

Application of theoretical knowledge to process control for the development of feeding strategies in fed-batch fermentations

Yaeseong Hong

Institute of Bioprocess and Biosystems Engineering

Framework

- **Course:** Bioprocess Engineering Advanced Practical Course
- Project implementation in Fed-batch cultivation part
- Consists of colloquium, experimental conduct, written report and final presentation
- 4 groups with each a size of 3-4 students
- Master students of Bioprocess Engineering, and Chemical and Bioprocess Engineering (international) in their final semester

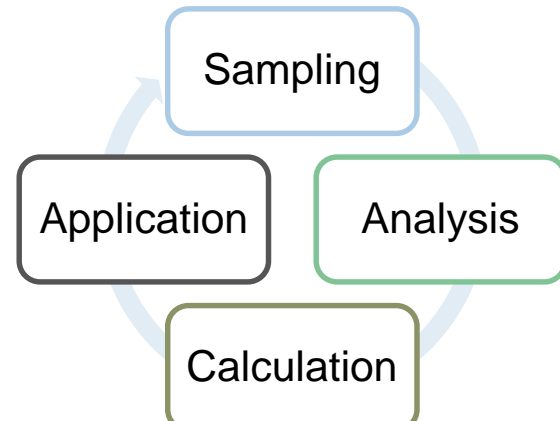
Problem definition

- Strict following of the manual limits the learning experience [3].
- Absence of discussions during the experiment [1].
- Once the reactor is set-up, students are not occupied between the sampling time points.

New didactical concept

Theoretical Knowledge from lectures:
Learned background

Practical application

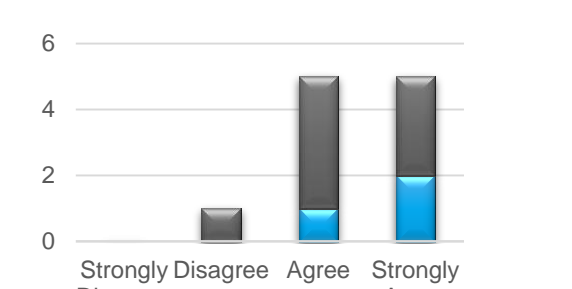


Critical reflection:
New learning experience

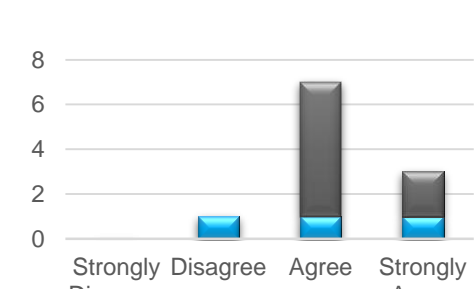
- Previously: Process control guideline was given
- **New concept: Dynamic feed calculation and application to a running process and reflection of its impact**
 - Sampling, analysis, calculation and application accompanied by group discussions
 - Active discussions are stimulated by repeated adjustments [1]
- **Presentation of utilized strategy after the experiments**

Evaluation (September 2018, N≤11)

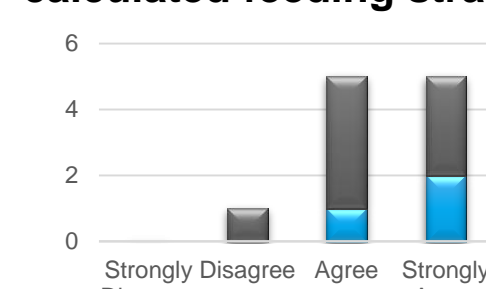
This experiment helped me understand different aspects and influential factors for the cell growth in a fermentation.



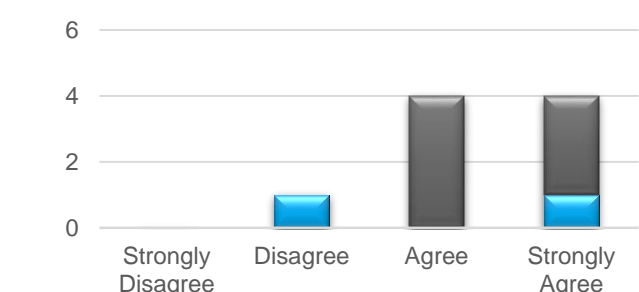
I was able to identify and utilize key-parameters for the feeding strategy from the theoretical derivation.



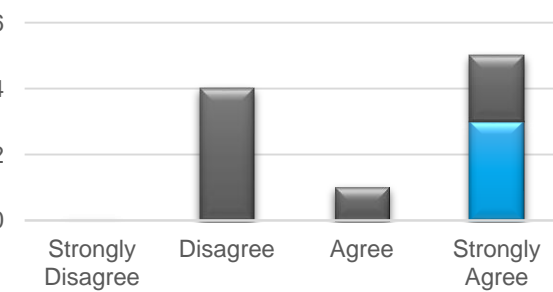
I was able to extend my knowledge regarding fermentation techniques by applying previously calculated feeding strategy.



In this course, I was able to contribute my ideas and suggestions during discussions and conduction of the experiment.



I learned new important techniques in this course.



- The implementation of dynamic feed calculation shows positive acceptance and percipience for the learning experience. Students showed agreement for better understanding of the 'influential factors' and 'key-parameters'.
- Students raised the wish to be able to contribute more own ideas and freedom in the design of the experiment.
- For students who have participated in the pervious practical course, a general repetition of applied techniques limited the outcome.
- There was a general lack of discussion and scientific analysis in the report and presentation, which is crucial for the research-based element of this project.

Project objectives

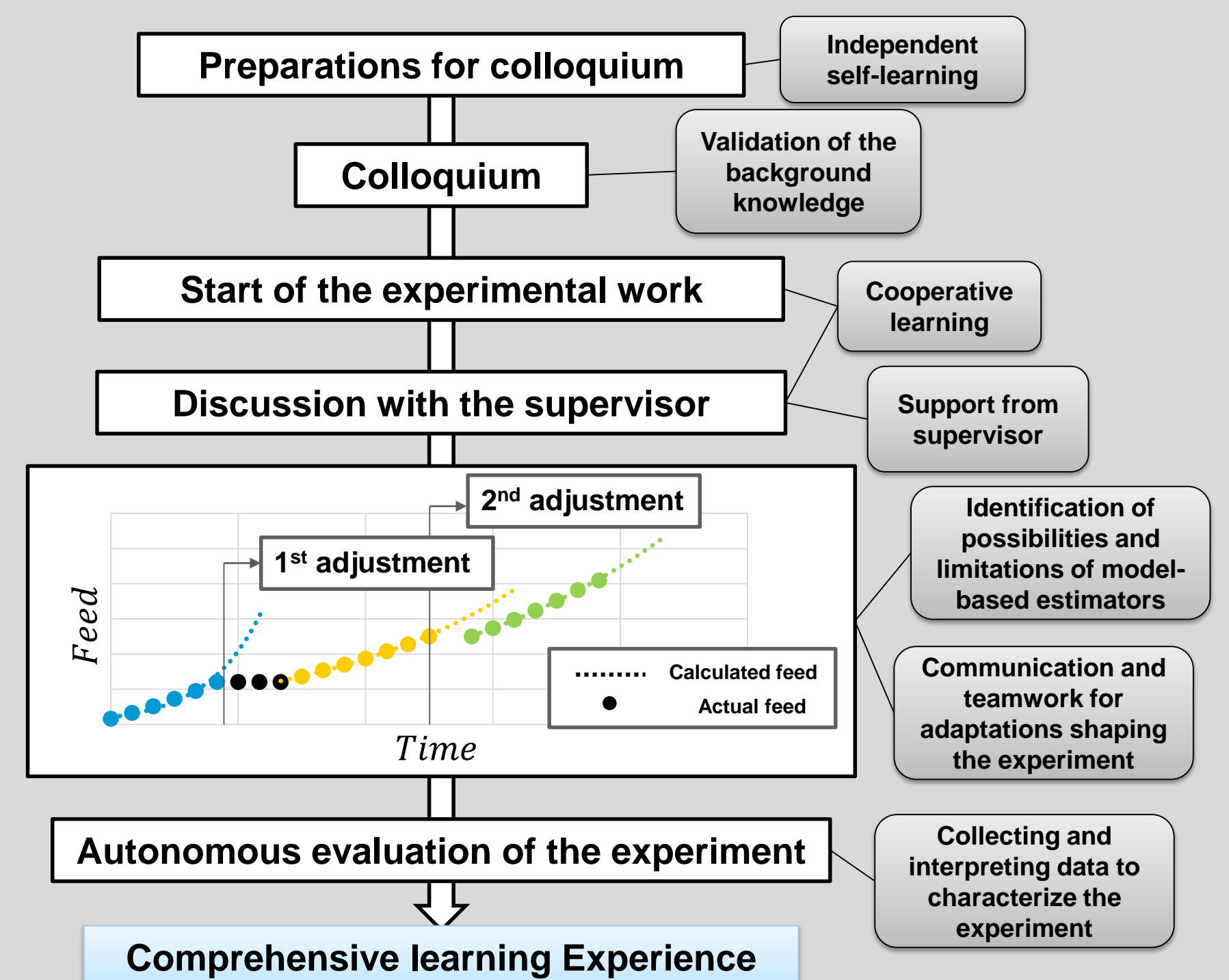
- Deeper understanding of process control
- Differences between theory and practical application [2]
- Active team assignment: decision making as process engineers [1]
- Reflection of decided process strategy after the analysis

Project implementation

- **Research-based element: Active design of dynamic feed for a fed-batch fermentation process**

Project procedure

1. Theoretical derivation of the feed calculation and required assumptions for application are described in the script.
2. After the first fermentation phase (batch fermentation) is initiated, supervisors and students discuss the required calculation for dynamic feed calculation.
3. With the initiation of the feeding-phase, data from sampling are to be analyzed and compared with the running process data and calculated estimations.
4. If a notable deviation between sampled data and the estimation is found, students adjust the dynamic feeding calculation by modifying the key parameters for the calculation.
5. After conducting the practical experiments, the participants present their results and reflect the application.



Side notes

- For the initial run, only the 'exponential feeding' was implemented. This project aims in the future to enable students to choose from a variety of different model-based feeding strategies.
- The previous feeding control guideline was given additionally as a fast analysis method.

Conclusion

- The implementation of dynamic feed calculation improved the research-based learning experience and team-based discussions.
- Variety of different 'feeding' strategies is to be extended. Thus, flexibility and possibilities of own contributions are to be increased.
- To improve the autonomous scientific and research-based aspects, more literature-based analysis and research are to be guided with more detailed instructions and support.

[1]: Cooper, Melanie M.; Kerns, Timothy S. (2006): *J. Chem. Educ.* 83 (9), p. 1356.

[2]: Russell, Cianán B.; Weaver, Gabriela C. (2011): *Chem. Educ. Res. Pract.* 12 (1), pp. 57–67.

[3]: Lewis, Scott E.; Lewis, Jennifer E. (2005): *J. Chem. Educ.* 82 (1), p. 135.

Contact Information:

Yaeseong Hong - Institute of Bioprocess and Biosystems Engineering
Hamburg University of Technology, Denickestr. 15, D-21073 Hamburg
Tel.: +49 (0)40 428 78 4401, E-mail.: yaeseong.hong@tuhh.de