Building Bridges Between Academia and Industry: 
Forms; Foundations; Functions
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INTRODUCTION

The opening of a new medical research facility is, by definition, a tangible expression of progress, and a visible demonstration of continuing, firm dedication to medical science. In this particular instance, celebrating 75 years of pediatrics at Yale, we are afforded a welcome opportunity to address a broad question raised often by those whose entire careers have been devoted to or are likely to be devoted to academic medicine.

The question — what is the world of medical science like for those based in the often frenetic, sometimes tumultuous pharmaceutical industry — can be answered in a number of ways. The “sound bite” answer is that it is a very different world, ferociously competitive — even dog eat dog (which of course contrasts so sharply with academia where it is just the opposite). Our less flippant response will focus on the nature and importance of bridges connecting two of the three key players in our country’s medical research enterprise: academia and industry. The third key player is, of course, government in its many forms and functions.

COMPARING AND CONTRASTING RESEARCH IN ACADEMIA AND INDUSTRY

To understand more clearly the scientific goals, methods and culture of the industrial side of the medical research bridge, a few vital statistics concerning two organizations, Yale School of Medicine (YSM)\(^b\) and Bristol-Myers Squibb (BMS), are illustrative of today’s large academic and large pharmaceutical research organizations. In the most recent year BMS spent nearly four times as many dollars on research and development overall as did YSM (Table 1). These dollar values are not fully comparable because YSM’s number does not include research funds sponsored by clinical departments through their faculty practices. That degree of imprecision aside, it is safe to conclude that YSM and the BMS Pharmaceutical Research Institute are in the top tier of their respective kinds of institutions with respect to financial participation in research. Manpower dedicated to the scientific endeavor doesn’t differ significantly between the two institutions but the related expenditures do — reflecting the lower stipends paid to the much larger fraction of junior participants (students; postdoctoral fellows) at YSM.

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\(^{b}\) Abbreviations: YSM, Yale University School of Medicine; BMS, Bristol-Myers Squibb Company.
Table 1. Vital statistics.

| Yale University School of Medicine 1995-1996 | Bristol-Myers Squibb Pharmaceutical Research Institute 1996 |
|--------------------------------------------|-------------------------------------------------------------|
| Research and Training: $215 million         | Research and Development: $800 million                      |
| Faculty, Research and Training Staff: 3,000 | Scientific and Administrative Staff: 3,600                  |
| Major Site: New Haven                      | Four major U.S. sites, linked to a network of smaller sites worldwide: Princeton, NJ (Headquarters); Wallingford, CT; New Brunswick, NJ; Seattle, WA |

Another key difference between these institutions is in single versus multiple research sites. Conducting all research at a single site provides YSM a major advantage when compared with the significant obstacles posed by BMS' multiple site network. Foremost among these obstacles are those pertaining to communication and collaboration—cultural traits that YSM is justifiably famous for. Working together over long distances complicates all parts of the research and development organization at BMS. It is particularly challenging for the Drug Discovery Division, that part of the pharmaceutical research institute most like the basic science departments in academia, and comprising more than 1000 people and about 75 percent of the discovery research budget. This critical group is spread over three sites (Princeton NJ, Wallingford CT, and Seattle WA). Its internal efforts are bolstered by three categories of external collaborators: large academic alliances; small academic collaborations; and various sized relationships with biotechnology companies. This global array now includes more than 10 academic alliances, 60 smaller targeted technology and single investigator agreements and 10 highly focused arrangements with biotechnology companies.

Closer examination of these two representative, leading edge academic and industrial institutions suggests research cultures that are distinct, complementary and, sometimes, convergent. We think there are five important dimensions which must be understood if alliances between these natural allies are to flourish:

The principal goals are critically different. For academia these are well known: the acquisition and dissemination of new information; the education of the next generation of medical researchers. Pharmaceutical research and development, on the other hand, has one overarching goal — the design, discovery, and development of new medicines. Acquiring proprietary rights through patents and licenses is a secondary, related goal. Further, dissemination of knowledge from basic as well as applied science is an important goal — in common with that of academia.

The organizational characters are distinct — as would be expected given the goals just described. The academic setting is noted for the independence and the autonomy of the individual investigator in initiating research efforts which are highly decentralized and usually quite discipline oriented. In industry research efforts and priorities are delineated, not by individual investigator preferences, but rather by a more centralized discovery and development program aimed at specific disease targets notable for unmet medical need and commercial opportunity.

The planning modes differ in important ways as well. In academia, research planning is a responsibility clearly delegated to the principal investigator and episodically tied to
cycles of funding. In industry, planning is a continuous undertaking with responsibility for strategic program planning seated at the highest levels of the research organization and fed from its subunits with their therapeutic area emphasis. The industry planning process is continuous and inextricably linked to the budget process.

The funding for research programs is similarly distinct. In academia, the sources are invariably multiple — NIH, NSF, VA, HHMI, foundations, voluntary health agencies. In industry the source is invariably a single one, the business itself, reflecting the investment top management considers appropriate given the state of the business. In industry, research funding and business strategy are closely linked. In academia, success in securing funding defines the scope and scale of the efforts.

Not surprisingly, the principal interactions of academic and industrial medical research organizations with the federal government differ substantively. The academic organization has, for many decades, looked beseechingly to a variably responsive government for financial sponsorship of its work. In turn, it provides the expertise for the peer review process that effectively sets the research agenda in the institutions receiving funding. For the pharmaceutical company's research organization, relationships with the federal government are primarily and continuously linked to the regulatory oversight function of the FDA. Our personal experiences tell us that academia's relationship with NIH and other federal sponsors is more often characterized by advocacy, whereas FDA's relationship with the pharmaceutical industry is, by its very nature, legalistic and often adversarial. For completeness, it is important to point out industry's involvement with government through participation in cooperative research and development agreements and in the peer review process.

While the differences in the two research cultures are real — even formidable — considerable progress has occurred over the last two decades in recognizing their respective merits and building bridges.

THE BRIDGE BETWEEN ACADEMIA AND INDUSTRY

How are connections to be made between these institutions, so long separated by prejudice and misunderstanding as well as by fundamental purpose? To address this, we'll consider a metaphoric bridge with three structural elements: foundations; forms; and functions

Table 2: Building the bridge between academia and industry.

| Key Foundations:          |
|---------------------------|
| • New biological knowledge and resulting commercial opportunity – the “endless frontier.” |
| • Interdependent Expectations: |
|   – Academia expected to produce research that can be translated into products for diagnosis and therapy. |
|   – Industry expected to apply new knowledge to product development. |
| • Interdependent Needs: |
|   – Availability of continuously fresh scientific expertise. |
| • Durability of Relationships: |
|   – Openness of communication |
|   – Respect for proprietary concerns |
|   – Agreed upon ownership of intellectual property rights |
|   – Funding to fuel the effort |
|   – Due diligence in commercializing inventions |
|   – Sharing the rewards of success |
Table 2 suggests the key elements of the foundation that are necessary for a bridge between the two cultures — elements which permit the structure to be built and to endure. The sharing of an "endless frontier" view of science (as described by Vannevar Bush) is the most basic ingredient. This element cannot suffice in the absence of acknowledgment by the parties involved that their expectations and needs are and must remain interdependent throughout a relationship whether short-term and highly focused or longer term and of broader scope. The durability of an effective bridge must be continuously tested against the openness of communication achieved, against the need to respect proprietary concerns of the industrial party, against the agreements reached concerning ownership of intellectual property and those articulating the flow of funds for the effort. Ultimately, for the bridge to remain viable, there must be inventions to commercialize and rewards to be shared therefrom.

The characteristic forms of the bridge follow from the foundation "stones" just described. The most common, and some would say the most successful, form is represented by an industrial research contract with an individual academic investigator. These are aimed at focused acquisition of targets or technologies. Closely allied are the somewhat more broad-based agreements with one or a group of academic investigators aimed at a single therapeutic area. Quite straightforward arrangements govern industry's purchase of exclusive and non-exclusive technology licenses with varying royalty provisions and the traditional employment of academic consultants who serve on a retainer basis. Less frequent, and to date less successful in meeting the interdependent expectations and needs of the parties, have been the large "umbrella" agreements with an academic institution covering multiple investigators and/or targets. Historically general in scope, such agreements are often: less easily understood by the working scientists in the participating organizations; more difficult to oversee; and seen as too unrestricted to provide value to the industrial partner.

Figure 1: Academia/Industry Cooperation.
The third structural element of our metaphoric bridge pertains to the key functions that the bridge subtends. In our view the following four key functions are essential:

- To emphasize continuously that improving the health of the public is the overarch-
ing goal of the country’s medical research enterprise;
- To bring to the public the specific “fruits” of the nation’s investment in medical research by accelerating progress in identifying and developing solutions to important medical problems;
- To replenish society’s intellectual capital, i.e. the human pipeline, of the medical research enterprise;
- To permit academic investigators and institutions to share equitably in the financial rewards of their discoveries.

**YALE AND BMS: A CONTEMPORARY EXAMPLE**

From the numerous academic/industrial collaborations the authors have worked with, and from review of the considerable literature available concerning specific arrangements, one bridge involving YSM and BMS is a shining success. Figure 1 depicts this particular “span.” Building on successful negotiation, this cooperation focused squarely on the common goal of improving health, in this instance improving antiviral therapy for patients with HIV. It recognized the differences between the partners and maximized their respective contributions. At one end, YSM contributed its expertise in antiviral and infectious disease research; at the other end, BMS provided its antiviral research and development expertise. Linked by patents and license agreements, the industrial partner developed and secured broad geographic approval for a new HIV reverse transcriptase inhibitor effective in adults and children — d4T (Zerit). This medication is being widely used as part of the two and three drug combinations that are changing the outlook for patients with AIDS.

It took more than 15 years for YSM and BMS to build, travel, and maintain this bridge. It involved risk, uncertainty, debate, patience and trust. This particular bridge epitomizes the best in American medical research — creative basic science, effective technology transfer, committed industrial capability. More than a dream, successful academic/industrial cooperation may truly be the next critical frontier for our country’s and the world’s medical research enterprises.

**CONCLUSION**

As the Yale Children’s Hospital Research Center opens, we see a strong parallel for it and the metaphoric bridge we have been discussing. The new Center is a jewel in Yale’s crown; a site where intellectual strength and fine facilities meld to support one of academia’s premier departments of Pediatrics. The Center will be a home for the discovery of fundamental knowledge which, hopefully will bridge, with industry’s participation, to preventive, diagnostic or therapeutic modalities aimed toward improving the present and future health of our country’s most precious resource — its children.