Part 2: When Pigs Fly: A case study examining genetic engineering and synthetic biology

"As I was saying," Zach Buckley was on a roll now. He was waiving his fork like a sword and JoAnn and Peter were preparing to duck. "You biologists always say that it would be helpful for pigs to have wings—"

"It's clams." Peter muttered, knowing it didn't matter. "We usually say clams."

"OK, clams then. It would be great for clams to have wings but the genetic raw material isn't there. Darwin said evolution starts with variation. If the alleles aren't there, if the variety isn't there, if the raw material isn't there. What's evolution to do?"

"Right," said JoAnn Tessier, Zach's colleague in the Department of Biological Engineering and co-director of the proposed Synthetic Biology research center the University hoped to open. "We can do things that evolution can't!"

"Yeah, but should you? Look, I'm not just some guy reading a newspaper and I know that bacterial photographs and floating bacterial clumps are just proof of concept. And I know that color changing grass and terra-forming Mars with gourd houses aren't really on the to-do list but what have you done? I –"

"And who made headlines with the mouse with the human ear on its back?" JoAnn added before Zach took over.

"What have we done?" Zach was loud now, his face slightly red. "What about Keasling and his E. coli producing Arteminisin, or Church's work on biofuels, or replacing a stop codon or all the work on bacterial computing?"

"Those are great, but they really prove my point. You guys are tinkering with the genes and you don't even know how they operate."

"Maybe," said JoAnn, "But you use a computer and you don't know how a silicon chip works. We all make use of black boxes in our work. And many of our reporter devices are variations on the lac operon and the two component signal system. These are found in nature and are totally benign. Some of us do understand how they work but for others it's just a tool. They don't need to. Besides, the pharmacy industry has been giving out drugs without knowing the mechanism of action since the days of the shamans. Do you think those folks eating willow bark knew what a receptor or a prostaglandin was? We could wait for you to study this stuff to death but you know you just find new questions."

"OK, I get that. But how can you guys be so confident that you're not playing with fire. I really admire Keasling's and Church's work and, while I don't think Venter can say he actually synthesized a genome, you may be on the way to creating cells that truly are machines. But it's a long way off."

"Look, Peter, it may not be as far off as you think. And what are we supposed to do, wait for minimal cells before we do anything? The money is here now, the opportunity is here now. Obama's Bioethics Commission supported us. It's exciting to be part of the creation of a new field. Yeah, we don't just move genes around. We engineer them. We design them. And we are safe. SynBERC is always examining safety issues." Zach was calming down.

"Don't you think that's a bit condescending? A bit of hubris to say you don't just move genes around. You design them. Lots of time and genius went into that 'just.'" Now Peter was turning red.

"Condescending?" JoAnn blurted, "How often have physicists dismissed a problem as 'an engineering problem'? As if the only interesting thing is what happens in their head. Once they have the proof, let's leave it to the engineers. Time travel, it's possible, it's just an engineering problem. Come on. Yeah, we build things. But we also follow a design process just like your scientific method. Sometimes I think you guys are out to just satisfy your own curiosity. Without those trivial 'engineering problems', could science claim to help people?"

“Yeah, we’re always chauvinists for our field, I get that”, Peter said as he raised that eyebrow. “But what about all the DARPA money you guys take. Doesn’t that bother you?”

“Peter, we take any grant money we can get, just like you and everybody else. Besides, SynBio has potential to counteract terrorist attacks and what about using bacteria to help find landmines?”

“Right, terrorism.” Peter sat up higher in his chair. “Sure, you guys can engineer viruses to become lethal so we can learn how to neutralize that, but then you have to publish that research. Couldn’t terrorists use that for their own means? I’m all for research and being transparent, but I’m on the fence about that. I feel like we’re physicists prior to World War II.”

“Wow, Peter,” JoAnn said as she was wrapping up the second half of her sandwich to eat later, “it sounds like you are on the side of the people bothered by Mikey’s iGEM team.”

“No, I just have some concerns about you upstarts,” Peter said with a grin. “I know it is safe but I do have my questions. You’ve given me some things to think about and discuss with Mike. Hope it wasn’t too contentious.”

“What, you think we eat lunch with you because we like you?” said Zach as he tossed his brown bag into the recycling bin. “Actually, these are all things that we can expect to face at the City Council hearings on the SynBio center. Hey, tell Mikey I’ll try to stop by their next iGEM meeting. I think that they wanted help isolating a gene. He says it’s cooler when I help than when you do!”

Hmm, Peter thought. Maybe I’ll send an email to Mr. Kelly and direct him to some papers.

Questions:

1. How does synthetic biology differ from genetic engineering?
2. What are the goals of synthetic biology?
3. What are the steps of the engineering design process?
4. The discussion mentions several advances in synthetic biology. Research and briefly describe these.
5. Why is the military interested in synthetic biology?
6. How are synthetic biologists ensuring biosafety?
7. Are the rewards presented by synthetic biology worth the risk?

Some links:

http://www.bioethics.gov/ (President’s Commission)
http://www.time.com/time/magazine/article/0,9171,1997447,00.html (risks and reward of synthetic biology)
http://www.synbiosafe.eu/uploads///pdf/Our%20Synthetic%20Futures.pdf (next three links examine synbio)
http://allscienceconsidered.wordpress.com/2009/12/05/biobricking-and-the-future-of-synthetic-biology-2/
http://www.slate.com/articles/technology/future_tense/2011/02/faking_organisms.html
http://www.nytimes.com/2010/05/21/science/21cell.html
http://genomebiology.com/2010/11/6/124 (above two links are about Venter and synthetic cells)
http://www.newyorker.com/reporting/2009/09/28/090928fa_fact_specter (Keasling)
http://blogs.discovermagazine.com/notrocketscience/2012/02/09/hacking-the-genome-with-a-mage-and-a-cage-2/ (rewritten stop codon)
http://www.nytimes.com/2011/12/06/science/drew-endy-better-computing-for-the-things-we-care-about-most.html?_r=1&ref=science (bacterial computing)
http://www.sciencedaily.com/releases/2009/11/091116085053.htm (landmines)
http://www.lastwordonnothing.com/2011/12/05/synthetic-biology-and-weapons-of-war/
http://www.smartplanet.com/blog/science-scope/darpa-wants-synthetic-biology-to-be-fit-for-manufacturing/8748 (above two links are about synthetic biology and the military)
http://synberc.org/content/articles/risk-research-commentary (SynBERC statement on risk)