Four archetypes of Open Science Partnerships
Connecting aims and means in open research collaborations

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Abstract
Open Science Partnerships (OSPs) are gaining attention as an alternative or supplement to university-industry collaborations with more restrictive policies on IPR and knowledge sharing. OSPs are however not a homogenous phenomenon; they differ in important respects that influence what they can be used for, and the impact they can create. This exploratory study draws on a qualitative case study of five biomedical OSPs and engagement with OSP practitioners to identify key elements in the design of OSPs. We argue that understanding the purpose of an OSP is crucial to understand how OSPs differ. We distinguish between two key components of this purpose. The first refers to the *predominant purpose* of the OSP, as indicated by the relative weight placed on the advancement of the *progress* of science vs. the advancement of the *use* of science, notably in the private sector. The second refers to the *nature of the research aims* pursued by an OSP, focusing on whether they are *directed* or *open-ended*. Based on these two components, we propose four ideal types of OSPs that highlight the varied forms that such partnerships can take. These archetypes are intended to provide a starting point for researchers interested in better understanding of the nature and scope of OSPs, and for practitioners wishing to ensure that means applied match the desired ends when designing OSPs.

1. Introduction
A number of Open Science Partnerships (OSPs) have emerged around the world. They are precompetitive public-private research partnerships that adhere to principles of open science. This includes freely sharing research outputs in the public domain and precluding participants from seeking Intellectual Property (IP) rights protection on outputs from the partnership. More specifically, Gold (2021, p. 2) defined OSPs as "private-public collaborations that have certain common elements: open access publications, open sharing of data, tools and materials and the absence of intellectual property rights that restrict improvement or use of jointly created inventions."

The open principles that define OSPs differ markedly from standard practices in precompetitive research partnerships which often restrict the sharing of outputs and allow

participants to secure the rights to any IP that may be developed in the collaboration (Stevens et al., 2016). Indeed, OSPs are typically aimed at removing "roadblocks not only to the sharing of information, but to its use" (Gold, 2021, p. 7). They seek to address long-standing challenges associated with the patenting of early-stage basic research, mitigating barriers to university-industry collaboration, and strengthening the uptake of scientific research outputs in industry and society. They can strengthen university-industry collaboration (Perkmann and Schildt, 2015) while reducing barriers to such collaboration and to the use of science (Morgan Jones et al., 2014; Morgan Jones and Chataway, 2021).

Though OSPs remain relatively rare, their number is growing, and they are gaining attention as a means of addressing long-standing challenges associated with collaborative arrangements with more restrictive policies on IPR and knowledge sharing beyond the partnership. Despite the growing interest in OSPs, they have been the subject of limited scholarly attention. Prior work tends to focus on a single OSP (Morgan Jones et al., 2014; Morgan Jones and Chataway, 2021; Perkmann and Schildt, 2015) or refers to OSPs as a general concept (Ali-Khan, Jean, and Gold, 2018; Ali-Khan et al., 2018; Gold, 2021; Gold et al., 2019). Yet OSPs are not a homogenous phenomenon. Although they share the common elements described above, they differ in many other respects, including how these elements are deployed in practice. Yet such differences have not yet been the subject of systematic study. To understand the emerging phenomenon of OSPs and their potential impact on the progress and use of science, we need to better understand how OSPs differ, and how these differences matter.

This paper takes a first step in this direction, by identifying attributes of OSPs that are useful in understanding how OSPs differ and how such differences may ultimately affect the outcomes and impact of OSPs.

We draw on prior academic work on organizational design (e.g. Burton 2006; Greenwood and Miller 2010) to identify design elements that can be used to characterize and distinguish between OSPs. Research on organizational design has proposed several models for characterizing key elements of how organizations are designed to accomplish their goals. Building on one such model put forth by Good et al. (2019), we focus on three elements of the design of OSPs: their *purpose* (i.e. what goals they exist to attain), their *activities* (what they do and how tasks are organized), and their *structure* (including how they are owned and funded, but also how key decisions about how they will pursue their goals are taken).

Using insights from case studies of five OSPs in biomedical research, we generated a list of attributes that could be used to characterize OSPs. Based on insights from interviews and from a workshop held with OSP practitioners, the relationship between organizational design components was examined.

In this exploratory study, we argue that understanding the purpose of an OSP is crucial to understand how OSPs differ. We distinguish between two key components of this purpose. The first refers to the *overarching purpose* of the OSP, as indicated by the relative weight placed on the advancement of the *progress* of science vs. the advancement of the *use* of science, notably in the private sector. The second refers to the *nature of the research aims* pursued by an OSP, focusing on whether they are *directed* or *open-ended*. Based on these two components, we propose four ideal types of OSPs that highlight the varied forms that such partnerships can take. We also investigate how the purpose of an OSP shapes key attributes of

its activities and structure, including how they are governed and how their openness principles are translated into practice.

2. Data and method

Given the limited prior work on OSPs and the emerging nature of the phenomenon of OSPs, we took an exploratory approach to this study. Moreover, given the limited prior research on OSPs, we chose an inductive approach to ensure that the characterization of the design of OSPs was informed by real-world cases. To this end, we undertook qualitative case studies of five OSPs within the biomedical field, in which the vast majority of OSPs has emerged. The selected OSPs were identified through internet searches and assessed according to the following criteria: they had to (i) have formal, goal-oriented agreements among at least one public academic partner and at least one private sector partner; (ii) have an explicit focus on open sharing of knowledge, data, tools, materials and other research outputs with no (or minimal) restrictions on sharing and further use of research outputs; (iii) be ongoing at the time of study or terminated within the past five years.

We identified five OSPs that met these criteria: The Structural Genomics Consortium (SGC); Open Targets (OT); The Enabling & Unlocking Biology in the OPEN (EUbOPEN); The Early Drug Discovery Unit (EDDU); and The Open Discovery Innovation Network (ODIN). These OSPs are briefly described in Table 1.

Data was collected initially through a document study of publicly available material and semi-structured interviews with representatives of each OSP, undertaken in late 2021 and early 2022 to identify common features and relevant singularities across OSPs.

Based on data gathered through this document study and interviews, the organizational design of each of the five OSPs studied was characterized according to the three design elements identified above: their purpose, their activities and their structure.

Using insights gathered through the interviews, we identified as many *components* to describe the OSPs' purpose, activities and structure as we could. Interview data were also used to generate possible *attributes* for each of these components, that is, to identify possible states. As a result, a list of OSP design components and possible attributes of those components was generated.

For instance, one of the components of OSPs' activities is the *scale of its activities*; for this component, we identified two attributes: *large scale* and *limited scale*. With access to data on more OSPs, the list of components could presumably be extended, and the range of possible attributes more fine-grained. Thus, the design components and attributes identified here should be seen as a preliminary attempt to better understand key features of how OSPs are designed.

The preliminary set of possible components and attributes for characterising OSPs was then explored in a second round of interviews in early 2023. The aim of these interviews was to validate the list and gather missing data on OSP attributes identified after the first round of interviews.

Table 1. Presentation of the five OSPs included in the comparative study

OSP	Brief description
Structural Genomics Consortium (SGC)	SGC is a registered charity whose mission is to accelerate the discovery of new medicines using open science. Its research operations are funded by pharmaceutical companies, governments, and charities who both participate as research partners and in the governance of the partnership. SGC was founded in 2003 as a result of interactions between Glaxo-SmithKline scientists and officials from the Wellcome Trust, inspired by the Human Genome Project. There have been different phases since the beginning of the initiative, with each phase having different goals and different funders. The SGC is currently in its 5th phase (2020-2025). SGC is funded by a combination of philanthropic, government, and industry funding. Initially, the SGC was started with funding from the Wellcome Trust, GlaxoSmithKline, and the Canadian and UK governments. Today, the SGC has a broad range of funders and is operated at different laboratories in Canada, the UK, and the EU.
Open Targets (OT)	OT is a large-scale, multi-year partnership that uses human genetics and genomics data for systematic drug target identification and prioritisation. It was established in 2014 with seed funding from GSK as Centre for Therapeutic Target Validation, but was rebranded in 2016 as Open Targets. It's located at the Wellcome Genome Campus in the United Kingdom, and announced in 2019 that it had been renewed for another 5-year period.
EUbOPEN	EUbOPEN aims to generate open-access tools to unlock disease biology, primarily inflammatory related. The partnership is funded by the Innovation Medicines Initiative (IMI) who granted the project 65.8 million euros. The funding also includes cash and in-kind contributions from companies, non-EU partners, and partners associated with IMI. The project began in 2020 and has a duration of five years.
Early Drug Discovery Unit (EDDU)	EDDU is part of the umbrella of open science initiatives at the Neuro (the Montreal Neurological Institute-Hospital), a research and teaching institute at McGill University in Canada. In 2016, the Neuro implemented an open science initiative, which was established by the Montreal Neurological Institute (MNI) at the Faculty of Medicine at McGill University, initiated by the director and executive team of the MNI.The open science initiative at the Neuro was originally launched as a five-year experiment (2016-2021). EDDU is an open collaboration among academia, industry partners, and funding partners with the aim to accelerate drug discovery and improve access to treatments for people suffering from neurological diseases. It was initially launched in 2015 as the iPSC/CRISPR Platform with a focus on Parkinson's disease. In 2019, the iPSC/CRISPR Platform became known as EDDU. EDDU lists both philanthropic and industry partners.
Open Discovery Innovation Network (ODIN)	ODIN is a 3-year pilot project (2020-2023) funded by the philanthropic organisation the Novo Nordisk Foundation. It is anchored at Aarhus University in Denmark. It is a platform where academic and industrial researchers can co-create research projects that will help pave the way for better and more efficient drugs in the future. ODIN provides funding for collaborative projects among researchers at Aarhus University and private sector firms. These projects are selected on a competitive basis.

Based on insights from these interviews, an online workshop was held in March 2023 with representatives from the OSPs to discuss key organizational design elements of OSPs and useful and meaningful dimensions for developing archetypes. Thus, the archetypes proposed in this paper draw on findings from the case studies as well as insights and experiences from practitioners developing and leading OSPs initiatives.

3. Results

Characterising the organizational design of OSPs

Guiding by the three organizational design elements identified above – the purpose, activities and structure of an organization – and the data collected on the five OSPs included in the study, a list of design components was developed. These components can be seen in Table 2, which also lists the attributes or possible states of these components.

For some design components, the attributes were mutually exclusive; for others, they were not. As alluded to earlier, the attributes listed should not be seen as exhaustive of the potential option space that exists, but only captures the variation that could be identified in the five OSPs examined in this exploratory study.

Table 2. Identified components and attributes of the organizational design of OSPs

Element	**Components**	**Attributes**		
Purpose	Predominant purpose	Advance the *progress* of science (i.e. the advancement and speed of scientific progress)	Advance the *use* of science (i.e. focus on uptake and application of science in industry)	
	Nature of the research aims	Directed (specified research aims)	Open-ended (broad scope of research aims)	
Activities	Organization of research activities	Top-down designed research programs)	Bottom-up developed research projects)	
	Relatedness of research activities	Related/cohesive	Unrelated/disparate	
	Scale of research activities	Large scale	Limited scale	
	Openness to entry	Restricted / discriminatory access	Non-discriminatory access	
	Open sharing in the public domain	Mediated	Automatic	
Structure	Ownership (autonomy)	Independent (autonomous unit)	Consortium (joint venture)	Embedded in a university (internal unit)
	Decision-making authority	Concentrated	Distributed	
	Influence of industry participants	Limited	Significant	

Two key design components reflect the purpose of an OSP
Our study revealed significant differences across the OSPs examined. These differences set the conditions under which the OSPs operate and ultimately shape their outcomes. Based on interviews and the online workshop held with OSP practitioners, key design features of OSPs could consistently, and not surprisingly, be traced back to the purpose that the OSPs were established to serve. As outlined in Table 2, we identified two components of that purpose.

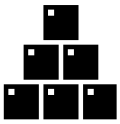
The first of these components is the *predominant purpose* of the OSP. This refers to the overarching motivation to establish the OSP, understood as the main intended impact by which the OSP would ultimately be assessed. While all the OSPs examined referred both to purposes related to advancing the progress and speed of science as well as to purposes related to bolstering the uptake and application of scientific results in the private sector, the OSPs differed in the relative weight given to these two sets of purposes, meaning that a predominant aim could be discerned. Some stated motivations of OSPs give priority to scientific missions over industrial applications. An example of an OSP oriented primarily towards scientific goals is the SGC, which aims to advance and enhance the quality of scientific research that ultimately seeds the development of new drug discovery programs. Meanwhile, other OSPs more explicitly emphasise the involvement of, and expected impact on, industry, including Open Targets which is aimed at decreasing the difficulties and costs associated with drug development, and ODIN, which was established to increase and accelerate the use of science in industry. The two main attributes identified for the predominant purpose of OSPs are therefore: *advance the progress of science* and *advance the use of science*.

The second component identified to describe the purpose of OSPs is the *nature of the research aims* pursued. The possible attributes identified for this component are whether the research aims are *directed* or *open-ended*. Some of the OSPs examined pursue very specific aims. For instance, the SGC's mission is to understand all proteins encoded by the human genome in order to accelerate the discovery of new medicines. Other OSPs are motivated not by a desire to achieve specific research objectives but rather to promote open research and collaboration within a given topic. For instance, the EDDU's mission is to undertake fundamental research that can lead to the development of new and improved treatments for neurological disorders. What their activities have in common is that they build on induced pluripotent stem cells, but the individual activities themselves can differ greatly in scope and aims. Similarly, ODIN was established to promote open university-industry collaboration within early-stage drug discovery research. ODIN has funded projects within two thematic areas, biomarkers and target validation, but these were selected not due to specific scientific aims but because they were deemed well-suited for open, precompetitive collaboration.

Four archetypes of OSPs – distinguished by differences in the ends they pursue
Based on the two components describe above, we propose four archetypes of OSPs, defined by the stated purpose they were established to serve, and illustrated in Figure 1.

The aim of the archetypes is not to characterise the five OSPs studied. Rather, the archetypes should be seen as ideal types of OSPs that underline that different ends call for different means. The aims of OSPs shape their design and, ultimately, their impact. A real-life OSP may not fit neatly into any one archetype and may even have aspects of multiple archetypes.

Figure 1. Four archetypes of OSPs

		Predominant purpose	
		Advance progress of science	Advance use of science
Research Aims	Directed	**THE MISSION** 	**THE CLUB** 
	Open-ended	**THE INFRASTRUCTURE** 	**THE HUB** 

1. *The mission* refers to OSPs that are directed towards specific research aims and attached greater weight in their stated purpose on advancing the progress of science than on advancing the use of that science by e.g. the private sector. The core activities of the SGC to understand the functions of proteins encoded in the human genome would be an example of this.

2. *The infrastructure* is also primarily scientifically-driven, but rather than concentrating on certain research aims, it pursues activities that build on an existing scientific infrastructure, biobank, set of methods or the like. EDDU provides an example of collaboration built on its existing capabilities and infrastructure to work with induced pluripotent stem cells.

3. Among the OSP archetypes that attach greater relative weight to supporting the use of science to bolster innovation in industry, we find the *club*, which refers to industry-oriented, directed partnerships pursuing specific research goals. Open Targets is an example of a partnership that has developed a trusted and bounded collaboration amongst selected pharmaceutical companies and research labs to accelerate target identification and validation in key strategic areas of interest for the industry participants.

4. Finally, the *hub*, like the infrastructure, is open-ended in its research aims. Unlike the infrastructure, however, its focus is on providing a platform for academic-industry collaboration. ODIN is an example of an OSP which stimulates needs-oriented basic research collaborations developed and executed in close collaboration with industry partners, resulting in a portfolio of heterogeneous activities developed by project participants.

OSP archetypes and the means they employ to pursue desired ends

We argue that understanding the purpose of an OSP is crucial to understanding other key design features, including how the OSP is governed and how openness is implemented in practice. In the following, we examine how the purpose of an OSP – as synthesized into the four archetypes – affects other key design characteristics of the four archetypes in Table 3 and in the following.

Table 3. Design component attributes, by OSP archetype

Components \ Archetypes	The mission	The infrastructure	The club	The hub
Purpose (archetype-defining components)				
Predominant purpose	Advance the progress of science	Advance the progress of science	Advance the use of science	Advance the use of science
Nature of research aims	Directed	Open-ended	Directed	Open-ended
Activities				
Organization of research activities *	Top-down designed research programs	Bottom-up developed research projects	Top-down designed research programs	Bottom-up developed research projects
Relatedness of research activities *	Related/ cohesive	Unrelated/ disparate	Related/ cohesive	Unrelated/ disparate
Scale of research activities *	Large scale	Limited scale	Large scale	Limited scale
Openness to entry	No clear pattern	No clear pattern	No clear pattern	No clear pattern
Open sharing †	Automatic	Automatic	Mediated	Mediated
Structure				
Ownership (autonomy) *	Independent organization	Embedded/ independent organization	Independent organization	Embedded/ independent organization
Decision-making authority	Concentrated	Concentrated	Concentrated	Distributed
Influence of industry participants †	Limited	Limited	Significant	Significant

* Component appears linked to the purpose component *predominant purpose.*
† Component appears linked to the purpose component *nature of research aims.*

As indicated by the symbols in the table, most of the components of the activities and structure of OSPs appear to be shaped by the components of their purpose.

Based on insights from the interviews with the five OSPs studied, and the online workshop with OSP practitioners, design components that appear to be shaped by the nature of research aims of the OSP are:

- *Organization of research activities:* OSPs with directed, specified goals are likely to have top-down designed research programs that ensure that activities set in motion will actually be able to realize the chosen goals. In contrast, OSPs with open-ended goals tend to have bottom-up developed projects that can have little in common other than building on a common infrastructure or emerging from the same collaborative hub.

- *Related of research activities:* Similarly, activities within a directed OSP are likely to be related and/or complementary, to allow for coordinated efforts to contribute towards a shared goal. Activities within an OSP with open-ended goals are, unsurprisingly, not necessarily related or coordinated in any way.

- *Scale of research activities:* Specified goals pursued in a coordinated research program are likely to involve a larger scale of activities, incl. for instance high-throughput, high-efficiency set-ups. OSPs with open-ended goals and a more fragmented, bottom-up developed set of activities are less likely to have the need or resources for large-scale set-ups.

- *Ownership (autonomy):* The five OSPs examined had very different organizational set-ups. The relationship between purpose and ownership is not entirely clear, but the exploratory study indicates that large-scale directed programs are likely to involve multiple partners and thus likely to take form as independent organizations e.g. independent legal entities like the SGC or distinct research consortia like EUbOPEN and Open Targets. In contrast, open-ended OSPs would be less reliant on a given organizational forma and could in principle be either independent or embedded in a university.

Design components that appear to be shaped by the predominant purpose of the OSP are:

- *Open sharing:* OSPs with a greater relative focus on advancing the *use* as opposed to the *progress* of science are more likely to give participants i.e. options for mediating open sharing, including e.g. reviewing public disclosures for potential IP or possibilities to delay the timing of disclosure. These were described by one practitioner as “safety valves” rarely if ever used, but which can mitigate perceived risks for industry partners in open science collaborations. OSPs focused primarily on the advancement of science are likely to have extensive and strict protocols for the public sharing of outputs from the OSP.

- *Influence of industry participants:* Unsurprisingly, OSPs with a greater relative focus on enabling the uptake and application of science are likely to give industry participants greater opportunities to influence key decisions about e.g. activities pursued than OSPs with a greater relative focus on the advancement of science.

Design components that could not be clearly linked to the purpose of OSPs are:

- *Openness to entry:* While it might have been expected that OSPs with a greater relative focus on science *use* might have more barriers to entry, the exploratory case studies do not suggest this. Only in one of the cases studied was this linked to restrictions on access to OSP. However, the case studies suggest that a range of factors may have a de facto effect on entry into OSPs. For instance, in large-scale activities such as missions and clubs, the substantial resources needed can lead to sizeable fees for entry, which can create barriers to entry even if there are no official barriers to entry. In infrastructure and hubs, requirements of industry partners to contribute financially or through in-kind contributions may also create de factor barriers for some firms to participate.

- *Decision-making authority:* Again, this aspect of the governance of an OSP could have been expected to be linked to the relative focus on the progress vs. use of science or the directed vs. open-ended research aims, but the exploratory study painted a more nuanced picture. Arguments for concentrating decision-making authority could be associated with the need to ensure tight coordination of a large-scale research program in an OSP with directed aims, or as a means of offering influence to key industry partners in an OSP with emphasis on bolstering the use of science to foster innovation in industry. Yet other factors also appear to affect how decision-making authority is allocated. In an infrastructure OSP, for instance, concentrated decision-making authority can be crucial to ensure that the total portfolio of projects adheres to key principles guiding collaboration with the infrastructure; in a hub OSP, key decisions about activities within the projects are allocated to the individual projects, given the more fragmented nature of activities within such OSPs.

4. Discussion

The growing phenomenon of OSPs calls for fine-grained approaches that are capable of exploring potential implications in the practice of research in domains where collaborative arrangements are usually shaped by IP and in the valorisation of this change in knowledge flows and technology transfer processes.

Towards that goal, our findings demonstrate that despite some fundamental similarities, OSPs are not a homogeneous phenomenon. On the contrary, the OSPs examined show important organisational variety. Taking an organizational design perspective, we argue that the purpose of an OSP shapes other key design features of OSPs and proposed four archetypes of OSPs that connect desired ends to the means that must be deployed to achieve those ends.

It should be underlined that the propositions put forth above are exploratory, as they are based on insights from just five OSPs. As the number of OSPs increases, and more data can be considered, the list of design components and attributes, and our understanding of the relationships between them, can be expanded and become more fine-grained. In particular, exploring mechanisms that can be used to mediate openness in and from the OSP are interesting to delve deeper into, for instance with regards to how they ultimately affect the level of openness of these partnerships.

Moreover, it should be stressed again that the archetypes represent ideal types, and not necessarily real-life OSPs. In practice, an OSP may include multiple programs and projects that fit into different ideal types. The purpose of the archetypes we propose is not to capture

the full complexity of individual OSPs but to highlight crucial differences in their objectives, which affect the way in which OSPs are designed.

Future work could not only seek to validate and extend the archetypes we propose, but also delve deeper into them, for instance investigate factors affecting the suitability of different OSP archetypes in different contexts. Further work could also examine key success factors in different OSPs, as these are likely to differ across archetypes. For instance, for mission OSPs, maintaining a high-performing, high-efficiency and high-throughput operation is likely to be crucial, as well as ensuring buy-in from critical partners and funders with limited influence on the overall aims of the mission. For infrastructure OSPs, the quality and scope of potential applications of the infrastructure are likely to matter for its success, as well as its ability to build an appropriate portfolio of activities over time. For clubs, key challenges may involve making sure that the moving parts fit together as intended, and ensuring that safety valves do not undermine the open principles of the OSP. Finally, for hub OSPs, ensuring intermediation that adds value to the development of collaborations and projects is likely to be crucial, as well as ensuring that distributed activities in distinct projects adhere to key principles and overall aims of the OSP.

Ultimately, our exploratory thus attempts to shed light on an emerging phenomenon to offer an informed starting point for researchers interested in a better understanding of the nature and scope of OSPs, and for practitioners developing OSPs and wishing to ensure that the means they apply match the desired ends. Our proposed archetypes are intended to serve as a managerial inspiration for the design and development of future OSPs, particularly for practitioners and funders, by fostering informed decisions about critical goals and how to organise an OSP to serve its purpose.

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Open science practices

The document studies undertaken and the OSP descriptions developed in connection with the comparative study presented in this paper can be shared, though they have not yet been made openly available. The paper also draws on interview data, which due to GDPR issues is not shared openly, but which can be shared subsequent to removal of personal data.
Moreover, the study draws on close engagement of OSP practitioners from the OSPs included in our comparative study.

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