

# Peer-to-Peer Interaction

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Peer-to-peer interaction describes an approach to interaction and collaboration between participants in a shared project or activity that is characterized by network-based organizational structures, a shared common resource base, and an assumption that all participants have the potential to make constructive contributions. Modern forms of peer-to-peer interaction are substantially inspired by, and often themselves utilize, online peer-to-peer communication technologies; however, the principles and ethics of peer-to-peer interaction have also been translated to offline contexts.

## Technological inspirations

In computer science and network theory, peer-to-peer (or P2P) networks are distinguished from other network types in the first instance by their largely decentralized, truly networked structure: instead of hub-and-spoke or client/server configurations, peer-to-peer networks are organized without or with only minimal central administrative hubs. Apocryphally, the Internet itself was largely designed following peer-to-peer principles, in order to withstand major network disruptions from nuclear attacks or other critical failures; however, its current structure as a network of (country-, technology-, or provider-specific) networks does not represent a fully developed peer-to-peer network, as failures of the crucial connections between individual networks can severely undermine connectivity between constituent parts. Similarly, last-mile Internet connectivity through consumer-grade Internet service providers (and at the consumer end point, through wired or wireless routers) tends to operate using hub-and-spoke network models.

The peer-to-peer networking principles present at the hardware layer of the Internet are sufficient to support peer-to-peer connectivity at the software layer, however: Theoretically, save for the artificial barriers imposed by firewalls and other protective measures, any device connected to the Internet is able to address and exchange data with any other device, using the TCP/IP protocol suite that underpins almost any form of Internet-based communication. Other, content-specific data transmission protocols, such as FTP (for file transfers), HTTP (for Web content), or the proprietary protocols used by particular software applications, are built on top of the TCP/IP layer, and many such protocols incorporate aspects of peer-to-peer interaction. The Hypertext Transfer Protocol (HTTP), for example, enables any Web user to access Web content and servers

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that are identifiable by URL or at least by IP address, but the degree of interactivity permitted with such content is determined on the server side.

Other models for content distribution take a more fully developed approach to peer-to-peer networking. In doing so, they tend to embrace a second key principle of peer-to-peer interaction: the existence of a shared, common resource base in which the availability of individual resources is abstracted from their specific current location. A major example of this approach was the early peer-to-peer file-sharing platform Napster, launched in 1999: Napster created a global, searchable catalog of the music files (as well as movies, software packages, and other materials) shared by participating users, and identified where identical files were being made available by multiple participants. Napster clients seeking to download specific files (or portions of files) were then automatically directed to any one of these multiple copies, facilitating the rapid diffusion of these files across the Napster network. In effect, this joined together the individual data stores of all participating users as a shared, global, cloud-based library of music, movies, software, and other content.

However, Napster remained vulnerable due to its reliance on a central catalog of all available content, and the forced closure and subsequent takeover of the original Napster by content industry interests, as a result of its role in facilitating sharing users' infringement of artists' and music labels' copyrights, effectively disabled its peer-to-peer network. More recent generations of file-sharing softwares therefore also implement a crucial third principle of peer-to-peer interaction: They treat all clients as potentially equal participants. Modern file-sharing protocols such as BitTorrent enable clients to join ad hoc "swarms" of other clients with whom they exchange content, rather than requiring them to announce their activities to a central server acting as a global register of participants. This also means that BitTorrent networks are substantially more resilient to disruption: While popular sites, such as The Pirate Bay, that are used by individual file sharers to announce the availability of their content may be shut down by copyright industry interests, such sites are redundant and easily replaced by others. By contrast, under the more centralized Napster model, the shut-down of its central register crippled the overall network.

Although the unauthorized sharing of copyrighted material accounts for a significant proportion of file-sharing traffic using BitTorrent and similar protocols, it should be noted that the protocol is also used for a range of entirely legitimate purposes, and especially for the distribution of very large files that would be difficult to download reliably using more standard mechanisms. A range of open-source software packages are regularly distributed using BitTorrent, while various music and movie publishers are now also using BitTorrent to distribute personalized content packages to paying end users. Similarly, various spin-offs utilize advanced peer-to-peer protocols for their own purposes: for example, popular Internet videoconferencing software Skype, which shares a common origin with file-sharing tool Kazaa, utilizes a peer-to-peer connectivity model that draws on other nodes in the network to help relay calls. Such forms of peer-to-peer interaction are therefore very immediately inspired and facilitated by peer-to-peer networking technology.

## Social peer-to-peer interaction

Additionally, the core principles that underpin peer-to-peer connectivity have been abstracted from their technological origins, and implemented across a range of projects and practices. The P2P Foundation, an unaffiliated international grouping of researchers and practitioners exploring peer-to-peer interaction, defines three key principles

that are essential for P2P processes to occur in a full-blown manner: 1) peer production as a mode of production; 2) peer governance as a mode of governance; 3) universal common property as a mode of distribution and access. But P2P can also occur in a partial manner wherever resources are distributed. (P2P Foundation, 2012)

These three principles draw directly on the technological frameworks for peer-to-peer networking, which assume the equal potential of participants (making peer production possible), employ decentralized network structures (enabling peer governance), and generate a shared resource base (which requires common property frameworks).

Projects and activities that translate peer-to-peer principles from technological to social contexts proceed, therefore, by instituting processes of “commons-based peer production” (Benkler, 2006) or “produsage” (Bruns, 2008): They extend an open invitation to potential participants to make their contributions to the shared effort, independent of formal qualifications or participatory track record. This necessarily results in a flattening of preexisting hierarchies, although new hierarchical or at least heterarchical structures may emerge in turn—peer production is not usually an anarchic or disorganized practice, but it does employ different organizational forms than conventional, industrial production. These are usually meritocratic, based on a proven track record of contribution to a shared aim: Peer-to-peer “accepts authority based on expertise, initiation of the project, etc.” (Bauwens, 2005, p. 12).

Michel Bauwens, founder of the P2P Foundation, suggests that this combination of the open access to participation and the self-organization of the community of participants is governed by a belief in “equipotentiality ... the assumption that the individual can self-select his contributions, which are then communally validated” (in Poynder, 2006, p. 1): In other words, peer-to-peer interaction assumes not that all contributors to its activities are simply functionally equal, but that they do have equal *potential* to identify the areas in which they are able to make a constructive contribution to the common project. The continuous communal evaluation of their contributions is also expected to militate against an ossification of emerging community structures: “the open process of participation (equipotentiality) precludes a systematic strengthening of reputation so that it could become a factor of conservatism (as it is in science and its dependence on dominant paradigms) and power” (Bauwens, 2005, p. 38).

Peer-to-peer interaction also depends on the existence of a shared stock of informational (and potentially also physical) resources with which individual participants can engage. For the field of knowledge production, von Hippel defines this shared resource as “an information commons, a collection of information that is open to all on equal terms” (2005, p. 165). In turn, the resources that individual participants develop by

building on the materials gathered within this commons are usually themselves again made available to others through the commons; this is enforced in some cases through the adoption of binding legal frameworks that specify the conditions of content use and development, including open-source or Creative Commons licenses.

Participation in peer-to-peer interaction is generally driven by a combination of intrinsic and extrinsic motivations. Intrinsic motivations may include not only a sense of commitment or obligation to the common cause of the peer community, but also the expectation of personal betterment as a result of participating (including an improvement in personal and professional skills, or a growth in social status within or beyond the peer community); extrinsic motivations may include tangible incentives and rewards offered for participation (but a strong focus by participants on such rewards, rather than on the common good of the peer community, may also overprivilege certain forms of peer interaction and undermine social cohesion). Overall,

commons-based information communities or networks will form when the following conditions hold: (1) Some have information that is not generally known. (2) Some are willing to freely reveal what they know. (3) Some beyond the information source have uses for what is revealed. (von Hippel, 2005, pp. 165–166)

## **Applications, projects, and movements**

Outside of purely technological environments, peer-to-peer interaction principles have been applied in a wide range of contexts. Many forms of user-led content creation operate on a peer-to-peer basis, especially where they are principally initiated by user communities themselves rather than by commercial or other third-party interests: Most prominently, open-source software development and collaborative editing in Wikipedia and related knowledge management projects are fundamentally based on peer-to-peer interaction. Here, information communities in von Hippel's definition, organized using heterarchical and meritocratic principles, have been established around the shared, common knowledge base compiled over time by current and previous participants, and new contributors are continuously invited to engage with, add to, and revise the existing resources.

Open-source principles have also been translated to the field of news and journalism, where especially the early Indymedia initiative based itself substantially on peer-to-peer principles (Platon & Deuze, 2003). While it operated a network of several hundred centralized Web sites for specific cities, regions, and countries, these sites themselves were interlinked with each other, and peer production approaches were adopted by most of the local Indymedia collectives. Indymedia was especially successful in providing the means for peer production, well before the arrival of mainstream platforms for user-led content creation, and in thereby establishing an information commons for global alternative politics; its commitment to flat and even anarchic organizational structures kept it from developing sustainable peer governance structures, however, ultimately undermining the project. A range of subsequent citizen journalism initiatives continued to embrace peer-to-peer interaction principles, nevertheless, and the

loosely organized network of the global blogosphere can be understood as a form of peer-to-peer interaction in its own right.

More fleetingly and ad hoc, like-minded communities of peers engaging with news and journalism also form and dissolve again in social media spaces such as Facebook and Twitter, especially around acute events. Social media serve as always-on, background, “ambient news” platforms (Hermida, 2010), which push to the foreground as news breaks, leading interested users to flock around topical user profiles or hashtags that can serve as a common gathering point for those sharing as well as seeking information. Journalists, domain experts, or other lead users may serve as news curators in these environments, as Hermida, Lewis, and Zamith (2014) have demonstrated for the example of NPR journalist Andy Carvin on Twitter during the upheavals of the 2011 Arab Spring: They help to orchestrate and channel the peer-to-peer interactions around the topic and thereby organize the shared information commons.

Beyond journalism itself, social media spaces such as Facebook and Twitter also provide the platform for peer-to-peer interaction at a more general level, and at a global scale. These platforms centrally embrace networked organizational models (demonstrated, for example, by the way in which professional networking platform LinkedIn cuts through traditional organizational hierarchies by allowing any member to seek a direct connection with another, independent of professional status), and largely encourage the development of self-governing peer communities managing their own information commons. Similarly, many modern massively multiplayer online role-playing games (MMPORGs) provide open-ended, immersive games environments in which players are empowered to develop their own networks and governance structures. In these cases, commercial operators provide the underlying infrastructure and frameworks that are available to user communities to develop their own peer-to-peer interaction practices and activities.

Peer-to-peer interaction practices that were inspired by online networking models have been translated into offline spaces. In the contexts of mass protest movements, the “human microphone” that was used during recent protests by the Occupy movement can be seen to replicate online peer-to-peer principles without resorting to the use of technology. Here, in situations where the use of electric amplification technology is impossible or prohibited, the statements of protest speakers are relayed orally from peer to peer to ensure widespread transmission. Peer-to-peer interaction principles are also employed by a range of leaderless or at least heterarchical, networked organizations ranging from Anonymous to al-Qaeda: Both for ideological reasons and in order to make the group more resilient to outside disruptions, such organizations divide into a series of loosely networked, more or less independently operating cells that share common goals and approaches and collaborate on an ad hoc basis. Outside of alternative and underground politics, such network-centric organizational structures can also be found in fields where flexible, occasional networked interaction may be beneficial to otherwise independent actors: This includes, for example, the arts, where individual artists may form temporary alliances to engage in peer-to-peer interaction aimed at producing group works, attracting funding, or lobbying policy-makers.

## Challenges and criticisms

Peer-to-peer interaction processes centrally trust in the ability of participating communities to self-organize, collaborate, and mitigate disruptions. Such trust is not always warranted, as persistent malevolent disruptions (for example, in the form of trolling, spamming, or freeloading) or even continued well-meaning but inappropriate contributions by peer participants may disrupt peer interaction processes beyond repair. Alternatively, there is also a danger that interaction processes between peers may remain unproductive if participants are too similar in their ideas and attitudes, leading to “groupthink” and intellectual stagnation. It is likely, therefore, that productive peer-to-peer interaction requires a sufficiently diverse contributor base, yet one that is not so diverse that its members are unintelligible to each other.

Supporters of peer-to-peer interaction principles suggest that under favorable conditions, what can emerge in the community of participants is a form of “collective intelligence” (Lévy, 1997); the community as a whole and those who draw on the ideas and information it gathers and produces are thus able to benefit from the “wisdom of crowds” (Surowiecki, 2005). This view is encapsulated in the open-source software development aphorism “given enough eyeballs, all bugs are shallow” (Raymond, 2000), which claims that a sufficiently large (and by extension, sufficiently diverse) group of actively engaged, volunteer developers and testers will be more efficient at identifying problems and finding solutions than a small team of professional software designers. However, such beliefs have been derided by more pessimistic commentators as a “cult of the amateur” (Keen, 2007), which seeks to overthrow long-established structures of knowledge production and professional accreditation. In this view, these conventional structures, and the production processes they favor, are necessary and crucial for ensuring that critical errors are not overlooked by the peer production process’s more stochastic approach to quality assurance.

Overall, it is unlikely that this continuing debate will find a single solution. The relative effectiveness of professional and peer production models is likely to depend on a large number of environmental factors that are unique to any given case, including the diversity and expertise of the competing professional and peer participants, the industry funding or volunteer time available to the project, and the extrinsic and intrinsic motivations of contributors. Peer production success stories such as Linux or Wikipedia should not obscure the fact that many other crowdsourced projects do fail, while conversely such failures should not be seen as incontrovertible proof that peer production models themselves are inherently flawed. It should also be noted that some of the harshest criticism of peer-to-peer interaction models has come from representatives of hierarchical organizations that are most immediately threatened by alternative network-centric models: The open-source community, for example, has identified a range of what it calls “fear, uncertainty, and doubt” (FUD) campaigns by the commercial software industries that seek to discredit open-source software.

The fundamental reliance of peer-to-peer interaction models on shared, commons-based resources also means that they are forced to address potential repercussions from the “tragedy of the commons” problem recognized by economic theorists:

mere freeloading that depletes the commons without engaging productively with it. Advocates of conventional copyright models have used this to argue against more permissive licensing schemes such as open source and Creative Commons:

the key idea is that since the commons is open to all, no one has an incentive to invest in its improvement by producing and sharing valuable innovations. The solution, it is claimed, is “enclosure” dividing the commons into pieces of individual property. (Quiggin, 2006, p. 491)

However, such concerns apply only in the context of finite physical resources that can be depleted by (over)use: At least for those forms of peer-to-peer interaction that build largely on online technologies and informational content, such depletion is usually impossible. As Bauwens notes, online “P2P operates in a sphere of abundance, where a tragedy of the commons, an abuse of common property, cannot occur, or at least, not in the classical sense” (2005, p. 2). (Freeloading and other manifestations of the tragedy of the commons do pose potential challenges again as peer-to-peer interaction models move from online to offline contexts, however.) Online, the challenge shifts from preventing overuse of the common resource to encouraging not only its usage, but also active contribution to its continued development. This challenge can be addressed at least in part by ensuring that the investment of time and effort to participate at least in an entry-level capacity is minimized, and that the graduation toward higher-level participative activities proceeds by following a number of easily achievable steps. Successful peer production projects are thus often characterized by “their modularity and their capacity to integrate many finegrained contributions” (Benkler, 2006, p. 100).

Some peer-to-peer interaction may take place within commercial, proprietary environments, and is thus confronted with a different range of challenges. For example, peer-to-peer interaction using social media, or peer-to-peer interaction by players in an immersive games environment, is governed by the specific terms of service and commercial agenda of the platform provider; users may be able to use a platform for free, but their activities and data are in effect sold to advertisers and analysts, much as television audiences are sold to television advertisers, or are restricted in diversity and duration unless higher-level capabilities are added by taking out premium access subscriptions. In other models, voluntary peer-to-peer interactions are conducted as a prelude to commercial transactions, and platform providers claim a share of the proceeds: This model applies, for example, in the case of online auctioning site eBay or peer-to-peer accommodation booking platform Airbnb, or for most online dating platforms. In other, similar cases, providers employ so-called “freemium” models: Basic peer interaction may be freely available, but higher-end functionality is available only to paying subscribers.

Such models constitute an example of what J. C. Herz describes as “harnessing the hive” (2005): a corporate provision for and enclosure of peer-to-peer interaction processes. Some such harnessing frameworks are benign and mutually beneficial to both platform provider and peer community, constituting a fair transaction between both sides; in other cases, however, peer-produced content may be harvested and commercially exploited beyond acceptable limits without remuneration of the original contributors, or the community itself may subsequently be hijacked by unforeseen unilateral changes to the conditions of use set by the platform operator. Where such more

exploitative approaches to the commercial harnessing of peer communities are being employed, peer-to-peer interaction models have been accused of enabling and legitimizing the commercial abuse of volunteer efforts.

SEE ALSO: Community; Computer-Mediated Communication; Computer-Supported Cooperative Work (CSCW); Collaboration and Cooperation; Distributed Communication; Interactivity; Models of Communication; Network Society; Network Theory and Models; Prosumption, Produsage; Social Media; User-Generated Content

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