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Leveraging AI-Generated CAD Lecture Previews to Enhance Accessibility for Hearing-Impaired Students

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Abstract

In an Aerospace and Mechanical Engineering program, a tailored curriculum adaptation was introduced to support all students, with particular attention to hearing-impaired learners in AME308: Computer-Aided Design (CAD). Hearing-impaired students received standard OSAS accommodations, including 1.5x extended time for homework/exams and direct TA support, while AI tools were adopted to address pedagogical gaps. The course's dynamic nature—evolving through student interactions—rendered traditional notes inadequate. To bridge this gap, lecture recordings and AI-generated summaries (created using ChatGPT) were provided to all students, benefiting those with hearing impairments, temporary absences, or diverse learning needs.

The approach leveraged ChatGPT to transform Zoom subtitles and lecture materials into structured previews, reviewed by TAs for accuracy. While initially designed for accessibility, the AI summaries saw class-wide adoption due to their universal utility. Feedback from students,

including a hearing-impaired participant who cited ”improved confidence in technical discussions,” confirmed the method’s effectiveness in fostering inclusivity and academic equity.

This work demonstrates how AI-augmented tools can complement both institutional accommodations (e.g., OSAS) and traditional teaching, offering a scalable model for inclusive technical education.

Introduction

Advancements in Artificial Intelligence (AI) have opened new possibilities for transforming education, particularly in enhancing accessibility for students with disabilities. Among these innovations, AI tools such as ChatGPT have shown immense potential in improving learning experiences for hearing-impaired students by generating tailored educational content. This paper focuses on leveraging ChatGPT to create lecture previews for AME308: Computer-Aided Design (CAD), a key course in the Aerospace and Mechanical Engineering program. The course primarily uses Siemens NX as its CAD software, and its technical nature presents unique challenges for hearing-impaired students who may struggle with traditional teaching methods.

While hearing-impaired students in AME308 qualify for standard institutional accommodations (e.g., 1.5x extended time for exams/homework and direct TA support through OSAS), these measures alone cannot address all pedagogical barriers, such as real-time lecture comprehension. Although AME308 combines hands-on practice with theoretical learning, hearing-impaired students often miss key information during dynamic classroom interactions. To address these gaps, we propose a novel and universally beneficial teaching approach that integrates AI-generated lecture previews. These previews summarize key concepts and outline lecture content in a concise, structured manner, and—alongside Zoom recordings—were made available to all students to support diverse needs (e.g., temporary absences or language barriers).

The structure of this paper is as follows: First, we discuss the challenges faced by hearing-impaired students in technical courses like CAD and how existing accommodations and the current AME308 lecture format fall short in ensuring full accessibility. Next, we detail the methodology of generating lecture previews using ChatGPT, including how subtitles from previous lectures are utilized and refined. This is followed by an evaluation of the approach’s effectiveness based on structured student feedback from both hearing-impaired and neurotypical peers and engagement metrics. Finally, we conclude with insights into the broader implications of AI-assisted teaching for inclusive education and propose future directions for integrating AI in technical education to promote accessibility and equity.

This work demonstrates how AI can complement institutional support systems to create inclusive learning environments, bridging gaps that traditional accommodations alone cannot resolve.

Lecture format

In the regular AME 308 classroom, the professor demonstrates design techniques in Siemens NX in real time using a projected screen while describing the step-by-step process. When introducing key concepts, the professor uses slides to explain definitions and related ideas before demonstrating the practical software operations. This teaching approach is highly effective for hearing-abled students, as it allows them to learn the software through hands-on practice while deepening their understanding of the concepts.

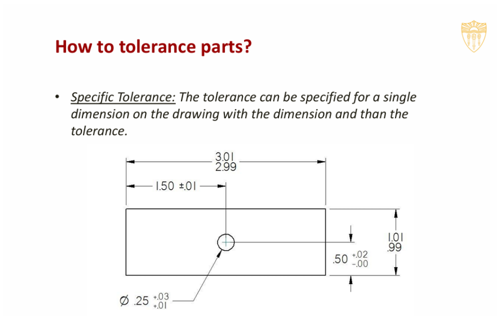


Figure 1: Lecture slides introducing tolerance on engineering drawing

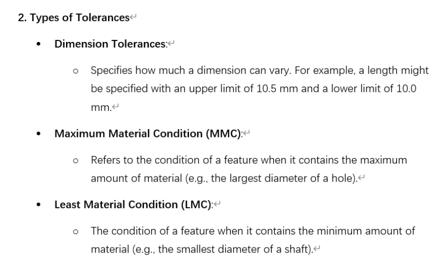


Figure 2: AI generated preview for students understanding tolerance

However, for hearing-impaired students, there is a significant risk of missing critical definitions or software operation details due to their hearing limitations. To address this challenge, in addition to attending regular classes, AI tools such as ChatGPT are utilized to provide additional support. Specifically, the teaching assistant (TA) generates course previews based on key concepts, previous course recordings, and the professor's lesson content, using AI tools to distill the most essential information. Hearing-impaired students receive these previews before the start of each lecture, enabling them to familiarize themselves with the course material in advance.

This paper will use the GD&T (Geometric Dimensioning and Tolerance) course as an example to illustrate how this approach effectively supports hearing-impaired students by ensuring they can grasp both the theoretical concepts and practical operations. Shown in Figure 1 and Figure 2, lecture slides does not include enough information for tolerance definition, while AI generated preview could provide specific tolerance definition and explanation. By combination of lecture content and AI generated preview, Hearing impaired student could better acquire knowledge.

AI aided preview

The AI-generated previews mentioned in this paper are based on the previous year's GD&T course recordings, which are transcribed into subtitles using speech recognition software. While Zoom recordings with automated captions could theoretically serve as an alternative, our pilot tests revealed significant limitations: (1) caption accuracy for technical terms like "geometric tolerancing" dropped below 70%, and (2) the raw transcripts lacked logical structure, requiring excessive manual editing to extract actionable steps—a process that took TAs 3× longer than refining ChatGPT outputs.

These generated subtitles are then uploaded to ChatGPT with a suitable prompt, such as: "This is the GD&T course content from the NX software class. Please generate a preview to help with learning." After ChatGPT generates the preview, the Teaching Assistant (TA) carefully reviews the content to ensure it contains sufficient information. This hybrid approach (AI + human review) proved more efficient than relying solely on Zoom's automated tools, as it consistently produced organized, student-ready materials in half the time.

Table 1: Preview topics and content

Overview of GD&T	Types of Tolerances	Application of Tolerances	Symbols and Notations
1. Definition	1. Dimension Tolerances	1. Aerospace	1. Common Symbols
2. Importance	2. Geometric Tolerances	2. Automotive	2. Usage
	3. Maximum Material Condition	3. Civil Engineering	
	4. Least Material Condition		

Table 2: Continued Table 1

Engineering Software Operations	Specific Examples	Class Interaction and Feedback
1. Editing Title Blocks	1.Feature control frame	1. Class Interaction
2. Tolerance Annotation		

Through this preview, students can familiarize themselves with an overview of the GD&T course in advance. Notably, the structured format outperformed Zoom's linear transcripts in helping students locate specific software instructions—critical for hearing-impaired learners who cannot simultaneously watch demonstrations and read captions. The preview provides a clear introduction to the types of tolerances, their definitions, as well as the corresponding symbols and icons. Furthermore, the detailed step-by-step software instruction section offers precise guidance on software operations. This approach effectively prevents hearing-impaired students from missing critical software operation details during the lecture and enhances the efficiency of learning related concepts and skills.

AI aided preview enhancement in regular lecture content

By using the preview, the learning experience of hearing-impaired students is significantly enhanced, particularly in understanding key concepts. The AI-generated preview improves their learning efficiency by providing structured explanations of essential content.

For example, Figure 5 displays the slides from the lecture introducing geometric tolerances. These slides only show the symbols for different types of tolerances without explaining their specific meanings. During the lecture, the professor verbally introduces these concepts, which is not accessible for hearing-impaired students and may cause them to miss critical information. Therefore, the preview's role in providing clear explanations of these concepts becomes crucial. By reviewing the symbols and their meanings before class, students can better understand and engage with the lecture content.

Moreover, since this course heavily focuses on software operations, mastering the software is equally important. Figure 3 illustrates the professor demonstrating how to add tolerances to engineering drawings, where students can only see the software interface projected on the screen. Because software operations involve multiple steps, it is impractical to create PowerPoint slides

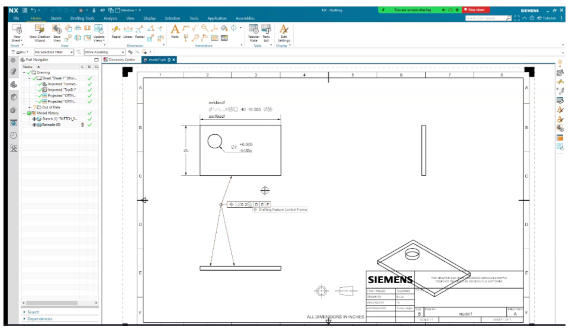
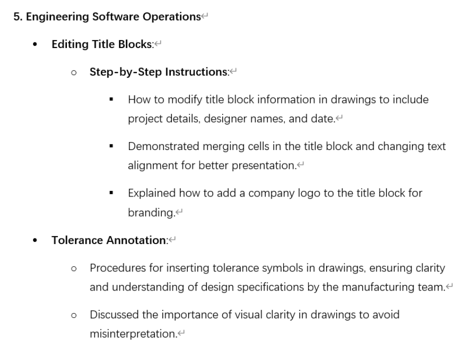


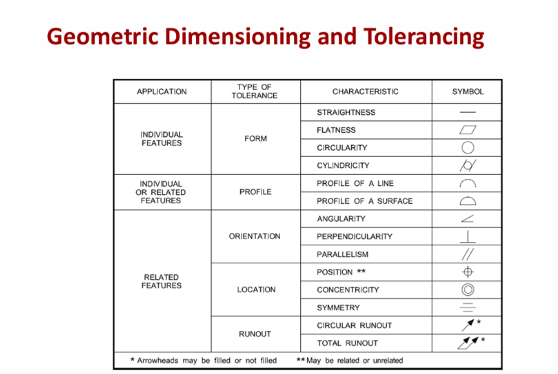
Figure 3: Lecture software operation



5. Engineering Software Operations

- **Editing Title Blocks**:
  - **Step-by-Step Instructions**:
    - How to modify title block information in drawings to include project details, designer names, and date.
    - Demonstrated merging cells in the title block and changing text alignment for better presentation.
    - Explained how to add a company logo to the title block for branding.
- **Tolerance Annotation**:
  - Procedures for inserting tolerance symbols in drawings, ensuring clarity and understanding of design specifications by the manufacturing team.
  - Discussed the importance of visual clarity in drawings to avoid misinterpretation.

Figure 4: AI generated preview for software operation

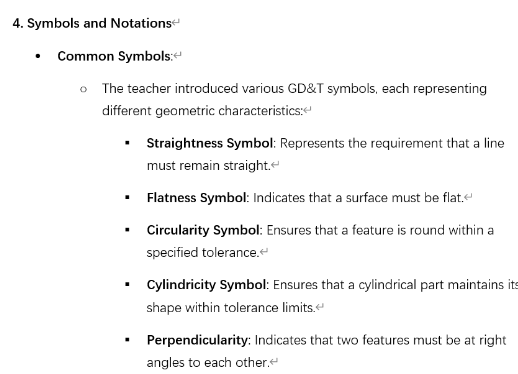


Geometric Dimensioning and Tolerancing

APPLICATION	TYPE OF TOLERANCE	CHARACTERISTIC	SYMBOL
INDIVIDUAL FEATURES	FORM	STRAIGHTNESS	⏤
		FLATNESS	⏥
		CIRCULARITY	○
		CYLINDRICITY	⌭
INDIVIDUAL OR RELATED FEATURES	PROFILE	PROFILE OF A LINE	⌒
		PROFILE OF A SURFACE	⌓
RELATED FEATURES	ORIENTATION	ANGULARITY	∠
		PERPENDICULARITY	⊥
		PARALLELISM	//
	LOCATION	POSITION **	⌖
		CONCENTRICITY	◎
		SYMMETRY	⌯
	RUNOUT	CIRCULAR RUNOUT	↗ *
		TOTAL RUNOUT	⌰ *

* Arrowheads may be filled or not filled ** May be related or unrelated

Figure 5: Lecture Geometric tolerance definition



4. Symbols and Notations

- **Common Symbols**:
  - The teacher introduced various GD&T symbols, each representing different geometric characteristics:
    - **Straightness Symbol**: Represents the requirement that a line must remain straight.
    - **Flatness Symbol**: Indicates that a surface must be flat.
    - **Circularity Symbol**: Ensures that a feature is round within a specified tolerance.
    - **Cylindricity Symbol**: Ensures that a cylindrical part maintains its shape within tolerance limits.
    - **Perpendicularity**: Indicates that two features must be at right angles to each other.

Figure 6: AI generated preview for Geometric tolerance

detailing every single step. As a result, the professor primarily relies on verbal explanations alongside live demonstrations, which are not accessible to hearing-impaired students.

As shown in Figure 4, the preview generated from the previous year's lecture includes key details on software operations, such as editing the title block and adding tolerance annotations. While the preview does not provide step-by-step instructions, it highlights the two main operations for adding tolerances to engineering drawings. This allows students to identify which parts they do not understand or struggle to perform, so they can pay closer attention to those areas during the lecture.

Furthermore, if students still encounter difficulties, they can use the preview to locate the relevant concepts and seek clarification from the professor or teaching assistant during office hours. This targeted approach not only helps students focus on critical areas but also ensures more efficient and effective learning for hearing-impaired students.

Discussion

Student Feedback Analysis (30 participants: including 1 students with hearing impairments)

1. Understanding Theoretical Concepts (All Students)

The preview materials were widely praised for explaining definitions, with students with hearing impairments particularly noting their accessibility value: ”The concepts were clearly explained and easy to follow.” — Student with hearing impairment A (verified through OSAS)

2. Lack of Software Operation Guidance (Students without hearing impairments)

While all students appreciated the theoretical framework, students without hearing impairments more frequently noted practical gaps: ”The preview didn't show how to actually perform operations in NX... we had to wait for the in-class demonstration.” — Student B (without hearing impairment)

3. Need for Step-by-Step Software Instructions (Students with hearing impairments)

All 3 students with hearing impairments emphasized the need for integrated operational guidance: ”When the lecture pace is too fast, we need visual step-by-step instructions with diagrams.” — Student with hearing impairment A

Conclusion

In summary, this is an innovative approach to using AI tools to assist teaching, particularly in supporting hearing-impaired students and enhancing the inclusivity of engineering software courses. This paper has detailed the methodology and demonstrated the effectiveness of the AI-generated preview.

However, to achieve even better results, further research and improvements are necessary. As highlighted in the student feedback, the current preview still has limitations in supporting software operations. In the future, AI tools can be leveraged to generate more detailed software operation guides. Additionally, teaching assistants and professors can collaborate to create step-by-step visual instructions tailored to the course content. By combining these visual instructions with AI-generated previews, the learning experience for hearing-impaired students can be further enhanced, ensuring more comprehensive support in both theoretical understanding and practical application.

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