Finally, programmable logic controllers are demonstrated in-house, both for their functionality and ladder-logic programming. These demonstrations provide a valuable experience for the students that pictures and diagrams alone cannot equal.

In addition to the weekly demonstration periods, one or two plant tours have been scheduled each year to local biotech manufacturing sites. This experience has been extremely useful to the students in integrating the knowledge they have gained from the remainder of the course material.

POTENTIAL LIMITATIONS OF THE APPROACH

To assure that the students taking this course remain marketable in the wider chemical engineering job market, many of the equipment design issues of a mainstream equipment design course are still taught (*e.g.,* pipes, pumps, pressure vessels, heat exchangers)—but the equipment is discussed in the context of a biotech facility. Unit operations and ideas unique to the biotech/pharmaceutical industry, such as fermentation, chromatography, clean utilities, sanitary design, and cGMP, are also stressed throughout the course.

The addition of instruction in reading P&IDs, demonstrations of actual equipment used in processing, and tours of production facilities have been particularly useful and would likely be beneficial in a mainstream chemical engineering equipment design course as well. Students completing this course have received simultaneous job offers from biotech and chemical companies, so it appears that the flexibility of this approach is evident to potential employers.

Teaching a course in this subject does require some knowledge of the industry. This knowledge could be gained from previous industrial experience, extensive reading, collaborative teaching with personnel from local companies, or an industrial sabbatical.

CONCLUSIONS

This new course on biotech manufacturing facility design and regulatory compliance is a unique experience for chemical engineering students who are planning to join the biotech or biopharmaceutical industry after graduation. The reception from students and industry alike has been overwhelmingly favorable. Both groups see the information disseminated through this course as practical, and mastery of the subject matter allows the students to make a more rapid transition to industry and thereby to become productive sooner.

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