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Perspective

Socially Responsible Licensing, Euclidean Innovation, and the Valley of Death

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I. FOREWORD

> "For many of today's technologies…new products require a variety of skills, more than available in any single firm. Hence, there is a need for strategic alliances and innovative licensing arrangements in order to produce a product. To make these efforts work, it is important to facilitate cooperative research efforts between firms and research entities of different nations."

John Barton, Professor, Stanford Law School.[1]

> "Energy, climate and all the things that are associated with them—water, food, poverty—are going to be the defining issues of the coming century…How do we get research done and out in areas that don't have immediate profit drivers? Well, we faced that in health care with…neglected diseases. And we succeeded via

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[1] ICTSD PROGRAMME ON INTELLECTUAL PROPERTY RIGHTS AND SUSTAINABLE DEVELOPMENT, NEW TRENDS IN TECHNOLOGY TRANSFER 22 (2007).

> something that we've pioneered called socially responsible licensing."

Graham Fleming, Vice Chancellor for Research, University of California, Berkeley.[2]

> "A new type of thinking is essential...[T]he human race...finds itself in a new habitat to which it must adapt its thinking."

Albert Einstein.[3]

A decade into the 21st Century, tremendous global inequalities persist. The equity aspects of global development, perhaps most poignantly as regards access to health care and clean energy, ultimately affect us all.

In April 2010, Stanford Law School honored the contributions and legacy of Professor John Barton.[4] Professor Barton inspired a generation of scholars and practitioners to innovate at the intersection of science and law to address such profound disparities.

The University of California at Berkeley ("UC Berkeley"), publicly-supported and with social impact part of its mission, approaches intellectual property ("IP") management and research collaborations very much in this spirit, recognizing that both the power and the responsibility to improve the outlook for such global issues extend beyond public institutions.

II. INTRODUCTION

This paper reviews perspectives gained through UC Berkeley's Socially Responsible IP Management and Licensing Program ("SRLP") program, which promotes solutions to critical needs in the developing world, including by stimulating outside investments, to maximize the societal benefits of UC Berkeley research.[5] Addressing such challenges requires capitalizing on opportunities to mobilize the right resources and players, at appropriate times and in practicable ways, toward shared goals. Our key starting principles: effective collaborations and other forms of multi-party cooperation must build on and preserve appropriate incentives and outcomes for each participant; creative and adaptive collaboration structures often produce valuable results in faster, more iterative, and non-linear ways than traditional models of technology transfer and licensing; and real-time sharing of data, materials and reports requires paradigm shifts on the part of collaborators, both at the institutional and academic levels.

UC Berkeley's work with innovative IP management and collaboration models

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[2] Opening and closing remarks at the Philomathia Foundation Symposium on Climate and Energy (Oct. 1, 2010).

[3] *The Real Problem is in the Hearts of Men*, NEW YORK TIMES SUNDAY MAGAZINE, Jun. 23, 1946.

[4] George E. Osborne Professor of Law, Emeritus, Stanford Law School (b. 1936 – d. 2009).

[5] SRLP is a program of UC Berkeley's Intellectual Property and Industry Research Alliances office ("IPIRA"). *See Socially Responsible IP Management*, IPIRA, http://ipira.berkeley.edu/socially-responsible-ip-management (last visited Sept. 15, 2011).

through SRLP helps bridge financial gaps to deployment of new technologies, with socially- and environmentally-desirable impacts. In certain fields such gaps are particularly wide, reflecting, for example, long research and development ("R&D") timelines, substantial required investments, and regulatory hurdles prior to commercialization. Crossing such "Valleys of Death" requires creatively and carefully combining inputs, outputs, components, and participants.

Multi-party alliances and collaborations can lower future transaction costs and other barriers to transactions that ultimately catalyze commercial outcomes. By crafting solutions to problems in novel ways, with the university as a continuing player, we are building a repository of tools and methodologies with respect to IP rights, goals, incentives, and rewards. Clearly, there are no universal, one-size-fits-all approaches to structuring such innovative collaborations. But reviewing a subset of deal structures and IP management strategies from SRLP's experience may provide useful general insights and models for future use. Strategies that allow the university to stay involved longer into the translational and applied research space, without compromising its mission and goals, have relevance to several research fields and industries. Thus, the creation, analysis, and improvement of such "model pathways" helps not only to attract and advance high impact projects, but also to inform broader discussions on paths forward to address pressing global challenges.

Technology research, development, and commercial deployment are typically depicted in linear sequence, along the following lines:

discovery → development → translation

with the attendant categories of:

basic research → applied research → commercial R&D → commercial deployment.

Traversing funding gaps requires dispelling the notion that innovation follows a linear road. We find that productive research and development collaborations often take place both in sequence and in parallel, and with robust feedback mechanisms integral to both design and practice—more of a series of U-turns, switch backs, forked paths and potholes to be navigated simultaneously by several drivers. Our work charting out model pathways for multi-party business models and corresponding IP management strategies often evokes higher-order geometric shapes. Thus, one of us whimsically uses the term "Euclidean innovation" to help envision ways of creatively designing collaborations and transaction structures. At the intersection of science, law, business, politics, and international diplomacy, solutions of every shape and size are needed.

III. ADDRESSING UNMET NEEDS THROUGH IP MANAGEMENT, COLLABORATIONS, AND NEW BUSINESS MODELS

A. Spanning Funding Gaps with Private-Public Partnerships

The world faces persistent challenges with regard to projects that require

substantial investment to address the needs of the economically disadvantaged. Such projects may target food and agriculture, neglected diseases, and climate and energy, among many others. Catalyzing follow-on investments in innovative research projects is no small feat in any setting. Commercializing innovative products and services in ways that are accessible to the world's poor is even more of a challenge. Addressing such challenges often requires creatively aligning incentives among multiple parties to simultaneously promote profit opportunities while finding ways to meet needs not met through the market alone.

SRLP, with its goal of deploying IP rights in a socially responsible manner, strives to make widely available the benefits of emerging technologies and associated services, including to the worlds' poorest.[6] Addressing both market and non-market factors in collaboration design and licensing contracts also often involves identifying and protecting commercial opportunities for for-profit participants, even in light of the risks and costs of product development, regulatory affairs, manufacture and distribution, and the like.

Solutions to these challenges may be found through multi-party collaborations, particularly with so-called private-public partnerships ("PPPs") and a particular sub-species, product development partnerships ("PDPs"). PPPs are organizations that combine resources and activities of private and public or charitable entities to accomplish specific goals aligned with the missions of each participant. PPPs and their networks may play an essential role in bridging translational research gaps, especially in areas where R&D time frames are long and required investments large.

Moving projects from pure discovery into the applied or translational phases of innovation improves their risk:reward ratio, making commercial uptake and investment more likely. That in turn can catalyze other forms of investment as well. Without PPP/PDPs' financial and practical participation, much university research with promise to address the needs of the poor would remain on the basic research side of this Valley of Death, without the means to traverse it. University collaborations with PPPs/PDPs advance and add value to early-stage academic projects. A key insight as to translational innovation under the PPP/PDP collaboration model is that *timelines are compressed through processes that proceed in parallel, coordinated fashion, as opposed to in sequence*.

In drug development for neglected diseases, for example, PDPs may forge partnerships both up and down the value chain of drug development. They partner upstream with universities on drug discovery and initial development, and downstream with pharmaceutical companies on further development and/or deployment. In doing so PDPs bridge crucial middle ground in terms of translating discoveries into products. Whereas universities receive much of their research funding from public agencies and primarily produce basic research results, PDPs add value to collaborative research projects by performing R&D, providing drug development and regulatory expertise, and by leveraging their resources and those of their partners to fund university projects. PDPs have funded personnel, equipment, and research tools for research, often in the more

[6] In UC Berkeley's relevant license and research agreements, "economically disadvantaged countries" are defined in a number of ways including: "low and middle income countries" as defined by the World Bank, "less developed" or "least developed" as defined by the United Nations, or by naming the countries (such as "all countries except for the U.S., Japan, Canada, Australia and Europe").

applied, translational space, and has enabled universities to obtain follow-on research grants.[7]

Below are a few examples from experiences within the SRLP at UC Berkeley: two projects addressing crop improvement through agricultural biotechnology, and one advancing development of a malaria therapy.[8]

B. Pesticide-Free Solanaceous Crops

Crop disease can cause massive failures in agriculture. For subsistence farmers and in small-scale agriculture, durable resistance to crop disease can tip the balance between scarcity and plenty, with attendant consequences for those who rely on these crops to survive.

Large, non-organic industrialized agricultural approaches to plant disease resistance often rely on topically applied herbicides and pesticides. Crops that harbor and express inherent resistance to plant disease can be grown without application of such chemicals. But the traits that confer resistance to infection must be cultivated and managed for their effects to be robust and long-lasting.

Two Blades Foundation ("Two Blades") enables, cultivates, and deploys improved crops through stewardship of durable disease-resistance traits. Its stewardship in this area of agricultural biotechnology pertaining to "input traits" is necessary to ensure that the trait is not diminished by overuse, disuse, or inappropriate deployment. Other disease-resistant traits have been destroyed or weakened and ultimately not expressed in the plant through overuse.[9] This fate can be avoided under Two Blade's research management and deployment strategies. Without such stewardship the beneficial traits either would not be commercialized at all, or would not be distributed to small-holder farmers and small agri-businesses.

UC Berkeley and Two Blades have collaborated to conduct research on disease resistance, which will ultimately benefit growers in developing (and developed) nations. The essential elements of this collaboration involve long-term funding for basic research at the university from the following sources: a charitable foundation, a license back to the foundation, and a bifurcated commercialization strategy that provides pesticide-free solanaceous crops, such as tomatoes and peppers for Subharan Africa at cost, that are subsidized by sales in for-profit markets such as the United States. The foundation then continues to fund follow-on research at the university—in parallel with its own research in-house—with revenues from commercialization, its endowment, and partnering. While the products are based on an exclusive license to a single entity, the market is served by the licensee acting in several market niches with multiple goals.

IP contracts include restrictions on both UC Berkeley as the licensor and the

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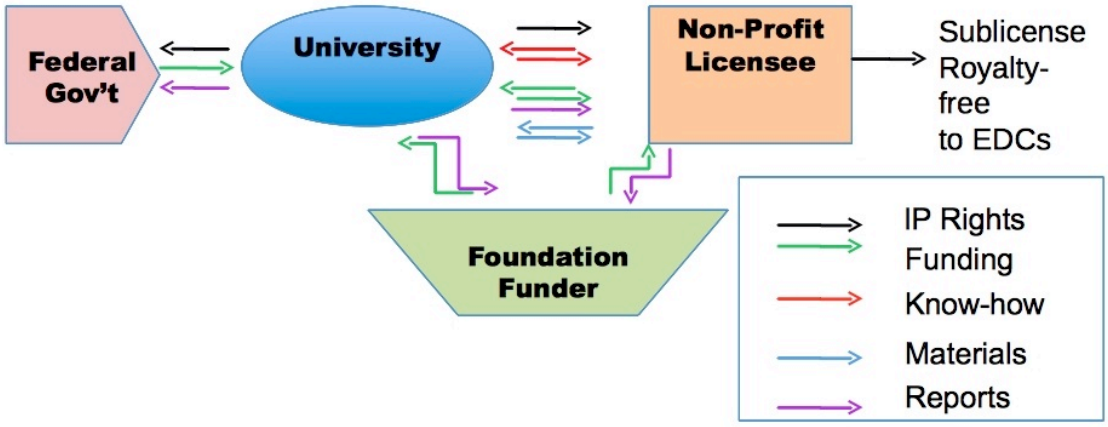
[7] University spin-off or startup companies and biotech companies also focus on translation, but they are usually for-profit entities.

[8] Examples of PDPs in the health field include: the TB Alliance, Aeras Global TB Vaccine Foundation, the Drugs for Neglected Diseases Institute (DNDi), the Global Alliance for Vaccines Initiative (GAVI), the International Partnership for Microbicides, Medicines for Malaria Venture (MMV), the International Aids Vaccines Initiative (IAVI), the Institute For One World Health, the International Vaccines Initiative, PATH Malaria Vaccine Initiative, the Innovative Vector Control Consortium, and others.

[9] For example, genetically engineered wheat rust resistance-conferring traits are durable for only 2-3 years before they become ineffective.

foundation as the licensee. Most of the restrictions reflect SRLP's social impact goals and the foundation's charitable objectives, contemplating sales and distributions in developing country markets "at cost" to be funded, in part, by profits from sales in industrialized markets.[10]



C. Bio-Fortified Sorghum

A second PPP collaboration targets the creation of a fortified staple crop. Existing strains of sorghum can be cultivated in dry, hot climates and on poor soils, but are not very nutritious due to low levels of vitamins and minerals. They are also difficult to digest, especially when cooked. An estimated 500 million people in developing countries rely on sorghum as a primary food source, more than half in Africa. The objective of the project is to improve nutrition and health of people in the arid and semi-arid tropics. Africa Harvest Biotechnology Foundation International ("AHBFI") is a non-profit organization dedicated to fighting hunger and poverty in Africa. AHBFI received a grant from the Gates Foundation to develop enhanced, bio-fortified sorghum to alleviate hunger and nutritional deficiency in dry climates, with an emphasis on sub-Saharan Africa.

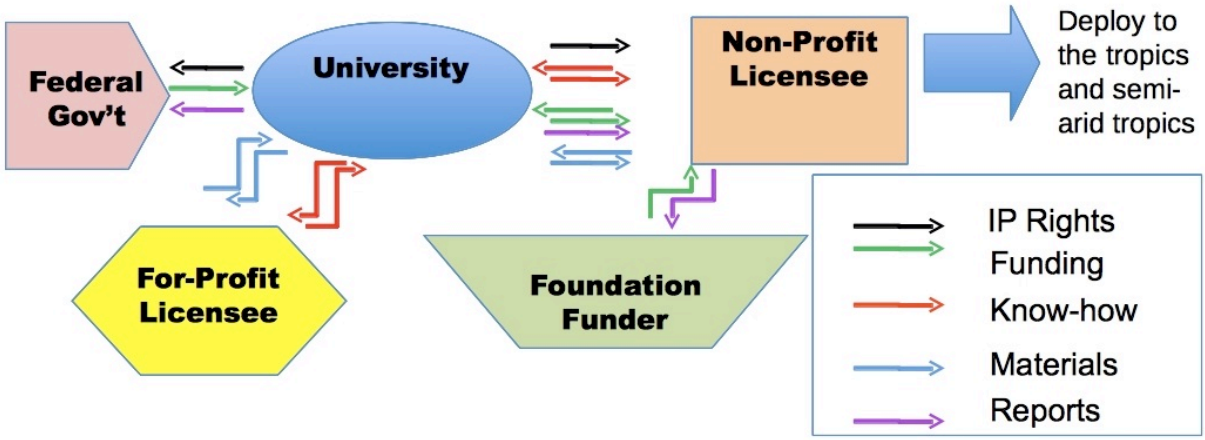
UC Berkeley is one of several collaborators, together with other research universities and two agricultural biotechnology companies. UC Berkeley received funding from AHBFI through a sub-award to support its research contribution to the project, which focuses on making bio-fortified sorghum more digestible to humans. This work focuses on breaking disulfide bonds of plant storage proteins in sorghum grain. In return, UC Berkeley granted to AHBFI a non-exclusive, royalty free license to IP developed with the funding, as well as a license to related research materials. The licenses allow AHBFI ultimately to sell or distribute bio-fortified sorghum (or to allow

[10] For example, distribution is expected to be funded in part by sales from the large tomato market in Florida, which as of 2003 was producing about 40% of the tomato crop for the U.S. market. United States Department of Agriculture, Economic Research Service, *Greenhouse Tomatoes Change the Dynamics of the North American Fresh Tomato Industry*, ERR-2, at 52, *available at* http://www.ers.usda.gov/publications/err2/err2g.pdf.

sublicensees to do so). The improved "Africa Biofortified Sorghum" varieties will provide more protein, vitamins, and minerals to consumers than existing strains, and the enhanced nutrients will be more "bio-available" to humans.

The license is restricted by a defined field-of-use and, by extension, the charitable objective. UC Berkeley granted the free license prospectively, in advance of IP being created in the collaboration. This approach, and the collaboration structure, preserve incentives so as to induce funding, research, and development by each party as appropriate. The collaboration includes both for-profit and nonprofit participants, aligning goals for all parties. The collaboration also recognizes that, in certain regions, commercial brokers or other intermediaries represent the best mechanism to distribute seed with improved traits, and strives to overcome traditional barriers to participation by commercial entities. For example, AHBFI's breeder partners in Kenya, Egypt, South Africa and Burkina Faso were provided with sorghum engineered with traits developed at Berkeley (and elsewhere), in order to introgress traits (through cross-breeding, or genetic hybridization and repeated back-crossing) into varieties of local interest and then provide the resultant seed to local farmers.

A number of related agreements pertaining to the transfer and use of research tools, IP rights, and materials were needed to augment the grant from AHBFI and to ensure that the research program at UC Berkeley could ultimately be deployed in accordance with the overarching philanthropic mandate. AHBFI acts as the project manager, administers funding, consolidates IP rights, and out-licenses them as a package as necessary.



D. Semi-synthetic Artemisinin for Treatment of Malaria

A multi-party PDP collaboration model drives SRLP's semi-synthetic artemisinin ("SS Artemisinin") project. Annually, malaria strikes a quarter of a billion people, among over three billion people at risk, and results in nearly a million deaths, mostly children under age five.[11] Artemisinin, a compound isolated from the wormwood plant *Artemesia annua,* is an effective treatment for malaria, especially when combined with other drug

[11] World Health Organization, *World Malaria Report 2008*, 9, WHO No. WHO/HTM/GMP/2008.1 (2008).

ingredients to create Artemisinin-based Combination Therapies ("ACTs"). Artemisinin is produced botanically in many countries including Vietnam, China, and many parts of Africa. However, the availability of *Artemesia annua* is subject to growing season cycles and price swings, producing undesirable supply instability. Increasing the supply and reducing the price of artemisinin by means other than plant growth can make the ACTs more widely and consistently accessible.

The SS Artemisinin project began as a collaboration between UC Berkeley, for-profit start-up Amyris Biotechnologies, Inc. ("Amyris"), and a San-Francisco-based PDP, Institute for OneWorld Health ("iOWH"), but later came to include a French pharmaceutical company, sanofi-aventis group ("sanofi-aventis"). In December 2004, the Bill & Melinda Gates Foundation ("Gates Foundation") funded an initial five-year project to develop a low-cost semi-synthetic artemisinin. Amyris spun-out of the laboratory of Professor Jay Keasling, a chemical and biomolecular engineer at UC Berkeley. Dr. Keasling and others developed a "synthetic biology" approach to making artemisinin in microbes involving the synthesis of terpenes. Additionally, and as it turned out importantly, this technology platform may also be used to produce other practical products, including nutraceuticals, flavors and fragrances or other molecules that share a common chemical structure[12]—among them biofuels, currently a central focus of Amyris' efforts.

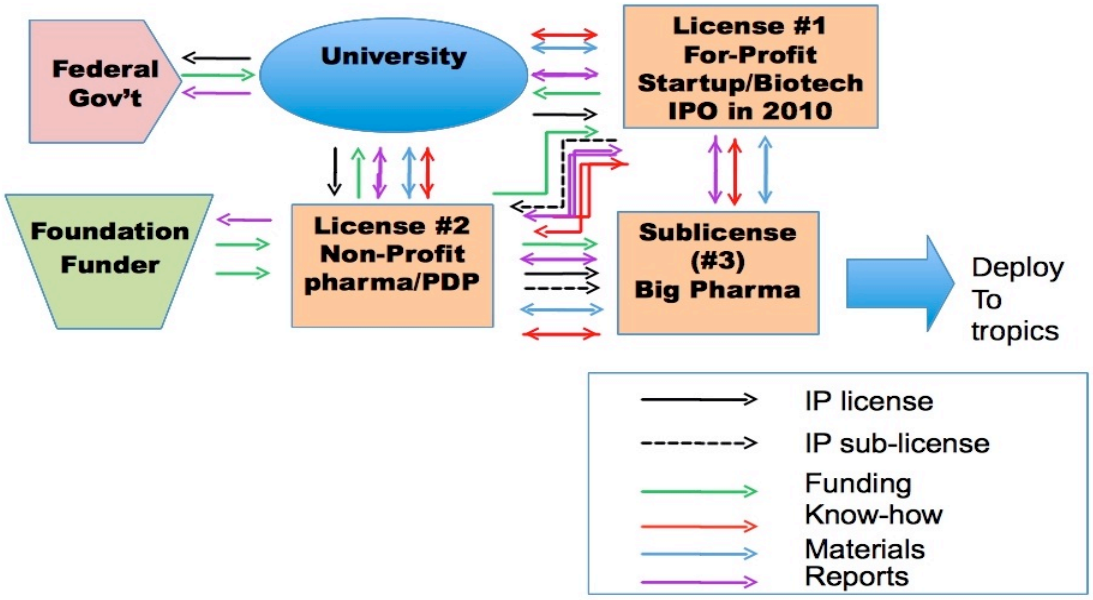
The essential elements of the model for this collaboration involve a PDP funded by a philanthropic foundation seeking a low-cost malaria therapy. The grantee project manager aggregates relevant IP rights for transfer of all rights, in an appropriate bundle, to entities for commercial-scale manufacture. The partners work in parallel to decrease risks of the R&D portion of the project, with a PDP and a university startup company bridging elements in order to produce non-profit and for-profit commercial outcomes, respectively. The startup company received significant non-dilutive funding to pursue a dual commercialization strategy beginning with a near-term non-profit goal that enables demonstration of "proof-of-principle" for a platform technology. From that platform a long-term for-profit strategy for the start-up is launched. A combination of licensing and research collaboration ultimately results in the pharmaceutical company providing an affordable drug to the poor in 88 countries where malaria is prevalent. The pharmaceutical company must accomplish this on a no-profit, no-loss basis, taking into consideration both near and long-term return on investment. Such access and affordability terms in a license to early stage, unproven technology were made sufficiently attractive to a commercial partner through a sublicense that carries price restrictions after the project has been developed by intermediaries, thereby reducing risk through the collaboration.

The initial Gates grant to iOWH—$42.6 million—provided funding to the collaborators that allowed UC Berkeley to perform basic research, Amyris to perform translational/applied research, and iOWH to shepherd the project towards worldwide implementation and distribution and bring in a commercial partner, sanofi-aventis. The initial grant supported integration of basic, applied, and commercial research. Funding the collaboration in this way streamlined translation from bench to bedside, enabling the research to be performed in parallel, rather than in sequence.

[12] A structure based on terpenes or isoprenes.

The resultant shortening of the usual product development timeline constitutes an improvement over the existing paradigm, in which the university receives grant funding for basic research, usually from federal funding agencies. It then typically engages in a technology "push" model, one based on filing a patent and marketing the patent rights. Given that patents covering early-stage, basic research results with unproven utility in terms of providing defense of commercial products are not generally attractive to potential licensees, the process can stall at that point.

In contrast, the SS Artemisinin project's "pull" model aligns the goals of the parties with those of the funder, and the ultimate goal of the collaboration is pre-determined. Patent licensees are selected accordingly, and key licenses granted sooner and in a more coordinated way than they might otherwise be, thereby boosting transaction efficiencies and lowering uncertainty. The barrier to commercial uptake is lowered and R&D timelines are condensed.



To meet the accessibility and affordability goals for the project with respect to the drug price, the collaborators have no expectation of royalty returns in the malaria field. The deal and IP rights structure of the collaboration was transacted through multiple contracts signed up-front and simultaneously. A three-way collaboration agreement established the public-private partnership and outlined milestones to be achieved by each party and the target dates for completion. Two IP rights licenses from UC Berkeley covering methods for applying synthetic biology to terpene synthesis were issued to each of iOWH and Amyris.[13] Amyris received a royalty-free license for malaria drug applications in the developed world and in all other fields of use, without territorial restriction, that the invention could be applied to. The licenses contain "mandatory sublicensing provisions" stating that Amyris must grant sublicenses to a third party if it has discovered and can reduce to practice a methodology that uses one or more of the

[13] Amyris subsequently sublicensed their malaria rights in the developed world to iOWH. Amyris also received the right to commercialize non-malaria applications of the method in the developing world under royalty-bearing terms.

licensed inventions for the purpose of producing, for free or at cost, artemisinin solely for the for the treatment of malaria in defined "Economically Disadvantaged Countries" if neither Aymris nor its sublicensees are meeting this goal.[14] iOWH also received a royalty-free license from UC Berkeley, for the malaria drug field of use only, in 88 developing countries where malaria drugs are needed for the poor. UC Berkeley also agreed to grant additional licenses to follow-on IP rights developed during the collaboration.[15]

The collaboration benefits all the parties. The university benefits from increased research funding, including diversification of funding sources; the opportunity to demonstrate alternative IP management strategies coupled to new business models to forge new research paradigms and maximize social impact; the opportunity to test and prove public-private partnership collaboration parameters that inform public policy and university policy outcomes; the opportunity to develop clauses[16] under its humanitarian socially responsible licensing program[17] and fulfill its social and public service mission on a global scale; achievement of its economic development goals with respect to spinning out start-up companies that create jobs, goods, and services in its innovation ecosystem; and potential royalties that may be realized from sales by Amyris of non-malaria applications. In addition, its star researcher and entrepreneur achieved the first Biotechnology Humanitarian Award from the Biotechnology Industry Organization[18] and the satisfaction that he is bridging a critical divide: "Anytime you can do fun science and save a million lives a year, that's great."[19]

As a for-profit company, Amyris applied the innovations developed for the SS Artemisinin project to commercial applications that rely on the same platform technology. While it did not make a profit from the malaria project *per se*, it parlayed knowledge and tools from the project to launch successful commercial projects and garner investments. The significant $12 million in funds provided to Amyris through "bootstrap" philanthropy exceeds the amounts that the typical start-up company can raise from private capital investors in months and years *before* it has demonstrated "proof-of-principle" of licensed inventions. This early funding allowed Amyris to establish proof-of-concept for its technology platform under which it refined the methodology with

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[14] Under the collaboration agreement that established the public-private partnership, Amyris also grants royalty free licenses to iOWH to project IP covering the malaria drug development processes.

[15] The follow-on licenses are limited to IP rights developed in the collaboration with funding from the collaboration.

[16] Clauses address, for example, the following: nonassertion or non-patenting in the developing world, royalty-free IP rights in the developing world, humanitarian field-of-use and licensed territory restrictions, humanitarian reservation of rights, royalty sharing, attribution, and tiered pricing based on economically disadvantaged population definitions (based on poverty levels). *See* Memorandum by Carol Mimura on Guidance and Sample Clauses for Use in Developing Strategies, Licenses, Research and Collaboration Agreements in IPIRA's Humanitarian / Socially Responsible Licensing Program (SLRP) at Berkeley (Aug. 17, 2010), *available at* http://ipira.berkeley.edu/sites/default/files/shared/doc/SRLP_Guidance_&_Clauses_v100817.pdf.

[17] *See* SOCIALLY RESPONSIBLE IP MANAGEMENT, http://ipira.berkeley.edu/socially-responsible-ip-management (last visited Sept. 5, 2010).

[18] Press Release, Biotechnology Industry Organization, Jay Keasling Receives Inaugural Biotech Humanitarian Award from the Biotechnology Industry Organization (May 20, 2009) (*available at* http://www.bio.org/news/pressreleases/newsitem.asp?id=2009_0520_02).

[19] Bennett Daviss, *Malaria, Science and Social Responsibility*, 19 THE SCIENTIST 42, 43 (2005), *available at* http://www.f1000scientist.com/article/display/15349/.

charitable funding, before turning to long term, for-profit applications in other industries (with private capital). In Amyris' case, an early commercial application was developed in the biofuels industry that relies on plant-based feedstocks. Amyris raised significant subsequent venture capital to develop biofuel applications,[20] and the company went public in 2010.[21] This is perhaps the clearest example to date, within SRLP's experience, that demonstrates the non-linear development and varied benefits—both economic and societal—that can flow from novel multi-party R&D collaborations.

As a non-profit pharmaceutical company and PDP, iOWH is able to make malaria treatments more affordable for people in the developing world, in furtherance of its mission and the terms under which the Gates Foundation funded this project and others at iOWH. It also forged a strong relationship with UC Berkeley that resulted in exposure to additional collaborative projects, including one in the diagnostics field,[22] and other funding opportunities. The Gates Foundation suggests that this type of public-private partnership is an example of "Creative Capitalism," bringing industry, philanthropy, non-profit organizations, and governments together to fight the world's enduring problems.[23]

iOWH aggregated the IP rights for the process, sublicensed these rights to sanofi-aventis, and paved the way for a no-profit, no-loss program.[24] Aggregation of the IP rights allowed iOWH to provide meaningful exclusivity to sanofi-aventis. Sanofi-aventis is completing the last leg of the race by performing the scale-up, derivatization, manufacturing, and distribution steps through its "Access to Medicines" program.[25] iOWH has received an additional $10.7M grant from the Gates Foundation to fund large scale production and commercialization with sanofi-aventis.[26] As a starting material for ACTs,[27] semi-synthetic artemisinin does not have to undergo clinical trials to prove biological equivalence to the existing, approved drug precursor, but the manufacturer or provider must demonstrate that it is chemically identical to the approved molecule.

Scale-up and sourcing of the precursor in quantities that are sufficient to meet the market demand is an enduring challenge. Sanofi-aventis is performing through its Access to Medicines unit and does not expect to profit from sales of the product *per se*. It must nevertheless achieve a target marginal cost of production for the project to be viable for launch and sustainable in the long run. Good will and good intentions only go so far in the overall calculations of actual and marginal cost of production. Subsidies through co-

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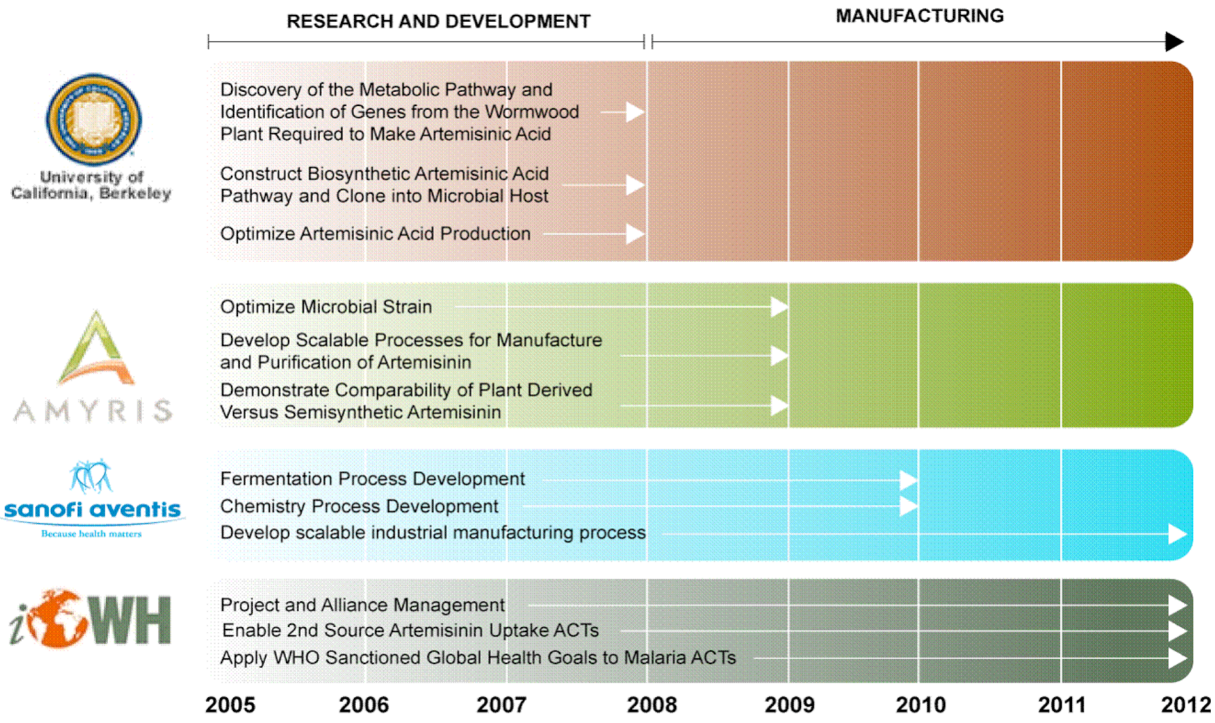
[20] *See Amyris – Overview*, AMYRIS.COM: RENEWABLE PRODUCTS FOR THE WORLD, http://investors.amyris.com/ (last visited Sept. 5, 2010).
[21] Will Kane, *Amyris IPO Holds Steady*, SAN FRANCISCO CHRONICLE (Sept. 29, 2010), http://articles.sfgate.com/2010-09-29/business/24102107_1_greenhouse-gases-biofuels-jet-fuel.
[22] SILICON BIODEVICES, http://www.siliconbiodevices.com/ (last visited Sept. 5, 2011).
[23] Steve Hamm, *Cheaper Artemisinin to Fight Malaria,* BUSINESS WEEK (Jan. 15, 2009, 5:00 PM), http://www.businessweek.com/magazine/content/09_04/b4117083623738.htm.
[24] Press Release, OneWorldHealth, Amyris Biotechnologies and Sanofi-aventis Announce Development Agreement for Semisynthetic Artemisinin (Mar. 3, 2008) (*available at* http://en.sanofi-aventis.com/binaries/080303_ARTEMISININ_pdf_tcm28-14641.pdf).
[25] *Sanofi – Access to Medicines*, SANOFI: A DIVERSIFIED HEALTHCARE COMPANY, FOCUSED ON PATIENTS' NEEDS, http://www.sanofi-aventis.us/live/us/en/layout.jsp?cnt=8314A5A2-6A0E-45A8-8572-729F68EF8ECB (last visited Sept. 5, 2011).
[26] Press Release, Institute for One World Health Moves Closer to Increasing Supply of Accessible, Affordable Ingredient for Treatment of Malaria (Jul. 7, 2010) (*available at* http://www.oneworldhealth.org/press_releases/release/pr_1278691423).
[27] Technically known as a pre-Active Pharmaceutical Ingredient (or pre-API).

payments from the Global Fund[28] for qualified ACTs will lower the price, which in the final analysis may be one of the key factors on the demand side of the equation. Intergovernmental agencies, international treaties, NGOs, and global relief agencies are as important as technology and business strategies in achieving such effective partnership outcomes.

On the incentive side of the equation, in addition to selling semi-synthetic artemisinin, sanofi-aventis will be able to combine the synthetic product into ACTs it currently sells. Increasing availability of artemisinin will also enable sanofi-aventis and other companies to develop and market new ACTs, as well as enable market expansion of current ACTs. Price restrictions in the sublicense and partnership agreements, combined with the company's tiered pricing strategies (based on consumer income levels under its Access to Medicines program) and co-payments for ACTs, will ensure access and affordability for the poorest—as long as the product is launched. This in turn, depends on manufacturing processes achieving all remaining process development and production targets. Projections for commercialization in 2012 are on track; the world awaits.[29]

Since the commencement of the project, which began in December 2004, the partners achieved the following milestones [note that this chart extends beyond the present time, as it is intended to be an overall project synopsis]:



[28] *Eligible ACTs*, THE GLOBAL FUND TO FIGHT AIDS, TUBERCULOSIS AND MALARIA, http://www.theglobalfund.org/en/amfm/firstlinebuyers/acts/ (last visited Sept. 14, 2011).

[29] Low-cost ACTs from this project constitute one aspect of a multi-pronged, global effort to reduce the cost of ACTs, thereby increasing their availability. The Affordable Medicines Facility – malaria (AMFm), pays for "buyer co-payments" to pharmaceutical companies that enable public and private purchasers to buy ACTs for dramatically lower costs compared to non-subsidized prices. The AMFm is currently financing low-cost sales in Africa, Madagascar and Cambodia under a pilot program.

E. Open Innovation Pool for Neglected Tropical Diseases

Neglected diseases include infectious, tropical diseases that disproportionately affect those in low-income countries. Those affected may be many, and their medical needs great, but their ability to pay for innovative medical interventions is typically low. Such diseases are neglected for lack of profit drivers and therefore adequate private investment.

A new PPP collaboration was born when Andrew Witty, CEO of GlaxoSmithKline ("GSK"), announced radical changes to the massive pharmaceutical company's approach to providing medicines to the global poor in 2009.[30] He announced drug price reductions in least developed countries as well as reinvestment of profits from sales in those countries in health infrastructure such as doctors, nurses, and clinics. GSK also made available hundreds of its patents in a pool from which others could license the elements of a research program on neglected, tropical diseases. Coupled to a new open innovation research campus called Tres Cantos in Spain, GSK seeks to stimulate collaboration and investment on neglected, tropical diseases that suffer from lack of investment due to lack of a profit driver. Among other things, the "Pool for Open Innovation Against Neglected Tropical Disease" is a mechanism for aggregating information about researchable projects that could ultimately lead to a valuable priority review voucher from the U.S. Food and Drug Administration, and making the information available under defined terms. The pool is managed by BioVentures for Global Health.[31] The pool can provide research tools, IP rights, and know-how that can be brought to bear on diseases that require collaboration and sharing across private and public-sector lines in novel ways.

UC Berkeley is one of several owners of IP rights that have made patent rights available through the pool. To streamline the process by which interested parties can view the available rights and evaluate their interest in licensing them, UC Berkeley has offered to make the licensing as transparent and automated as possible. It is offering licenses under a Public License through Creative Commons' GX[32] or Green Exchange initiative.[33] Prospective licensees or collaborators can view the IP rights and the standardized license, which is simple and ready-to-sign, thereby avoiding uncertainty, negotiation and other transaction costs. This is one small gesture, but it is a component of a larger "model collaboration pathway collaboration" demonstration with many elements, including those that can be semi-automated. For example, collaborators seeking methods by which to implement target pricing goals for a project will be able to select from among different contract clause options, and/or will be able to compare and contrast the number and nature of inputs that are required to obtain a given outcome and model the optimal effects and timing.

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[30] Sarah Boseley, *Drug Giant GlaxoSmithKline Pledges Cheap Medicine for World's Poor*, THE GUARDIAN (Feb. 13, 2009), http://www.guardian.co.uk/business/2009/feb/13/glaxo-smith-kline-cheap-medicine.

[31] POOL FOR OPEN INNOVATION AGAINST NEGLECTED TROPICAL DISEASES, http://ntdpool.org/ (last visited Sept. 5, 2011).

[32] *See Model Patent License*, PATENT TOOLS PUBLIC DISCUSSION, http://wiki.creativecommons.org/Patent_Tools_Public_Discussion (last visited Sept. 5, 2011).

[33] UC Berkeley is also offering licenses through other sites that facilitate license automation, such as the Kauffman Foundation's iBridge interface.

F. New Frontiers

From the university's point of view, the opportunity to stay involved further into the value chain is valuable and instructive. Consistent with UC Berkeley's role as a land grant institution, exposure of students to problems of relevance to industry is appropriate to "advance the useful arts." Projects that are appropriate to be performed in an academic setting advance students in their degree work, are publishable, non-confidential, and not of a truly commercial nature. In many disciplines such as engineering, chemistry, architecture and biotechnology, feedback from industry that informs research direction is highly sought. Input from industry can result in researchable topics and in general, can illuminate how and where academics fit in to the innovation community of which great research universities are an integral component. The proximity of cutting-edge research institutions to robust sources of private capital have engendered entire industries, including California's information technology and biotechnology industries. Both contribute significantly to California's economy and create synergistic industries that also create jobs for the state such as in the service and professional services sectors, including the IP and financial sectors. The newest arrival in this industry-creating foundry based on synergistic innovation and collaboration is the alternative energy industry. It is growing and thriving due to the same confluence of factors that nurtured its predecessors. The lessons learned in bringing the various components of the innovation ecosystem together from the biotechnology and information technology industries will continue to be relevant to local and international collaborations in the alternative energy and clean technology space.

While the collaborations and associated IP management strategies discussed above focus primarily on agriculture and neglected diseases,[34] UC Berkeley and its collaborators are committed to bringing the same spirit of collaboration and innovation to addressing challenges associated with climate and energy. Energy is required to address many conditions that affect poverty, including heath infrastructure, sanitation and clean water, agricultural innovation, and in-country technological advancements that ultimately spur economic development.

We must bring the right resources to bear on the urgent challenge of developing technology and systems solutions for a low-carbon future that promotes equity and economic opportunity. It may not be easy. Power and fuels will remain commodities, but innovations to make them more widely available and less environmentally harmful will require substantial investments.

Together with its research partners, the Lawrence Berkeley National Laboratory and the University of Illinois at Urbana-Champaign, UC Berkeley participates in a 10-year, $500 million public-private partnership with global energy company BP, p.l.c. to research biological applications to energy. This groundbreaking industry-academic sponsored research award, the largest of its kind to date, represents one form of collaboration between government, industry, and academia in a multi-disciplinary quest for alternative energy solutions that lessen our dependence on petroleum products. A

[34] In this perspective we have omitted examples under the SRIP in the areas of diagnostics, sanitation and vaccines due to space limitations.

combination of proprietary and open research coupled to a grants-making process that has funded hundreds of researchers to date has mobilized scores of collaborative teams to advance projects in areas where traditional funding sources are not available. The collaboration demonstrates how innovation at the public-private interface can produce faster and synergistic results in compressed time frames over different fields.

IV. INNOVATION ON INNOVATION ITSELF

Developed nations are in many ways in a position to coordinate and to mobilize resources for the common good and apply them to global health and clean energy. Realizing this potential in practice will require flexible and varied IP management strategies coupled to strategic business models and nuanced ways of implementing policy solutions.

Improvements in global health and advancement towards a low-carbon and sustainable energy future cannot be addressed in isolation. Solutions are inextricably linked to poverty, food security, sanitation, international laws and treaties, energy security, and political stability. The United States and other nations support the United Nations Millennium Development Goals to fight poverty. Investments to alleviate global poverty pay off in many ways, including in global health and energy security.

Nothing short of *innovation on innovation itself* is needed now. Institutions like UC Berkeley and its research collaborators, and insights gained from SRLP techniques wherever they are applied, can provide useful examples and play meaningful roles in global discussions as to how best to coordinate policy, technology, intellectual property, regulatory, and international law in a cohesive manner.[35] Academia is but one piece of the puzzle and its role complements those of many others, including industry, government, other research institutions, foundations, international treaties, laws and agencies, NGOs, and financial institutions.

Effective approaches will include both push and pull mechanisms, acknowledge multiple influences on dynamics of supply and demand in different regions, and account for a wide range of existing infrastructures and institutions as assets or challenges to be addressed. Transactions and collaborations will only be consummated when we have an alignment of goals for all stakeholders and when we have retained incentives for all participants, including key market participants that remain active once initial collaborations conclude.

The ultimate benefits of these types of collaborations flow from compressing R&D timelines by innovating around the classical approach to technology development and transfer in fields where the R&D timelines are long. Parallel innovation under the university-PPP collaboration model resulting in overlapping processes and non-linear feedback loops advance projects towards the commercial uptake stage by traversing common gaps.

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[35] *See, e.g.*, JOHN ZYSMAN AND NINA KELSEY, BERKELEY ROUNDTABLE ON THE INTERNATIONAL ECONOMY, THE GREEN GROWTH ECONOMIES PROJECT PART TWO: COUNTRY CASES AND ANALYSIS (2011), *available at* http://brie.berkeley.edu/publications/Green%20Gowth%20Economies%20Part%202_%20Country%20Cases.pdf.

We hope that the mere sharing of collaboration model pathways will serve as a guide to the construction and implementation of IP management strategies and business models in many disciplines to address pressing needs in a wide range of areas, including but not limited to agriculture, health, and energy.