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We're All Programmers Now

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Summary.   Generative AI and other easy-to-use software tools can help
employees with no coding background become adept programmers, or what the
authors call citizen developers. By simply describing what they want in a prompt,
citizen developers can collaborate with… **more**

When Jason Allen took home the top prize for emerging digital artists at the Colorado State Fair, in 2022, he got much more than a blue ribbon and a $300 check. Allen, the president of the gaming company Incarnate Games, had created his submission, "Théâtre d'Opéra Spatial," using a generative AI tool called Midjourney.

He gave the system a text prompt, and the software designed the work in seconds, though he said he spent two weeks refining it. (He has not publicly revealed the exact prompt.) Artists and critics vented frustration about Allen's win in the *Atlantic,* the *New York Times,* and other outlets. They warned of the impact of newly released generative-AI tools, such as ChatGPT, DALL-E, and Bard, which allow technical (and artistic) novices to generate compelling text, photos, and videos in an automated and near-instantaneous fashion. But not only artists are concerned about what these tools signify for their field. IT professionals, too, have taken note. Generative AI can help employees who have no coding background become adept programmers, or what we call *citizen developers.* By simply describing what they want in a prompt, nontechnical employees can collaborate with generative AI tools to build entire applications—a process that until recently required advanced programming ability.

Citizen development, if executed aggressively and carefully, could change the relationship between employees and organizations. Information technology has historically involved builders (IT professionals) and users (all other employees), with users being

relatively powerless operators of the technology. That has often led to a struggle by IT professionals to meet users' needs in a timely fashion and has created communication problems among technical experts, business leaders, and application users. Citizen development has sparked a new era in which employees not only improve or streamline their own processes and tasks but automate them entirely.

Citizen development raises a critical question about the ultimate fate of IT organizations. How will they facilitate and safeguard it without putting too many obstacles in its way?

With no need for an IT professional to design and build new applications, systems developed using generative AI will be more likely to fit the specific needs of their users, increasing the probable effectiveness of the applications. IT professionals will be freed up to focus on complex systems and technologies that truly require their expertise. Nonetheless, many IT staffers with whom we've spoken are opposed to citizen development. They fear that it will result in poor-quality systems that the IT team will have to repair—or that generative AI tools will replace IT entirely. An organization might end up with as many systems as employees. It might become dependent on citizen-developed systems known to only a few employees, or whose developers have long since left the company. This explosion of "gray IT" across the enterprise and the cost of reworking broken technical systems that would ensue is an important issue. Without proper controls and guardrails, widespread citizen development could result in chaos.

Despite those valid concerns, the need for citizen developers is obvious. Software vendors have begun adding generative AI interfaces to their products to facilitate chat- or voice-based

requests for transactions, data, and analysis. We anticipate that most business software will soon be created or interacted with through similar systems. Widespread citizen development could usher in a broader and faster approach to technology-based innovation, including digitization, automation, and data analysis. AT&T, ING, Johnson & Johnson, PwC, Deloitte, and other large companies are experimenting with citizen-development initiatives. (Disclosure: One of us, Tom, is a Deloitte adviser and has been paid to speak at Johnson & Johnson events.) They're learning which employees to include in citizen-development projects, what roles they should play, how they should be trained, and how to create a culture of peer learning and collaboration.

Citizen development raises a critical question about the ultimate fate of IT organizations. How will they facilitate and safeguard citizen development without putting too many obstacles in its way? To reject its benefits is impractical, but to manage it carelessly may be worse. In this article we—an academic, a consultant, and a practitioner, with decades of experience in AI and analytics—share a road map for successfully introducing citizen development to your employees. To broaden our knowledge of citizen development, we interviewed managers at eight companies, reviewed online discussions about the topic, and discussed citizen-oriented tools with several vendors. (Tom has previously coauthored articles in HBR about both citizen data science and the previous set of tools for citizen development, called low code/no code.)

The Citizen-Developer Dilemma

The process for building an application with generative AI often starts when a user asks a chatbot (or whatever interface the system uses) how to accomplish something. For example: "How would you build an iPhone app for customer service?" The system will describe the ideal steps for building the app. The user can then ask for descriptions of each step. The level of detail will depend on the user's technical ability, but the system can guide the user through every step of the process, no matter how granular or basic. Users who get stumped, or who find that the code generated isn't working, can tell the tool what they're seeing, and it will help them figure out the problem. This process will most likely involve trial and error, but the power to generate the code and the application is at everyone's fingertips.

ING bank, based in Amsterdam and operating in 40 countries, used a similar process when it needed to develop more machine learning (ML) models to put into production. Facing a lack of professional data-science talent in many of the countries in which

it operates, ING began to explore citizen data-science capabilities. The bank, where one of the authors of this article (Kerem) was recently the global chief analytics officer, is working to supply citizen developers with technical expertise and to identify the use cases that are possible with automated ML. There is no doubt that ING's employees can create some ML models—to predict, for example, the probability that customers will click on an app message or respond to an email campaign. That can free data-science professionals from doing simple and repetitive data-management and analytics tasks. But aspiring citizen developers at the bank need proper training and hands-on experience to be successful. The ML models built by ING's employees also need to be free of strict regulatory requirements, though some documentation may be required for them. Finally, IT must still deploy and manage the tools and platforms needed to support automated ML development and use. Those are just a few of the immediate issues ING is addressing as it constructs a policy for citizen development.

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Few organizations have even begun to consider the challenges associated with citizen development. For example, what happens to a citizen-developed application if a department comes to depend on it, and the employee who developed it leaves for another company? Other challenges relate to sufficient technological expertise. For example, some data-science organizations believe that people without a professional data-science background cannot know enough about model

development to do it effectively, even with automated ML capabilities. They are concerned that decisions harmful to the organization will result from citizen-developed algorithms. Other companies point out that even professional data scientists have created models with bias or drift (poor predictions over time), and if they can get data science wrong, how can novices avoid even more mistakes? But we've found no evidence of long-term damage.

We do know of some examples of citizen-developed programs that briefly went astray. One European telecommunications company, for instance, was very early to embrace robotic process automation (RPA) programs, which automate tasks by following strict business logic and inputs. The company's RPA team—composed of business, not IT, employees—was not yet fully equipped or fully understood within the broader organization. The first problem was that a loop included in the automation coding for testing purposes was not removed when the code was put into production. As a result, numerous free iPhones were sent in error to customers. The second was that an incorrectly programmed RPA bot applied credits to customer accounts, raising an alarm with the firm's audit and compliance team. One citizen developer came close to being fired.

RPA can be misused to automate one's own tasks in order to take on an additional job in another company. Executives who have voiced concern about this envision workers secretly holding down two or three full-time jobs with the help of RPA or generative AI, and we've found online discussions in which such "overemployed" individuals describe their experiences. Companies can ameliorate this problem by rewarding employees for their innovation—offering higher compensation, or more responsibilities, for those who can automate their jobs.
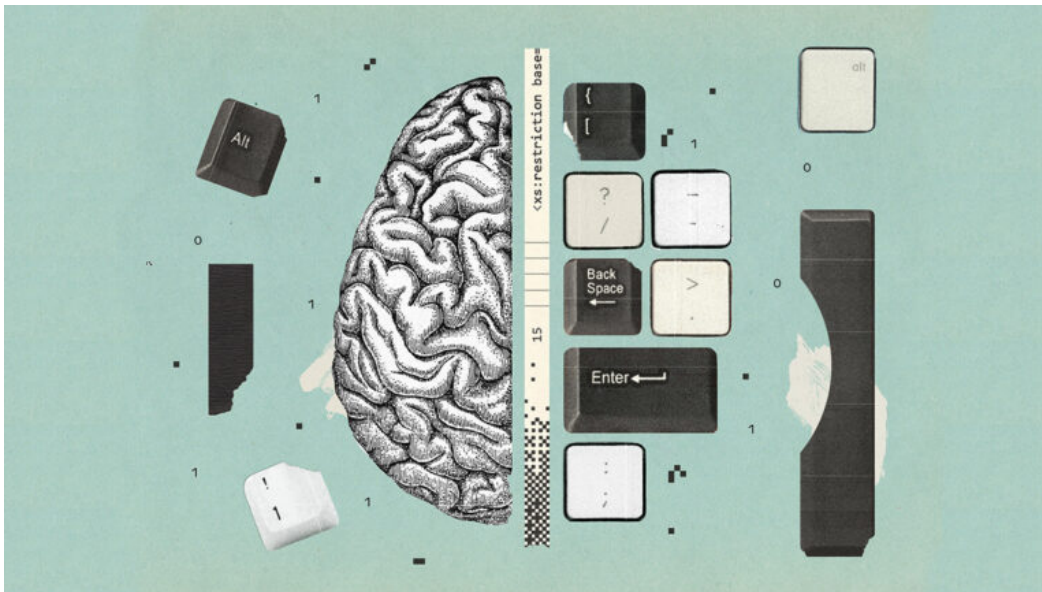
Blake Cale

Perhaps the most important issue with citizen development right now is not any particular coding snafu, governance gap, or covert use of automation to collect multiple paychecks. It is the fact that many organizations have failed to pursue the potentially tremendous impact of citizen-led innovation. They are unaware of the opportunities and benefits, dissuaded by resistance from IT, or unable to develop the necessary support and governance mechanisms.

A Case Study: PwC

PwC has established a broad process for citizen development that it calls the "digital accelerators" program. Launched in 2017, the program originally had three components: data science, automation, and data management. It was recently revised to include low-code/no-code solutions and productivity improvements. The company has announced plans to teach its 65,000 employees AI skills, including generative AI. Citizen developers are recruited from among PwC employees and volunteer to take online courses in relevant technologies. After they've been certified, they may take time away from their roles to develop applications that are relevant to PwC's client service or internal administration. Employees who develop highly useful

applications receive some modest compensation. The products and technology group that organized the program initially expected 500 volunteers but ultimately enrolled 2,000.

The program has produced a number of benefits for PwC. Technology-development groups used to be siloed within each business unit (audit, tax, advisory), but citizen developers have since engendered sharing and integration across them. Some projects have been embedded in enterprise capabilities; others (such as new visualization approaches) are used in client engagement. Citizen developers usually return to their business units, bringing with them technological capabilities they previously lacked.

One digital accelerator, Emily Donoghue, came from the tax practice, where she'd been frustrated by some of the tedious tasks she was required to perform. She and her team created a program that automated a workflow for extracting data from various spreadsheets. The program saved 40 hours of work on an audit engagement and eventually became a standard digital asset in PwC's internal library, which is available for use by anyone in the firm.

Organizations need to complete several tasks if they want to be as successful at citizen development as PwC is. All the tasks must be undertaken, but they needn't be done in the following order, and changes or improvements in one task can often be made without dramatically altering others.

Task 01: Recruit and Classify Your Citizen Developers

Formal or semiformal recruiting efforts are likely to result in significant numbers of employees who step up to build technical applications. Many functions and units include people who are experimenting with citizen development, so a companywide request for volunteers will probably result in lots of raised hands.

Managers in IT groups and in automation or data-science centers of excellence will probably be aware of potential interest. Promoting courses in related technologies may also help with recruitment.

Some companies look for certain traits in the employees they recruit for these initiatives. Johnson & Johnson, for example, says that it seeks people with a logical mindset, technical competence, and an aptitude for learning, plus experience with rules-based work. Some people may be motivated to learn in order to help themselves juggle multiple tasks or have more free time. Others are motivated by the goals of the enterprise and are recruited, trained, and (sometimes) incentivized to automate, analyze, and optimize the work they perform. Their aim may be to gain recognition or to ease the boredom of tedious work, but the benefits of their efforts accrue mostly to their employer. Still others may be motivated by benefits to society; they may volunteer to help with health care or environmental research by using tools and procedures to collect, analyze, and document information. Companies in the private sector may want to promote recruitment as a path to employee growth or philanthropic achievement.

Governance of systems may now be the primary challenge for the citizen-development movement. But governance itself could increasingly be automated.

The types of citizen developers vary according to the roles they play. They include *scouts,* who identify opportunities for improvement and change; *designers/architects,* who develop new and better ways of doing things; *developers/automators,* who

build the applications that deliver those process improvements; and *data scientists/analysts,* who study, analyze, and report on the status of the old and new processes.

Deloitte's AI Academy created differing internal "AI fluency" programs for AI leaders, strategists, citizen developers, project leaders, and researchers. Some programs involve certification upon completion; others are more informal. Some are full-time, some part-time. Employees have needs and desires for varying levels of technical expertise.

Task 02: Train and Certify Your Developers

Citizen development does require some training, though not a lot. On average, the companies where we conducted interviews offer from 40 to 80 hours of instruction in the technologies and techniques needed to succeed. Some, such as Dentsu, a global advertising and marketing firm, offer hackathons at which newly trained citizen developers can build applications. Training requirements vary by how much professional supervision citizen developers are likely to have. If, for example, all the models they develop must be reviewed by professional data scientists before they are put into production, less formal training may be needed.

Because citizen-developed systems typically link to, change, or extract and analyze data from existing transactional systems, their developers also typically need an understanding of corporate IT architecture and guardrails for safe data access and usage. But again, if those systems are certified by IT or other professionals, training may be unnecessary. At the very least, someone in the organization should keep track of what applications have been developed, who developed them, what purpose they are being used for, and whether they have been certified as enterprise grade.

At companies that believe that processes should be improved before they are automated, citizen developers should receive training in incremental process-improvement techniques such as Six Sigma and Lean. Another option is to have a centralized group of process-improvement specialists available for a quick analysis before automation.

Some companies don't require their citizen developers to be certified. Others require internal tests and certification. Still others use third parties to carry out certification. The degree to which certification is necessary may depend on how critical the given business area is or how much external regulation it is subject to.

Task 03: Build a Citizen-Development Infrastructure

To help citizen developers succeed, companies should give them standard tools and build infrastructure to make development easier. Whether the tool is a generative-AI system, an RPA tool, a low-code/no-code offering, or an automated machine-learning system, companies should provide training on it and encourage the sharing of partial or complete solutions. Many vendors now offer easier-to-use, low- or no-code versions of their standard software, designed specifically for citizen developer use. Vendors are also developing hubs, marketplaces, and portals that allow citizen developers to share reusable, certified datasets and completed applications or components of them and are creating "feature stores"—repositories of reusable variables—to help citizen developers build ML models.

One important requirement for improving the impact of citizen developers is to connect solutions to production environments owned by business units. Especially with more-sophisticated tools such as automated machine learning, companies must ensure that models are accurate and robust.

Task 04: Empower Community Learning

Citizen developers need to learn from one another about how best to solve business problems with technology. One way to foster such peer learning is to offer regular classes, solution showcases, and presentations by external speakers. Since citizen developers are neither typical businesspeople nor typical technologists, communities can offer a bit of group therapy when challenges arise and may keep people from giving up on development. They also provide a feedback mechanism for management to create appropriate career and promotion paths, especially for those employees who want to become professional automators, data scientists, or full-time IT workers.

Task 05: Prepare to Manage Value Created by Automation

It's likely that some observers will question an investment in citizen development if the value it creates goes unmeasured. Citizen development typically generates insights whose monetary value can be difficult to assess (although some central analytics teams do calculate the value of their use-case portfolios). The easiest measurement is of the time saved through citizen-developer automation of previously human-performed tasks, and several companies we've observed or worked with have accumulated millions of minutes of freed-up time. At some point it is fair to ask what employees are doing with the time saved. As one skeptical CFO put it, "We can't eat hours."

A large pharmaceutical company decided that it had an enormous opportunity to use AI and automation technologies to transform and optimize key business processes. The company had a central data-science group, but it employed external consultants for robotic process-automation projects. It decided that the consultants were too expensive and concluded that it could train employees outside of IT to do automation work. The corporate services division partnered with the IT function to create technology standards and training for its citizen developers. The

program went well, and many processes were substantially improved. The company met its goal of $500 million worth of employee time saved ahead of schedule.

The leaders of the initiative, however, had some doubts about where it would all lead. One manager told us, "Governance is a concern that's increasing for us in terms of business continuity and change management. Have we prepared for 30% of finance being run on citizen-developed applications? We realize that a tipping point is coming, and we wonder if we have the appropriate controls in place. We're not sure we do."

Some companies have made progress in overcoming the resistance of IT professionals to citizen-developer activities. One excellent example is in the data-science business unit of Kroger, where leaders realized the potential of citizen development and knew that the grocery chain had many capable business analysts. To enlist support for these "insight scientists," the professional data scientists were asked to teach them automated machine-learning tools, review their models, and work with them to learn more about the business.

A Case Study: AT&T

AT&T puts a strong emphasis on citizen development. The company has well-developed facilitation approaches and has undertaken many of the tasks we've discussed. With help from its several hundred professional data scientists and automation specialists and thousands of citizen developers, it is attempting to put AI and automation at the heart of its business.

AT&T has tried to aid employee efforts to analyze data with machine-learning models. The goal is to support all aspects of the ML pipeline, including obtaining the appropriate data, engineering it to create the desired features, building the model, deploying the model, monitoring and refining its performance

over time, and governing it effectively. The company has created a feature store containing commonly used data to reduce the need for time-consuming data wrangling, which can take up to 80% of a data scientist's time. Its citizen developers can choose from among more than 26,000 model-building features. Both data scientists and citizen developers find the store incredibly useful.

AT&T has also put more than 3,000 bots into production. Some of the earliest ones were in the business operations area, such as providing new circuits for customers. The company has an Automation Center of Excellence and employs 20 full-time employees and some contractors there. It could not have scaled so rapidly from its start in 2015 without participation from citizen automators. The center tracks all robotic process-automation projects and has calculated that 92% of them are undertaken outside the center. Bot implementations have saved about 17 million minutes of manual effort each year, generated hundreds of millions of dollars in annual return, and achieved a 20-fold return on investment.

AT&T has developed a technical infrastructure to support both professionals and citizen developers. It includes competitions, an operations tool that coordinates all activities in the development pipeline, strategies for integrating RPA and machine learning, and a search tool for commonly used data and features. The company also maintains a "bot marketplace" of previously developed solutions, with configuration assistance from the center of excellence if necessary. About 75 reusable components

are added every month to the marketplace. AT&T is exploring the use of generative AI to create machine-learning models and automation bots.

AT&T bolsters citizen development and automation with community-building activities. For data science it has created an "AI democratization forum" with weekly virtual live demos that educate employees about particular issues or new capabilities AT&T has developed. About 200 employees participate every week, few of them professional data scientists. The company offers online training materials and 575 courses on various aspects of data science, and certifications are available on vendor tools. A 40-hour training program is offered to anyone who wants to become a citizen developer. In addition, the center of excellence hosts an annual "automation summit" for groups within the company to present and share their projects.

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Digital transformation is already necessary for almost every organization, and the shortage of qualified professionals to implement it will continue. It may eventually be the case that citizen developers are the primary engines in this effort. It's easy to imagine that in the relatively near future some companies will be able to turn all technology development activities over to them, perhaps with external vendors providing some IT infrastructure. Or what's left of corporate IT may evolve into facilitating, assessing, and certifying the work of nontechnical employees.

Technology development will continue to get easier as programs become more automated and AI-based. Generative AI will no doubt improve over time, making everyone a potential programmer. At the moment, governance of systems is perhaps the primary challenge for the citizen-development movement. However, it seems likely that governance itself will increasingly

be automated. Machine-learning operations systems already structure ongoing governance and algorithm accuracy for ML models, and we are likely to see related systems for other types of citizen-developed technologies.

One vendor of low-code tools advertises that users can "turn [their] ideas into actions." The citizen-development movement is part of a new era of business change driven by technology and data.

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