

Why Ag Engineers *May* Make Good Biological Engineers

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Biological engineering (BE) has a thousand definitions, but most understand it as a discipline that relates engineering problem-solving to or with living things. As a discipline, BE has a unique body of knowledge (a good working knowledge of biology) and its own methods (analogical systems approach, modeling, and black-box input-output relationships). BE falls into the class of engineering disciplines called science-based, similar to mechanical, electrical, or chemical engineering, which represents engineering based on particular sciences; studying these disciplines prepares the engineer for employment in many different types of jobs. The other class of engineering disciplines is applications-based. These are represented by mining, aerospace, biomedical, and other similar specialized engineering disciplines. Agricultural engineering (AE) is an applications-based engineering discipline.

There are certain expectations for BE (Johnson, 2011):

- Have knowledge of biological principles and generalizations that lead to useful products and processes.
- The ability to transfer information known about familiar living systems to those unfamiliar.
- The ability to avoid or mitigate unintended consequences of dealing with any living system.

In order to meet these expectations, BEs need:

- Thorough knowledge of engineering principles
- Thorough knowledge of biological principles and expectations (not usually taught in biological science courses)
- Broad systems viewpoint
- Appreciation for influences of environment on biological responses
- Expertise in some specialty
- Creativity, innovation, application ability
- Don't forget:
 - Humanities
 - Communications skills
 - Ability to work with others

Ag engineers have much of the knowledge and many of the skills and to make them good biological engineers. They have:

- Broad background, able to integrate sundry pieces of information.
- Appreciation for living things and their interactions.
- See agriculture as applied biology.
- Practical approaches.
- Many know modeling techniques.

But, there are impediments to the transformation of AE into BE:

- Not all of agriculture is biological.
- Not all ag engineers work in agriculture.
- Agriculture is only one part of biology.
- Ag engineers often lack general biology courses.
- Ag engineers often avoid psychology, human physiology and health care.

This last point probably represents the largest obstacle to the transformation of AE into BE. Ag engineering is an applications-based discipline, but BE is science based. To make the transition, AEs must learn how to become BEs. That means that they must see biology as a whole. No part of biology, whether it be genetics, ecology, psychology, or medicine, can be excluded from the domain of BEs because principles of biology apply at all levels and all applications. Indeed, many of the most basic advances in biology these days are coming from medical motivations. Biology is a whole and cannot be divided (Johnson, xxxx). We should not even try, if our eventual goal is to represent honestly the field of BE. Name changes are not enough, and even those societies with BE in their names (ASABE, IBE, SBE) each represent only part of the BE field.

There are many different possibilities for BE contributions. These include such far-ranging examples as:

- Constructed wetlands.
- Genetically modifying microbes to induce the intestine to produce insulin.
- Modeling movement of pathogens through soil.
- Entertainment Engineering to produce thrilling experiences, such as theme park rides and gymnastic theatrical shows.

Just as one electrical engineer is not expected to know everything about power distribution and semiconductor fabrication, so all BEs are not expected to know all about all possible applications of engineering to or with living things. However, the expectation can be that all BEs are familiar enough with the biological principles that govern each of these examples. In that way, new design possibilities can present themselves by transferring knowledge gained from one particular application to another. This is the way that the three expectations given previously can be achieved.

Agricultural engineers have a good foundation upon which to make the transition to biological engineers with agricultural areas of application. Nevertheless, some changes in knowledge and outlook are needed.

References:

Johnson, A.T., 2005, Biology Should Not Be Divided, *IBE Newsletter*, vol. 9.1 (spring).

Johnson, A.T. 2011, *Biology for Engineers*, CRC Taylor and Francis, Boca Raton, FL.