Scientists tend to superspecialize—but there are ways they can change

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If scientists' knowledge is segregated in non-overlapping silos, there can't be cross-pollination between fields. Credit: Doc Searls, CC BY

Crossing disciplinary boundaries is unusual – and crucially important. In 1998, groundbreaking thinker and eminent biologist EO Wilson cautioned against scientific overspecialization, warning that thought silos "…must be torn down in order for humanity to progress." Sociobiologist Rebecca Costa argued in 2010 that "the more fortified and numerous silos become, the further away humankind strays from a unified,

systemic approach to our greatest threats."

The big problems we face today demand interdisciplinary innovation. Look no further than the international climate talks in Paris for an example of an issue that must be approached by individuals with deep disciplinary expertise but also from an interdisciplinary perspective. Big ideas come from understanding the big picture and making cross-boundary connections, not only from eking out incremental advances in an esoteric subfield.

Not surprisingly, universities, research organizations and funding agencies of all stripes – keenly aware of the enormous potential of cross-disciplinary collaboration – enthusiastically tout their support for all things interdisciplinary. Think of nanotechnology, which draws on physics, biology and chemistry. Or disease control efforts that rely on public health officials, behavioral scientists, biostatisticians and epidemiologists.

Deep and broad research approaches both have advantages and disadvantages. So why do people in different scientific specialties so rarely engage in meaningful collaborative projects? My collaborator Andrew Hess and I recently investigated scientists' goals and work styles with an eye toward the depth versus breadth of their research output.

Sure it's structural, but people *can* choose

Amidst the calls for boundary-spanning collaboration, the fact is that most scientists work within institutional and professional contexts that overwhelmingly favor and reward deep specialization. Consider the names of departments and journals, how communications flow within rather than across unit boundaries, and how pay and grant monies are allocated. For some, the word "generalist" is pejorative, but collaborating across disciplines does not need to be a bad thing. In fact, in one survey

of faculty, 70% agreed with the value of cross-disciplinary work.

Beyond structural determinants, what are the personal drivers that shape the depth versus breadth of researchers' professional output? While investigating this question, Andrew Hess and I defined deep research as that which adds to our knowledge in highly specialized ways. We defined broad research as that which spans a greater variety of topics.

How our researchers rated depth versus breadth

What do funders value in grant proposals? Credit: Ohio Sea Grant, CC BY-NC

In our first study, we provided medical researchers with descriptions of two hypothetical studies. One was deeply specialized; the other was broad and boundary-spanning. Both had relevance to the participants' expertise, and we said they were fully funded. We asked them to rate the attractiveness of the two studies along dimensions including risk, significance of opportunity, potential importance and so on.

The results were clear: all else being equal, the broader study was seen as representing a riskier and less significant opportunity, of lower potential import. Respondents were less likely to follow up on the interdisciplinary research. Forced to choose, two-thirds of the researchers said they'd pursue the deeper over the broader study.

Fundamentally, these scientists saw boundary-crossing research as offering high levels of professional risk with low rewards and only meager professional returns.

Output reflects mindset

In the next study, we collected questionnaire data from 466 medical researchers about their goals and outlooks. Then we compared their responses with archival data that allowed us to objectively assess the depth and breadth of their 10-year publication portfolios. The questionnaires provided useful insights into key work-related behaviors and attitudes, including such traits as competitiveness and conscientiousness.

We were able to relate the researchers' behaviors and mindsets, as reflected in their questionnaire scores, to the breadth and depth of their published research. It turned out that researchers' goals predicted the depth versus the breadth of their publication portfolios.

Researchers who were strongly motivated to demonstrate high

performance (*performance goal orientation*) exhibited more depth over a decade of research, but not more breadth. The opposite – more breadth, and not more depth – held for those who reported great interest in trying and learning new things, even if doing so would prove costly in terms of time and professional advancement (high *learning goal orientation*).

How much impact can research have if it's just an incremental advance in a super-specific discipline? Credit: U.S. Army Africa, CC BY

This finding makes sense when you consider that performance is often judged by publications in highly specialized journals that advance

knowledge in a researcher's specific subfield. One would have to be driven to learn new things, perhaps at significant cost, in order to willingly buck the expectation and go for a broader approach that isn't often rewarded. Research doesn't happen by structural fiat; it's also driven by what the individual scientist finds intrinsically appealing and rewarding.

Our scientist participants also differed in the extent to which they focused their efforts on exploiting their current knowledge versus exploring for new knowledge. By default, scientists tend to capitalize on existing specialized expertise.

Management theory and research make it clear that individuals and organizations both tend to favor the safer exploitation of current knowledge over exploration. All else equal, it's more efficient and less frustrating to refine a previous finding. It's tough to shift gears and investigate an altogether new question on a different topic requiring new learning, and likely mistakes, along a longer path to a publication. The unintended result, of course, is that the potential boundary-pushing benefits of exploration remain unrealized.

Ready for a change

Here's an important point, with big implications: the behaviors we observed are not necessarily indicative of deeply ingrained personality traits. They're just styles of work that can be changed if individuals choose to change them. Once scientists become aware of what their tendencies are, they can start to think strategically about how they might alter them. By changing how they allocate time, effort and resources, researchers can strive for greater breadth (or depth) in future projects.

Some companies – including Apple, Unilever and the Cleveland Clinic – work hard to break down silo thinking and want their professionals and

managers to be "T-shaped." The vertical in the T is a specialty. The crossbar represents knowledge of other specialties, and/or, crucially, experience and skills in working creatively and effectively with people in different areas. For example, researchers Uhlenbrook and de Jong describe T-shaped competency profiles using water professionals – hydrologists, hydraulic engineers, land use specialist, water economists and water governance experts – who all need to collaborate, valuing each other's expertise and willingly crossing subspecialty borders.

Our study looked at individual research behaviors and output. But the implications of those individual actions are nothing short of global. The tremendous value of research characterized by finely honed specialization and depth is undeniable. But as global events – including the climate change talks in Paris – daily remind us, it's only through effective collaboration and meaningful disciplinary boundary crossing that we will find solutions to the massive and complex challenges facing the world today.

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