11:07:24 From Ananth Raman to Everyone:

I love the term "tribal knowledge." It plays a crucial role in many contexts and one can expect that such "tribal knowledge" will give way to science.

11:09:56 From Ananth Raman to Everyone:

According to Google, "The global biotechnology market size was estimated at USD 1,023.92 billion in 2021 and is expected to grow at a compound annual growth rate (CAGR) of 13.9% from 2022 to 2030. Expected size $3 TRILLION in 2030." Is that right? I am surprised.

11:10:37 From ken fordyce to Everyone:

Merck is a great team - I got them to know them from coaching for Edelman 2022. An model for MS/OR. A match for wafer fabrication in complexity. Oscar will become the Karl Kempf of bio manufacturing.

11:14:35 From Ananth Raman to Everyone:

How clearly are these phases delineated? Can you identify these phases in practice?

11:15:29 From Tugce Martagan to Everyone:

Yes, you can identify these phases by measuring some critical process parameters.

11:21:06 From Ananth Raman to Everyone:

I suppose this raises a question; which parameter can we expect will remain stable (and which parameter will bot remain stable -- even when processes or materials are tweaked?

11:26:14 From Oscar Repping to Everyone:

Additional background info to put the difficulty of Biomanufacturing in perspective; Chemical synthesis; 100kg component A + 100kg component B = exaxtly 200kg of component AB...versus….Biological process; 100kg component A + 100kg component B = can everything between 10kg and 1000kg of component AB

11:32:41 From ns68@rice.edu to Everyone:

How does research in engineering, e.g., chemical engineering, relate to or differ from the work/future directions discussed here?

11:33:42 From Ananth Raman to Everyone:

Great question. I should let the experts answer but my understanding is "traditional" chemical engineering is less variable.

11:35:09 From Tugce Martagan to Everyone:

Most research in chemical engineering focus on the underlying biology/chemistry of these processes but there is a need for linking these cell-level models with operational trade-offs and business risks.

11:35:38 From Ananth Raman to Everyone:

Can the group talk about the organizational reaction? In other contexts, which have gone through similar transitions, the implementation challenges have been significant

11:37:50 From ns68@rice.edu to Everyone:

@Tugce: Thanks. Is there an opportunity for integrating cell-level and ops/decision-making models?

11:41:17 From Tugce Martagan to Everyone:

@ns68: yes, there is definitely a great opportunity for linking cell-level and ops/decision making models (especially under uncertainty, limited data, etc)

11:43:39 From Oscar Repping to Everyone:

That is correct @Ananth Raman. @ ns68; the used highly variable raw materials in combination with small differences in work execution (e.g. exposure time of an enzyme to the culture) and unknown biological factors (e.g. cytokine interactions) is significantly different than in the Chemical industry

12:04:05 From Amir Karimi to Everyone:

Thank you for sharing the insights.