Two types of curiosity

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I believe there are two types of questions through which scientific curiosity expresses itself. The first, most obvious one, is the stuff of scientific heroes like Darwin or Einstein. These are the questions about the understanding of fundamental processes. What explains the diversity of insect species in the Amazon forest? What makes some tectonic plates drift apart at the staggering speed of 10 centimeters a year? How does the electrical wiring of the human heart work, or how did language evolve? All these are questions to us because we want to *know* something about the cause of phenomena and the forces that shape them. This is what I would call first order curiosity.

The other type of questions derives from the desire to *change* something. The *change* question is more directly driven by the desire to improve the world around us. How do plants protect themselves against insects by emitting chemical warning signals and can we use this to reduce pesticides? Can solar panels absorb more light and transform it efficiently into electricity? How are brain cells activated to improve our memories? This second order curiosity is of a different nature, profoundly experimental, often based on trial and error and not necessarily focused on grand theories. The results are no less spectacular to our daily lives: they have helped us to feed and clothe ourselves and created the freedom to express ourselves.

Sometimes the answers to these two sets of questions contain the same ingredients: understanding the functioning of the human heart also helps to prevent cardio-vascular disease. First and second order curiosity questions cut across disciplinary boundaries. The *knowledge* questions occur as frequently in the humanities as in the natural sciences, and, vice versa, the *change* questions are just as relevant to both. Of course, the difference between the two types of curiosity is more gradual than absolute. Perhaps the best way to capture the difference is to say that first order curiosity helps us to understand our place in the universe and second order curiosity helps us to deal with our human limitations.

It is mostly a personal choice, or coincidence or both, which makes one dedicate one's life more to one type of question or the other. As a student I chose one of the most applied scientific fields, the agricultural and food sciences, because I wanted change. With all the naiveté of a young adolescent I threw myself into a subject which, I hoped, would allow me to make a difference to world hunger. I spent the subsequent years on very practical work around typical second order questions: how to increase the production of the crops on poor soils, how to preserve seeds or reduce food losses. But as the years flew by, my interests shifted gradually. Today, I still want to make a difference and help to feed the world. But I am also fascinated by true first order questions, to understand what agriculture means to human evolution. This started with the work I undertook on how human land use contributes to patterns of global and climate change.

What I find most challenging now is the peculiar combination of the two types of curiosity. I am ever more interested in the mental tools that are necessary to understand what shapes the future and how we can change it. In my field, one of the most important one of these tools is the concept of closing chemical cycles. This sounds more mysterious than it is. Just think for a minute of our most common daily food, our bread. Each slice of bread contains nutrients, such as minerals and proteins. These nutrients come from soils, manure, fertilizer or from the air. Most of these are lost in the process of producing food: an atom of nitrogen or phosphate from fertilizer may never reach the wheat plant, or get lost in the process of separating the individual wheat grain from the bran or be excreted by humans. In other words, we continuously lose valuable nutrients from the process of food production. However, there is no reason why we cannot retrieve them and reuse them, either as source of energy (the case of cellulose of the cell walls), or to reintroduce them in the process. There are even ways of using discarded bran as a new source of protein for humans or animals. The possibilities are nearly endless.

What truly engages my curiosity here are not the technicalities in themselves, however impressive the engineering, nor the theory, but the mental shift needed to conceive of a completely different way of looking at things. Not as a linear process of inputs (seeds, fertilizers) and outputs (bread), but as an endlessly revolving cycle where waste becomes an ingredient for new applications. We knew some of this from ecology, but until recently we did not think of applying these principles to human made systems. Reformulating our world in this new way makes it more understandable and at the same time more manageable. And it feeds my curiosity to imagine what the next grand concept will be.