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The pharmaceutical technology landscape: A new form of technology roadmapping

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ABSTRACT

Practitioners are finding it increasingly difficult to develop effective roadmapping efforts for many new products and innovations. We argue that this difficulty stems from the fundamental differences between many of today's innovations and earlier ones. Many current innovations are: using technology differently; more heavily constrained; forcing new business models and increasingly being shaped by drivers. Current roadmapping techniques do not translate well to this new reality. Roadmapping efforts for these innovations are increasingly failing to meet their primary goal of including technology into the strategic process of firms, regions or industries.

We seek to address this concern by creating a new roadmapping technique, one we name *Technology Landscaping*. We build this technique by basing it upon the relevant sections and structures found in first and second generation roadmapping theories and practices. We then apply new theory and processes that are in alignment with the nature of these new products and innovations. We test our model through a case study of new pharmaceutical industry innovations. Finally, we present our new roadmapping technique.

1. Introduction

Technology roadmaps were developed to insert technology into the strategic processes of firms, industries or regional development activities [120]. Technology roadmaps traditionally plot the technology requirements of one or more products or innovations along a single technology pathway over time. Technology roadmaps provide both strategic and tactical value for those that use them. At least two separate generations of roadmaps provide value to today's industries and firms. The highly successful first generation roadmap techniques advance architecturally stable technology product platforms like those found in the semiconductor industry [42,56]. Similarly, successful second generation technology roadmaps provide value for emergent disruptive technology bases like MEMS or nanotechnology [120,122]. Both first and second generation roadmapping techniques mirror the nature of the innovations and products they serve.

The nature of many new pharmaceutical innovations and products, however, vary greatly from the architecturally stable product platforms served by first generation roadmaps or even emergent disruptive technology based products served by the second. Further, these new pharmaceutical innovations are prototypical of other new innovations in a variety of industries. It is then no wonder then that roadmapping participants are finding it increasingly difficult to apply existing roadmapping techniques to these new innovations [80,82]. Yet many firms, industries and economic development activities would benefit from

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a roadmapping process for these new innovations. Here we provide one path that roadmapping techniques can evolve for a third time to meet the needs of a new generation of innovations.

We argue that in order to build an effective third generation roadmapping technique we must first define the nature of these new technology innovations, particularly the differing nature of these innovations and products from previous ones. Each new generation of roadmap development has been driven by the changing nature of the innovations and products under review. We next build on the first two roadmapping techniques, identifying the value that they bring to the third generation process. Finally, we apply newer theory to build our new roadmapping technique.

We identify six important manners in which the nature of many new pharmaceutical innovations and products differ from earlier products and innovations. First, these innovations are created at the interface of multiple root technologies [9,14]. Second, these innovations often do not benefit from a unit cell such as the transistor does for the semiconductor roadmaps. Third, differing applications drive innovations that will require differing and often multiple critical dimension development for each technology being utilized. Fourth, the boundary conditions constraining today's innovations and products are much stricter than ever before [12]. Fifth, drivers are much more important to these new innovations. Sixth, new business models such as focused consortia [7] are driving technological development without benefit of predetermined architecturally stable product process platforms. Using these differences as a baseline we then review the current roadmap and innovation literature in order to develop a new third generation roadmapping technique.

We provide the new pharmaceutical innovation process as a case study [136] to further develop data and test new roadmap tactics in order to present a robust third generation roadmapping model. Many new pharmaceutical innovation processes have resisted current roadmapping techniques [8]. Newer pharmaceutical innovations often do not follow the traditional pharmaceutical industry single root technology innovation base.

We found that new pharmaceutical innovations are often generated at the interface of multiple technologies. We collected interviews at conferences to identify the technologies that serve as the bases of new pharmaceutical innovations. We grouped these technologies into five root categories.

We next compiled pharmaceutical drivers from primary and secondary case based techniques. This step in our roadmapping process emphasizes the new importance of drivers in our roadmap process. We further, incorporated the pharmaceutical industry new business model of consortia into our roadmap. We used these consortia much in the same way as the first generation roadmaps utilize important architecturally stable process product platforms. We functionalized the time axis for technology maturity time along multiple critical dimensions by modifying Technology Readiness Level (TRL) and Technology Readiness Assessment (TRA) techniques. We incorporated our findings and present a new third generation roadmap technique.

2. Literature review

Our literature review is designed to assist in the development of a new roadmap technique that suits the nature of many recent pharmaceutical innovations and products. We have segmented the literature review into three sections. We discuss in Section 2.1 the six ways that more recent pharmaceutical innovations differ from earlier ones. We conclude that the nature of these innovations is not well served by traditional roadmapping techniques. We next discuss in Section 2.2 the value and gaps in current roadmapping techniques as applied to these innovations. Finally in Section 2.3 we review current literature that enables new roadmapping segments required by these innovations.

2.1. The changing nature of many new pharmaceutical innovations

First, we discuss how new pharmaceutical innovations substantially differ from traditional ones. There are at least six ways that new pharmaceutical innovations differ. We postulate that these new innovations and products cannot be adequately addressed by traditional roadmapping techniques.

2.1.1. Many of today's innovations are using technology differently

First and second generation roadmaps are focused on a single root technology based innovation or product. A shift has occurred and many of today's pharmaceutical innovations are increasingly generated at the interface of two or more root technologies [106,6]. Innovations developed at the interface of multiple root technologies are perhaps the single most problematic issue for current roadmapping techniques to address. Roadmapping practitioners often try to cope with this by designating a single technology as most important to an innovation, disregarding all others, or by trying to generate a roadmap for every single root technology and every differing critical dimension required of that technology [128]. Neither choice efficiently allows for the inclusion of technology into the strategic processes of firms, industries or regional economic activities.

2.1.2. No unit cell

Today's pharmaceutical innovations do not have a unit cell (component) such as a transistor [109]. The transistor is the unit cell or base element in the ITRS semiconductor first generation roadmapping effort. The lack of a unit cell does not allow for shared learning across industrial applications [109]. The lack of a dominant unit cell (component) makes it very difficult to use the strata structure Y axis or vertical segment of the traditional roadmapping process.