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The intellectual pillars of user innovation - a co-citation analysis

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Introduction

This paper deals with user innovation, an innovation research branch that has been well established. We speak of user innovation if the user rather than the manufacturer has developed and utilized innovations. Eric von Hippel described this phenomenon explicitly in the early 1980s. He formulated the differences between user and manufacturer innovations as: *"Users […] are firms or individual consumers that expect to benefit from using a product or a service. In contrast, manufacturers expect to benefit from selling a product or a service."*
Von Hippel's research gave rise to a paradigm shift because manufacturers had previously been regarded as the sole source of innovation. In the tradition of Schumpeter (1926) and his followers, manufacturers regarded the expected innovation benefits as the main driving force of innovation. From this view-point, which Von Hippel described as the "manufacturer-active paradigm," customers – like users – are passive recipients of these innovations. Their contribution is consequently limited to the formulation of demands, as well as the adoption and utilization of new products and services (innovations).
In contrast to this traditional point of view, von Hippel could show and empirically underpin that users are –in certain application fields – very strong sources of innovation (see Von Hippel 1976).
In contrast to manufacturer innovation, the main motive for user innovation lies in the satisfaction of a need and/or user problem for which there is (as yet) no corresponding solution. Consequently, the user him/herself becomes innovatively active and first creates a (problem) solution in the form of a functioning prototype. If the underlying need is not a unique one and/or is also useful for other users, inquiries will arise over time, which manufacturers will usually recognize and seize. Manufacturers only become innovatively active if they find the recognized opportunity economically interesting.
These early fundamental findings have in the meantime expanded into an own research stream (user innovation research). In addition, the observation that users are self-innovating has been empirically confirmed in a wide range of application areas. Consequently, the described phenomena have been demonstrated in various industries and/or in the context of different product categories, for example, scientific instruments (see Riggs, von Hippel 1994; von Hippel 1976), medical techniques (see Chatterji, Fabrizio 2011; Lettl 2005, 2007; Lettl, Gemünden 2005; Lettl et al. 2006b; Lettl et al. 2006a), assembly systems (see Herstatt, von Hippel 1992), information systems (see Morrison et al. 2004; Morrison et al. 2000), kite surfing equipment (see Franke et al. 2006; Tietz et al. 2005), diving equipment (see Schreier et al. 2007; Schreier, Prügl 2008), mountain bikes (see Lüthje et al. 2005), mountaineering (see Fauchart, Gruber 2011; Harrison, Corley 2011; Lüthje 2004; Schweisfurth 2012), kayaks (see Baldwin et al. 2006; Hienerth 2006; Hyysalo 2009), sailing boats (see Raasch et al. 2008), music software (see Faulkner, Runde 2009; Jeppesen, Frederiksen 2006), toys (see Janzik

2010), baby products (see Shah, Tripsas 2007), and computer game equipment (see Schweisfurth 2012)
Meanwhile, various phenomena and/or aspects are researched under the user innovation topic and there are close connections to further fields of research, such as open innovation, open source innovation, crowdsourcing, online communities, and open content (see Schweisfurth et al. 2011).
Precisely because of the increasing multiplicity of researched phenomena that are currently included in the user innovation concept, it seems appropriate to take a step back and analyze the concept's origins and basic principles more precisely. With this paper, we thus pursue the objective of developing the intellectual and theoretical pillars of the user innovation field of research and of demonstrating the tradition in which the current research finds itself.

Methodology

We embarked on a co-citation analysis in order to present the various research streams that underlie user innovation (see Meyer et al. 2009; Raasch et al. 2013; Schäffer et al. 2006; Schildt et al. 2006). Co-citation analysis is a bibliographic method with which the relationship between distinct entities can be measured. Co-citations indicate the proximity between these entities. When two publications (or authors) are both cited in the reference list of a third publication, this is called a co-citation. Since co-citation is based on the assessment of experts and/or scientists in a certain field, a contextual proximity can be assumed between these co-cited publications in a given case. Co-citation analysis can be either author-based or publication based (see Chen et al. 2010). Whereas author-based co-citation analysis reveals the social structures in a field (see Chen et al. 2010), publication-based co-citation analysis represents the intellectual or contextual structure (see Chen et al. 2010; Gmür 2003). This approach demonstrates the theoretical foundation and the key basic contextual fields ("key ideas"; see Small 1973) of a scientific field. Since our objective is to present the historical intellectual tradition of user innovation research, the publication-based co-citation analysis is an appropriate approach.
For this purpose, we proceeded in three steps (see Chen et al. 2010): data collection, data preparation (construction and visualization of the matrix), and identification and interpretation of the cluster.

Data collection

We utilized two centrally important databases to identify relevant publications in the user innovation field (EBSCO Business Source Premier and ISI Web of Science). We searched for three key phrases, which, as central concepts, outline the field: user innovation, lead user, and user entrepreneurship. We identified a total of 210 publications (104 in EBSCO, 106 in Web of Science) up to 2012. Subsequently, we cleared the database of duplicates, non-English articles, articles without a peer review, conference contributions, working papers, and accidental contextual hits. The consolidated database contains 129 articles.

Data preparation

The next step comprised the preparation of the co-citation matrix. We extracted the references of each of the 129 articles to construct the matrix. The focus here was on the identification of the intellectual pillars of user innovation (see Raasch et al. forthcoming) and

not on the articles' links within the research field. Consequently, we included all the remaining references in a database (the 4645 articles referenced by the 129 publications). Thereafter, we consolidated the sources of, for example, different editions of the same book, while working papers were matched with original articles that were published later. To guarantee a concise representation rich in content, we eventually only accepted those sources in the analysis that the original articles (221 sources) referenced more than three times. In conclusion, we transformed the data base into a 221 x 221 citation matrix. We applied the co-citation value (CoCit) as the proximity measurement. This proximity measurement has a value of between 0 and 1 and, for two publications, A and B is calculated as follows (see Gmür 2003):

$$CoCit_{AB} = \frac{(Cocitation_{AB})^2}{\min(Citation_A, Citation_B) \times (\frac{Citation_A + Citation_B}{2})}$$

Identification and interpretation of the cluster

To visualize the network and the cluster, we utilized the Organizational Risk Analyzer software developed at the Carnegie Mellon University. Figure 1 represents the overall network in its complexity.

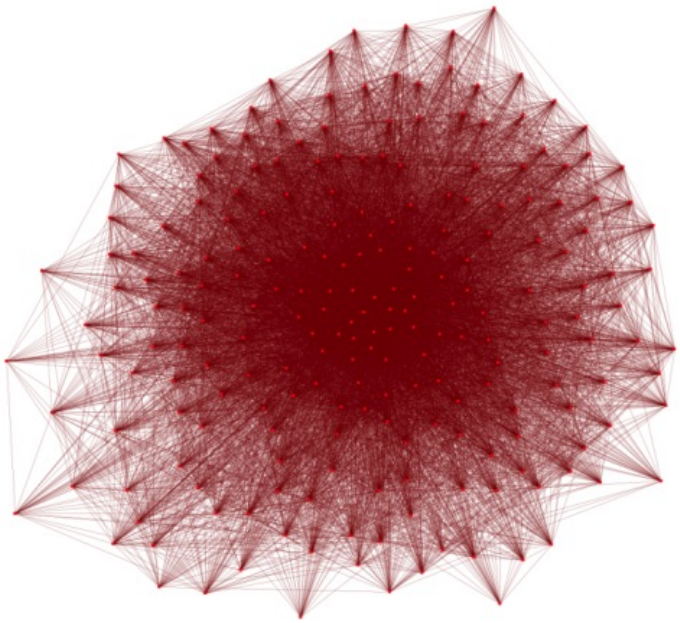

Figure 1: Overview of the total network

A threshold value has to be selected to make the cluster of publications with a close contextual relationship visible. Only publications with a co-citation value greater than the threshold value were shown. The threshold value was started at 0.1 and increased stepwise until an accumulation became visible. At the value of 0.5, a total of 12 clusters emerged. These clusters represent contextually related publications on the user innovation topic. We then read these publications, analyzed the contextual common features, and labeled the cluster correspondingly to implement the contextual categorization. The 12 emerging cluster were assigned to five main topics – classics from user innovation, influences from

economics, influences from psychology and sociology, influences from innovation and entrepreneurship, and influences from marketing –, which we gave abbreviated titles.
Note that in the graphical representation of the cluster, the co-citation value does not calculate the relevance of individual publications, i.e. the number of citations, but the coherence between two publications. To provide an indication of the number of citations, the size of the individual nodes are scaled according to the total number of citations.

Results

Classics of user innovation

Early examples of user innovation in the field of industry

This cluster comprises early examples of user innovation in the field of manufactured goods. They incorporate the first empirical evidence of industries in which manufacturers did not primarily drive innovation, but users did. The publications in this cluster are based on data from chemical engineering and manufacturing technology (see Enos 1962; Freeman 1968; Lionetta 1977), as well as from computer technology (see Knight 1963, 1963). Authors repeatedly cite these fundamental studies. Von Hippel (1976; 1977) and his followers' early publications also fall into this category. His studies can be viewed as the cornerstone of the user innovation research field because he was the first to systematically show that users play a dominant role in the early phases of the innovation process in both product innovation (here, scientific instruments; see Von Hippel 1976) and process innovation (here, semi-conductor manufacturing; see von Hippel 1977).
We can, however, also ascertain that other scientists before Von Hippel already described the user innovation phenomenon, although this phenomenon did not pervade science at that time.

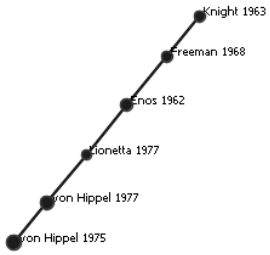

Figure 2: Early examples of user innovation in the field of industry

Lead users and end user innovation

The publications in this cluster can actually also be regarded as classics of user innovation research. In comparison with the previous cluster, the focus here is on user innovations in the end user area and on lead users research.
By 1986 Von Hippel had already described the classic lead user method conceptually (see Von Hippel 1986). Publications followed that described and evaluated method to identify and integrate lead users into the entrepreneurial innovation process. Two particular publications were of primary significance for further research: Urban and von Hippel (1988) demonstrated that lead users' product concepts are preferred to the ordinary products of

other users. As part of an action research study in the building reinforcement industry, Herstatt and von Hippel (1992) showed that the utilization of the lead user method can lead to more lucrative and faster results than the classic marketing research methods.
A further part of the studies empirically prove the influencing factors of user innovation. Franke and Shah (2003), for example, find that innovative users in the area of sport possess a higher "lead userness" and occupy a central role in user communities. In a similar area (outdoor products), Lüthje (2004) identifies that product utility and commitment to a product field favor user innovation and that innovative users also adopt new products sooner. Morrison et al. (2000) find that there is a positive relationship between leading edge status and available technical resources on the one hand and innovation behavior on the other hand. In this way, they establish a relationship with diffusion research and confirm that, in line with diffusion theory, lead users often have innovator status. Lüthje, Herstatt, and Von Hippel (2005) broaden the perspectives once again: specifically, locally available (technical) knowledge promotes user innovations. In his book "Democratization of Innovation," published in 2005, Von Hippel consolidated these publications concisely and provides the research field with new impulses.

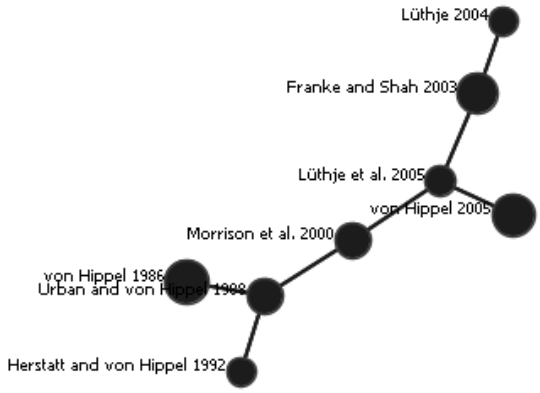

Figure 3: Lead users and innovation by end users

Influences from economics

Collective innovation models

Collective innovation models provide important basic principles for the free disclosure of ideas, i.e. those parts of innovation-relevant knowledge that are not directly rewarded (see Harhoff et al. 2003), which are time and again viewed as the central building blocks of user innovation and open source innovation (see Schweisfurth et al. 2011). In addition, Allen's (1983) works were some of the first contributions to this phenomenon with regard to the 19th century steel industry. Instead of protecting blast furnaces with patent laws, their construction designs were shared with local competitors to allow technical problems and technically uncertainties to be jointly solved and to compete with global competitors. In his historical case study, Nuvolari (2004) shows that rapid technological change benefits those local industry clusters that deploy free knowledge exchange instead of protecting their innovations with patents. Finally, Benkler (2006) transfers these ideas to the information society. He argues that non-competitive information products and low communication costs benefit production systems that allow the free sharing of goods and strengthen the

autonomy of individual network actors. This idea is taken up time and again in the realm of user innovation research.

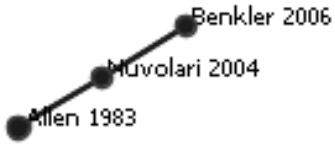

Figure 4: Collective innovation models

Intellectual property rights and acquirement of innovation benefits.

In user innovation research, intellectual property rights are traditionally viewed critically, because they reduce innovation activities and information transfer between users and restrict free disclosure, which is described above. This cluster includes publications that are critical about the efficiency of intellectual property rights. Taylor and Silberston (1973) critically analyze the British patent system and point out alternative ways of organizing the protection of intellectual property. Mansfield's (1985) contribution shows that technological knowledge diffuses rapidly from a company even it is protected by patent law. Furthermore, Levin et al. (1987) show that patents in many branches do not provide effective mechanisms for the appropriation of innovation benefits and also do not unconditionally contribute positively to welfare. In addition, they argue that many branches have better mechanisms (secrecy, lead time) with which to foster innovations. Cohen et al. (2000) confirm these findings and add that patents often do not serve to protect an invention as such, but to block competitors.

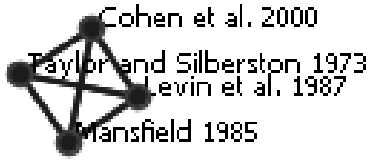

Figure 5: Intellectual property rights and acquirement of innovation benefits.

Knowledge, innovation, and evolution

This research cluster comprises key publications from the evolutionary economy area. Their fundamental assumption is that actors in the economic sphere's actions are only limitedly rational and that when they make decisions, they are led by cognitive heuristics (see Baron 2000). Companies can therefore absorb and process knowledge successfully if they already have some experience or prior knowledge of the corresponding field (see Pavitt 1987; Rosenberg 1982). From these basic assumptions, Nelson and Winter (1982) infer that companies develop specific routines by means of which they make decisions and solve problems. These routines can only be conditionally changed because they build on one another and are path-dependent .

This path dependency of companies and the cumulative knowledge building result in organizations often not recognizing new radical innovations. Users therefore generate new

ideas that evolve from user experience and diffuse them, while established companies only adopt them later (see Baldwin et al. 2006; von Hippel 1976).

Figure 6: Knowledge and innovation

Influences from psychology and sociology

Problem solving

Innovation (and specifically invention) can be conceptualized as problem solving (see Terwiesch, Xu 2008). The publications from this cluster postulate that cognitive distortions often restrict innovative problem solving. People prefer problem solutions they already know and that lie in an existing knowledge corridor (see Birch, Rabinowitz 1951). Duncker (1945) coined the phrase "functional fixation" for this phenomenon, which Adamson confirmed in his studies (see Adamson 1952; Adamson , Taylor 1954). According to Von Hipple (1988), functional fixation is one of the principal reasons why market research with existing clients reaches its limits when truly new products need to be designed. "Typical" customers and/or product users' utilization knowledge pre-shape them and they therefore prefer problem solutions with which they are already familiar. According to Von Hippel, lead users can, conversely, compensate for this cognitive distortion. "Although the insights of lead users are as constrained to the familiar as those of other users, lead users are familiar with conditions that lie in the future for most-and, so, are in a position to provide accurate data on needs related to such future conditions." (see von Hippel 1988, p. 107). Consequently, the "ahead of the trend" component of the lead user construct has its theoretical roots in this cluster.

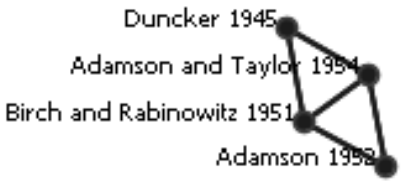

Figure 7: Problem solving

Network theory

Especially in the field of user communities, which is about the sharing of innovation knowledge, user innovation research shows that this is largely based on theories that describe social networks. Burt and Granovetter's publications particularly describe the theory building in this case. Burt (1992, 2004) is specifically engaged with the question of the roles that gaps (structural holes) play in networks. Actors close to such gaps and those who simultaneously bridge different networks can benefit particularly. They are distinguished by their knowledge and creativity advantage. In particular, lead users can assume specific roles

in innovation and diffusion networks, because they provide important connections between otherwise unrelated actors.
On the other hand, Granovetter (1973) shows that actors' success in networks is often based on weak ties. This explains, for example, why on-line user forums, etc. can be innovative and successful although they involve only loose acquaintances

Figure 8: Network theory

Influences from innovation and entrepreneurship

Radical innovation

This cluster deals with the issue that – especially in radical and discontinuous innovation projects – existing clients and/or users can only be integrated with difficulty. They often prefer existing solutions and therefore cannot imagine new applications and markets (see Von Hippel 1988).
Veryzer (1998) conducts an explorative study in eight discontinuous innovation projects. He traces the development process of completely new products and shows that these projects are technology-driven in the first phases and are normally disconnected from potential applications. Only after the design phase, do the user feedback and market valuation come to the fore. Lynn et al. (1996) support Veryzer by arguing that classic market research techniques are of no help in the discontinuous innovation environment. They propose a probe-and-learn process in which early product versions are introduced into distinct potential target markets and the experiences gained from these tests are later reintroduced into the development. Analogously, Urban et al. (1996) propose a virtual product test for such early market tests.

Figure 9: Radical innovation

Entrepreneurship and qualitative methods

This cluster includes two different thematic strands: qualitative research methods and entrepreneurship. These are in one cluster because many studies on the recognition of entrepreneurial opportunities in the user innovation realm are qualitative (see Hienerth, Lettl forthcoming; Lettl, Gemünden 2005; Shah, Tripsas 2007).

The basic principles of the recognition of entrepreneurial chances form the basis of three publications (see Shane 2000; Shane , Venkataraman 2000; Venkataraman 1997). The key finding of these publications is that information corridors guide the discovery of opportunities. The cognitive schemes of user entrepreneurs with prior knowledge and experience in a certain application area, allow these schemes – rather than other people – to observe problems and, thus, opportunities in this application context.
The other publications in the cluster are more methodological. Three of these (see Chetty 1996; Eisenhardt 1989; Perry 1998) deal with the case study methodology in general and provide guidelines for the process ranging from research question to assessment. Miles and Huberman (1994) focus on different qualitative data analysis strategies. In his book, Krippendorf (2004) deals specifically with content analysis as a method.

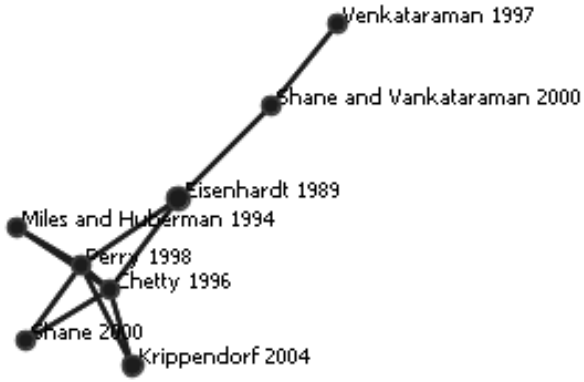

Figure 10: Entrepreneurship and qualitative methods

Influences from marketing

Online communities

User innovation research has often chosen innovative user communities and networks as a research topic and context. The early publications on these organizational forms are an especially important pillar of this research. Kozinets (2002), for example, was the first to provide recommendations regarding the methods with which this new manifestation could be qualitatively researched (netnographic method). Butler et al. (2002) explain how on-line user communities are organized and which user groups undertake which assignments. The other publications focus on the interaction between companies and user communities: McAlexander et al. (2002) explore the development of successful brand communities and Filler et al. (2006) how companies can integrate user communities in the innovation process.

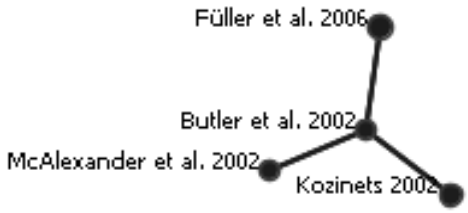

Figure 11: Online Communities

Customer knowledge and brand orientation

The following two clusters form a subtopic since both deal thematically with market orientation and customer knowledge. The conceptualizations of Kohli and Jaworski (1990) and Narver and Slater (1990), published in the same year, are key publications in this regard. Market orientation describes the market-related orientation of the company. In conjunction with user innovation, the integration of customer needs plays an important role. The publications included here indicate that in highly innovative product development projects, a customer focus does not usually lead to targeted innovation, since the involved customers can mostly not express their needs (see Atuahene Gima 1995; Ulwick 2002). Furthermore, companies often lack suitable internal processes to deal internally with knowledge that is difficult to formulate (see Madhavan , Grover 1998). Both phenomena recur in Polanyi's finding, which he formulated as: tacit knowledge cannot be codified (see Polanyi 1966).

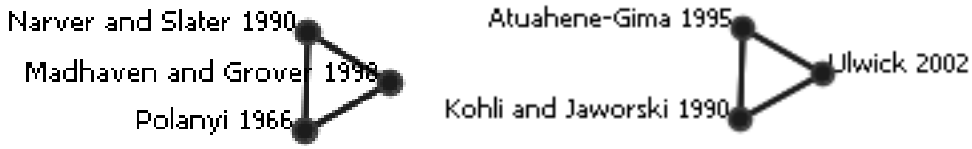

Figure 12: Customer knowledge and brand orientation

Summary and discussion

Our analyses show that user innovation research is based on very distinct scientific pillars and thus does not follow from a single theoretical tradition. Consequently, findings from economics, psychology, sociology, and classical business studies fields (e.g. marketing) are included in the research. It is anticipated that, following the general patterns of research fields' scientific evolution (see Raasch et al. 2013), and using interdisciplinary research as a point of departure, the user innovation field will increasingly gear itself towards existing research streams. In mainstream management journals, most recent publication activities concerning user innovation indicate that user innovation research has arrived in classic, management-oriented business administration (see Alexy et al. 2012; Autio et al. 2013; Baldwin, Von Hippel 2011; Dahlander, Frederiksen 2012; Von Hippel et al. 2012).
Besides the research questions raised by Bogers et al. (2010), we believe that the following themes in user innovation research will play a specific future role.

- Organizational aspects of user innovations and their utilization for companies.

  Although it has in the interim been recognized that users can be innovative, the question is still: which organizational mechanisms can be used to make those innovations useful for companies? Potential organizational forms build on-line communities (see Füller et al. 2007), address internal users of company products (the embedded users; see Schweisfurth 2012), increase the absorptive capacity for user knowledge (idhu et al. 2007), co-create with users (see Von Hippel, Katz 2002), and offer special user workshops (see Lüthje, Herstatt 2004). Research findings are specifically useful in this respect if they can draw conclusions about which organizational mechanisms promise success for which type of innovation problems. In this regard, the question arises: how can companies dismantle successive barriers that often stand in the way (e.g. due to violations of IP rights through user

innovation, risking product safety through product modifications and, thus, the associated warranty claims)? Braun and Herstatt presented the first publications on this topics (see Braun, Herstatt 2007, 2008).

- The interaction patterns between manufacturers and users in innovation ecosystems.

  Such ecosystems occur, for example, in the medical field in which various actors – i.e. users (patients), manufacturers (healthcare providers) and hybrids (doctors) – become involved in innovation. This raises the question: which values are generated at what point and which critical resources are required to acquire appropriate innovation benefits?

- The sustainability and/or ecological efficiency of user innovations.

  To date, this aspect has been completely neglected in user innovation research. User innovations do not necessarily have to be "better" than manufacturer innovations. They certainly have the potential to be and it is likely that, in the future, users themselves will increasingly start such initiatives. Herein lies a considerable innovation potential – also for companies that would specifically like to gain knowledge for their product development. The same applies to frugal innovation, i.e. products/services tailored to the needs of users (in developing countries) that cannot be satisfied by means of western "standards" because they are either functionally not ideally tailored and/or are simply too expensive. Here, too, there are considerable chances for both innovation research and practice.

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