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# From Cooking to Advanced Manufacturing --Controls, Automation, and Beyond

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2014 UCONN open house

# Ingredients of Kung Pao Chicken

## Marinade

- 1 tablespoon soy sauce
- 2 teaspoons Chinese rice wine or dry sherry
- 1 1/2 teaspoons cornstarch
- 1 pound boneless, skinless, chicken breasts or thighs, cut into 1-inch cubes

## Sauce

- 1 tablespoon Chinese black vinegar, or substitute good-quality balsamic vinegar
- 1 teaspoon soy sauce
- 1 teaspoon hoisin sauce
- 1 teaspoon sesame oil
- 2 teaspoons sugar
- 1 teaspoon cornstarch
- 1/2 teaspoon ground Sichuan pepper
- 2 tablespoons peanut or vegetable oil
- 8 to 10 dried red chilies
- 3 scallions, white and green parts separated, thinly sliced
- 2 garlic cloves, minced
- 1 teaspoon minced or grated fresh ginger
- 1/4 cup unsalted dry-roasted peanuts



Courtesy of Diana Kuan

# The Cooking Procedure

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# The Difference of Controls

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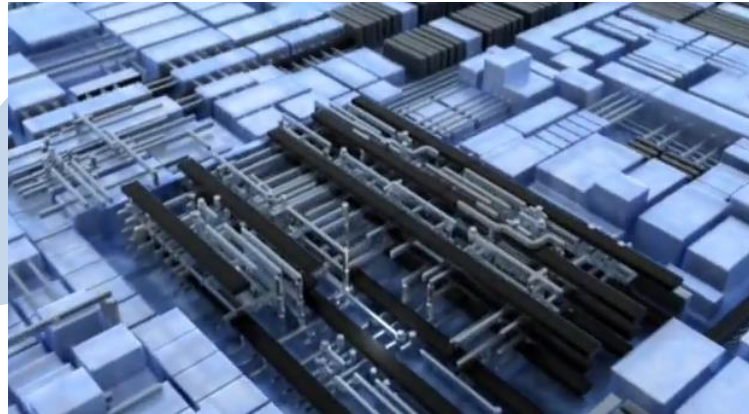
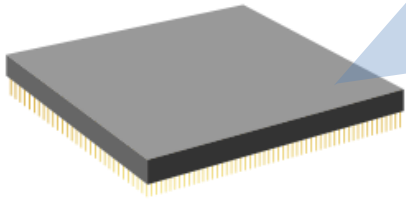
Courtesy of Diana Kuan

Errors tolerable in control of cooking process.

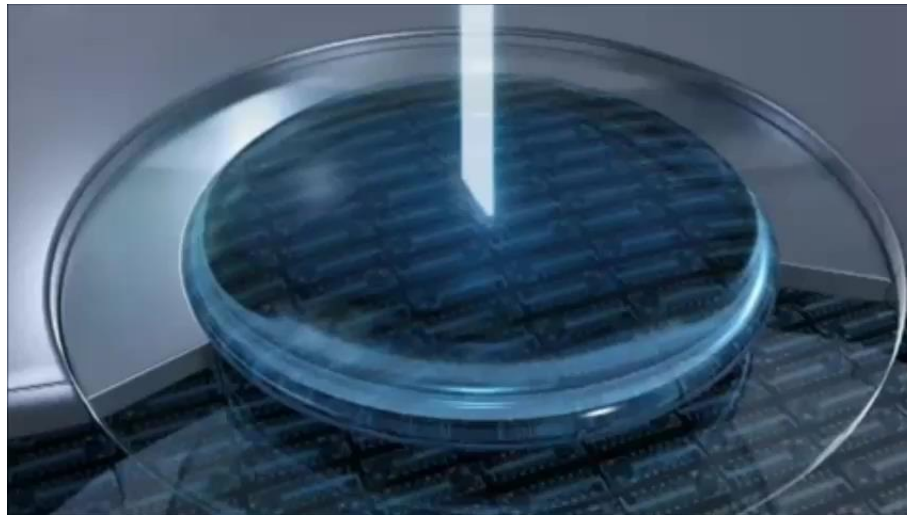
Controls are essential in many engineering applications with MUCH smaller error tolerances.

# Semiconductor Manufacturing

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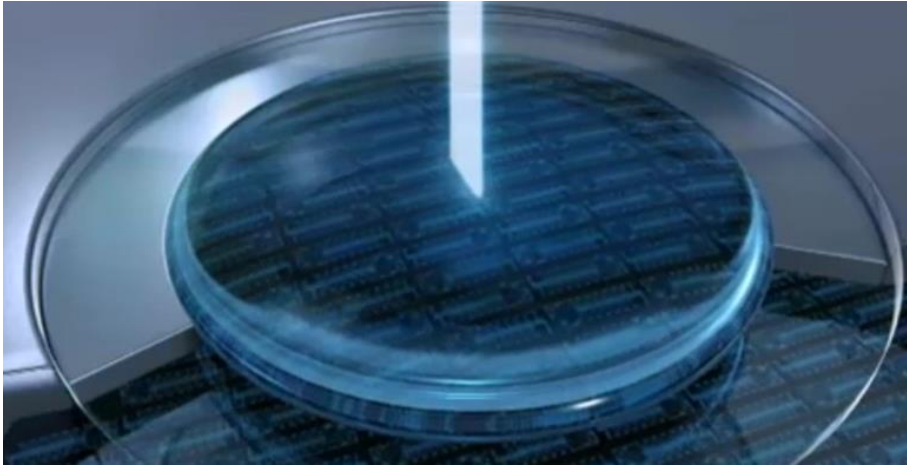


Billions of transistors are “built” into chips at the size of a finger nail, via photolithography.



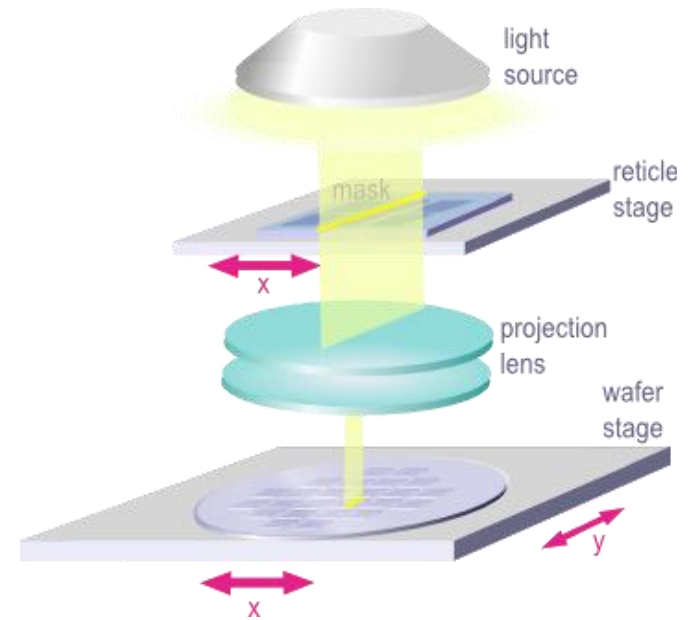
Courtesy of ASML

# The Control Problem



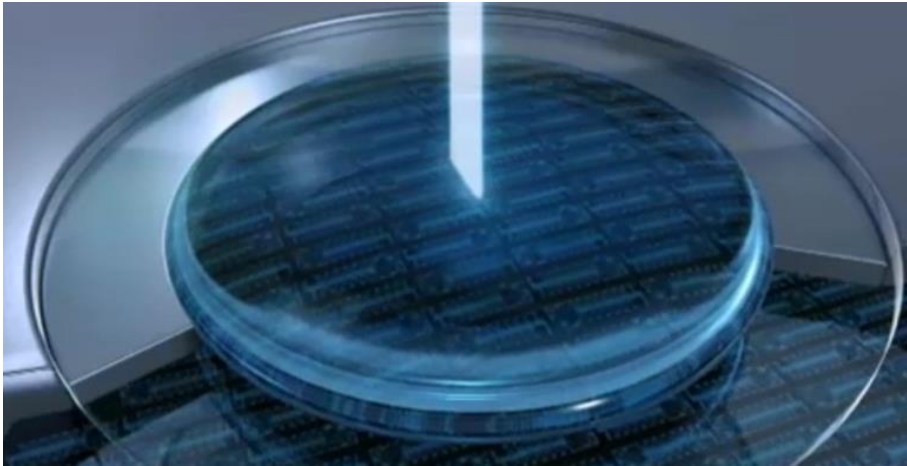
Courtesy of ASML

## Photolithography



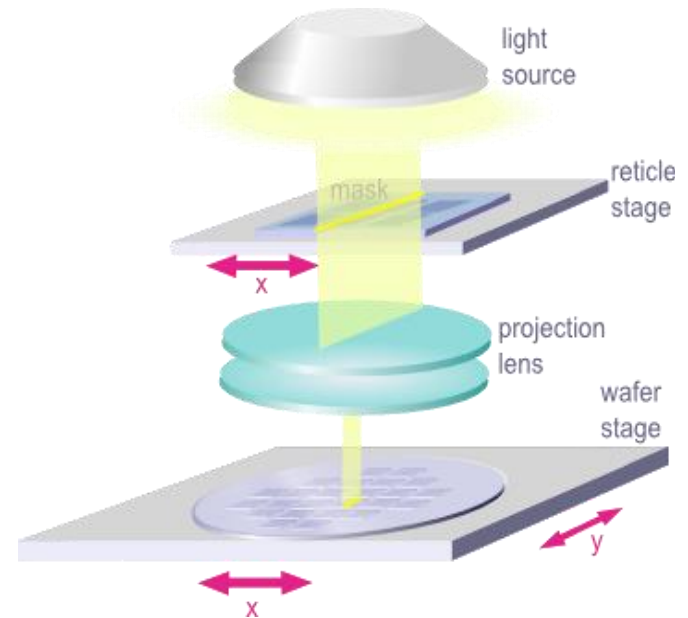
nm-scale precision manufacturing

# The Control Problem

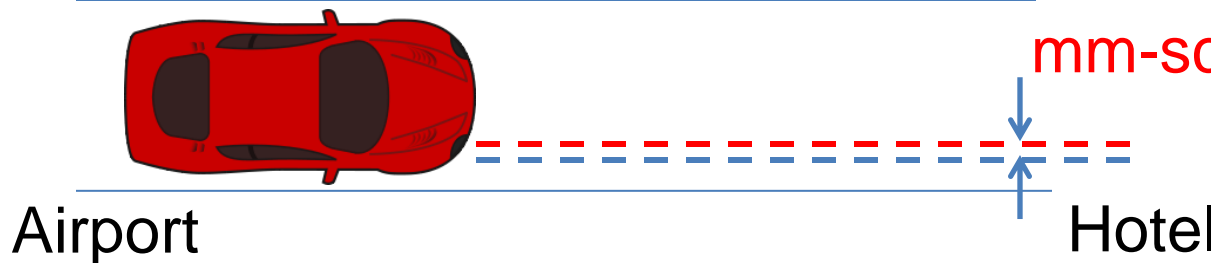


Courtesy of ASML

## Photolithography

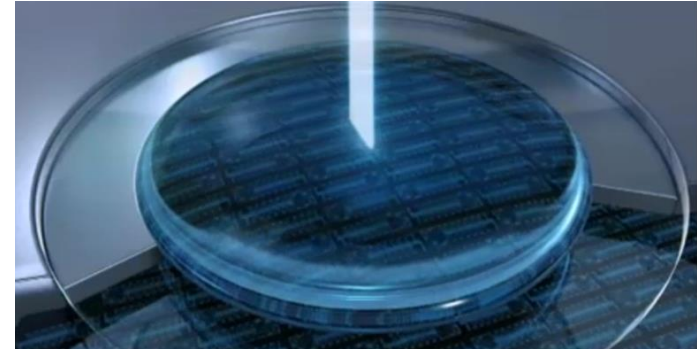
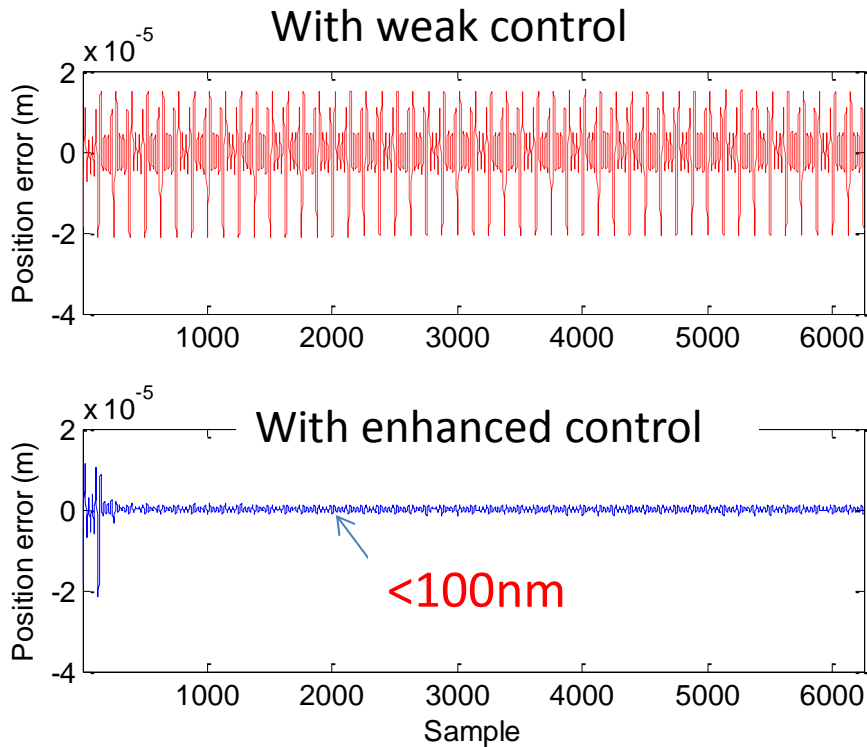


Analogous to driving:



mm-scale error tolerance  
between two runs

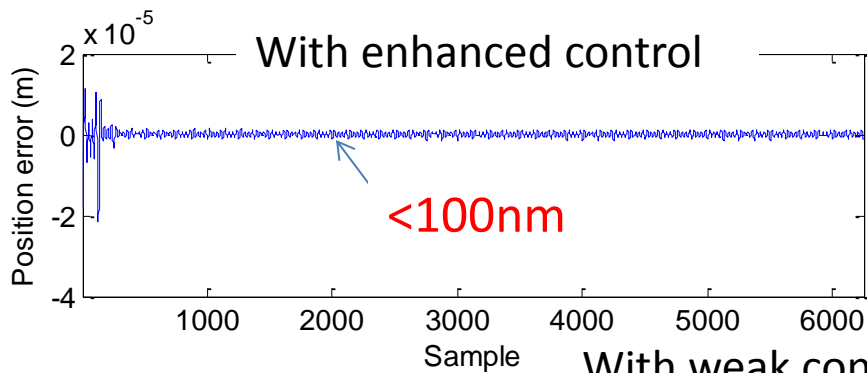
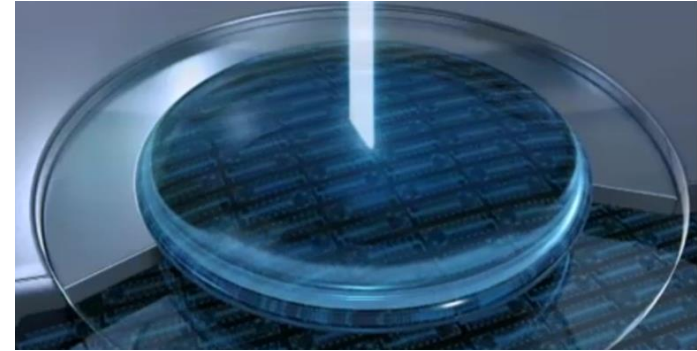
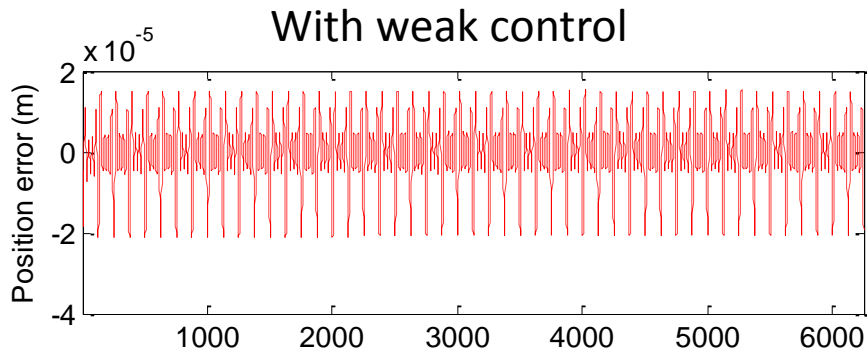
# The Role of Automation and Controls



X. Chen and M. Tomizuka, "Control Methodologies for Precision Positioning Systems," in Proceedings of 2013 American Control Conference, Washington, DC, Jun. 17-19, 2013, pp. 3710-3717.



# The Role of Automation and Controls



With good control



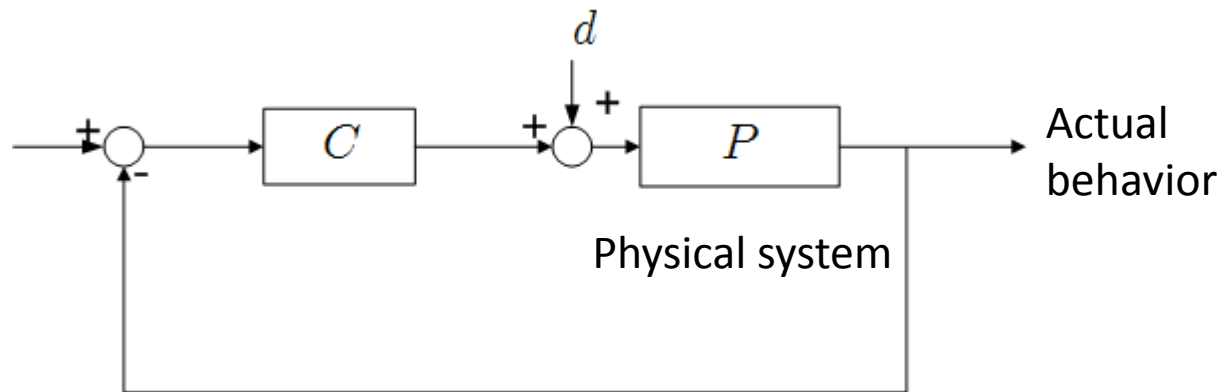
# Control Engineering

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Control engineering or control systems engineering is the engineering discipline that **applies control theory to design systems with desired behaviors.**

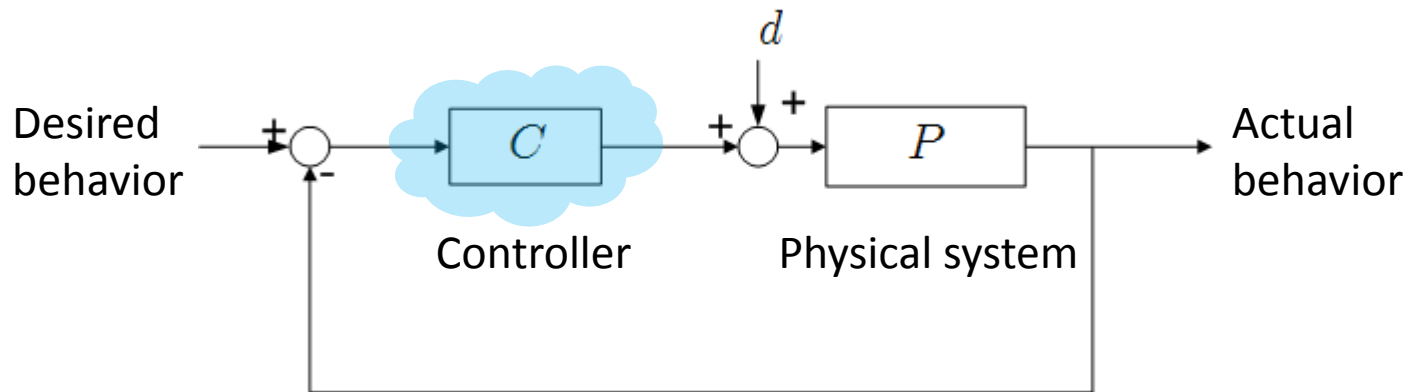
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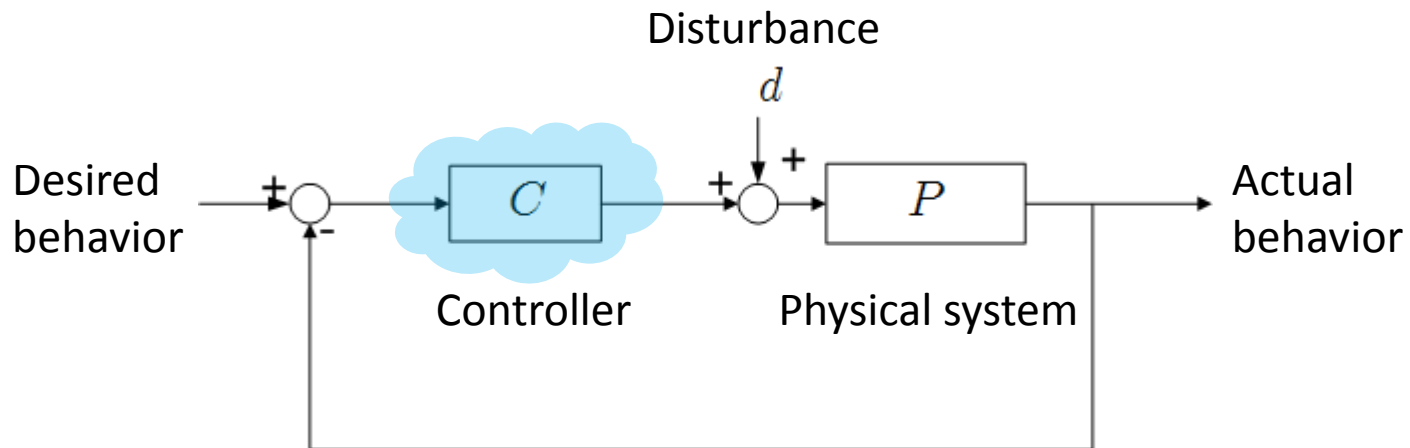
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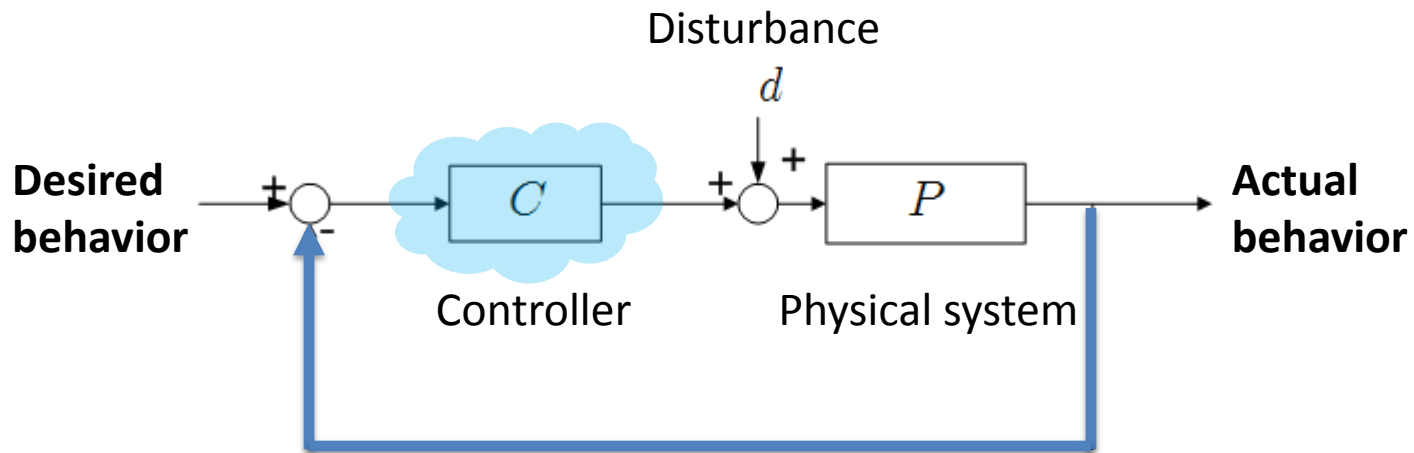
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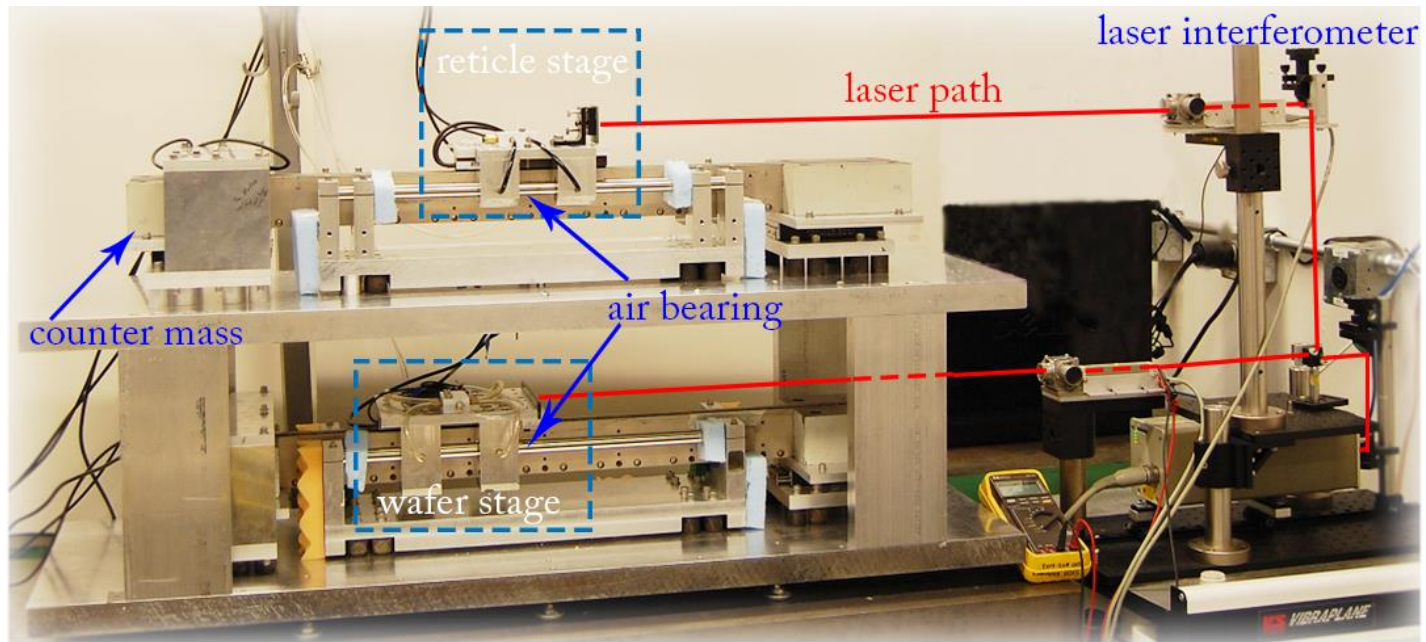
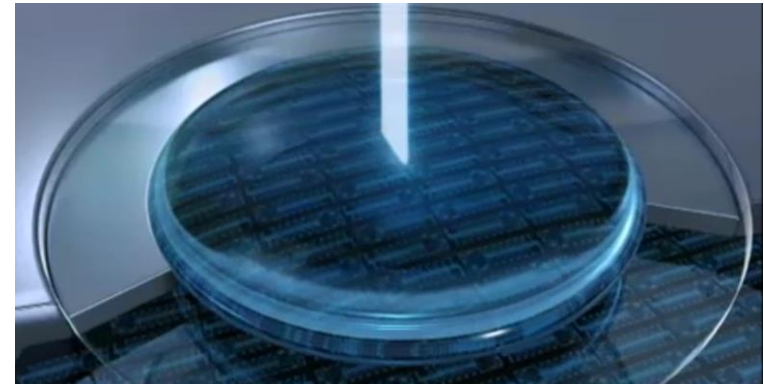
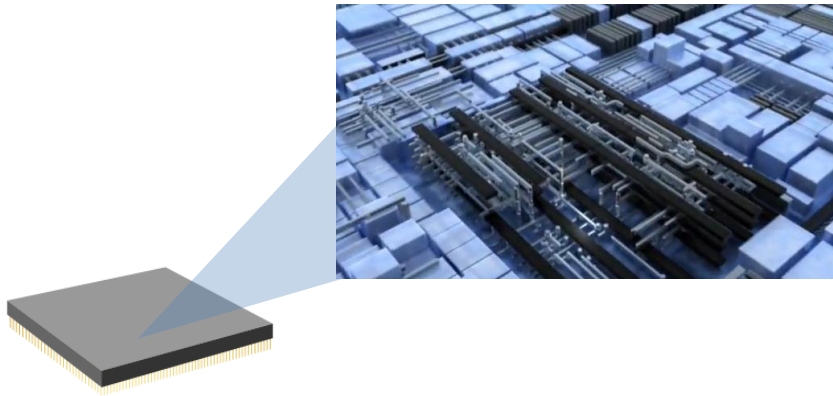


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# Example of Control Systems: Wafer Scanner



# Example of Control Systems: HDDs

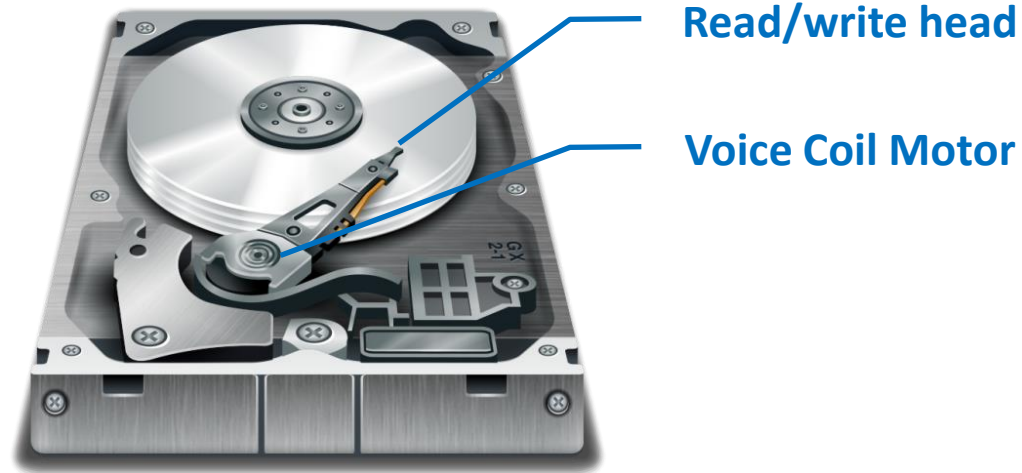
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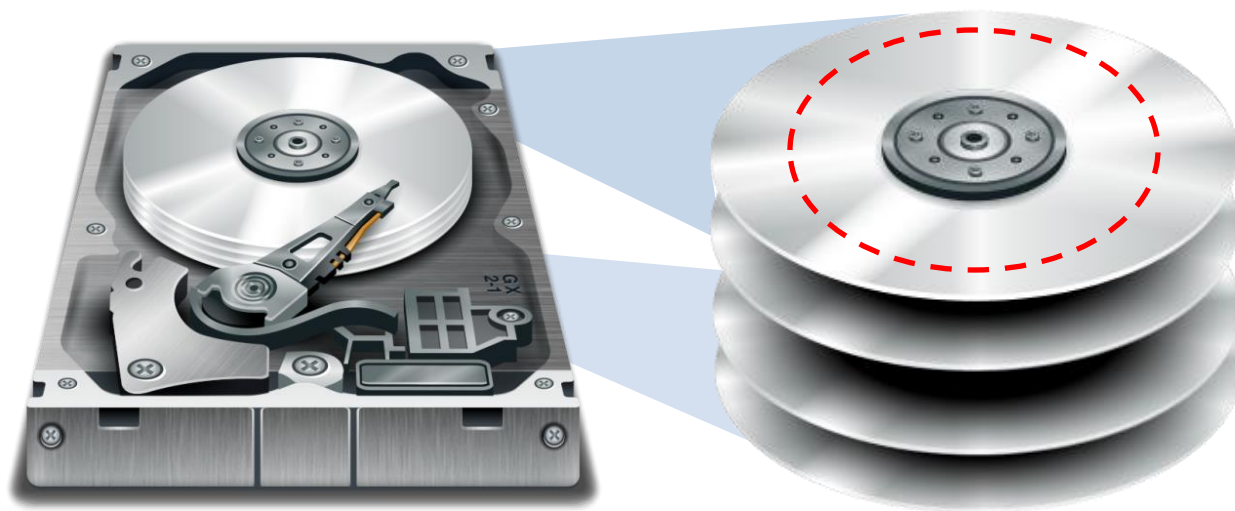
# Example of Control Systems: HDDs

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# Example of Control Systems: HDDs

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**>900,000 tracks per inch**

**~ ten thousand tracks on a human hair!**

X. Chen and M. Tomizuka, "New Repetitive Control with Improved Steady-state Performance and Accelerated Transient," IEEE Transactions on Control Systems Technology, vol. 22, no. 2, pp. 664-675 (12 pages), Mar. 2014, doi:10.1109/TCST.2013.2253102

# Example of Control Systems: Vehicles

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A. Oshima, **X. Chen**, Sumio Sugita, and M. Tomizuka, "Control Design for Cancellation of Unnatural Reaction Torque and Vibrations in Variable-gear-ratio Steering System," in Proceedings of 2013 ASME Dynamic Systems and Control Conference, Stanford University, Palo Alto, CA, Oct. 21-23, 2013

# More Examples of What We Do

<http://xchen.lab.uconn.edu>

