micron STEM

Product Development: Build a Solid State Drive (SSD)

Activity guide

Reviewed: 2025

micron

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Objectives

These activities will enable students to:

- Understand the various roles and responsibilities in a technical product development process
- Practice communication skills relevant to discussion around Solid State Drive products
- Learn about the components of a Solid State Drive

Standards

This lesson aligns with the following Next Generation Science Standards (NGSS) and Common Core State Standards (CCSS):

The NGSS standards most relevant are those in the Engineering, Technology, and Applications of Science (ETS) domain, especially the practices and performance expectations that guide students through the design, testing, and optimization of products.

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution.

MS-ETS1-2: Evaluate competing design solutions using a systematic process.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process.

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

The Common Core State Standards are designed to prepare students for college, career, and life, emphasizing real-world skills such as problem-solving, critical thinking, and collaboration—all essential for product development.

Mathematics

- **Modeling (High School):** Students use mathematics to solve real-world problems, including those encountered in product development.
- **Problem Solving:** Students make sense of problems and persevere in solving them.
- **Reasoning and Proof:** Students construct viable arguments and critique the reasoning of others.

English Language Arts & Literacy

- **Technical Reading and Writing:** Students read and comprehend technical texts and write clear, coherent explanations—skills needed for documenting product development processes.
- **Research to Build and Present Knowledge:** Students conduct research projects to answer questions or solve problems, mirroring the investigative nature of product development.

College and Career Readiness Anchor Standards

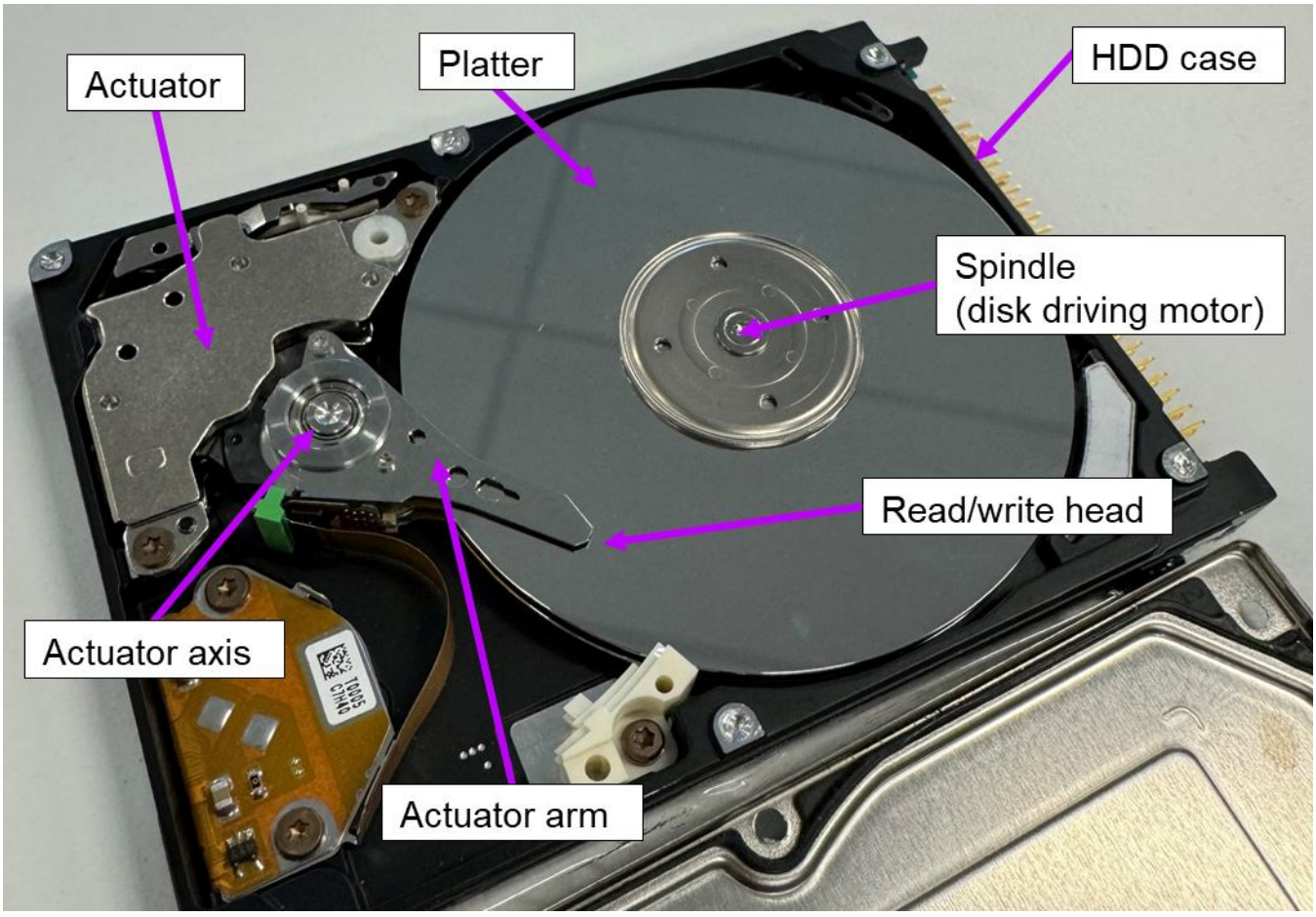
- **Critical Thinking and Collaboration:** Students work together to solve complex problems, communicate effectively, and adapt to new challenges.

SSD vs. HDD

Solid State Drive – *no moving parts*

Micron SSD product examples

Hard Disk Drive – *many moving parts*



See the presentation for definitions of the hard drive components.

SSD vs. HDD

SSD: Solid State Drive – Uses flash memory to store data, which means no moving parts. SSDs are more expensive, but use less power, are faster and smaller than HDDs. The first SSDs were used starting in the early 2000s and became more common in laptops around 2010.

HDD: Hard Disk Drive – Controls the electromagnetic disk (a rotating metal platter with a magnetic coating) that provides data storage for a computer. Data is stored on the disk with an 'arm' that accesses the data while the disk is spinning. In 1956, the first HDD was 24 inches wide with 3.75MB of memory. Today's HDD size is most often 2.5 inches with Terabytes of memory.

SSD Memory Components Defined:

Nonvolatile Memory: A kind of memory that retains data in the absence of power.

Volatile Memory: A kind of memory where data is lost when the device is turned off and power is no longer provided.

NAND Memory: (also known as **NAND Flash memory**), a type of nonvolatile storage technology that does not require power to retain data. It is used in CompactFlash cards, USB Flash drives, SSDs, etc. NAND flash development has been focused on reducing the cost per bit and increasing maximum chip capacity so that flash memory can eventually replace hard disk drives. If you have a smart phone, NAND Flash memory is typically where your pictures and videos are stored: if your smart phone runs out of battery (no power) your pictures and videos can still be retrieved when you charge it back.

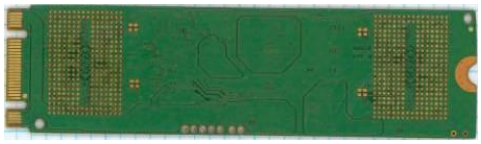
RAM – Random Access Memory: A type of computer memory that can be accessed randomly; that is, information is accessed in any order instead of sequentially like it is on a CD or hard drive, so the computer can access the data much faster. More RAM usually means a faster computer.

DRAM – Dynamic Random Access Memory: A type of random access semiconductor memory that stores each bit of data in a separate tiny capacitor within an integrated circuit. The capacitors are charged to store either a 1 or a 0, depending on arrangement of charges. These capacitors leak, or discharge charge over time, requiring data to be restored or 'refreshed'. Because the capacitor memory state is not fixed (leaks charge), it is known as 'Dynamic' and the refreshing requires constant power making DRAM also known as 'Volatile' memory. DRAM is much faster than NAND and is used by the CPU much like a scratch pad, to store (temporarily) information. It's the working memory your computer uses while running programs. On PCs, "Installed RAM" typically indicates the amount of DRAM memory.

SSD Components & BRICK Equivalents

Printed Circuit Board (PCB): The foundation on which the SSD is built.

GREEN or TAN Base = $10



Connector: This is the Interface between the SSD and the outside world. A single connector is slower & works for older systems; multiple connectors are faster.

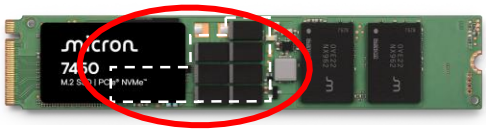
GOLD Tile = $3 per Tile

Controller: The brains of the SSD – Manages the information in and out of the memory (NAND or DRAM).

RED Brick = $8 per Brick

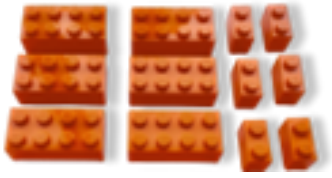
Power Management: Responsible for managing and regulating power delivery across all internal components. A single brick is minimally effective – multiple bricks provide more effective power management functionality.

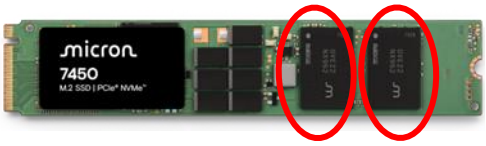
GREY Plate = $5 per Plate



NAND Storage: Permanent storage – Data can be stored in NAND for years.

ORANGE **Brick, Each DOT = 1x2 (32GB) = $3 per Brick, 2x4 (128 GB) = $12 per Brick**

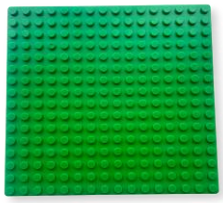
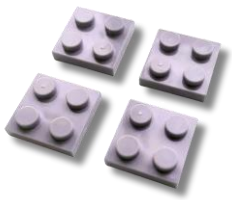


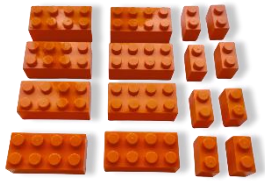
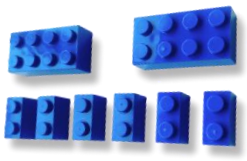


DRAM Memory: Temporary memory - faster than NAND - buffer between controller and NAND to increase speed of the external interface.

BLUE Brick, Each DOT= 1x2 (4 GB) = $4 per Brick, 2x4 (16 GB) = $16 per Brick

SD Build and Cost Worksheet

	Component	Brick	Cost	x	Quantity	=	Total
	**Printed Circuit Board** The foundation on which the SSD is built	**GREEN Base** 	$10.00	x	*1*	=	$10.00
	**Connector** Interface between the SSD and the outside world	**YELLOW Plates** 	$3.00	x	*# plates*	=	
	**Controller** The brains of the SSD – Manages the information in and out of the memory	**RED Bricks** 	$8.00	x	*# bricks*	=	
	Power Management Responsible for managing and regulating power delivery across all internal components	**GREY Plates** 	$5.00	x	*# plates*	=	

	Component	Brick	Cost	x	Quantity	=	Total
	**NAND Storage** Permanent storage – Data can be stored in NAND for years	**ORANGE Bricks** 1x2 (32 GB) $3 2x4 (128 GB) $12 	*$3.00 or $12.00*	*x*	*# bricks*	=	
	**DRAM Memory** Temporary storage faster than NAND buffer between controller and NAND to increase speed of the external interface	**BLUE Bricks** 1x2 (4 GB) $4 2x4 (16 GB) $16 	*$4.00 or $16.00*	*x*	*# bricks*	=	
					Total SSD Cost	=	

Mobile

Enterprise

Devices

Industrial

Autonomous Vehicles

Markets and Customers:

Each team is assigned a market for their SSD

- If there are six teams, then two teams are assigned the “Mobile” market segment
- Be sure each team understands that their SSD should meet the requirements listed for their market segment
- Give the ‘Understand your Market’ paper to the team member with the ‘Marketing’ role in each team

Help students understand the market segments

- Mobile – Students are very aware of mobile devices. Encourage them to consider how they interact with their phone, or smartwatch, or other wearables.
- Enterprise – Students may understand this if you mention ‘the cloud, or data stored and used by social media (e.g. TikTok, Instagram). This market segment is all about storing information that is accessible through internet searches.
- Devices – Students can relate this to their use of tablets/iPad, laptops and Chromebooks as well as gaming systems.
- Industrial – Students may be the most far removed from this market segment. Best to connect to factories that use robotics to manufacture high tech items.
- Autonomous Vehicles – Even if students don’t have personal experience with self-driving cars, they have heard about them in the media. Give them the freedom to think of future autos.

Understand your Market

Devices

Products: Desktop Computer, Laptop, SMART TV / Appliance

Most Important: Price, Low Energy Consumption,

Least Important: Durability (maximum 3 year life cycle)

Typical Memory Range: NAND: 128 – 512 GB

DRAM: 1 – 8 GB

BUDGET: $100

Understand your Market

Enterprise

Products: Datacenter, Cloud Computing

Most Important: High Reliability & Security, Fast Data Access

Least Important: Low Cost

Typical Memory Range: NAND: 1 – 2 TB
DRAM: 8 – 64 GB

BUDGET: $200

Understand your Market

Industrial

Products: Military, Factories, Air Transportation, High Speed Trains

Most Important: High Reliability & Data Access

Least Important: Low Cost

Typical Memory Range NAND: 500GB – 1 TB

DRAM: 4 – 32 GB

BUDGET: $125

Understand your Market

Mobile

Products: Cell Phones, Tablets, Handheld Gaming, Smartwatch

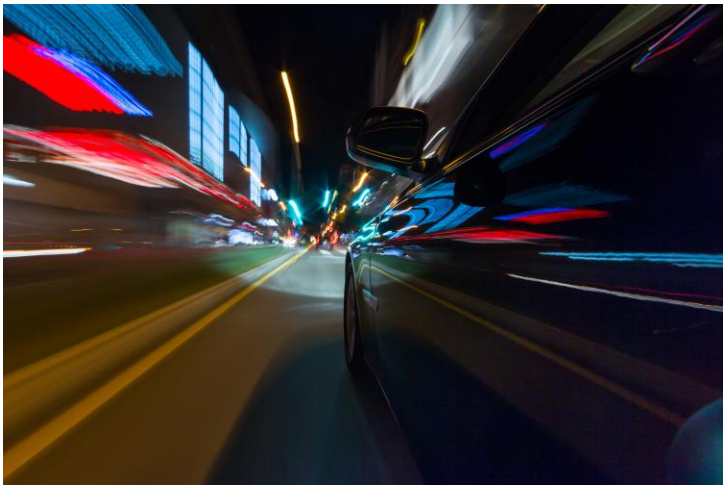
Most Important: Small Size (form factor), Low Cost and Efficient Power Management

Least Important: High Reliability

Typical Memory Range NAND: 64 – 512 GB
DRAM: 0 – 8 GB

BUDGET: $50

Understand your Market



Autonomous Vehicles

Products: Electric and Self Driving Cars

Most Important: Very High Reliability, Fast Data Access and Efficient Power Management

Least Important: Low Cost

Typical Memory Range NAND: 64 – 512 GB

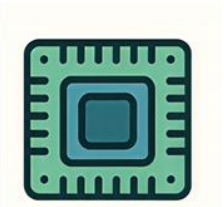
DRAM: 0 – 8 GB

BUDGET: $180


Marketing


Architect


Procurement


Board Layout


Quality

Roles:

Each team member is assigned a role

- Place at each seat, so student is assigned their role based on where they sit – most efficient
- Do not change roles UNLESS someone REALLY makes a fuss over having a different role
- Be sure each student reads their role
- Support the team to collaborate while also helping each student complete the tasks for their role
- Encourage students to think creatively. Can certain components be stacked? (e.g. NAND on NAND for all customers. DRAM and NAND for Mobile, to save space). Does placement on the board matter? (e.g. data goes into DRAM first, where should it be vs connector? Power management ties to ALL components, where should those bricks be placed?

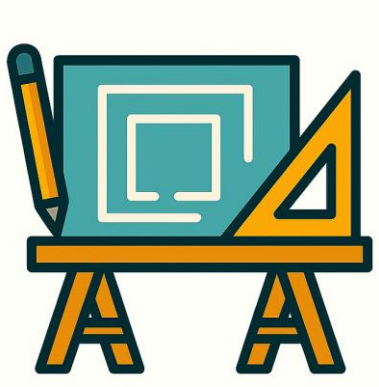
Understand your Role

Marketing - 1st

Understand Customer Priorities

- ✓ Determine the most important feature(s) of the SSD
- ✓ Identify all features that must be included
- ✓ Identify any features that could be left out
- ✓ Ensure final SSD product meets customer priorities

Understand your Role



Architect - 2nd

Based on Marketing decisions – set the following:

- ✓ Amount of NAND memory
- ✓ Level of power management
- ✓ Size (form factor)
- ✓ Type of controller: basic or customized
- ✓ Connector number and placement
- ✓ Is there any DRAM & how much?

Understand your Role

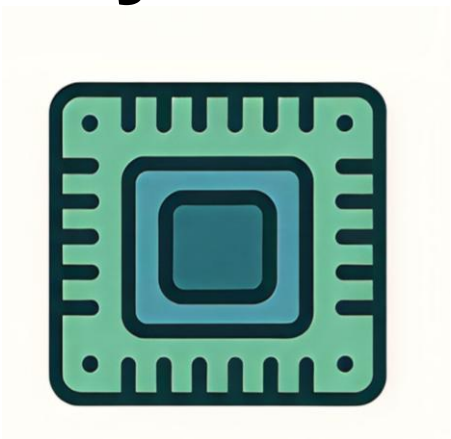
Procurement - 3rd

Procurement manages the spend vs budget allowance

Based on the list created by the Architect

- ✓ Identify the number of 'bricks' or 'dots'
- ✓ Calculate:
  - cost of each set of components
  - total cost of the SSD
  - percentage each component is of the total cost
- ✓ Manage the overall budget

Understand your Role



Board Layout - 4th

Places the components on the Printed Circuit Board (PCB)

- ✓ Based on direction from the architect and procurement decisions
- ✓ Determine placement for each of the components onto the PCB
- ✓ Ensure the final component locations optimize the proper features and performance

Understand your Role

Quality - 5th

Final testing and…

- ✓ Confirm number of components with Architect
- ✓ Check with Procurement on the budget
- ✓ Check placement of components with Board Layout
- ✓ Call in Marketing to confirm customer priorities
- ✓ Gives final approval/rejection