Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

> *"I think we need much greater connective tissue" among all of the players – government, industry, academia and philanthropy. "We need more efficiency, more interaction, more collaboration."*
>
> Kelvin Droegemeier,
> Director of the White House Office of Science and Technology Policy

The image of the triple helix with three forces spiraling around each other has proven to be a powerful and inspiring image of the collaboration between government, business, and academia. The partners in such collaborative arrangements no doubt share an interest in making the collaboration successful. However, they also have specific interests and goals of their own. Too many triple helix arrangements have failed, because they did not consider this basic fact. Achieving their own goals is not necessarily the intention with which partners enter the collaborative effort, but they may well end up following this strategy. We start this paper with a brief description of what can be considered a typical case of 'successful failure' in a triple helix organization. We then review the literature regarding reasons for success or failure of triple helix organizations. We find that transparency and credible sanctions for self-interested behaviour are important requirements for successful triple helix arrangements. We then use notions from cybernetics and organizational design to develop basic rules for the design of triple helix arrangements. Basically, these rules and arrangements aim to ensure that self-interest and common purpose will concur.

Introduction

Collaborative arrangements in research, development, or innovation between universities and other public research institutions, private companies and government, or government agencies (so-called 'triple helix' arrangements) are of key importance for technological and economic progress. While these arrangements were more or less accidental in the past and/or guided by specific interests like national security (armaments) or international prestige (outer space), they are now increasingly seen as 'systems of innovation' that can be subject to conscious management, regulation, and organization (Cavallini et al. 2016; Mazzucato 2013).

The expression 'triple helix' was coined by Etzkowitz and Leydesdorff (1998, 2000) to refer to the complex interactions between the three types of actors involved. It obviously refers to the famous 'double helix' structure of DNA, discovered in the early 1950s. A DNA molecule consists of two strands that wind around each other and are connected in various places, so that the structure looks like a twisted ladder. The image of the triple helix emphasizes the relative independence of the three actors spiralling around each other over time. Government and/or business are usually the sources of funding, while research takes place at universities and/or business; and innovation takes place in business. There is usually only one government (or government agency) involved, but there may be more than one company or university participating. The arrangement can refer to a single project, to a program consisting of many projects, or to an organization or agency in which the three parties collaborate, for instance, through representatives in a steering board as part of a regional development effort. In the following, we will mainly speak of 'projects', but the argument basically refers to all forms of triple helix organizations.

Some authors have introduced civil society as a fourth type of actor and consequently speak of a 'quadruple helix' (Arnkil et al., 2010). Philanthropy, mentioned by U.S. President Donald Trump's science adviser in the introductory quotation, can be considered as one possible representative of civil society. The argument of this paper does not depend on the number of actors involved. We limit ourselves to 'triple helix' because it is the most commonly used expression. Carayannis and Campbell (2010, 2012) have gone even further and

Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

included the natural environment as a fifth element in a 'quintuple helix'. We don't think this is very helpful. Although the importance of the natural environment for innovation cannot be denied, it is somewhat confusing to consider the natural environment as an 'actor' in the same way that the other four actors are. One could indeed argue that climate change and other environmental problems have been caused by the fact that the natural environment cannot (re)act in the way that human beings and their organizations do.

The three types of actors in the triple helix are very different in history, culture, and purpose. They enter into collaboration with very different interests: companies hope to achieve competitive advantage, universities are interested in scientific publications, government hopes for improved performance of the economy, more employment, more progress in the development and implementation of specific technologies, or the achievement of other public goals, for instance, with regard to climate change. The participating actors may agree on the need to investigate specific problems or to develop specific technologies, but once the money has been allocated, researchers want to be left alone, companies sit on their intellectual property rights, and governments can only guess if public goals have been achieved efficiently, if at all. Efforts to gain more control often result in cost-increasing bureaucratic rules. More often than not, projects or programs are proclaimed to be successful, because none of the parties involved is interested in saying that targets have not been met.

In this paper we develop some design rules for triple helix arrangements that have the specific aim of keeping all parties involved, focused on an agreed common goal. As a further introduction to the issue at hand, we sketch the problems of a recent project in which we were involved ourselves (section 1). In section 2, we briefly review the literature on the causes of success and failure of triple helix arrangements. We find considerable attention to issues of management and leadership, but relatively little to the conditions that allow management and leadership to be effective.

The paper provides insights into the necessary conditions for effective leadership. These conditions constitute the substance of the design rules presented in section 3. Building on insights acquired in the first two sections, we use notions from cybernetics and organizational design to develop design rules for triple helix organizations. These rules aim to create an environment that influences the behaviour of all participating parties in such a way that they see it as being in their best interest to act in the way they had promised in the first place, that is, to serve the common purpose. Before concluding, we briefly react to two objections frequently made to our approach.

1. A Case of Successful Failure of a Triple Helix Organization

A couple of years ago, our department was involved in a large research program funded by a multinational company. It involved a technical university, the research department of the multinational in question, and a partially government-funded independent research organization. On top of staff contributions from the three participating organizations, 40 PhD projects were initiated. The purpose of the program was to develop an integrated approach to the application of a wide range of technologies needed to improve the production operations of the multinational in question. The underlying problem was that many of these technologies had been developed, or at least been identified, but so far, the different pieces of the puzzle had not fit together so that implementation in actual production was slow in spite of the fact that considerable investment had already been made in these technologies. The involvement of our department in the program was relatively limited. We were approached to help think about technological implications for how work is organized in the various production locations of the multinational, and also about organizing the research program itself.

After the program had run its course (after about five years), two further activities were initiated: one involving the multinational and the technical university, and the other involving the independent research organization, the technical university and several companies from the same industry as the original partner. These two programs have meanwhile also been completed. Was the original program a success or a failure? The fact that similar follow-up activities were initiated does suggest that it was considered successful. One of the difficulties in answering this question is that it is not so easy to (re)construct a measure of success. Obviously, the true measure of success would be the achievement of an integrated technology solution as envisaged at the start of the program. However, that didn't happen; or at least, far less than hoped for. Nevertheless, all participating partners were quite satisfied with the program results. The technical university received funding for a large number of PhDs. The professors supervising the PhD projects generated new publications in their areas of expertise. The independent research organization was happy to have access to a considerable flow of new

knowledge, with which it could hope to acquire new industry research contracts. The multinational company was happy to have direct access to university research and especially to be able to recruit candidates among the 40 PhD students. Clearly, apart from the official goal of the program, all partners had their own goals or at least an understanding of the minimum that they would be able to get out of the program.

One of the reasons that the integration effort did not get as far as expected was that staff at the multinational's research lab suffered from the not-invented-here syndrome, that is, they were more interested in developing their own solutions internally than adopting solutions coming from outside. Another reason was that neither the researchers from the partner organizations nor the 40 PhD students were located in one place. Face-to-face contacts in different locations were limited and specialists tended to cluster with their own kind. Moreover, neither the university professors nor the PhD students were very motivated to spend a lot of time integrating their results with those of others. The main goal of the PhD students was to complete their dissertation within the time available, and they therefore were reluctant to spend time communicating about things not immediately relevant to their own project. The 40 projects had been defined to form a more or less coherent program, but once started the projects tended to develop their own logic and it was difficult to keep them on the originally planned track.

Program management was present to organize program meetings for participants, but was not very strong. It's not that they were incompetent or bad managers; they simply didn't have the power to take corrective action, to keep projects on track, or to force people to spend more time on integration. And even if they would have had such power, they seldom had enough information to find out if projects were proceeding as planned and if enough attention was paid to integration efforts.

In the following section, we take a look at the literature on success and failure of triple helix organizations to find out recommendations that would help avoid the kind of problems encountered in this case.

2. Literature Insights on Factors Contributing to Triple Helix Success and Failure

The literature on triple helix collaboration provides a considerable number of factors that contribute to the success of a project or program. One of them frequently mentioned is 'trust', but this begs the question how trust becomes established and how it remains alive over the course of a project.

Scheirer (2005) reviews 19 empirical studies of the sustainability (in the sense of long-run survival) of American and Canadian health-related programs. On the basis of her cross-study analysis, she argues that five important factors influence the extent of sustainability: (a) the possibility to modify the program over time, (b) the presence of a "champion", (c) a clear "fit" between the program and the mission and procedures of the organization that is mainly responsible, (d) the presence of readily perceived benefits to staff members and/or clients, and (e) support from stakeholders in other participating organizations.

Gray et al. (2011) study five cases of industry–university cooperative research centres in order to identify possible causes of success and failure. Their findings largely confirm Scheirer's observations, but they argue that the deeper single cause of success or failure is leadership or lack thereof. In their analysis, all failure cases involved leadership shortcomings. Directors did not devote enough time or were marginalized in their organization (for example, because they were not tenured). Some directors departed without a successor picking up where they left off. Even if there was continuity in leadership, there was failure in adapting the centre to changing environmental requirements. In contrast, the only successful centre studied exhibited both continuity in leadership and effective coping with environmental turbulence.

Gray et al. (2011) also point to some "fatal flaws" that will quickly lead to failure in research centres. These flaws are less organizational, and have more to do with the capabilities and motivations of the participating organizations. Companies may have insufficient absorptive capacity to make knowledge transfer possible. Or they may have the capacity, but be unwilling to share knowledge with others and/or value IPR (Intellectual Property Rights) such that they do not want to run the risk of scientists claiming some of their findings. Moreover, although university staff may be motivated, institutional support from the university may not be forthcoming. The university board may in the end be more interested in scientific publications than in collaboration with companies, especially if this involves focusing on problems in the region instead of global science problems.

In an assessment of a mobility-related program in the Netherlands, Bressers (2012) found that researchers and

Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

consultants so much dominated the program that the "demand side", that is, the government that paid for the whole program, was not really heard. However, because research fulfilled all formal requirements, government representatives saw no possibility to modify the program according to their interests. Instead, they more or less withdrew. In a similar vein, Amaral (2015) found that lack of government involvement is an important explanation for lack of growth and "maturation" of triple helix projects. At the same time, he finds that local governments lack the expertise to actively intervene in innovation processes. This problem is exacerbated when the project's management lacks experience in dealing with a large diversity of participants.

Ranga and Etzkowitz (2013) argue that triadic entities (like triple helix programs) have a higher potential than dyadic entities for turning tension and conflict of interest into convergence and confluence of interest. They see an important role for "conflict moderation" (in which government agencies can play a role) and "collaborative leadership". In their concluding section, however, they emphasize the importance of the "motivation" of triple helix actors, "to engage in joint projects and set common goals". It remains unclear, however, under what circumstances the actors' "motivation" will be sustained over time.

A "practical guide" for connecting universities to regional growth, published by the European Commission (Goddard, 2011), does indicate that collaboration between universities, companies, and public authorities is not a matter of course. It provides a detailed discussion of the ways in which regional demand and knowledge supply can be brought together, and emphasizes the need for public authorities to clearly specify the needs of the region. Several case studies in the guide point to "enablers" of success, but there is no discussion of the organization and management of collaborative projects beyond the general observation that "leadership" is important and should be formally organized at the regional level with high-ranking representatives of participating parties.

Having looked over the literature, we find that program evaluations as well as case studies focus on the proclaimed goal of a triple helix project, but pay little attention to the particular and possibly diverging interests of participating parties. The main exception is constituted by conflicts of interest with regard to IPR that frequently arise in collaborations between companies and universities, especially when companies are not paying 100% of the bill, or when potentially competing companies are involved (Perkmann et al. 2013). However, here too, it is usually argued that "moderation" and "leadership" will help sort things out. It remains unclear under what conditions leadership and moderation can be effective.

Trust is an important issue in any collaborative scheme. Partners in a triple helix project promise each other to contribute to a joint effort. It can be safely assumed that at the start of the project, all partners in a triple helix project are prepared to collaborate However, collaboration takes time and many things can happen that have an impact on the willingness to collaborate: managers, professors, politicians and civil servants come and go; research goes into an academically interesting direction, but the interest of the companies involved goes into another direction; political priorities change; each partner has a different time horizon regarding success. So once the project is underway, there are many reasons why partners may start to lower their expectations. If any partner expects that (some of) the other partners will not contribute as promised, this partner will start to focus on the things he wanted to do anyway and before long all the others will follow.

In the studies on success and failure of triple helix organizations, the possibility of sanctioning lack of cooperation and selfish behaviour is seldom mentioned. The emphasis on leadership and the need to involve 'high ranking' people in supervisory functions does seem to suggest that such people have the power to sanction in one way or another. Of course, leadership does not only consist of punishing people; leadership can also be inspiring and supportive. However, leadership without the ability to show its teeth is likely to be ineffective. This insight also provides us with a different perspective on the need for mutual trust that is so frequently mentioned in the literature. Trust in the behavior of others arises from the conviction that they will be punished if they do not behave as promised.

Sanctions are only possible if leadership is informed about what is going on. Conversely, reporting obligations in triple helix projects don't make much sense, if there are no sanctions in the background. Reporting obligations can be bureaucratic and burdensome. Moreover, the reporting is often self-reporting and therefore not necessarily very reliable. We conclude that the presence of reliable information about the behaviour of partners and empowerment of management to sanction unwanted behaviour are important requirements for the design of triple helix organizations.

Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

3. Design Rules for Triple Helix Organizations

Collaboration is a central theme of organization theory and design. Organizations are usually defined in terms of people collaborating for a common goal. Yet it is also generally recognized that people in organizations also have goals of their own. In fact, they may not be interested at all in the goals of the organization, only contributing to it because they get paid for it. That is why motivation is an important aspect in organization design (Wiley, 1997). Motivation can be intrinsic, if the individual has "internalized" the goals of the organization and largely considers them to be identical with his or her own goals. It can also be extrinsic, guided by a system of rewards and punishments. Although modern organizations prefer to emphasize intrinsic motivation, if only because knowledge-intensive work is difficult to subject to objective measurement and control (Adler & Chen, 2011), they usually also evaluate individual performance and eventually dismiss people who do not perform well.

In the previous sections we saw that transparent behaviour and empowered leadership are important organizational requirements for successful collaboration. The following design rules aim to fulfil these requirements. For this purpose, we make use of basic tools from cybernetics and organization design. From cybernetics we draw on the feedback cycle (Ashby, 1956; De Sitter et al., 1996), which with regard to a process consists of the activities measurement or registration (of results), evaluation (against a target), and intervention (if the target has not been reached). An important issue in cybernetics is the possibility of assigning some or all of these three activities to separate actors, which differ from the persons carrying out the process in question. If the persons in the process take care of their own feedback cycle, one can speak of self-regulation (self-reporting, self-evaluation, and self-correction). From theories of organization design, we take the following notions: the centrality of the external demands made on the organization for the organization design (Nadler & Tushman, 1997; Galbraith, 2002), the distinction and separation between performance and control (Hackman, 1990; De Sitter et al., 1996; Burton & Obel, 2018), and the view of organizations as information processing systems (Galbraith, 1974; Simon, 1996).

Design Rule 1. The purpose of the collaborative triple helix effort should be clearly stated.
Organization design starts with demands made upon an organization. Although this may seem self-evident, lack of clarity or imprecision with regard to purpose is the first step toward failure.

Design Rule 2. Contributions of each partner should be specified in detail.
It should be specified as clearly as possible what each partner is expected to contribute to the project. These contributions should not just be specified in number of hours or for instance "two PhD theses", but also spelled out what is supposed to be done in these hours, and how the work (for instance, a PhD thesis) will contribute to the purpose of the project. Primary contributions like money and time should naturally be specified, but also secondary contributions like the obligation of a participating company to provide data, or to engage in serious discussions about the results of a researcher's work.

Design Rule 3. It should be specified as clearly as possible what each partner hopes to get out of the project.
Note that we are not speaking of the project's purpose here, but rather about the benefits participants hope to receive from the project. Sometimes, a party's contribution and the possible benefits seem almost identical. For the participating university, and certainly for the PhD student, having a PhD thesis completed is already valuable, regardless of whether it contributes to the project's goal. For the project, however, it is important that the thesis produces useful knowledge that can be implemented by the participating companies. In that case, somebody's contribution becomes somebody else's benefit. The expectations of government, which is often only a financial contributor, should also be clearly specified. As we have seen (Bressers, 2012), lack of specified government expectations may lead to spending money on activities the government isn't really interested in. Successful triple helix projects instead are projects in which government is not just a source of finance, but also an active partner with interests of its own (Amaral, 2015).

Design Rule 4. Contributions and expected benefits should be laid down in a document and discussed at kick-off.
The common purpose, contributions, and expected benefits of each party, should be specified in such a way that they are measurable, preferably quantifiable, so that progress can be measured over time. This information should be laid down in a document that should be available for discussion at the kick-off meeting. A deep understanding of each other's possible contributions and expectations will be helpful throughout the duration of the project. Specifying the expectations of all partners

at the start may also lead to a reformulation or further clarification of project goals.

Design Rule 5. An independent evaluator should be part of the project from the beginning.
It is desirable to have an evaluator or evaluating party participating in the project. The evaluator should be independent from all other participating parties, so that there is no reason to consider him biased. The evaluator will collect management information. Moreover, such concurrent project evaluation is usually cheaper and more informed than ex-post evaluation.

Design Rule 6. The evaluator's task is to regularly collect information on the activities of all partners.
The evaluator is charged with drawing up the kick-off document and with regularly collecting data on project activities, producing progress reports, and comparing progress with the promises and expectations laid down at the start of the project, that is, producing (interim) evaluation reports.

Design Rule 7. Evaluator reports are made available to all participants.
Transparency requires that information concerning the project's progress with regard to contributions and targets should be made available regularly to everyone involved.

The evaluator carries out most of the work collecting and reporting on data. This way, some of the drawbacks of self-reporting can be avoided. Nevertheless, participants are required to provide data to the evaluator at their request. In that sense, there will still be self-reporting, but a third party (the evaluator) now critically reviews the data provided by each partner.

Design Rule 8. Project management is tasked with ensuring collaboration by all parties.
Project management is specifically charged with promoting the overall purpose of the collaborative exercise. It must see to it that all partners effectively collaborate as promised. Informed by evaluation reports, and by its own experienced estimation of the situation, project management makes ready action if necessary.

Design Rule 9. Project management is empowered to sanction undesirable behaviour.
Management has the power to withhold rewards or in other ways punish partners who do not fulfil their obligations as specified in the project's kick-off document and underlying contracts. Real leadership, however, means that there is no automatic sanctioning, if someone does not fulfil their obligations.

Design Rule 10. Project management decides if action is necessary on the basis of evaluator reports and other available information.
Leadership is also about understanding and forgiving. There may be good reasons for undesirable behaviour that became visible in an evaluation report. Project management may decide not to intervene, but it will have to explain its actions to the partners, because evaluation reports are visible to all. Note that intervention by project management and evaluation are separate activities. Evaluation reports should be as much as possible factual reports, simply comparing what happened with what was supposed to happen, and providing evidence as collected in data and other documentation. If a party does not agree with an evaluation in a report, the discussion should not be with the evaluator, but rather with project management.

Design Rule 11. Project management is ideally independent of the participating parties.
In smaller, one-off projects, project management often comes from one of the participating parties, usually the leading party in the project. The project manager will thus be seen by the others primarily as a representative of his or her own company or institution. And in such a case, if their own organization fails to deliver as promised, it will be difficult if not impossible to start sanctioning partners. In larger programs, it is often possible to have the far better organizational device of an independent party, consultancy or agency taking the role of project management. Independent project management may also have interests of its own, but these will seldom concur entirely with any of the other parties. After all, an independent project manager has an interest in getting more similar jobs in the future, and would like to be known as someone who keeps programs and projects on course.

4. Discussion

These design rules aim to create a working environment in which it is difficult for project actors to deviate from their promises. What is proposed here is to assign the different elements of a cybernetic feedback cycle to different actors. Registration (or measurement) is done by the participants themselves and by the evaluator. evaluation is assigned to the evaluator, while interventions are the task of project management. By assigning these tasks to separate actors, we create a greater level of transparency than would be possible if

they were assigned to a single actor. First of all, there is transparency created by evaluation reports. All participants are aware of the evaluator's task of getting as much valid information as possible, and also that the evaluator will make it publicly known if a participant is not forthcoming with necessary project information. Secondly, because the evaluation reports are accessible to all participants, the project manager cannot sweep them under the carpet. They will instead be under pressure to react to deviant behaviour or to explain to all participants why no action has been taken. Thirdly, as a result of this transparency, trust can easily develop among actors. Trust arises from the knowledge that project management has the right and the power to intervene. Since everyone is aware of this, actual intervention will seldom be necessary.

Providing project management with enforcement power to punish individual partners is a necessary element of these design rules, but also the most difficult part. Especially when a project or program has been funded by government, neither the advocating politicians nor the civil servants involved are keen to admit that public money has not been well spent. It is easier to say that the effects of the project cannot be measured, or will only become visible in the future, rather than when the project ends (which may be true). That's why it is important to identify measurable targets and contributions at the project's outset. Even if the targets are clear, however, it still may not be easy to prove that a participant has not contributed as promised.

Forcing participants to pay back money they have received (and since then spent) may become a time-consuming affair that involves lawyers. Withholding payment of (the last instalment of) the budget after the completion of the project may be easier. However, there are other, non-financial ways to sanction undesirable behaviour. Naming and shaming is important in this respect. In most triple helix projects, the participating companies and universities are interested to participate in follow-up activities or in other programs. This becomes difficult if it is known from earlier projects that a participant has acted in an untrustworthy way. The prospect of participating in other and/or follow-up projects should have a positive impact on participant behaviour in a project. Here too, transparency is of key importance.

A possible objection to the above design rules could be that they display an unwarranted lack of trust in the sincerity of the participants and their motivation to turn the project into a success. Some people argue that "motivation" is a critical success factor in a project. It is obviously difficult to deny that projects are likely to fail if participants are not motivated. Our reply to such objections would be that structural preconditions have to be created for motivation to stay alive. Projects usually take many years to set up and a lot can happen that undermines the original motivation of the partners, not necessarily because anyone consciously or willingly refuses to deliver. Delays may arise, for example, because of changes in personnel. If there is no transparency, a lack of confidence in the contributions of one partner can easily arise and may create reluctance to go all out for the project by other partners. Project management needs to pick up signals of this kind (possibly generated by the evaluator's activities) as early as possible, and visibly undertake action to either correct false impressions or to ensure that the partner in question gets back on track.

Another objection to these design rules could be that triple helix projects are very often research projects, and it is often impossible to predict what will come out of research. If the participating parties knew that, then research wouldn't be needed. Therefore, the idea of specifying clearly at the beginning what, for instance, a university will contribute to the project should be rejected. Although this argument contains a grain of truth, it can also be an excuse for the university researchers to simply "do their own thing" as soon as funding has been secured. If they do that, other partners may quickly lose motivation.

It is obviously impossible to specify in detail what will come out of a research project, but it is very well possible to describe general aims and expectations. Likewise, this can be done for how each of the partners will be involved, and indeed empowered, to ensure that the project at least tries to come close to these aims and expectations, or pivots and departs from them with the agreement of all partners.

Conclusion

Triple helix organizations, projects and programs suffer from a tendency to lose track of their original aim and to degenerate to the point where participating parties mainly focus on things they would have done anyway. We found that the literature on success and failure of triple helix organizations points to many factors of success, but does not provide us with many useful instruments showing project participants how to organize for success. In response to this gap in the literature, we presented 11 rules for designing triple helix organizations, based on fundamentals found in cybernetics and organization design.

Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

Organizations built according to these design rules are characterized by transparency, and the ability of managers to sanction non-collaborative behaviour. This is achieved, among other things, by early identification and clarification of the goals and interests of all participants, by the continuous registration and evaluation of all activities by an independent evaluator, and by the separation of evaluation from intervention by management. The possibility of sanctions for partners that do not keep their promises to the initial agreement is an integral part of triple helix project design. Our analysis makes it clear that while transparency will usually make sanctions unnecessary, the threat of sanctions is nevertheless important. This feature is often considered problematic in triple helix arrangements because there is no clear hierarchical relationship between the participants.

The question remains why partners in a project would agree to design their project along the lines proposed here. Roughly speaking, there are two main reasons. First, organizations funding a project may make it a precondition for funding. Second, these or similar design rules may be codified into a general norm for the organization of triple helix and other collaborative projects. If so, conforming to this norm will become an indication of quality and not conforming to it a signal that the project should not be taken too seriously.

Acknowledgements

The ideas underlying this paper were first presented at the Triple Helix Conference in Manchester, September 5-8, 2018. The author wishes to acknowledge inspiring conversations on public organization with Harry van de Loo. He is also grateful for comments made by the reviewers of this journal.

References

Adler, P.S. & C. Xiaoling Chen. 2011. Combining creativity and control: Understanding individual motivation in large-scale collaborative creativity. *Accounting, Organizations and Society*, 36(2): 63–85.

Amaral, M. 2015. Management and assessment of innovation environments, Triple Helix. *A Journal of University-Industry-Government Innovation and Entrepreneurship*, 2(19). doi: 10.1186/s40604-015-0030-5

Arnkil R., A. Järvensivu, P. Koski & T. Piirainen. 2010. Exploring Quadruple Helix. Outlining user-oriented innovation models. *Final Report on Quadruple Helix Research for the CLIQ project*, under the Interreg IVC Programme, Tampere: University of Tampere, Work Research Center.

Ashby, W.R. 1956. *An introduction to cybernetics*. Chapman & Hall, London.

Bressers, N. 2012. The triple helix organization in practice: Assessment of the triple helix in a Dutch sustainable mobility program. *Science and Public Policy*, 39(5): 669-679.

Burton, R.M. & B. Obel. 2018. The science of organizational design: fit between structure and coordination. *Journal of Organization Design*, 7(5): 1-13.

Carayannis, E.G. & D.F.J. Campbell. 2010. Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate To Each other? a Proposed Framework for a Trans-disciplinary analysis of Sustainable development and Social Ecology. *International Journal of Social Ecology and Sustainable Development*, 1(1), 41-69.

Carayannis, E.G., T.D. Barth & D.F.J Campbell. 2012. The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship*, 1:2. DOI: 10.1186/2192-5372-1-2

Cavallini, Simona, Rossella Soldi, Julia Friedl & Margherita Volpe. 2016. Using the Quadruple Helix Approach to Accelerate the Transfer of Research and Innovation Results to Regional Growth. *Technical Report, Committee of the Regions*, EU, Brussels. DOI: 10.2863/408040

De Sitter, L.U. et al. 1997. From Complex Organizations with Simple Jobs to Simple Organizations with Complex Jobs. *Human Relations*, 50(5): 497-534.

Droegemeier, Kelvin. 2019. Director of the White House Office of Science and Technology Policy https://www.sciencemag.org/news/2019/02/exclusive-first-interview-trump-s-new-science-adviser

Etzkowitz, H. & Leydesdorff, L. 1998. The Endless Transition: A "Triple Helix" of University-Industry-Government Relations. *Minerva*, 36: 203-208.

Etzkowitz, H. & Leydesdorff, L. 2000. The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University-Industry-Government

Design Rules for 'Triple Helix' Organizations

Ben Dankbaar

Relations. *Research Policy*, 29(2): 109-123.

Galbraith, J.R. 1974. *Designing complex organizations*. Addison-Wesley, London.

Galbraith, J.R. 2002. *Designing Organizations: An Executive Guide to Strategy, Structure and Process*. JosseyBass, San Francisco.

Goddard, J. 2011. Connecting universities to regional growth — A practical guide, Smart Specialization Platform. *EU Regional Policy*, Brussels.

Gray, D., E. Sundstrom, L.G. Tornatzky and L. McGowen, 2011. When Triple Helix unravels. A multi-case analysis of failures in industry–university cooperative research centres. *Industry and Higher Education*, 25(5): 333-345.

Hackman, J.R. 1990. *Groups that work (and those that don't): creating conditions for effective teamwork*. Jossey Bass, San Francisco.

Mazzucato, M. 2013. *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. London: Anthem Press.

Nadler, D.A. & M.L. Tushman. 1997. *Competing by Design. The Power of Organizational Architecture*. Oxford University Press, New York/Oxford.

Perkmann et al. 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy,* 42(2): 423-442.

Ranga, M. & H. Etzkowitz. 2013. Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *Industry and Higher Education*, 27(3): 237-262.

Scheirer, M.A. 2005. Is Sustainability Possible? A Review and Commentary on Empirical Studies of Program Sustainability. *American Journal of Evaluation*, 26(3): 320-347.

Simon, H.A. 1996. *The Sciences of the Artificial*. MIT Press, Cambridge, Mass.

Wiley, C. 1997. What motivates employees according to over 40 years of motivation surveys. *International Journal of Manpower*, 18(3): 263-280.

About the Author

Ben Dankbaar is emeritus professor of innovation management and organization design, Nijmegen School of Management, Radboud University Nijmegen, The Netherlands. He also held a chair on management and technology at the Science Faculty of the same university. Before coming to Nijmegen, he worked as an assistant professor at the University of Amsterdam and as a researcher at the Berlin Social Science Center (Germany) and the Maastricht Economic Research Center on Innovation and Technology (MERIT) in Maastricht, The Netherlands. Ben has been guest professor at Hitotsubashi University in Tokyo and guest researcher at Macquarie University in Sidney and the Max Planck Institute for Social Studies in Cologne. He has published widely on technology and work organization, organization design, innovation management, innovation policy, industrial policy and sustainability. He has a special interest in the automobile industry, which he has been following for over 35 years.

Citation: Dankbaar, B. 2019. Design Rules for 'Triple Helix' Organizations. Technology Innovation Management Review, 9(11): 53-61. http://doi.org/10.22215/timreview/1283

Keywords: triple helix, design rules, motivation, sanctions, lea