CPS Education Panel — Scribe Summary

Source: "CPS Education.m4a," approximately 73 minutes. Prepared from a locally generated transcription, with unclear passages rechecked. Timestamps are approximate; uncertain speaker names and wording have been omitted.

The discussion examined how cyber-physical systems (CPS) education should evolve, particularly its interdisciplinary prerequisites, curriculum structure, relationship to AI and robotics, teaching resources, and visibility to employers. Participants repeatedly emphasized the difficulty of combining breadth with meaningful technical depth. The closing recap identified several proposed community efforts, but did not establish assigned owners or deadlines.

Major themes

1. **Defining a realistic introductory course — approximately 03:00–14:00**

   Students enter CPS courses with widely different preparation in programming, mathematics, physics, communications, and control. This challenge affects both undergraduate and graduate teaching.

   One approach prioritizes shared terminology and core concepts so students can communicate with specialists across disciplines. Another uses an integrated application to introduce real-time systems, concurrency, modeling, verification, code generation, testing, and safety assurance. A pacemaker project illustrated this approach.

   Both approaches face limits: some students need foundational instruction, others already know particular topics, and brief coverage can leave students feeling that nothing has been explored deeply enough.

   Participants proposed clarifying introductory learning objectives and sharing adaptable teaching modules. One instructor offered an existing course as a potential community resource and expressed interest in collaborators.

2. **Building pathways beyond one course — approximately 14:00–30:30**

   Participants distinguished an introductory survey from a concentration, multi-course track, or full degree. Appropriate prerequisites and learning outcomes depend on which of these is intended.

   A proposal for at least two introductory courses received support in principle, but prompted concerns about crowded curricula and departmental approval. Concentrations within existing degrees were discussed as a potentially practical route, including combinations of existing courses in control, AI, statistics, algorithms, and related subjects.

Participants also described concern that enthusiasm for machine learning and LLMs can displace preparation in statistics, logic, classical planning, and mathematical modeling. These observations reflected instructors' experiences; the discussion did not establish a common prerequisite standard.

3. **Connecting CPS to robotics, physical AI, and employment — approximately 30:30–39:30**

   Participants recognized substantial overlap between CPS and robotics, while noting that CPS also includes applications beyond robotics. They favored avoiding competitive positioning between programs.

   Several suggested presenting CPS as a foundation for physical AI. A recurring concern was that employers may seek relevant skills without using "CPS" in job advertisements, making the value of a CPS qualification less obvious to students.

   Proposed responses included employer outreach, tutorials or workshops at major AI and machine-learning conferences, and short explanatory videos. One participant described existing industrial interest in CPS students through university partnerships, while acknowledging uncertainty about the breadth of demand.

4. **Strengthening research-community visibility — approximately 39:30–46:00**

   Participants discussed whether conference recognition and rankings discourage researchers from adjacent fields from participating in CPS venues. Conference consolidation, additional tracks, and efforts to improve formal recognition were described as ongoing or contemplated community work.

   Different explanations were offered for participation challenges: formal rankings, the field's unusually broad subject matter, and insufficient involvement by prominent researchers. Recruiting recognized leaders to conference roles was discussed as one way to attract wider participation.

   The discussion distinguished research-community building from employer awareness: both matter, but they require different efforts.

5. **Making hands-on projects reusable and accessible — approximately 46:30–57:30**

   Examples included pacemakers, small autonomous cars, drones, sensor kits, smartphones, and simulation exercises. Participants described projects as valuable for engagement and integration across topics.

   However, a project list alone was considered insufficient. Reusable materials should explain prerequisites, equipment, software, setup, and the CPS principles students are expected to learn. Sharing supporting materials, including grading tools where available, could reduce the substantial effort required to develop a course.

Cost and institutional restrictions were important concerns. Participants discussed loaned equipment, shared kits, simulator-based alternatives, and possible funding for educational equipment or testbeds. They also stressed that a functioning device does not automatically demonstrate understanding of CPS principles.

6. **Assessing understanding in the LLM era — approximately 57:30–61:45**

   Participants questioned how conventional assignments can demonstrate learning when online solutions and AI tools can complete substantial portions of the work.

   The discussion acknowledged the workplace relevance of using such tools, while emphasizing that students still need enough understanding to explain, diagnose, and debug their results.

   Oral examinations and short in-class quizzes were described as existing practices or possible responses. Experiences differed regarding student motivation, attendance, and the effect of demanding assessments on teaching evaluations. No common assessment policy was adopted.

7. **Broadening teaching materials and participation — approximately 61:45–71:45**

   Participants noted that the group's perspective leaned heavily toward computer science and that broader engineering participation would be valuable.

   They questioned whether existing textbooks adequately cover the range of CPS education. Some emphasized formal foundations and verification; others wanted more attention to sensing, communications, operating systems, real-time scheduling, and interactions between software and control.

   Interactive online textbooks, blogs with animations and adjustable examples, focused video tutorials, and very short introductory videos were proposed. Participants distinguished material that attracts interest in CPS from material that actually teaches it.

Points of agreement

There was recurring support for:

- Defining course goals around the intended audience and educational pathway.
- Recognizing that one semester cannot provide deep expertise across all CPS disciplines.
- Sharing adaptable courses, modules, and well-documented projects.
- Connecting projects explicitly to CPS learning objectives.
- Improving awareness of CPS skills among students, employers, and adjacent research communities.
- Developing more accessible and engaging learning materials.

These were recurring positions rather than formally voted resolutions.

Differences and unresolved questions

- How much technical depth should an introductory course require?
- Should CPS education center on one survey course, a sequence, a concentration, or a dedicated degree?
- Which foundations should take priority, particularly as AI content expands?
- How should programs describe CPS in relation to robotics and physical AI?
- How can hands-on learning remain affordable across institutions?
- Which assessments best distinguish tool use from genuine understanding?
- What balance of formal methods, engineering implementation, and AI belongs in shared teaching materials?

Proposed action items and their status

Proposed follow-up	Status in the discussion
Articulate introductory CPS course scope and learning objectives.	Included in the closing recap; no owner or deadline stated.
Share example courses and reusable teaching modules.	Included in the recap; one instructor offered a course as a possible starting point.
Build a community library of documented CPS projects and supporting materials.	Included in the recap; a community platform such as CPS-VO was suggested.
Explore funding for course development, educational equipment, and testbeds at institutions needing resources.	Included in the recap as a possible NSF-related effort; no funding commitment stated.
Improve CPS visibility through industry outreach and AI/ML conference tutorials, workshops, or short videos.	Included in the recap, particularly around CPS as a foundation for physical AI.
Develop interactive teaching resources, blogs, and short educational videos.	Included in the closing recap; no production plan assigned.
Encourage universities to recognize CPS concentrations within existing degrees.	Raised earlier as a possible action; no institutional commitment stated.

Decisions recorded: The discussion concluded with a recap of proposed directions. No formal vote, finalized curriculum, assigned action owners, deadlines, or funding approvals were stated.