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Physical layout of workspace: a driver for productivity in drug discovery

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Connecting knowledge islands is of paramount importance to create a competitive edge in science-driven companies. From a constructive perspective, new knowledge is created when individuals communicate. The most intensive level of connection is face-to-face encounters. Short feedback loops are essential for high productivity in research. We analyze the results from a study performed at Novartis's 'Knowledge Campus' in Basel, Switzerland. A change from conventional cellular offices to an ultramodern multispace concept radically changed the patterns of face-to-face encounters between individuals. In this article, we derive implications for the management of R&D and show that multispace concepts are advantageous when individuals depend on one another within multidisciplinary groups.

Introduction

More regulations, higher competition through a global talent base and an increasing number of lean and mean biotechs, as well as a broader set of different scientific approaches, are driving complexity in drug discovery. Larger markets and a growing variety of technologies lead to higher levels of specialization and, thus, a need for connecting knowledge islands inside and outside the borders of a company. Science-driven companies need to address this challenge because they have to integrate a large set of skills needed to push a project from ideas to market introduction. Large companies focus on the internal exchange of knowledge between groups whereas smaller and medium biotechnology firms foster the exchange of knowledge externally (e.g. with Universities, CROs or licensing partners). Independent of the size of the company, the interaction between individuals is of paramount importance. As groups grow, the distance between their members increases: the probability of encounters diminishes [1]. Thus, the size of the group is what matters most and not the size of the company.

Knowledge sharing is often understood as codification and exchange of scientific results in written form. However, real-time knowledge sharing takes place when individuals communicate face-to-face (FTF), and is a decisive factor in creativity. Many factors can influence the extent to which people are able to communicate: physical layout of workspace is an important one.

There was a trend in the 1960s to design workspace to enhance communication, with some pioneering work done by Allen [1–3] and later by Hatch [4] and Stryker [5] on measuring communication. During the past decade most companies focused on IT-based solutions to codify and distribute their knowledge. More recent approaches are based on open-source principles such as Wikipedia. However, humans are still the main driver for innovation, and improving their connectivity through specifically designed environments has been less of a focus. Shibayama *et al.* show a positive relation between scientist interactions, creative climate and knowledge-based acquisition, which positively impact general performance of companies [6]. With its 'Knowledge Campus', the Basel-based Swiss pharmaceutical company Novartis sees interactions and FTF communication as a paramount factor for success in today's challenging pharmaceutical market. The Novartis campus makes a radical change of existing workspace layouts toward openness, design and comfort, enhancing communication as a main goal. To measure whether the goal had been reached, Boutellier *et al.* [7] performed a comparative quantitative FTF communication study between Novartis's old cell-office area and the new multispace concept. Their original findings will be published in detail in R&D management [7]. In this paper, we highlight the implications of the different communication patterns identified in managing drug discovery.

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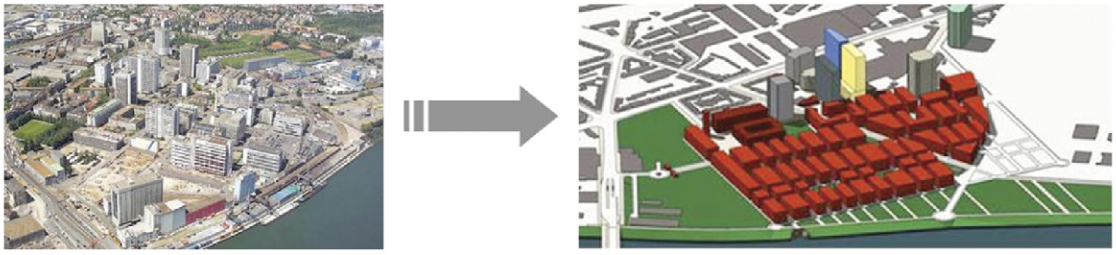

FIGURE 1

Novartis's Campus of Knowledge is a transformation of its traditional industrial St Johann site in Basel, Switzerland to and ultramodern science city. The architectural aim is to enhance knowledge creation within the company among its employees. For this purpose multispace has been integrated in the new buildings. Places for encounters (e.g. green areas, cafés and restaurants) have been built to facilitate communication between individuals from different workspaces.

Novartis campus

Novartis is creating a 'Campus of Knowledge' on its old St Johann site, a traditional industrial complex in Basel, Switzerland. The aim is to create an environment that fosters innovation through regular and chance interactions within an interdisciplinary community: green areas, restaurants, cafés and work areas were designed to connect specialists and enhance knowledge creation. At the office level, multispace concepts are applied systematically. The Novartis campus is the largest architectural R&D project throughout Europe and will take approximately 20 years (Fig. 1) to finish.

Multispace

Multispace was specifically developed in collaboration with the Fraunhofer Institute in Stuttgart for the campus. It offers a large diversity of rooms: quiet rooms, spaces for teamwork, break areas and meeting rooms are elements of the new work environment (Fig. 2). The multispace work concept can easily be adapted at low cost to changing requirements. The new office landscape is expected to facilitate access to tacit knowledge and to increase information sharing among organizational members; it should offer the advantages of open space by lowering barriers between individuals but also give employees options.

FIGURE 2

Multispace office environments have no cubicles. Each part of the space has a function facilitating the tasks its occupants need to perform.

This is where it differs from traditional concepts (e.g. open space).

There are two main theories on the configuration of workspace: (i) propinquity and (ii) privacy. The former, defended by [8] and [1], among others, suggests that openness of layout facilitates interaction and therefore productivity. The extreme of this model is the trading floor in a bank. The propinquity theory underscores the individual's need for privacy to be efficient. The multispace concept aims at offering both, privacy and propinquity.

Elements of multispace work environments

Multispace has no cubicles, or other physical obstacles between individuals. Each part of the space has its function: when two individuals need a separate room for a conversation, there are cells with curtains. If an individual needs to read something then sofas and other soft areas are available; there is a multitude of options matching the multitude of tasks and specialists in today's drug discovery process. High visibility management diminishes the need for formal control and avoids 'connoting control' with its negative impact on creativity [9].

Cell-offices

Cell-office spaces (Fig. 3) are classical layouts where each person has his or her own office surrounded by four walls and separated from common workspaces and other's offices by a door. The offices are often arranged in line along a corridor. In this study the area measured was two corridors in parallel connected by a common coffee area with a high table, table with chairs and a soft seating area.

Cell-office work environment

In this environment, interdisciplinary tasks have to be discussed in formal meetings where management makes sure that everybody knows what has to be achieved, leading to a high level of formal control.

Communication and its means in research productivity

FTF communication has a paramount impact on creation and sharing of knowledge. Nonaka's [10] process of organizational knowledge creation, highlighted in his SECI model, starts with socialization which enables tacit knowledge transfer from the group or an experienced individual to another individual. Nonaka differentiates tacit from explicit knowledge, where the latter can be codified and therefore easily transmitted. The tacit knowledge [11] is related to knowhow and experience. Like Wittgenstein's famous tune of a clarinet – everybody knows it, but nobody can describe it with words alone.

Communication is a means to share information and knowledge; its epistemology taken as purely cognitivistic [12] shows that FTF communication is the fastest and most comprehensive connection possible between individuals. Hence, facilitating planned and chance encounters between individuals is a means to increase human intellectual capital.

High creativity is conditional to drug discovery. When creativity is aimed, and knowledge creation is perceived from a 'constructivitistic' [13] point of view, longer FTF communication events might be of advantage to allow stronger ties and more knowledge creation. By contrast, it can be argued that weak ties prevent indoctrination and therefore allow more thinking out of the box [14–16] promoting a high diversity of opinions. We consider the free choice of options best suited to personal styles, roles and tasks as decisive for creativity. Everybody has to develop his or her specific learning and working style. There are immense differences between creative people: Leonardo da Vinci's meticulous and painstaking research into human anatomy is in stark contrast to Darwin's working style – long periods of debilitating sickness made it impossible for Darwin to work longer than a few hours per day for 27 years of his life.

We split a person's time into two parts: (i) when she communicates and (ii) when she concentrates [17] on problem solving. During the latter, individuals process knowledge created or amassed during communication time. The time it takes to reach and process information and get the next feedback is crucial for individual productivity. Hence, we seek a layout that allows

FIGURE 3

In a cell-office environment, one or more individuals have an office with four walls and a door. In the case of Novartis, each individual had his/her own office.

frequent but short communication events and that allows individuals as well to spend time without communication, to think and work in a way best suited to her or his specific needs.

In a workspace with many individuals, frequency, mean duration, number of participants per communication event, total extent of communication and time without communication are variables that can be influenced heavily through physical layout.

TABLE 1

The communication patterns revealed in Boutellier *et al.* [7] in a multi space environment and a cell office environment have a different impact on a number of indicators of creativity found in the literature

Creativity drivers	Cell-offices	Multispace offices
Probability of chance encounters	Low	High
Conoting control	High	Low
Feedback cycle times	Long	Short
Time to work on her/his own	Low	High
Diversity of opinion	Low	High

Method

Inside Novartis two areas were observed [7]: (i) a floor in a cell-office building and (ii) a floor in a multispace building. Because people work in a dynamic way in drug discovery and development, including traveling, the workspace as the unit of measure and not a test group was chosen. Fifteen days and a total of 2355 communication events were measured. Additionally, two areas were observed where the nature of the tasks being performed and the level of hierarchy were similar to avoid bias from the sample.

Findings

Based on the measurements, the following conclusions could be drawn for the multispace office compared to the traditional cell-office environment:

- Frequency: FTF communications per hour per person tripled from 2 to 6 in the multispace environment
- The average number of participants per encounter remained more or less constant
- The average FTF communication duration was halved from 2 to 1 min
- Total FTF communication time measured as the percentage of total presence time was higher with higher barriers: 45% in cell-offices and 35% in multispace environment

Time without communication increased by a factor of 4 – from 7% in the cell-office space to 28% in the multispace working environment.

We noticed that meetings decreased in length and that the absolute number of encounters lasting longer than 2 min remained constant. The number of short encounters increased. We conclude that the number of strong ties remained constant, whereas the number of weak ties increased because of higher frequency and lower mean duration of encounters.

Consequences for the management of drug discovery

Management implications of results (Table 1)

There are only few proven causal relationships between architecture and innovation. But it seems that the medieval monastery with its dual approach to cognition is still a prototype to be considered [17]. In the monastery time is split between working alone in a 'cell' and meeting with others in the cloister – either you communicate or you concentrate. In a monastery the split is fixed, in modern R&D the split is up to you.

In multispace offices, not to be confused with open-space offices, researchers have the choice to work on their own, 20% longer than in the cell-office, nevertheless they have three times more encounters with colleagues. Chance encounters increase, diversity of opinions as well and feedback cycles become much shorter.

It seems that wherever creativity is needed in drug discovery, multispace offices have a big advantage. They are not cheap but seem to suit today's needs of our multioption society. Pharmaceutical research is managed, coordinated and yet individual initiative should not be destroyed. It differs from basic research and implies a purposeful and rational organizational structure that must be considered. As described in [18] research can be divided into process-driven activities and creativity-driven one. The first generates data and the second interprets the data. Accordingly, the workspace may be divided into a data-generating area: the lab, and a data-interpreting area: an office.

The current office-lab spatial arrangements common to nearly all lab types are rooted in two important principles – move office activities out of the lab to reduce the time personnel spend exposed to hazards inherent in science work and apply Allen's work [17] – encourage scientists to interact more by reducing the distance between them as much of the time as possible.

The iterative process common to any hypothesis-driven research – design, synthesize, test, interpret the outcome – reflects different phases. Productivity in research depends on high speed of knowledge creation, hence on short feedback loops. There are times when a scientist needs information from another individual quickly, thus low barriers to access the information is helpful. There are other moments when interpreting results need longer discussions to crack a complex problem. And there are moments where a person needs to retreat to think and not to interact. The multispace area seems to allow frequent short encounters to get quick access to information while keeping several longer encounters without increasing the total time a person spends in FTF communication.

The difference between industrial research and basic research is that the former has a business objective and somewhat structured process involving different functions. Hence communication between individuals has the purpose to bring the team closer to its objective, thus not totally random. Current research management practices have favored the dissolution of silos for multidisciplinary teams. In [18] these teams are described as innovation studios.

Within these teams the generational exchange of knowledge between senior scientists and neophytes is important and multispace seems to offer the needed setting for a high level of knowledge exchange and creation. The concept is, however, limited mainly to the office areas where the infrastructure offered is similar to everybody. Within the lab, it is possible, even essential to provide an array of cellular and multispace opportunities tuned to the activity patterns of scientific testing, analysis, experimentation and observation. Yet the labs often need to support a specific scientific method, heavy equipment, specific environmental stability. The lab is a workshop designed to perform a specific task. The data-generating part of synthetic chemistry, molecular biology, ADME/toxicology, pharmacokinetics and analytical sciences require distinctly different spaces. Some of these activities are suggested to be organized as process factories in [18] depending on their output from prior process. Accommodating flexibility in the team composition between these activities would be cost-intensive because

each scientist needs expensive equipment related to his or her own field of research. Within 'process factories' economy of repetition defines the composition of groups and discipline-oriented organizational units are needed, especially within fields where the speed of knowledge creation is high [1].

Ideas and inventions occur everywhere, and scientists may spend most of their day in the lab. Thus it cannot be neglected it is a place of intensive knowledge creation. It could be argued that the cognitive perspective of creativity would prevail here.

The change from a cellular space to a multispace setting can be challenging; depending on personal preferences, emotions or the need for privacy. Yet for R&D managers being measured by the groups' productivity as a whole, multispace offers a greater flexibility than cellular spaces. The architect's job will be to enable individuals and the group to perform their tasks efficiently.

The challenge to connect physically distant activities goes beyond the multispace concept. For this purpose spaces have been created at Novartis campus to enhance chance and planned encounters between individuals that are not located in the same workspace at the level of the campus including restaurants, cafés and green areas.

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