]





3) **Resolution** is how detailed your story is:

- The smallest increment with which a machine can be positioned.
- Resolution gives a lower bound on the repeatability.
- Minimize static friction to get better resolution.

6. Current Level of System Precision

	Range	Repeatability
Wafer Stepper		
Diamond Turning M/C		
Grating Ruling Engine		
STM, AFM		

7. Basic Precision Machine Design Philosophy

1) Design should be made as mechanically good as is reasonably possible.

2) [ ] are then obtained via measurement, mapping, and servo control.

3) Make the design hospitable to measurement:

- Make room for sensors
- Design in alignment surfaces
- Minimize Abbe errors

4) Use [ ] whenever possible:

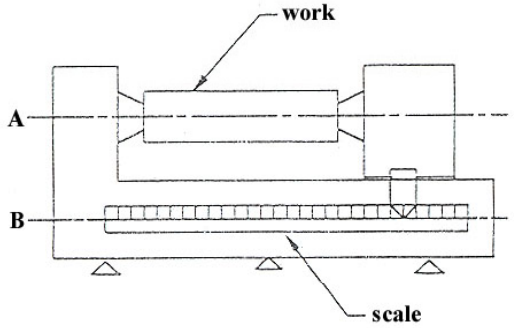
- Create a “platform concept” that is upgradeable merely by substituting components

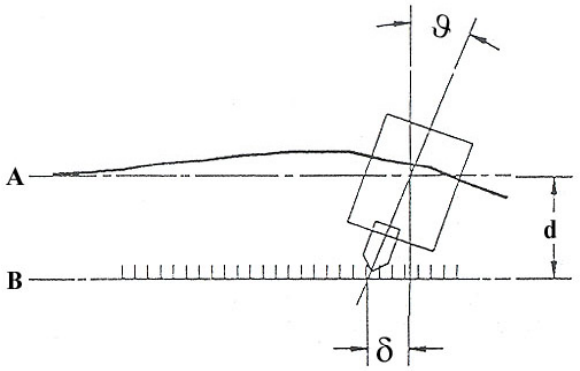
5) Choose bearings, actuators, sensors, and controllers as [ ] [ ]

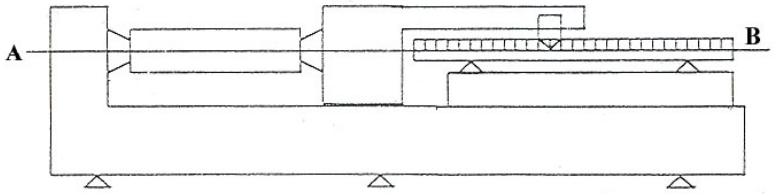
6) Design the machine as if you had to use it.

8. Abbe Errors (1)

" If errors in parallax are to be avoided, the measuring system must be placed [ ] with the axis along which displacement is to be measured on the workpiece" Dr. Ernst Abbe



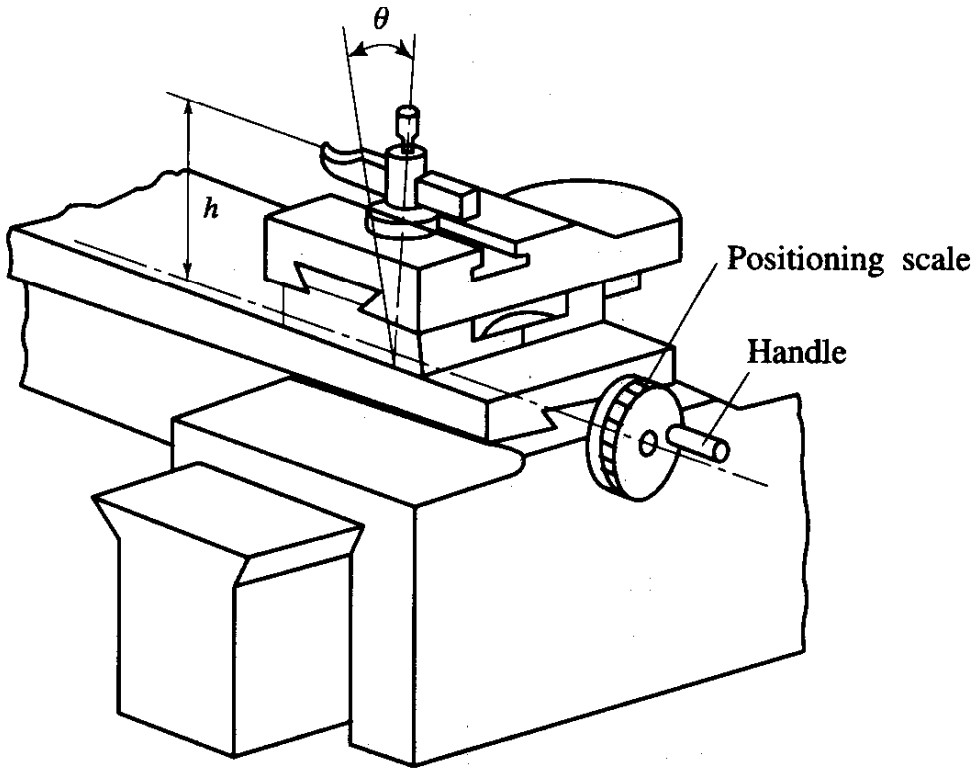




A good design of Abbe error with zero offset.

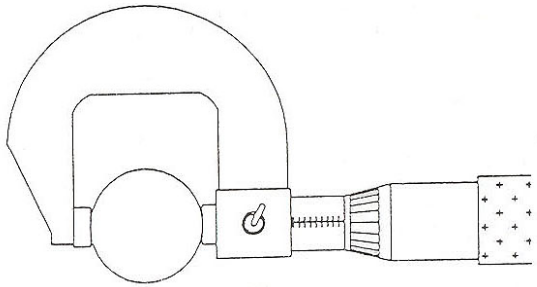
8. Abbe Errors (2)

Ex.) 선반공구대는 아베의 원리에 맞지 않음.

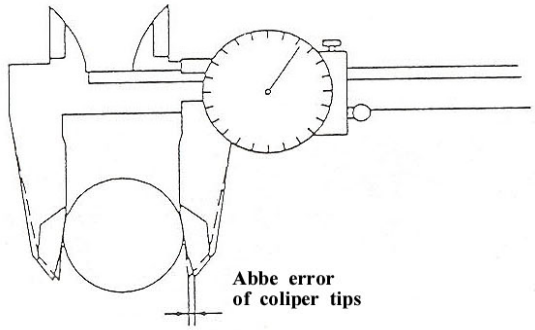


8. Abbe Errors (3)

- Perhaps the greatest design sin is amplifying an angular error by [ ]. This is also known as an Abbe error.



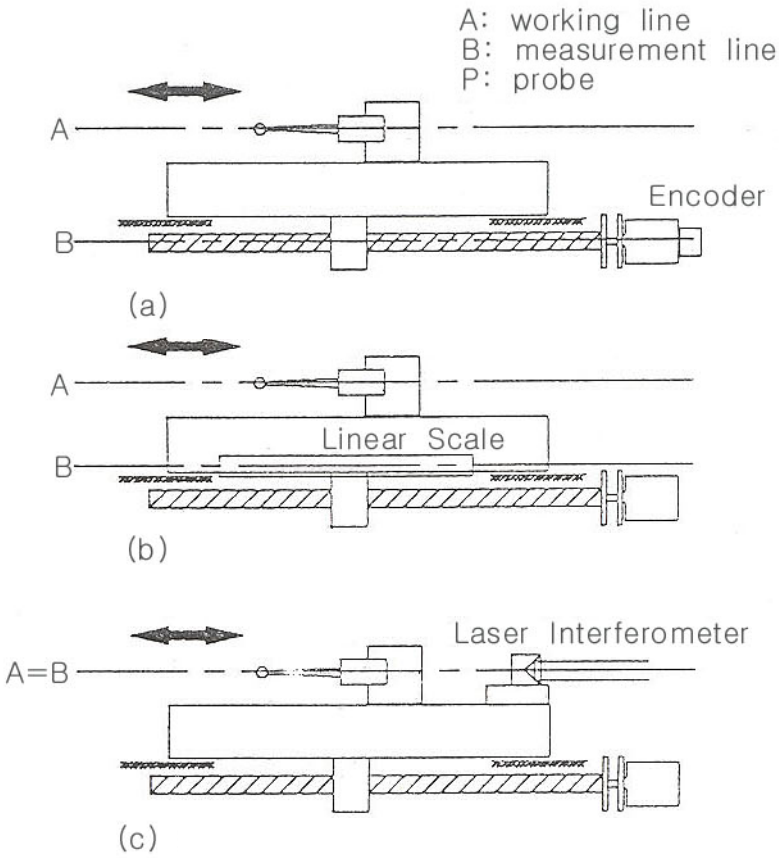
Bearing in-line

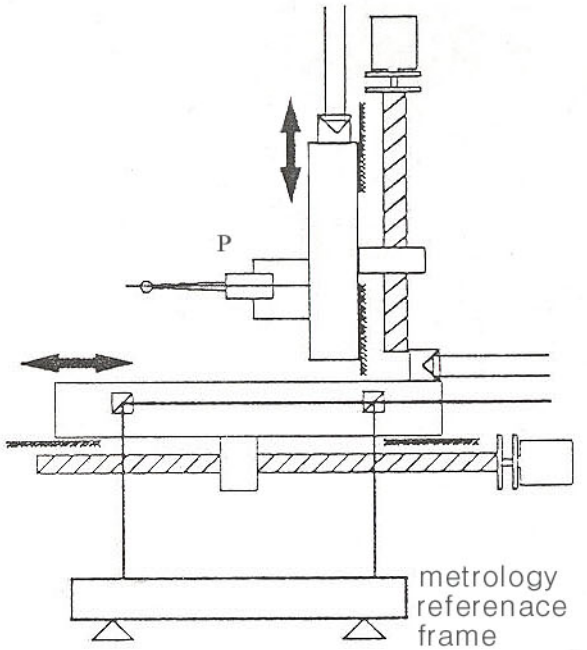


Bearing displaced

8. Abbe Errors (4)

- Examples of ball screw mechanism





(d) moving working line: active compensation of offset error using metrology reference frame.

9. Design Process

1. Carefully budgets [ ].
2. Defines [ ] to be accomplished.
3. Defines the resources available (materials, parts that can be used).
4. Creates solutions ranging from a “safe” solution to a neat, wild WOW solution.
5. Evaluates [ ] that can be created within the context of the allowable time and budget.
6. Updates the schedule and budget.
7. [ ]: Makes the design happen in a timely, orderly, well-documented manner.
8. Implements the design (competes) and then reflects on what went right and wrong.