

Opening up: Interdisciplinary guidance for managing open ecosystems

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Abstract

Practices of openness have grown popular across diverse domains (e.g. open science, open source software, open education) as they can spur innovation and liberalize society. But to date, we know little about how groups and leaders achieve such goals through openness, largely because knowledge remains siloed within fields. Thus, needs exist for interdisciplinary terminology and guidance on “doing openness.” In this Perspective, we address these needs first by defining an interdisciplinary concept – open organizing – that describes how people collectively pursue goals along dimensions of transparency, inclusion, and distribution of decision rights. Next, we distill four lessons for managing open ecosystems: balanced organization design, transparent power allocation, flexible information tools, and intentional social norm development. We do this by integrating expertise from academia and industry across multiple domains (including open scholarship, open education, open strategy, open source software, open design, and open innovation). Finally, we call for more research on openness – both within and across domains – to support those who seek to address great challenges of our time through openness.

Introduction

A growing number of fields, industries, and governments are adopting *openness*¹⁻⁶. We see its prevalence in open science, open source software, open education, open design, and open government, among other “domains” of openness. Some of these domains consist largely of decentralized, disjointed collaborations between academics⁷. Many others grow into interconnected *open ecosystems* in which managing organizations and distributed contributors shepherd open artifacts (like research software, hardware designs, data platforms, and online encyclopedias) that governments and philanthropies increasingly fund^{8,9}.

Openness is not new, though: philosophers have long sought to create open societies^{10,11}; open universities grew out of education traditions¹²; and physics, biology, and management increasingly

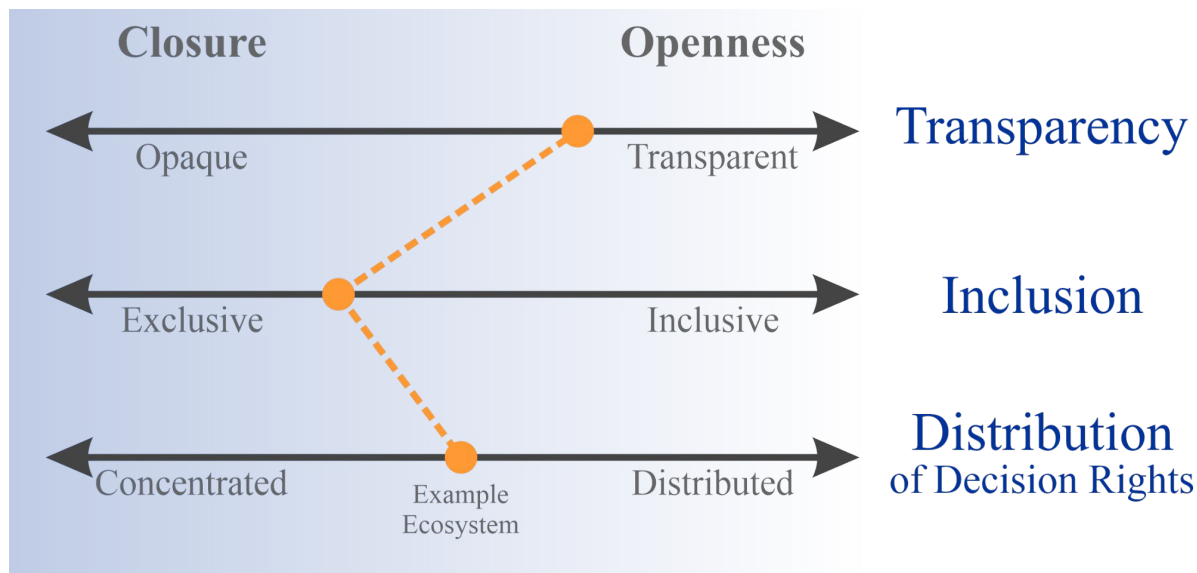


Figure 1: Dimensions of open organizing. Each horizontal line represents one dimension. The orange points and lines represent where a hypothetical ecosystem might fall on the dimensions. For example, an ecosystem might be accessible to those already in the ecosystem (more transparent), but difficult to gain access to (more exclusive), and with modest hierarchy among decision makers (both distributed and concentrated).

35 center the openness of systems^{13,14}. The increasing adoption of openness across domains has added
 36 to the diversity of meanings of openness. In this article, we define openness as an organizing prin-
 37 ciple, i.e., “ways by which work gets coordinated and information is gathered, disseminated, and
 38 processed within and between organizations”¹. Three dimensions underlie this principle: (1) *trans-*
 39 *parency/opacity* (who can see which information), (2) *inclusion/exclusion* (who gets to be in-
 40 *involved*), and (3) *distribution/concentration of decision rights* (who gets to decide) (Fig. 1)¹.
 41 Domains of openness may find themselves at different points with respect to each dimension, par-
 42 ticularly because these dimensions do not encompass the totality of openness in every domain (e.g.
 43 reproducibility and replicability are common in open science¹⁵). Still, these dimensions are com-
 44 mon to most domains of openness¹.

45 **Openness requires careful management**

46 Proponents argue that practices of openness (like transparent recordkeeping, attributing work to
 47 individuals, and free information access) provide means of achieving desired ends, such as inno-
 48 vation, accountability, and reproducibility^{4,9,15–19}. Openness also allows organizations to respond
 49 to changing societal values toward more equality, democratization, and liberalization^{6,20,21}. How-
 50 ever, just “opening up” does not automatically yield these benefits. Open ecosystems need careful
 51 management. For example, managers (whether individuals or groups) need to decide how open to

52 make their ecosystem as not all ecosystems *should* be open about everything (e.g. medical and
53 student records). Managers also need to be cautious of potential downsides to openness, such as
54 increased surveillance and decreased autonomy²².

55 Posing a further challenge, the dimensions of open organizing often conflict with one another. For
56 example, people weigh how much information to share against shifting societal values (like diver-
57 sity, equity, and inclusion policies) and power dynamics (who's in charge)^{1,7,23,24}. In open science,
58 policy mandates are driving open access^{18,25} (a form of transparency), amplifying scientific trust
59 and increasing readership²⁶. At the same time, these mandates favor historically wealthier and
60 larger centers of research, thereby excluding some scholars^{27,28} (exclusion) by pursuing innovation
61 through transparency (although financial support and incentive structures can offset open access
62 publishing costs to alleviate this). Enduring preservation, access, and reuse of open information
63 (transparency) also require investment in expensive data infrastructure (excluding those without
64 resources). In the domain of open source software – a domain long considered a bastion of open-
65 ness – some communities and companies are becoming less transparent to facilitate greater control
66 by concentrating decision rights²⁹. And while transparency can disseminate important technologi-
67 cal advances in indigenous and health contexts^{30,31}, it can also come across as extractivist, colonial,
68 and disrespectful of individual or collective rights³². Consequently, openness requires careful man-
69 agement and may not always be beneficial^{22,33–37}.

70 **Interdisciplinary guidance for managing openness**

71 Given the challenges of managing openness, we address the question: How can researchers, prac-
72 titioners, and leaders manage openness to achieve their respective goals? Even though there is
73 considerable knowledge about managing openness, this knowledge tends to remain distributed
74 within particular domains of openness. Put another way, what different domains know about man-
75 aging openness is rarely known to individuals in other fields or to junior scholars¹. This is likely a
76 result of knowledge boundaries between disciplines because different language, meanings, and
77 interests can make understanding how other fields manage openness more difficult^{38,39}. Consider
78 the varying meanings of openness within different domains, for example: software (open source
79 licenses⁴⁰ and communities) versus intelligence (open source intelligence, analyzing unclassified
80 data^{41,42}) versus education (open education, making knowledge widely accessible). These founda-
81 tional language and meaning differences can make it challenging to determine whether there is
82 any general advice on how to manage openness across fields.

83 In this article, we bring together insights from different fields to provide interdisciplinary termi-
84 nology and guidance on how to manage openness^{39,43}. This interdisciplinary view provides insights
85 into the dynamics of openness and closure in several domains; how, in different fields, practices
86 of openness result in both intended and unintended outcomes (like innovation, broadening partic-
87 ipation, and scientific validity); and how practices and outcomes manifest differently in different
88 domains. As such, the article holds potential to make science more transparent and trustworthy
89 given the general lack of reproducibility in multiple fields^{44–46}. Our recommendations could also

Box 1. Four lessons for open ecosystems

Organization design: Identify what you hope to achieve by opening up. Then, assess and design how open/closed your organizing will be along the three dimensions. Consider a balance of openness and closure to achieve your goals.

Power allocation: Pay attention to who has power and what powers they have. Make power structures more transparent to improve implementation and sustainability of open organizing.

Information sharing: Adopt flexible tools to aid creation, distribution, and accessibility of information for an array of contributors and stakeholders, over time.

Social norms: Intentionally craft norms and make them transparent. Make it easy, and eventually incentivized, for people to behave in agreed upon ways.

90 make open communities (for design, software, science, and others) more resilient to participant
91 burnout and funding uncertainty⁴⁷.

92 To that end, this Perspective provides interdisciplinary factors for readers to consider about how
93 to manage openness in their distinct contexts, through two techniques. First, we bring together
94 scholars and practitioners from diverse disciplines to share their experience in managing openness.
95 The group includes experts from open research, open education, open strategy, open source soft-
96 ware, open design, and open innovation. Second, we discuss our disciplinary knowledge of open-
97 ness along four lessons for open ecosystems (see Box 1). These lessons relate to *organization*
98 *design* (setting group goals, structures, and processes), *power allocation* (who holds what mecha-
99 nisms of influence), *information sharing* (its creation, distribution, and accessibility), and *social*
100 *norms* (values and practices people teach each other), factors that seem to be common across dif-
101 ferent fields. We close with a call to action for more research on open organizing and dialogue
102 across domains. We hope these insights will aid decision-makers and researchers alike as we en-
103 gage with important challenges of our time.

104 Organization Design

105 Early decisions to open up shape future decisions

106 The first decisions leaders often make are choices about their goals and how to coordinate (or
107 organize) people to achieve them. This means making “classic” organization design decisions (re-
108 porting structures, divisions of labor, processes, rules, etc.), but also design decisions on openness
109 (who has power to do what, how people should interact, who can see what information, and for
110 how long)¹. Specific choices of information and communication technologies, legal decisions (e.g.
111 licenses), and management policies (like codes of conduct) each enable certain activities while

112 constraining others⁴⁸⁻⁵¹. For example, wikis can enable more dynamic, scalable, and transparent
113 recordkeeping than a quarterly document release process might, but can also incur coordination
114 costs depending on their designs^{36,52}. Further, early decisions can have enduring effects on how
115 transparent, inclusive, and distributed an organization will be throughout its existence. Early deci-
116 sions about openness (like what to strive for and which members will lead those efforts) are diffi-
117 cult to reverse. This is because changes later on often conflict with stakeholder expectations and
118 social norms, which in turn can cost organizations some of their legitimacy^{53,54}.

119 **Complete openness/closure are challenging to achieve and maintain**

120 In most cases, striving for the extreme in each dimension of openness is difficult for organizations
121 to manage. Take the transparency dimension, for example. Information tends to remain opaque
122 unless owners record, share, make accessible, and preserve information over time². In open gov-
123 ernment, full transparency is challenging to maintain and can produce internal conflict that can
124 even threaten an organization's continued existence⁵³. While limited amounts of opacity can ena-
125 ble innovation, too much prevents groups from performing their best⁵⁵. On the other hand, trans-
126 parency is essential in some cases, such as for inspection, reproducibility, and replicability in
127 science^{44,45}. Thus, organizing designs need to carefully consider what information to make open,
128 balancing transparency and opacity⁵⁶. Open contexts often involve multiple platforms and actors,
129 so the ability to sustain a desired level of openness benefits from ongoing information awareness
130 (e.g. monitoring social norm evolution)⁵⁷ and information curation (i.e. strategic selection, inter-
131 pretation, and sharing of information)⁵⁸.

132 The inclusion dimension requires careful balancing too. Even when including everyone is the goal,
133 exclusion often needs to be present to maintain open collaborations. Exclusion removes actors that
134 consistently disrupt the goals of a community or harm other members such as via using aggressive
135 language⁵⁹, undoing others' contributions without explanation^{52,60}, trolling^{61,62}, plagiarism^{63,64}, and
136 other forms of antisocial behavior^{65,66}. As a result, exclusion can enable leaders and members to
137 better achieve inclusion³⁶.

138 In sum, early decisions have meaningful long-term implications, and striving for complete open-
139 ness along any of the three dimensions can have unintended consequences. These suggest a prag-
140 matic approach for open ecosystems:

141 *Lesson 1: Identify what you hope to achieve by opening up. Then, assess and design how*
142 *open/closed your organizing will be along the three dimensions. Consider a balance of open-*
143 *ness and closure to achieve your goals.*

144 Power Allocation

145 Power structures shape openness

146 Power is the potential to influence others through mechanisms (e.g. information, resources, au-
147 thority)⁶⁷⁻⁶⁹. People draw power from many sources in open organizing. Simply having data on
148 academic authorship (information about attribution) yields power by enabling new analyses of
149 outcome disparities. Such analyses empower efforts to advocate for greater publishing equity⁷⁰.
150 Likewise, legal rights (a form of resource) empower authors, artists, and indigenous creators by
151 providing them with greater flexibility to protect, distribute, and receive compensation for their
152 work. Power is also relational – existing between people⁶⁷⁻⁶⁹. Relationships of authority yield
153 power structures which can take many forms in open organizing contexts. Every person in a group
154 might get an equal vote (distributed power) or one person might hold all the votes (concentrated
155 power) among many other possibilities⁴⁷.

156 Power structures have multiple influences on open organizing contexts. In open organizations,
157 those with greater power typically decide who gets included and define social norms³⁶. Organiza-
158 tional power structures can also affect society more broadly. For example, the authority of organ-
159 ization decision makers (over whom to employ, how to incentivize employees, and where to draw
160 organizational boundaries) can create and perpetuate societal income inequality⁷¹. In open network
161 contexts, power is often more diffuse, with most individuals having few connections and a few
162 have many connections. These networks and the underlying organizing platforms (like Facebook
163 or GitHub) tend to create opportunities for leaders lacking formal authority to exert power by
164 managing information, harnessing emotions, and building collective identities around shared in-
165 terests^{58,72}. Making decision rights transparent can increase participation (and hence alter power
166 structures) in these contexts⁷³, but decision rights may need to be obscured in some cases to protect
167 vulnerable participants. For instance, the owners of social media channels for the open movement
168 Occupy Wall Street were labeled “leaders.” This made them vulnerable to criticism and rebuke,
169 thereby limiting their accomplishments⁵¹.

170 Open organizing tends to exclude people

171 As we see, then, openness tends *not* to benefit marginalized individuals or organizing efforts as
172 much as it benefits those with resources and connections (i.e. those “in power”). Open access
173 publishing exemplifies challenges faced by marginalized individuals: They may lack the funding
174 (e.g. for article processing charges), language competencies, and access to prestigious individuals
175 (like publishers and mentors) necessary for success in top academic publishing ecosystems. So
176 despite promises that open access would increase equity and extend the reach of marginalized
177 voices, the resources and connections required to participate continue to hamper these goals^{74,75}.
178 In open source software contexts, we see how organizing activities (i.e. administrative and mana-
179 gerial tasks) also become marginalized. Non-programming activities (e.g. coordinating members,

180 triaging requests, creating documentation) that support software development receive little budg-
181 eting, interest⁷⁶, and attribution^{77,78} (though many open source programming activities remain un-
182 dercompensated⁴⁷), making it more difficult for these individuals to receive recognition, rest, or
183 advance their careers^{47,79}.

184 Inclusion of marginalized individuals usually requires intentional management. In the age of re-
185 mote work, for instance, time zones can create power imbalances. If the majority of members of a
186 group are in a specific time zone and share information synchronously through meetings, infor-
187 mation shared with minority members (in non-majority time zones) may be of lower quality if the
188 organization is not intentional about asynchronous sharing⁸⁰. This may also lead to the quality of
189 open contributions by minority members diminishing as they are less informed, thereby leaving
190 minority members feeling powerless. Power struggles in open ecosystems often favor those with
191 information or prior responsibilities who may seek to maintain power to the exclusion of those
192 newly included⁸¹.

193 **Sustaining open organizing remains an open question**

194 In light of these power dynamics, making open organizing sustainable (i.e. providing ongoing
195 benefits⁸) becomes easier with transparency about power. Practically, this means sharing infor-
196 mation about power structures (including decision rights), labor (who does what tasks), and com-
197 pensation (who receives what benefits)⁷⁹. Transparent power structures help include less powerful
198 participants who may want to perform needed labor in volunteer-supported ecosystems⁷³. Then,
199 making labor more visible reveals actions that take place in an ecosystem, who performs them,
200 and how those actions affect group objectives⁷⁹. Combined with transparency about compensation
201 – receiving power in the form of money, attribution, roles, etc. – groups can see what labor they
202 are compensating such that they can incentivize desired activities^{17,78,79}.

203 Sustainable openness likely requires new compensation systems. This might mean new funding
204 and dissemination models, as well as fundamental changes in reward structures (e.g. tenure &
205 promotion). In open scholarship, for example, it is hard for open research practices to compete
206 with other priorities scholars have, such as publishing in prestigious journals. Thus, incentives
207 from funders, publishers, and institutions become essential to sustaining such efforts. One option
208 could be nonmonetary rewards, which online communities often use as alternative forms of com-
209 pensation and that can translate into offline rewards (such as jobs⁸²); however, these can also pro-
210 duce unintended consequences (like counterproductive behaviors⁸³). Regardless of the
211 compensation system, open organizing will likely require ongoing management of relationships,
212 information, and emotions to sustain action among a diffuse network of actors over time towards
213 collective goals⁵⁸. These intersections suggest a second lesson.

214 *Lesson 2: Pay attention to who has power and what powers they have. Make power structures*
215 *more transparent to improve implementation and sustainability of open organizing.*

216 Information Sharing

217 **Sharing information involves creating, distributing, and accessing information**

218 Sharing information involves decisions about what information exists, who receives what infor-
219 mation, and how accessible that information is². Each of these raises numerous questions: What
220 information is valuable to create? Where and how should we store it? Who can access it? For how
221 long? Should we disseminate certain pieces of information? To what audiences? How accessible
222 should we make it to them?

223 These questions do not have given answers, even in the “most open” environments. For example,
224 open collaboration environments (e.g. StackOverflow, Reddit, Slack) might seem to create abun-
225 dant opportunities for information sharing. But too much information can produce information
226 overload; important information becomes inaccessible amid volume and noise, diverse and con-
227 flicting information, unrelated tangents, and the resulting emotional and cognitive fatigue⁵⁸. Con-
228 sequently, newcomers may struggle to distribute novel and creative ideas for lack of how to frame
229 their ideas in terms of a community’s norms and values⁸⁴. These struggles can make newcomers
230 decide to leave, meaning novel viewpoints might not get shared in the future⁸⁵.

231 **Adopting flexible tools lets organizations tailor to their needs**

232 Flexible tools are important for effective open organizing⁸⁶. Tools can hinder openness if they are
233 not easy to use for both those sharing information and those receiving it. For example, with open
234 source code, GitHub has become widely accepted as the default tool for sharing code openly. In
235 open source software communities, many have argued that Git (the underlying version control
236 system) is not intuitive and only remains because it was created by a powerful developer behind
237 the Linux operating system. GitHub has tried to make Git more accessible by providing a user-
238 friendly, no-code interface that non-programmers can use. This encourages adoption, but also cen-
239 tralizes communities on specific platforms, making it more difficult for participants to explore
240 alternatives⁴⁷.

241 Information archiving becomes an important aspect of flexible tools, too. Practically speaking,
242 information tends to “disappear” from ecosystems without intentional preservation plans and re-
243 sources. Information storage formats are tools themselves that can hinder or encourage remix or
244 reuse of openly licensed materials (e.g. those that use Creative Commons licenses). A classic ex-
245 ample of this is the portable document format (PDF) which makes documents less accessible and
246 difficult to repurpose⁸⁷. Nor are all Creative Commons licenses considered “open” by all because
247 artifacts with a “no derivatives” component enable sharing of material, but limit the public sharing
248 of remixed versions of artifacts. Information formats also relate to preservation because, as formats
249 become obsolete, information in that format often becomes inaccessible. Overall, adopting flexible
250 tools⁸⁶ and incentivizing members to modify systems to meet their needs^{6,88} seem to hold potential

251 for addressing organizations' unique information and communication needs when opening up their
252 processes and practices.

253 *Lesson 3: Adopt flexible tools to aid creation, distribution, and accessibility of information for*
254 *an array of contributors and stakeholders, over time.*

255 Social Norms

256 Social norms are shared values and practices that people tend to follow in organizational con-
257 texts^{1,86,89}. An organization's social norms influence both what people experience in those settings
258 and what individuals and groups can achieve^{90,91}. As open organizing often lacks formal structures
259 and contracts, it relies heavily on norms to guide groups through social dilemmas – situations
260 where individual and collective interests clash⁹²⁻⁹⁴.

261 Though inadvisable, many organizations adopting openness strive for unrealistic ideals with their
262 practices (i.e. total transparency, being fully inclusive) by including more voices in decision-mak-
263 ing, giving people ample freedoms, and sharing more information with more people¹. They en-
264 shrine these values in codes of conduct and legal licenses which define what people are and are
265 not allowed to do⁹⁵. However, codes and licenses have mixed success, particularly in global and
266 multicultural contexts. On one hand, creating, clearly stating, and enforcing norms can lead mem-
267 bers and newcomers to feel more included, thereby increasing participation. On the other hand,
268 people need time to get familiar with and learn the social norms of new contexts before they can
269 fully and appropriately participate⁹⁶. Codes and licenses attract and repel people depending on
270 their enforcement and whether or not they carry assumptions that conflict with other cultures^{95,97}.
271 As such, codes of conduct and automated content management can foster effective open organizing
272 because they publicly define goals for social norms, mechanisms of enforcement, avenues of re-
273 course, and make this information accessible to all those in an ecosystem (not just the powerful)⁸⁴.

274 Encouraging conformance to norms presents challenges

275 The next challenge is getting people to follow the norms. One of the most successful processes in
276 open organizing to date comes from psychologists seeking to improve scientific reproducibility
277 (i.e. obtaining consistent results with the same inputs) and replicability (obtaining consistent re-
278 sults across studies)¹⁵. They use a five-step process to institutionalize social norms⁴⁵: (1) *make*
279 *actions possible* by building infrastructure, (2) *make them easy* by prioritizing user experiences,
280 (3) *make them normative* by growing community, (4) *make them rewarding* through incentives,
281 and (5) *make them required* through policy. Despite the financial costs (e.g. of running large stud-
282 ies) and even potential career costs (e.g. reputational risks from introducing contradictory evi-
283 dence), social norms are starting to change in social science; researchers now tend to endorse
284 practices that promote transparency and self-skepticism (e.g. replication, “getting [methods] right
285 over being right”^{45,98}). While this process may not work everywhere, it provides a starting point.

286 As ecosystems grow, leaders inevitably find it necessary to limit counterproductive behavior –
287 behaviors that undermine the goals of collaboration – by correcting norm and policy violations.
288 However, enforcing social norms in decentralized contexts is difficult because individuals do not
289 want to punish each other (or be punished) for loss of effort and fear of backlash (the “third-order
290 free rider problem”)⁹⁹. Offering rewards for enforcing norms helps limit this problem to some
291 extent⁶⁰. Beyond this, methods for limiting norm violations can largely be classified into formal
292 sanctions (clearly defined at the community level) and informal sanctions (spontaneously gener-
293 ated by the collaborators themselves). Formal sanctions tend to begin with warnings and escalate
294 to larger penalties such as removing contributions, temporary “gag orders,” and limiting the ability
295 to contribute; with exclusion from the community as the final option¹⁰⁰. Community moderators,
296 either chosen or elected members, often monitor and adjudicate disputes to ultimately determine
297 the extent of sanctions⁸⁹. Informal sanctions, then, include peer-to-peer monitoring, public sham-
298 ing, and editing of others’ contributions⁶⁰. Although sanctioning is never “fun,” members tend to
299 respond better to the enforcement of norms in open ecosystems when it comes from those with
300 lateral authority (those who control tasks) rather than vertical authority (those who manage peo-
301 ple)^{101,102}.

302 **Balance “what you want to you achieve” with “how you want to you achieve it”**

303 In the end, successful open organizing often strikes a balance. It strives for specific goals by nor-
304 malizing some open practices while eschewing others. In open science, for example, adopted
305 norms have begun to shift from rewarding novel outcomes to rewarding process transparency. To
306 date, reproducibility has proven difficult to achieve because of flexibility in data collection, anal-
307 ysis, and reporting, HARKing (Hypothesizing After Results are Known), p-hacking, and selective
308 reporting of more positive results¹⁰³. Proponents of open science argue that small constraints on
309 the scientific process (like pre-registering analyses and transparently documenting deviations) pro-
310 mote scientific rigor by making research processes, underlying data (not only the final results),
311 and conclusions easier to inspect¹⁰⁴. In open organizing terms, giving researchers the option to
312 slightly constrain their own decision rights – here, decision timing and data transparency rights –
313 enables increased transparency in pursuit of scientific rigor and trust. Hence, clear practices that
314 grow easier and more beneficial to follow hold promise for shifting norms in support of desired
315 practices and outcomes of open organizing.

316 *Lesson 4: Intentionally craft norms and make them transparent. Make it easy, and eventually*
317 *incentivized, for people to behave in agreed upon ways.*

318 **Conclusion**

319 The growing popularity of openness leaves society with needs for interdisciplinary terminology
320 and guidance on managing open ecosystems. In this article, we address these needs by bringing

321 together different disciplinary perspectives around the focal topic of open organizing, or how peo-
322 ple coordinate through practices of openness in effort to achieve innovation, liberalization, and
323 other goals. Building on the three dimensions of open organizing – transparency, inclusion, and
324 distribution of decision rights – we identify four main themes and related challenges. Addressing
325 each in turn through our collective expertise yields four lessons for effectively managing open
326 ecosystems (Box 1): balanced organization design, transparent power allocation, flexible infor-
327 mation tools, and intentional social norm development. We hope these lessons will provide deci-
328 sion-makers and researchers guidance in their choices about organizing through openness.

329 Despite our interdisciplinary, holistic view, many basic research topics and solutions to open or-
330 ganizing challenges remain unexplored. With respect to basic research, cross-domain studies and
331 collaborations (e.g. exploring open design findings in open innovation contexts) could prove fruit-
332 ful for confirming, contrasting, and expanding theories and descriptions¹. Such studies might use
333 our interdisciplinary language to bridge from one domain (and field) to another such that multiple
334 audiences can benefit, even if authors publish in disciplinary venues. Another priority is clarifying
335 how different organizational factors and reward systems affect individual and collective behaviors
336 in open organizing contexts, along with the resulting performance effects⁸³. The importance of this
337 topic arises from the need for a common understanding of tools (like codes of conduct), their effi-
338 cacies, and alternative norm management mechanisms. Third, investigating closure (i.e. opacity,
339 exclusiveness, and concentration of decision rights) would provide an important complement to
340 the focus on openness. Again, some objectives (like privacy) may benefit from “closing down”
341 more than opening up, but we need more evidence on the full spectrum of each dimension before
342 we can provide concrete conclusions for specific contexts. To explore these topics, researchers
343 might utilize datasets from (and contribute to) the Open Data Resources Website, a wiki that con-
344 solidates datasets from open government, open science, open source software, and other do-
345 mains¹⁰⁵.

346 In terms of solutions, the greatest needs remain for sustainability and accessibility practices – those
347 that enable open ecosystems to continue performing valued activities with less effort and greater
348 effect. Sustainability needs arise in nearly every domain of openness, from open source software
349 communities (how to keep software going when maintenance activities are costly?) to open gov-
350 ernment (how to involve constituents without platforming extremists?) to open science (how to
351 create compensation models that equitably incentivize open access?). Likewise, open ecosystems
352 often remain inaccessible (and therefore opaque and exclusive) due to perceived expenses of de-
353 signing for accessibility⁴³. New resources and incentives for accessible design could make a sig-
354 nificant difference to open ecosystem engagement. Open organizing holds significant promise for
355 a better future. We hope knowledge of its dimensions, challenges, and opportunities will catalyze
356 new efforts to reach such desirable futures.

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361 References

- 362 1. Splitter, V., Dobusch, L., von Krogh, G., Whittington, R. & Walgenbach, P. Openness as organizing principle:
363 introduction to the special issue. *Organ. Stud.* **44**, 7–27 (2023).
- 364 2. Stohl, C., Stohl, M. & Leonardi, P. M. Managing opacity: information visibility and the paradox of transpar-
365 ency in the digital age. *Int. J. Commun.* **10**, 15 (2016).
- 366 3. Leonardi, P. & Treem, J. W. Behavioral visibility: a new paradigm for organization studies in the age of digiti-
367 zation, digitalization, and datafication. *Organ. Stud.* 0170840620970728 (2020)
368 doi:10.1177/0170840620970728.
- 369 4. Obama, B. Memorandum on transparency and open government. (2009).
- 370 5. Levine, S. S. & Prietula, M. J. Open collaboration for innovation: principles and performance. *Organ. Sci.* **25**,
371 1414–1433 (2013).
- 372 6. Aitamurto, T., Holland, D. & Hussain, S. The Open Paradigm in Design Research. *Des. Issues* **31**, 17–29
373 (2015).
- 374 7. Trujillo, M. Z., Hébert-Dufresne, L. & Bagrow, J. The penumbra of open source: projects outside of centralized
375 platforms are longer maintained, more academic and more collaborative. *EPJ Data Sci.* **11**, 31 (2022).
- 376 8. National Science Foundation. *Pathways to Enable Open-Source Ecosystems*.
377 <https://www.nsf.gov/pubs/2023/nsf23556/nsf23556.htm> (2023).
- 378 9. National Science Foundation. *Dear Colleague Letter: Reproducibility and Replicability in Science*.
379 <https://www.nsf.gov/pubs/2023/nsf23018/nsf23018.jsp> (2022).
- 380 10. Bergson, H. *The Two Sources Of Morality And Religion*. (Macmillan And Company Limited., London, 1935).
- 381 11. Popper, K. R. *The Open Society and Its Enemies*. (Princeton University Press, 2020).
- 382 12. Weller, M. *The Battle for Open. Ubiquity Press* (Ubiquity Press, 2014). doi:10.5334/bam.
- 383 13. von Bertalanffy, L. The Theory of Open Systems in Physics and Biology. *Science* **111**, 23–29 (1950).
- 384 14. Scott, W. R. & Davis, G. F. *Organizations and Organizing: Rational, Natural, and Open System Perspectives*.
385 (Pearson Prentice Hall, Upper Saddle River, N.J., 2007).
- 386 15. *Reproducibility and Replicability in Science*. (National Academies Press, Washington, D.C., 2019).
387 doi:10.17226/25303.
- 388 16. Nosek, B. A. *et al.* Promoting an open research culture. *Science* **348**, 1422–1425 (2015).
- 389 17. Brand, A., Allen, L., Altman, M., Hlava, M. & Scott, J. Beyond authorship: attribution, contribution, collabora-
390 tion, and credit. *Learn. Publ.* **28**, 151–155 (2015).
- 391 18. Nelson, A. Ensuring free, immediate, and equitable access to federally funded research. (2022).
- 392 19. Holdren, J. P. Increasing access to the results of federally funded scientific research. (2013).
- 393 20. Dobusch, L., Heimstädt, M., Mayer, K. & Ross-Hellauer, T. Defining predatory journals: no peer review, no
394 point. *Nature* **580**, 29–29 (2020).
- 395 21. Pas, B., Wolters, R. & Lauche, K. Zooming in on Institutional Politics: Professional accountability systems as
396 institutional weaponry. *Organ. Stud.* **42**, 1085–1109 (2021).
- 397 22. Star, S. L. & Strauss, A. Layers of silence, arenas of voice: the ecology of visible and invisible work. *Comput.*
398 *Support. Coop. Work CSCW* **8**, 9–30 (1999).
- 399 23. Vedres, B. & Vasarhelyi, O. Gendered behavior as a disadvantage in open source software development. *EPJ*
400 *Data Sci.* **8**, 25 (2019).
- 401 24. McNutt, M. K. *et al.* Transparency in authors' contributions and responsibilities to promote integrity in scien-
402 tific publication. *Proc. Natl. Acad. Sci.* **115**, 2557–2560 (2018).
- 403 25. Else, H. A guide to Plan S: the open-access initiative shaking up science publishing. *Nature* (2021)
404 doi:10.1038/d41586-021-00883-6.
- 405 26. Huang, C.-K. *et al.* Open access research outputs receive more diverse citations. *Scientometrics* **129**, 825–845
406 (2024).

- 407 27. McNutt, M. “Plan S” falls short for society publishers—and for the researchers they serve. *Proc. Natl. Acad. Sci.* **116**, 2400–2403 (2019).
- 408
- 409 28. Rabesandratana, T. Open-access plan draws online protest. *Science* <https://www.science.org/content/article/open-access-plan-draws-online-protest> (2018).
- 410
- 411 29. Bommasani, R. *et al.* The Foundation Model Transparency Index. Preprint at <https://doi.org/10.48550/arXiv.2310.12941> (2023).
- 412
- 413 30. Contreras, J. L. *et al.* Pledging intellectual property for COVID-19. *Nat. Biotechnol.* **38**, 1146–1149 (2020).
- 414 31. Gold, E. R. What the COVID-19 pandemic revealed about intellectual property. *Nat. Biotechnol.* **40**, 1428–1430 (2022).
- 415
- 416 32. Hudley, A. H. C., Mallinson, C. & Bucholtz, M. *Decolonizing Linguistics*. (Oxford University Press, 2024).
- 417 33. Eisenberg, E. M. & Witten, M. G. Reconsidering openness in organizational communication. *Acad. Manage. Rev.* **12**, 418–426 (1987).
- 418
- 419 34. Prana, G. A. A. *et al.* Including everyone, everywhere: understanding opportunities and challenges of geographic gender-inclusion in OSS. *IEEE Trans. Softw. Eng.* 1–1 (2021) doi:10.1109/TSE.2021.3092813.
- 420
- 421 35. Lingo, E. L. Digital Curation and Creative Brokering: Managing information overload in open organizing. *Organ. Stud.* **44**, 105–133 (2023).
- 422
- 423 36. Dobusch, L., Dobusch, L. & Müller-Seitz, G. Closing for the Benefit of Openness? The case of Wikimedia’s open strategy process. *Organ. Stud.* **40**, 343–370 (2019).
- 424
- 425 37. Diriker, D., Porter, A. J. & Tuertscher, P. Orchestrating open innovation through punctuated openness: a process model of open organizing for tackling wicked multi-stakeholder problems. *Organ. Stud.* **44**, 135–157 (2023).
- 426
- 427
- 428 38. Dougherty, D. Interpretive barriers to successful product innovation in large firms. *Organ. Sci.* **3**, 179–202 (1992).
- 429
- 430 39. Carlile, P. R. Transferring, translating, and transforming: an integrative framework for managing knowledge across boundaries. *Organ. Sci.* **15**, 555–568 (2004).
- 431
- 432 40. The Open Source Definition (Annotated). *Open Source Initiative* <https://opensource.org/definition-annotated> (2006).
- 433
- 434 41. Glassman, M. & Kang, M. J. Intelligence in the internet age: the emergence and evolution of open source intelligence (OSINT). *Comput. Hum. Behav.* **28**, 673–682 (2012).
- 435
- 436 42. The Economist. Open-source intelligence challenges state monopolies on information. *The Economist* (2021).
- 437 43. Fox, E. *Usable Software Ecosystem Research*. 179 <https://user-project.superbloom.design/print-version/> (2023).
- 438 44. Errington, T. M. *et al.* Investigating the replicability of preclinical cancer biology. *eLife* **10**, e71601 (2021).
- 439 45. Nosek, B. A. *et al.* Replicability, Robustness, and Reproducibility in Psychological Science. *Annu. Rev. Psychol.* **73**, 719–748 (2022).
- 440
- 441 46. Fišar, M., Greiner, B., Huber, C., Katok, E. & Ozkes, A. I. Reproducibility in Management Science. *Manag. Sci.* **70**, 1343–1356 (2024).
- 442
- 443 47. Eghbal, N. *Working in Public: The Making and Maintenance of Open Source Software*. (Stripe Press, San Francisco, CA, 2020).
- 444
- 445 48. Majchrzak, A. & Markus, M. L. Technology Affordances and Constraints in Management Information Systems (MIS). *Encyclopedia of Management Theory* (2012).
- 446
- 447 49. Choose an open source license. *Choose a License* <https://choosealicense.com/>.
- 448 50. Roehling, M. The important but neglected legal context of virtual teams: research implications and opportunities. *Hum. Resour. Manag. Rev.* **27**, 621–634 (2017).
- 449
- 450 51. Schneider, N. *Governable Spaces: Democratic Design for Online Life*. (Univ of California Press, 2024).
- 451 52. Kittur, A., Suh, B., Pendleton, B. A. & Chi, E. H. He says, she says: conflict and coordination in Wikipedia. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* 453–462 (Association for Computing Machinery, New York, NY, USA, 2007). doi:10.1145/1240624.1240698.
- 452
- 453 53. Reischauer, G. & Ringel, L. Unmanaged transparency in a digital society: Swiss army knife or double-edged sword? *Organ. Stud.* **44**, 77–104 (2023).
- 454
- 455 54. Farrell, J. How to make data open? Stop overlooking librarians. *Nature* **624**, 227–227 (2023).
- 456 55. Meluso, J. & Hébert-Dufresne, L. Multidisciplinary learning through collective performance favors decentralization. *Proc. Natl. Acad. Sci.* **120**, e2303568120 (2023).
- 457
- 458 56. Vaast, E. Strangers in the dark: navigating opacity and transparency in open online career-related knowledge sharing. *Organ. Stud.* **44**, 29–52 (2023).
- 459
- 460 57. Danescu-Niculescu-Mizil, C., West, R., Jurafsky, D., Leskovec, J. & Potts, C. No country for old members: user lifecycle and linguistic change in online communities. in *Proceedings of the 22nd international conference*
- 461
- 462

- 463 *on World Wide Web* 307–318 (Association for Computing Machinery, New York, NY, USA, 2013).
464 doi:10.1145/2488388.2488416.
- 465 58. Long Lingo, E. L. Digital curation and creative brokering: managing information overload in open organizing.
466 *Organ. Stud.* **44**, 105–133 (2023).
- 467 59. Xu, B., Xu, Z. & Li, D. Internet aggression in online communities: a contemporary deterrence perspective. *Inf.*
468 *Syst. J.* **26**, 641–667 (2016).
- 469 60. Jan Piskorski, M. & Gorbatâi, A. Testing Coleman’s Social-Norm Enforcement Mechanism: Evidence from
470 Wikipedia. *Am. J. Sociol.* **122**, 1183–1222 (2017).
- 471 61. Coles, B. A. & West, M. Trolling the trolls: Online forum users constructions of the nature and properties of
472 trolling. *Comput. Hum. Behav.* **60**, 233–244 (2016).
- 473 62. Dineva, D. & Breitsohl, J. Managing trolling in online communities: an organizational perspective. *Internet*
474 *Res.* **32**, 292–311 (2021).
- 475 63. Bauer, J., Franke, N. & Tuertscher, P. Intellectual Property Norms in Online Communities: How User-Orga-
476 nized Intellectual Property Regulation Supports Innovation. *Inf. Syst. Res.* **27**, 724–750 (2016).
- 477 64. Fiesler, C., Feuston, J. L. & Bruckman, A. S. Understanding Copyright Law in Online Creative Communities.
478 in *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*
479 116–129 (Association for Computing Machinery, New York, NY, USA, 2015). doi:10.1145/2675133.2675234.
- 480 65. Cheng, J., Danescu-Niculescu-Mizil, C. & Leskovec, J. Antisocial Behavior in Online Discussion Communi-
481 ties. *Proc. Int. AAAI Conf. Web Soc. Media* **9**, 61–70 (2015).
- 482 66. Park, J. S., Seering, J. & Bernstein, M. S. Measuring the Prevalence of Anti-Social Behavior in Online Commu-
483 nities. *Proc. ACM Hum.-Comput. Interact.* **6**, 451:1–451:29 (2022).
- 484 67. Pfeffer, J. *Managing With Power: Politics and Influence in Organizations*. (Harvard Business Press, 1993).
- 485 68. Belmondo, C. & Sargis-Roussel, C. The Political Dynamics of Opening Participation in Strategy: The role of
486 strategy specialists’ legitimacy and disposition to openness. *Organ. Stud.* **44**, 613–635 (2023).
- 487 69. Long Lingo, E. & McGinn, K. L. A New Prescription for Power. *Harvard Business Review* (2020).
- 488 70. Larivière, V., Pontille, D. & Sugimoto, C. R. Investigating the division of scientific labor using the contributor
489 roles taxonomy (CRediT). *Quant. Sci. Stud.* **2**, 111–128 (2021).
- 490 71. Cobb, J. A. How Firms Shape Income Inequality: Stakeholder Power, Executive Decision Making, and the
491 Structuring of Employment Relationships. *Acad. Manage. Rev.* **41**, 324–348 (2016).
- 492 72. Long Lingo, E. & Elmes, M. B. Institutional Preservation Work at a Family Business in Crisis: Micro-pro-
493 cesses, Emotions, and Nonfamily Members. *Organ. Stud.* **40**, 887–916 (2019).
- 494 73. Freeman, J. The Tyranny of Structurelessness. *Berkeley J. Sociol.* **17**, 151–164 (1972).
- 495 74. Berger, M. Bibliodiversity at the Centre: Decolonizing Open Access. *Dev. Change* **52**, 383–404 (2021).
- 496 75. Druelinger, D. & Ma, L. Missing a golden opportunity? An analysis of publication trends by income level in
497 the Directory of Open Access Journals 1987–2020. *Learn. Publ.* **36**, 348–358 (2023).
- 498 76. Geiger, R. S., Howard, D. & Irani, L. The labor of maintaining and scaling free and open-source software pro-
499 jects. *Proc. ACM Hum.-Comput. Interact.* **5**, 175:1–175:28 (2021).
- 500 77. Young, J.-G. *et al.* Which contributions count? Analysis of attribution in open source. in *2021 IEEE/ACM 18th*
501 *International Conference on Mining Software Repositories (MSR)* 242–253 (IEEE, Madrid, Spain, 2021).
502 doi:10.1109/MSR52588.2021.00036.
- 503 78. Meluso, J., Casari, A., McLaughlin, K. & Trujillo, M. Z. Invisible Labor in Open Source Software Ecosystems.
504 Preprint at <https://doi.org/10.48550/arXiv.2401.06889> (2024).
- 505 79. D’Ignazio, C. & Klein, L. F. *Data Feminism*. (MIT Press, Cambridge, MA, 2020).
- 506 80. Gilson, L. L., Maynard, M. T., Jones Young, N. C., Vartiainen, M. & Hakonen, M. Virtual teams research: 10
507 years, 10 themes, and 10 opportunities. *J. Manag.* **41**, 1313–1337 (2015).
- 508 81. Splitter, V., Jarzabkowski, P. & Seidl, D. Middle Managers’ Struggle Over Their Subject Position in Open
509 Strategy Processes. *J. Manag. Stud.* **60**, 1884–1923 (2023).
- 510 82. Xu, L., Nian, T. & Cabral, L. What Makes Geeks Tick? A Study of Stack Overflow Careers. *Manag. Sci.* **66**,
511 587–604 (2020).
- 512 83. Chambers, C. R. Nonmonetary reward systems, counterproductive behavior, and responses to sanctions in open
513 collaboration environments. *Organ. Sci.* (2023) doi:10.1287/orsc.2020.14548.
- 514 84. Kraut, R. E. & Resnick, P. *Building Successful Online Communities: Evidence-Based Social Design*. (2012).
515 doi:10.7551/mitpress/8472.001.0001.
- 516 85. Sholler, D. *et al.* Ten simple rules for helping newcomers become contributors to open projects. *PLOS Comput.*
517 *Biol.* **15**, e1007296 (2019).

- 518 86. Meluso, J., Johnson, S. & Bagrow, J. Flexible environments for hybrid collaboration: redesigning virtual work-
519 ing through the four orders of design. *Des. Issues* **38**, 55–69 (2022).
- 520 87. Nganji, J. T. The Portable Document Format (PDF) accessibility practice of four journal publishers. *Libr. Inf.*
521 *Sci. Res.* **37**, 254–262 (2015).
- 522 88. Leonardi, P. M., Bailey, D. E., Diniz, E. H., Sholler, D. & Nardi, B. Multiplex appropriation in complex sys-
523 tems implementation: the case of Brazil’s correspondent banking system. *MIS Q.* **40**, 461–474 (2016).
- 524 89. Chang, J. & Danescu-Niculescu-Mizil, C. Trajectories of Blocked Community Members: Redemption, Recidi-
525 vism and Departure. in *The World Wide Web Conference* 184–195 (Association for Computing Machinery,
526 New York, NY, USA, 2019). doi:10.1145/3308558.3313638.
- 527 90. Berdahl, J. L., Cooper, M., Glick, P., Livingston, R. W. & Williams, J. C. Work as a masculinity contest. *J.*
528 *Soc. Issues* **74**, 422–448 (2018).
- 529 91. Brahm, F. & Poblete, J. Organizational Culture, Adaptation, and Performance. *Organ. Sci.* (2024)
530 doi:10.1287/orsc.2022.16791.
- 531 92. Simpson, B. & Willer, R. Beyond Altruism: Sociological Foundations of Cooperation and Prosocial Behavior.
532 *Annu. Rev. Sociol.* **41**, 43–63 (2015).
- 533 93. Wasko, M. M., Teigland, R. & Faraj, S. The provision of online public goods: Examining social structure in an
534 electronic network of practice. *Decis. Support Syst.* **47**, 254–265 (2009).
- 535 94. Jain, G., Shrivastava, A., Paul, J. & Batra, R. Blockchain for SME Clusters: An Ideation using the Framework
536 of Ostrom Commons Governance. *Inf. Syst. Front.* **24**, 1125–1143 (2022).
- 537 95. Tourani, P., Adams, B. & Serebrenik, A. Code of conduct in open source projects. in *2017 IEEE 24th Interna-*
538 *tional Conference on Software Analysis, Evolution and Reengineering (SANER)* 24–33 (2017).
539 doi:10.1109/SANER.2017.7884606.
- 540 96. Splitter, V., Seidl, D. & Whittington, R. Getting heard? How employees learn to gain senior management atten-
541 tion in inclusive strategy processes. *Strateg. Manag. J.* 1–49 (2024).
- 542 97. Anderson, J. & Christen, K. ‘Chuck a Copyright on it’: Dilemmas of Digital Return and the Possibilities for
543 Traditional Knowledge Licenses and Labels. *Mus. Anthropol. Rev.* **7**, 105 (2013).
- 544 98. Steinhart, G. & Skinner, K. *The Cost and Price of Public Access to Research Data: A Synthesis*. [https://ze-](https://zenodo.org/records/10729575)
545 [nodo.org/records/10729575](https://zenodo.org/records/10729575) (2024).
- 546 99. Elster, J. Chapter 3 Altruistic Behavior and Altruistic Motivations. in *Handbook of the Economics of Giving,*
547 *Altruism and Reciprocity* (eds. Kolm, S.-C. & Ythier, J. M.) vol. 1 183–206 (Elsevier, 2006).
- 548 100. Ren, Y., Kraut, R., Kiesler, S. & Resnick, P. Regulating behavior in online communities. in *Building successful*
549 *online communities: Evidence-based social design* (eds. Kraut, R. E. & Resnick, P.) 24 (MIT Press, Cambridge,
550 MA, 2012).
- 551 101. Dahlander, L. & O’Mahony, S. Progressing to the center: coordinating project work. *Organ. Sci.* **22**, 961–979
552 (2010).
- 553 102. Klapper, H. & Reitzig, M. On the effects of authority on peer motivation: Learning from Wikipedia. *Strateg.*
554 *Manag. J.* **39**, 2178–2203 (2018).
- 555 103. Simmons, J. P., Nelson, L. D. & Simonsohn, U. False-Positive Psychology: Undisclosed Flexibility in Data
556 Collection and Analysis Allows Presenting Anything as Significant. *Psychol. Sci.* **22**, 1359–1366 (2011).
- 557 104. Mellor, D. Improving norms in research culture to incentivize transparency and rigor. *Educ. Psychol.* **56**, 122–
558 131 (2021).
- 559 105. Meluso, J. Organizing Data Resources Website. <https://osf.io/8kum5/> (2023).