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Hackerspaces: A Case Study in the Creation and Management of a Common Pool Resource

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Abstract

Hackerspaces are community-operated physical places where individuals get together to build things. While the organization itself is private, the 'space' that is created for individuals to work has elements of a common pool resource (CPR). Previous literature finds technology to be important in effective CPR management. Through an ethnographic study of a hackerspace, we show how technology is crucial for management of the 'space'. In addition, we highlight how technology is used in hackerspaces to satisfy three of Elinor Ostrom's design principles for stable CPR management.

JEL Codes: L3, Z13

Keywords: Common pool resource, design principles, hackerspaces

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1. Introduction

In *Democracy in America* Alexis de Tocqueville ([1840] 1984: 201) states that "[i]n democratic countries the science of association is the mother of science; the progress of all the rest depends upon the progress it has made." Elinor Ostrom won the economics Nobel in 2009 for her contribution to the science of association as it relates to common pool resource (CPR) management. Ostrom (1990) lays out eight basic principles for CPR management drawing on numerous case studies of commons problems worldwide. Discovering and investigating new modes and methods of association, especially ones making use of emerging technology, is critical to de Tocqueville's science of association and Ostrom's work on CPR management (Ostrom, 2010).

Hackerspaces are one such new form of association. They are community-operated physical places where individuals can come together to build and make things.[1] Hackers pride themselves on making, playing with, and employing technology to solve old and new problems. The first hackerspaces opened in the early 2000s and took off as a movement in 2007 when a loose association of hackers met at an event called "Chaos Computer Camp". A speech by German hackers about the hackerspace concept led to the proliferation of these community-run workshops that at first glance appear to be a pure club good. Physical space and equipment within the space, however, are rivalrous but non-excludable since all members of the space have equal access. Equality of access to the space and equipment with no predefined limit, combined with the finite nature of said resources, gives hackerspaces the characteristics of a CPR rather

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[1] For more on hackerspace history and background, see http://hackerspaces.org/wiki/Theory.

than strictly a club good.[2] Understanding hackerspaces as a CPR provides the impetus for our study, since nearly all papers on CPR management focus on CPRs resulting from naturally occurring resources (see, for example, Ostrom, 2010) and not on CPRs created as part of an organization. Without the ability to effectively manage the created CPR, hackerspaces and the value they create to their members would not exist. Beyond the focus on privately created CPRs, however, the unique contribution that hackerspaces can make to the studies of CPR problems is in how hackerspaces employ technology to monitor, protect, communicate and otherwise manage their space and equipment.

Examining the ways that technology augments and enforces three of the CPR management design principles laid out by Ostrom (1990) is the focus of our paper. Specifically, we show that technology helps to ensure more efficient CPR management by enabling broader participation in collective-choice arrangements, improving monitoring, and reinforcing and clearly defining boundaries. The extensive use of creatively-employed technology make hackerspaces well suited for building off of Ostrom's insights into successful CPR management (1990; 2005). [3] For example, hackerspaces' effective use of digital communication in order to create a strongly connected community lies at the heart of why they remain effective as organizations even when growth means that everyone is no longer on a first name basis. Attention is also given to how the institutional context in which hackerspace communities function affects the development and implementation of its technological CPR management solutions.

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[2] We recognize that it is controversial to model the "space" of a hackerspace as a common pool resource as described by Ostrom (2010). Even if one rejects the use of the CPR terminology, however, hackerspace communities face many of the same problems in the management of the "space" that occur in naturally occurring CPRs. In both cases, if not addressed, the resource will be exhausted.

[3] There are numerous definitions of "technology" in the literature. Here it is used as a general term to describe technical gadgets, apparatuses and mechanical devices.

The research for this paper was conducted using ethnographic methods at a hackerspace in the US Midwest we call ‘Midwest Hackerspace’ to preserve the anonymity of its members. The ethnographic research involved attending public space meetings, joining in space activities, and talking with members as they worked together on various projects. An interview guide was constructed based on data collected during the observation period and the rest of the data were collected through member interviews.

The paper proceeds in the following manner. Section 2 discusses the role that technology plays in CPR management. The third section provides ethnographic and background information on Midwest Hackerspace while Section 4 discusses Ostrom’s design principles and provides evidence of how technology is used in the space to manage CPRs. Section 5 concludes.

2. The Role of Technology in the CPR Literature

The CPR management literature has paid considerable attention to technology such as the decision to adopt newer technologies (Moreno and Sunding, 2005), how new technology affects public policy (Avouyi-Dovi and Matheron, 2007), and how public policy influences technology adoption (Calef and Goble, 2007). Much of the discussion surrounding technology and CPRs has explored the effects of new technologies on agricultural resources, aquatic resources, and pollution. For example, Schweik (2000), De Alessi (2003), and Klein (2003) explore how technology opens up new possibilities for CPR management by focusing on forests, fisheries, and the atmosphere. No papers, however, address the specifics of integrating technology into institutional arrangements in privately-created CPR scenarios to solve problems associated with CPR management.

There are many questions that can be asked on this subject. For example, does using technologically mediated monitoring reduce trust between community members by creating asymmetric power relations between those who understand the technology and those who do not? It is easy to see how someone familiar with how an implemented technology functions could use that knowledge to her advantage. Even if she did not, other members might still distrust technology that they do not understand and through association distrust members who are in favor of the technology. Beyond these questions, this paper explores how technology can help manage and create new CPR scenarios, contributing to our understanding of the strengths and weaknesses of using technology in CPR management.

De Alessi (2003) notes that institutions influence whether advancing technology positively or negatively affects CPR management. He provides as an example the reduction of the length of the fishing season, which created incentives for fishermen to invest in newer fishing technologies in order to capture as much of the resource as possible in a reduced timeframe. Eventually, this led to the exhaustion of the CPR. He argues that if the institutional arrangement is changed to one of private property rights where technologically feasible, the incentives will be reversed and technology will be used to protect the CPR. For example, ocean fencing technologies exist but require some private property rights from government in order for investment to occur. The key point is that technology is neither inherently beneficial nor inherently harmful to CPR management, but is rather dependent on institutional arrangements and incentives.

While De Alessi’s work focuses on the possibilities for exclusion opened up by new technology, Klein (2003) shows how technology enables more effective monitoring using the example of remote sensing and auto emissions. Air pollution used to be impossible to monitor but new sensor technology has made monitoring accurate and cheaper. Effective monitoring makes practical sanctions for rule breaking possible, thus helping to ensure compliance (Ostrom, 1990). Klein's work also highlights important barriers to implementation such as special interest group pressure and the 'not invented here' attitude.

Foldvary (2003) uses lighthouses to illustrate how technology can help with excludability. Historically, lighthouses have had difficulties with exclusion since the good they provide is non-excludable. Except in the case of harbors where a tax could be levied on regular customers, it is difficult to exclude boats from free riding (Coase, 1974). Encrypted signals sent by lighthouses now allow for this excludability. These signals provide similar functions to foghorns and lighthouses but are useless without the decryption key, for which a monthly fee can be charged. The excludability provided by encrypting the guidance signals makes the lighthouse function as a club good (Foldvary 2003).

These papers provide historical examples of how new technology implemented in a context where private property rights are possible enables effective CPR management, illustrating some of Ostrom's design principles in action, particularly clearly defining boundaries, monitoring, and excludability. Each example, however, is a naturally occurring resource that the authors believe could be more efficiently managed in light of technological advances. Hackerspaces are different from these examples since hackerspaces are private social organizations created to provide a valued resource – the 'space.' Hackerspaces therefore provide a different case study to learn more about how technology can assist in CPR management.

Technology, however, is not sufficient. Institutional, social and cultural factors are also important. While hackerspaces are located across the globe in all kinds of cultural and social settings, the ideals and values that its members hold owe much to the hacker tradition that came out of the computing revolution of the 1960s (Raymond, 1999). The tradition of ‘hacking’—generating clever solutions to problems—as well as the closely-related Open Source Software (OSS) development movement, are instrumental to understanding why hackerspace communities provide a unique and valuable case study.

While hackerspaces have not yet been explored in economics, there has been a rich discussion of hackers and OSS development—important influences on the hackerspace movement—by Garzarelli (2004) and Langlois and Garzarelli (2008). The term ‘hacker’ is used to refer to intelligent and creative people with an interest in solving complex problems. While the word hacker is still largely used in the computer realm, it is also used to describe anyone with a penchant for developing creative solutions to difficult problems. A foundational belief or ethic within the hacker community is the idea that all information should be free. This idea is at the core of the OSS movement, which was founded by hackers.

Garzarelli (2004) explains that the difference between traditional corporate software development and OSS development is the difference between a rigid hierarchy and a fluid hierarchy. He is quick to note that this distinction does not mean that OSS development is unorganized. The key distinction, from whence OSS takes its name, is the manner in which OSS is released. Traditional software is given to customers in a form that makes it impossible to see the underlying code. Whatever clever solutions or breakthroughs that the programmers solved in the course of writing the program are invisible to those outside the corporation, meaning that similar problems might have to be solved across similar organizations. OSS, in contrast, has visible source code and often requires that anyone interested in modifying the software be allowed to do so as they please (Garzarelli, 2004; Raymond, 1999). According to Garzarelli (2004), OSS results in a form of self-correcting spontaneous order that minimizes unnecessary duplication because innovations are visible to all and can be easily modified and adapted to individual needs and circumstances.

From the viewpoint of institutional design, the non-rigid hierarchy provides another advantage. According to Raymond (2001: 30): “Given a large enough beta-tester and co-developer base, almost every problem will be characterized quickly and the fix obvious to someone.” We would argue that hackerspaces are like a piece of hardware with limited resources and the institutions governing use of the space is like a piece of software that dictates the use and replenishment of the hardware’s resources. In the case of the hackerspace, the community members are like voluntary software developers attempting to find the most efficient institutional design. The members test the institutional structure, tag the bugs or problems in the space, and help develop efficient solutions. In many respects then, hackerspaces are not radically different from the communities and case studies discussed by Ostrom (1990). In the case of those traditional communities, however, the approach and mindset is less explicit than it seemed to be for the hackerspace. The success of the OSS development approach seems to have implicitly influenced the approach to organizational design within at least one hackerspace community, based on member interviews. Hackerspaces gives us the opportunity to further examine Ostrom’s theories as well as explore how technology and lower barriers to accessing technology affect the function of organizations that create CPRs (in this case the ‘space’) as part of their mission.

3. Midwest Hackerspace

Midwest Hackerspace is located in a warehouse a few minutes from the central business district of a large Midwestern city in the United States. The space consists of four parts: a large open warehouse area, an electronics lab, a library, and a workshop. The warehouse area has designated work and storage space for larger projects and racks for storing smaller projects. At the rear of the warehouse is a workshop stocked with woodworking and metalworking tools and a laser cutter. Connected to this smaller workshop area is the electronics lab which doubles as the meeting room, a small office area with two large tables pushed together, a few computers, monitors, storage racks filled with spare parts, and soldering irons. Connected to the electronics lab by another door is the library—a small office filled with books and a shelf with small electronics parts.

The community had roughly 30 official members at the time of the research, but the space is rapidly growing based on visitors and interest in membership. Members ranged in age from 22 to 60, with the majority being in their mid-30s. There had been only one female member, who was on hiatus due to other commitments. Racially, the members of the space were entirely Caucasian with one Asian member. The occupational breakdown of the space was relatively diverse, though as one might expect, the majority were employed in software or mechanical engineering. Other prominent occupations were self-employed web designers, retail, or unemployed.

The space is open to the public during regular Tuesday night meetings and Thursday evening ‘Builder’s Night Out (BNO)’ events. The BNO events existed so that potential members could see the space, meet members, and work on projects with members. Between 15 and 20 people usually attended the Tuesday meetings and 10 to 15 generally attended BNO. The ethnographic research for this study occurred over five months during these open periods. Tuesday and Thursday evenings were chosen because these were the times that the majority of the members of the space were present to be observed participating in collective governance as well as participating in the space.

There are numerous resources in the hackerspace. It contains an assortment of tools ranging from welding equipment to a variety of laves and drill presses. Every tool and piece of equipment in the hackerspace is personally owned by a member and leased to Midwest Hackerspace LLC. The membership forms detail the rules for leaving personal tools in the space. These rules specify only that tools must be labeled with the owner's name and contact information, and must be placed in an area agreed to by the community. The last rule exists because of the scarcity of storage space and because tools can interfere with the operation of other tools. The space is also filled with an eclectic variety of spare parts used in electrical engineering, such as transistors, motors, and circuit boards.

On top of these communal resources, the space is also home to member projects. In fact, open access to the 'space' is one of the most important resources to members. Without the physical workspace provided by the hackerspace, many members would not have a place to use work on projects. Some examples of the projects present in the space are vehicles being converted from gas to electric, modified light projectors, computer monitors undergoing repair, and augmented Power Wheels cars. For individuals living in apartments or small homes, even small tools make too much noise for neighbors and family members. Even members in larger suburban homes wouldn't have space to work on larger projects such as electric car conversions.

Next to the space itself, the most important resource is the community. The first three kinds of resources are the most relevant in the context of CPR management, but the existence and quality of the other members plays a key role in the success of the organization. Many members stressed during interviews that the social and working relationships they formed with other members through working on projects together was the most valuable part of the space. There are few places one could go that provide an environment so conducive to making friends and connecting with other engineers and crafters through serendipitous exchanges of esoteric engineering knowledge. For these individuals, the desire to maintain good relationships with other members of the space provides a strong incentive to be trustworthy. As the community grows to members might not be on first-name basis, however, this incentive becomes less effective. The community aspect of the space is also the one part of the hackerspace that is not reproducible by a single individual.

4. The Role of Technology in the Space

Technology plays a major role in ensuring the safety of the space. There are three technological systems that contribute to the space's sustainability: a camera monitoring system, a radio frequency-based (RFID) access control system on the door, and a variety of digital methods enabling long distance communication between community members. In this section we discuss each of these systems in greater detail, showing how they ensure the continued existence of the space by promoting trustworthy behavior by members and preventing non-member abuse. We also note how each system aligns with one of Ostrom's design principles. In addition, because technology is not a silver bullet for CPR management, we discuss the cultural and social factors that make the technological solutions successful.

Clearly Defined Boundaries

According to Ostrom (1990: 91), clearly defining the boundaries of a CPR is key to efficient management: "Defining the boundaries of the CPR and specifying those authorized to use it can be thought of as the first step in organizing for collective action." It must be clear who is allowed to withdraw resources from the CPR and when they are allowed to do so. Appropriators within the hackerspace are the paying members and they have access to the physical space and permission to use the resources and equipment within. The physical space is leased to an LLC on which only the president, vice president and a lawyer are officially listed. Monthly membership fees of $80 go towards rent. While the hackerspace is not officially a nonprofit, there are no profits. The rules about who is able to make use of the space and when are clearly set: only paying members are allowed inside of the space outside of Tuesday and Thursday nights, though members can bring in a guest at anytime.

There are cases where the rules about who is allowed inside the space are not clear, as in the case of frequent visitors to the space. Visitors do not necessarily have access to the full resources of the space since they are not paying members. Informal rules decided by the other paying members dictate the parameters of these situations. For example, when a frequent visitor has not become a member due to financial constraints, the community will solicit contributions to pay the visitors membership fee. While these frequent visitors do not directly contribute financially to the space, they frequently contribute expertise, knowledge and time to the space. Only official members, however, are allowed to make use of the other resources within the space such as spare parts and storage.

Having a low-cost and effective method of excludability is essential to the existence of the space. While allowing members to bring visitors is important for the vitality and growth of the space, rules and norms to keep non-contributing members from taking full advantage of the space are crucial to prevent free riding. To lower the costs of exclusion, the president of the space created an access control system using radio-frequency identification (RFID) keys and a database with each key registered to each person’s name. The RFID keys can be swiped against an electronic lock in order to gain access to the space. Should a member cease to pay dues, the officers of the hackerspace can access this database and de-activate the code associated with that RFID key. Once dues are paid, the key can be easily reactivated. The ease of changing access rules for different RFID keys substantially lowers the cost of exclusion and flexibility in access compared to non-digital metal keys or a door code. Physical keys and locks need to be replaced if a member loses their keys, stops paying dues, or has a falling out with the community. A door code would be too easy to pass around to non-members who could access without a member in attendance. In addition, it is feasible that as the community grows it could implement a tiered membership system where higher paying members would have more frequent access to the space over members who preferred to pay less and have less frequent access. This kind of flexibility would not be possible with traditional locks.

The exclusion mechanism used by Midwest Hackerspace is a system used by the majority of hackerspaces. A nearby hackerspace actually enlisted the help of Midwest Hackerspace to install the same mechanism in their space. The influence of hacker principles clearly plays a role in this kind of information and technology sharing. The convention of using RFID-based access control systems for hackerspaces came about because some of the first hackerspaces used these systems and found them effective. In true hacker spirit, the first hackerspaces compiled information on how their organization and space was designed in the hope that mistakes and successes would allow more hackerspaces to appear and grow without having to solve the same problems from scratch. During interviews with the president of the hackerspace, he mentioned how helpful it was to be able to read about other hackerspace’s organizational structures and experiences.

It is possible to extrapolate from this simple mechanism two lessons for technology and CPR management. The first is an echo of De Alessi (2003) and Foldvary (2003). Advancing technology makes new exclusion mechanisms possible, which in turn allows for excludability in CPR situations where exclusion was previously inefficient, difficult or outright impossible. In the case of hackerspaces, having a cheap, flexible and reliable method for controlling who has access to the space is key to the growth and survival of the space. Without a RFID tags, it is unlikely these spaces could sustain the rate at which new members join and old members either leave or move away given the role that frequent visitors play in growing the space. While RFID lock systems are not new, the ability of an average person to obtain the parts and know-how to establish their own effective RFID system without the help of a specialized firm is a recent development. The second noteworthy lesson is that the technology is very simple, understandable, and difficult to abuse in a way that would not be immediately apparent to everyone in the community. Attempts to tamper with the system are easily spotted and reported thanks to the mutual monitoring, which we will discuss next.

Monitoring

Ostrom's fourth design principle is the necessity of having effective monitors in place to look after the condition of the CPR and the actions of appropriators. Ostrom (1990: 94) holds that monitoring is most effective when the monitors "…are accountable to the appropriators or are the appropriators." Without monitoring, it is difficult to ensure that people sharing the CPR are following the rules and acting responsibly. When the success of such a space depends on individuals contributing personal resources to the CPR as in the case of hackerspaces, it is important to ensure that individuals feel that those resources will be used appropriately and safeguarded. The monitoring system used in the observed hackerspace was a mixture of a technological solution and mutual monitoring.

Given the small size of the community and the repeated interactions that have bred a high level of trust among current members, the community is largely concerned about damage done by nonmembers. As the community grows, however, this may no longer be the case and some other system will become necessary. In order to provide some assurance to individuals who have personal property in the space as well as head off future problems associated with growth, the hackerspace has implemented a camera monitoring system. This community-developed monitoring system uses repurposed cameras to record footage to a member-accessible computer in the space. Discussions have also occurred about making the camera feeds accessible to members online. Before joining the space recruits sign an agreement to have their actions within the space monitored. The tradeoff for this system is privacy, but since the camera footage is usually only accessed if there is a problem no one in the community has expressed discomfort as of yet. Making the recordings accessible to the entire community ensures that the monitoring system is viewed as neutral, which is important for community buy-in.

Without an effective monitoring system that works at all times, members do not feel comfortable leaving their expensive and sensitive personal property in the space. Without member-provided tools, one of the major benefits of joining the hackerspace is gone. This affects the incentives to become a member, which in turn affects the cost per member given the current scale of the space. The monitoring system therefore plays a crucial role in ensuring that members feel comfortable leaving personal property in the space for the community’s use, which is essential to ensuring the survival and growth of the hackerspace.

Collective-choice Arrangements and Communication

Collective-choice arrangements, part of Ostrom's third design principle, are used by CPR institutions to "tailor their rules to local circumstances" (Ostrom, 1990: 92). A robust collective-choice arrangement is key to hackerspaces' ability to continually meet and overcome new challenges. It is from the effectiveness of Midwest Hackerspace's collective-choice arrangement, where the cost of changing rules is low and every member has a voice, that many of the technological solutions previously discussed arose. Technology, specifically the Internet, plays a key role. While many people attend the regular weekly meetings in person, for some the distance is too great or they have other commitments. Since the weekly meetings are when community concerns are raised and decisions implemented, it would normally be difficult for those who cannot attend to have their voices heard. The space, however, uses technology to overcome this problem.

First, anyone not able to be physically present in the space at the time of meetings can usually join the social networking service Google+. Google+ has a feature called "Hangouts" which are group webcam sessions. Hangouts are similar to chatrooms but where individuals are able to hear and see one another, with whoever is currently speaking appearing on the screen. The hackerspace holds meetings in the electronics lab which has a large monitor in the center of the back wall. One of the members will create a Google+ hangout on their laptop connected to this monitor, allowing everyone in the space to see and hear everyone who has joined the hangout. This allows those who cannot be physically present at the meeting to participate as fully as those able to be physically present. Second, for people who cannot attend the meeting physically or digitally, the space posts the meeting notes on their website. If anyone who was not present has comments or concerns, there are multiple avenues with which to voice their concerns. For instance, the space maintains an active mailing list and discussion forum, which are easily accessible and used frequently by members.

These digital communication channels also enable members who may not see each other physically in the space to interact on a regular basis. This is important for people who have personal property in the space, since there are plenty of people they may never meet personally due to different space visitation schedules. Digital communication channels create the ability to at least get a sense of other members of the community. As Ostrom (2005: 64-65) puts it, face-to-face communication allows the “common understanding of the problems jointly faced.” In the other words, the constant evaluation and working out of problems as they arise. While face-to-face communication is certainly important, this hackerspace shows that digital face-to-face communication can have the same beneficial effect. Part of this, however, may have to do with the comfort level of most members of the community in using digital communication tools. For many, the difference between face-to-face interaction and digital is negligible, at least with respect to actively participating in building and maintain the space.

5. Lessons from Hackerspaces

Our analysis using ethnographic research on Midwest Hackerspace LLC shows how technology effectively lowers the cost of implementing and sustaining three of Ostrom’s design principles for CPR scenarios. While not every hackerspace implements the same technology in the same way, hackerspace communities do share knowledge on how to manage their spaces through technologically mediated communication channels and physical conventions. This active sharing means that in many cases, hackerspaces use a lot of the same management techniques. This case shows that technology can do much to help in CPR scenarios when implemented in the right context, but that technology is not a silver bullet.

Hackerspaces are successful in their implementation of technology because the members are well versed in technology in general and it is in the best interest of every member to ensure that the space runs smoothly and grows. More members result in more tools, equipment, and knowledge. This creates strong incentives for members to come up with new ways of ensuring that people play by the rules and that the rules make sense. In addition, none of the community members relied on the hackerspace for income at the time of research. This removed a powerful incentive to defect from the norms of the space.[4] Another important key to the success of these technological solutions is that they are simple, easy to understand, accessible to the entire community, and the community itself designed and implemented the solutions. These technological solutions work in large part because members trust in the system and that trust flows from the collective choice arrangements and communication avenues employed in the hackerspace.

Hackerspaces are a highly specific CPR the likes of which have not been studied extensively before. Hackerspaces are built by communities that are, by their very nature, highly technically fluent and often affluent as well. Hackerspace communities have access to skillsets and resources that most CPRs will likely not. This makes it dangerous to extrapolate too far from this case study about how technology can be used in other CPR scenarios, especially outside of developed countries. However, there are some general lessons that can be learned about the effectiveness of using technology to solve CPR problems. Indeed, the findings in this research

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[4] It was hinted at in interviews with several members that hackerspace-associated startups were in the works. Future research could examine how opportunities for personal financial gain influences incentives and norms in these organizations.

clearly support the principles laid out by Ostrom (1990) on CPR management, as well as the work of Klein (2003), Alessi (2003) and Foldvary (2003) on technology and CPRs.

Further research could investigate and compare a variety of hackerspaces. Hackerspaces in huge urban areas like Los Angeles, California or New York City have more heterogeneous memberships. It would be beneficial to see if different solutions exist in these spaces, such as different management structures, or if technology is called upon to play an even bigger role in maintaining these larger spaces. Based on this research, it seems likely that technology increases in importance as the size of the hackerspace increases. Hackerspaces provide good case studies for research on technology and CPRs given the large number that exist, their disposition toward solving problems with technology, and the variety that exists in terms of size and location.

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